ISSN: 2690 - 0688

Case Report article

Journal of Humanities and Social Sciences

Yield Curve And Its Impact On Discount Rates In The Financial Evaluation Of A Project- Application case in Argentina

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Submitted: 22 Oct 2021; **Accepted**: 25 Oct 2021; **Published**: 05 Nov 2021

Citation: *Carlos Emilio Martínez, Juan Ledesma, Jorge Mario Cerrigone Lloyd, Wendy Tavernise, Ezequiel Cannizzaro and Alicia Asaro (2021) Yield Curve And Its Impact On Discount Rates In The Financial Evaluation Of A Project- Application case in Argentina. J Huma Soci Scie 4(2): 236-246.*

Abstract

This paper introduces some theories that attempt to explain the behavior of the "Temporary Structure of Interest Rates" (TSIR), which observe the correlation between various variables of the economy and projected interest rates, which will later serve as a reference for the determination of the discount rates of the projected flows in the economic-financial evaluation of a productive investment project. The empirical analysis focuses on evaluating the required returns on Sovereign Bonds issued in the Argentine Republic in dollar currency, which determine a yield curve that shows high levels of projected inflation expectations, such as high levels in the definition of rates discount of projected flows.

Resumen

El presente trabajo introduce algunas teorías que intentan explicar el comportamiento de la "Estructura Temporal de las Tasas de Interés" (ETTI), que observan la correlación entre diversas variables de la economía y las tasas de interés proyectadas, que servirá luego como referencia para la determinación de las tasas de descuentos de los flujos proyectados en la evaluación económico financiero de un proyecto de inversión productiva. El análisis empírico se centra en evaluar los rendimientos exigidos en los Bonos soberanos emitidos en la República Argentina en moneda dólar, que determinan una curva de rendimientos que pone en evidencia niveles altos de expectativas de inflación proyectada, como niveles altos en la definición de las tasas de descuento de los flujos proyectados.

Keywords: Term Structure Of Interest Rates, Theories of Expectations, Liquidity, Yield Curves, Discount Rates, Flows, Financial Evaluation, Project Returns.

Palabras Claves

Estructura temporal de las tasas de interés, teorías de las expectativas, liquidez, curvas de rendimientos, tasas de descuentos, flujos, evaluación financiera, rendimientos de proyectos.

Introduction

In order to carry out the economic-financial evaluation of a productive investment project, reference rates are needed that allow the discount rates of the projected flows to be established. When the context in which this evaluation must be carried out is fulfilled in the context of great macroeconomic instability, with high inflation rates, the cash flows are projected in dollar currency and for the financial valuation they can be discounted to current value taking as reference the structure of the yield curves of Sovereign and Corporate Bonds in US currency of the country in which the Project is being financially evaluated.

Consequently, the objective of this work is to present an introduction to the different theories that support the movements of the yield curves of Bonds, an instrument widely used in the primary market for the financing of productive investment projects, which are then negotiated in the secondary market, and whose rates have a decisive impact on issuance and investment decisions.

Then, in the first instance, there will be a brief conceptual presentation of the different theories that try to explain the behavior of the yield curves and that are a reference for making investment decisions, to then advance in the analysis of the current state of the yield curves. Bond yields in the Argentine Market, their evolution expectations, and their impact on the definition of discount rates

for the financial evaluation of Projects.

Yield Curves

The opportunity cost of money in an economy is a function of the term of the operation, and thus the market will discount a monetary unit with a different interest rate, depending on the term that is being evaluated. This interest rate for a specific term "t" is called "spot interest rate" or "spot interest rate" for term "t". On the other hand, the "Present Value" (VA) of a monetary unit maturing in "t" years is defined as:

$$VA = \frac{\$\ 1}{(1+i)^t}$$

Equation N°1: Discount of a flow

In this way and with this reference, it is possible to define the Temporary Structure of Interest Rates (TSIR) for a market of Securities with identical credit rating and nominated in the same currency, to the functional relationship between the spot rates in force and maturity correlated with these rates:

$$TSIR=i\ t=\ F\ (t)$$

Equation N°2: Term structure of the interest rate

The TSIR that is built with the Securities, whose issuer is the National State, will serve as a reference to set the interest rates of private issues (of companies that will issue "Corporate Bonds").

Continuing with the analysis, it can then be said that the TSIR yield curves will precisely represent the yields at a certain moment, highlighting the relationship between the yields of bonds with similar characteristics and the different maturity terms.

Likewise, having the Term Structure of the Interest Rates, it will be possible to evaluate and have an approximation in the prediction of the behavior of the yields of the Bonds, as well as help to understand how changes in short-term rates affect the levels of long-term rates, and consequently the monetary policy of a country and its evolution.

On the other hand, yield curves can provide information about the expectations of participants in the financial market, a relevant aspect for decision-making regarding the financing of productive investment projects in their primary stage, as well as may result from Great utility for projections of the main macroeconomic variables that put investment decision-making in context. Interest rates play an extremely important role in the allocation of resources through financial markets, influencing the saving and investment decisions of the economic agents of a country.

In this instance, it is worth highlighting that there are other interest rates that are relevant for investment decisions and that these are interest rates for future periods, called "Forward Interest Rates". Following the model of Svensson, these forward rates can be estimated from the information of the fixed income market (Bonds), using the prices of bonds with coupons [1].

In other words, spot rates (current) and forward rates (future) are normally expressed in annual terms, and the Forward Rate calculation model arises from spot interest rate equivalences. To give a reference to your calculation, so if you had, for example, the following information:

Term bond in years	Annual Spot Rates in%
1	3,00
2	4,00

Then, wanting to determine the Forward Rate from year 1 to 2, by rate equivalences, the following could be proposed:

$$(1+it)^t = (1+\ i_{t-x})^{t-x} x (1+if_{t-x})^x$$

Equation N°3: Interest rate equivalences

Consequently:

$$\left(1+i_{0;2}\right)^2 = \left(1+\ i_{0\ ;1}\right)^1 x\ \left(1+if_{1;2}\right)^1$$

$$(1+0{,}04)^2 = (1+0{,}03)^1 x\ \left(1+if_{1;2}\right)^1$$

$$\frac{(1+0{,}04)^2}{(1+0{,}03)^1} = \left(1+if_{1;2}\right)^1$$

$$\left(\frac{1{,}0816}{1{,}03}\right) - 1 = if_{1;2}$$

$$if_{1;2} = 0{,}0501$$

Therefore, in the example presented, the annual rate of 5.01% will be the forward rate from year 1 to year 2. With this calculation reference, future interest rates could be projected to have a definition of discount rates in the financial evaluation of projects.

Determinants of The Shape of The Yield Curve

In order to value determinants of yield curves, they can basically present three forms over time.

1. Upward sloping curve, which will show progressive increase in yield as maturity increases. This shape of the curve is also known as "Normal curve" or "Positive yield curve".
2. "Downward-sloping curve" or "Inverted curve", which will show that yields decrease as maturity increases.
3. "Flat curve" or "Flattened curve", which will show relatively constant yields for different levels of maturity.

To put in context the determinants of the forms of the yield curves, in this instance of the work it is worth mentioning the four theories that explain or support these curves, which are:

- ⇨ Theory of expectations (TEx).
- ⇨ Liquidity Theory (TLq).
- ⇨ Market Segmentation Theory (TSm).
- ⇨ Preferred Habit Theory (THp).

It is worth then to value these theories, since they will affect the definition of forward rates (future interest rates) that will serve as a reference in the projections of discount rates to be used in the financial evaluation of Projects.

Theory of Expectations (TEx)

This Theory was formulated by Lutz, and is based on the fact that the spot interest rates of a certain term contain the information about the expectations that investors have about the interest rates that will govern the market in the future [2]. This Theory takes the idea that economic activity takes place in a known context where fixed income instruments (Bonds) with different maturities are perfectly substitutable, in such a way that, for example, it would make it possible to invest in a type of Zero Coupon Bond (without interest coupon payments) maturing in three years would be equivalent to investing in a Bullet Bond (American-type Bond, with principal maturity at the end) maturing in one year, being able to renew this Bullet Bond successively two more times. Then, taking this equivalence of operations in Bonds, the return on the investment for a maturity (also called "maturity" or "maturity") would be the same, regardless of how that operation had been carried out, that is, with the options to acquire Securities or Bonds whose maturity is beyond a certain maturity, or failing that, investing in Securities with a shorter maturity, renewing them periodically (as in the mentioned example of the Bullet Bond).

Consequently, through the "Theory of Expectations" (TEx), forward rates could come to represent the future interest rates expected in the market. In this sense, and following the correlation between the shapes of the curves and the TEx, an ascending curve could indicate that the market would be expecting short-term rates to increase, while with a flat curve, it would be expected that rates of interest rates remain constant, and finally for an inverted curve the market would be predicting that short rates would drop steadily.

With this first reference, assuming that it is available as information that the market currently presents a flat curve, anticipating in the framework of economic policy decisions that interest rates tend to rise, then:

- ❖ Those interested in long-term investments would not buy long Bonds, since the rate structure would be expected to rise, causing the prices of the Bonds to fall. They would make investment decisions in short-term Bonds until a rate hike occurs, which allows them to redirect their investments to instruments that present a higher return expectation.
- ❖ Bond holders in anticipation of a rate hike, would anticipate the sale of long Bonds, reinvesting in short-term Bonds.
- ❖ Long-term borrowers would be incentivized to borrow in the long-term market as long-term costs would be expected to increase.

These three potential reactions of different market players would lead to a decrease in the demand for longer-maturing Bonds, and at the same time increase the demand for short bonds, tilting the curve upward until it is consistent with expectations of higher future interest rates. Using the same criteria, it could be considered that any event that tends to generate expectations of lower future interest rates will impact a yield curve that tends to adopt a negative slope.

It is worth mentioning that the "Expectations Theory" does not take into account two risks that cause uncertainty regarding the performance that could occur in a certain investment horizon, and that are important to highlight:

- Price risk.
- Reinvestment risk.

Price Risk

It refers to the uncertainty about the Bond Price at the end of the established investment horizon. If an investor plans to invest for 5 years, he can consider three operating alternatives:

a. Invest in a 5-year bond and keep it at maturity.
b. Invest in a 10-year bond and sell it after 5 years.
c. Invest in a 30-year bond and sell it at 5 years.

The return received in the last two alternatives will not be known at the end of the 5 years. In the case of the 10-year Bond, the price will depend on the rates expected in the following 5 years. Therefore, the Price risk is higher the higher the maturity of the Bond.

Reinvestment risk

In this case, it refers to the uncertainty regarding the interest rate at which the interest generated by a Bond can be reinvested until the expected maturity date.

An investor planning to invest for 10 years can consider three alternatives:

a. Invest in a 10-year bond and keep it at maturity.
b. Invest in a 1-year instrument, and upon maturity reinvest the interest in 1-year instruments during all 10 years of the investment horizon.
c. Invest in a 5-year Bond and upon maturity, reinvest the funds generated in a 5-year Bond.

In this context, regarding options "b" and "c", the return on the investment after 10 years would be unknown because the rates at which the coupons of the Bonds can be reinvested are also unknown.

The most widespread interpretation of the "Expectations Theory" suggests that investors would be expecting the return for any investment horizon to be the same, regardless of the chosen maturity strategy.

A second interpretation suggests that the return of the Bonds of different maturities could be the same as for a short-term investment horizon.

The third interpretation suggests that the return that an investor would achieve by reinvesting in short-term bonds during their investment horizon would be the same as if they had a zero coupon bond with a maturity that matches their investment horizon, given that the zero coupon bond it would not have reinvestment risk and consequently future interest rates throughout the investment horizon would not affect returns.

Theory of Liquidity (TLq)

Liquidity Theory is based on an analysis by Antal Fekete who would accept that long-term spot interest rates would contain sufficient information on short-term future rates, but would not incorporate the concept that fixed-income instruments (Bonds) could be perfectly substitutable with each other regardless of their maturity, and this would be based on the fact that with an increase in the interest rate in an economy, the prices of the securities with longer maturities would have greater decreases in their price given that

the Investors are generally risk averse [3]. In this context, investors would prefer to invest in short-term securities, then carry out successive renewals rather than invest in long-term securities.

Thus, the TLq would define that investors would prefer long-term maturities if they were offered a longer rate higher than the average expected future rates, by virtue of a risk premium that would be positively related to the maturity term.

For this reason, forward rates should reflect, on the one hand, expectations about interest rates, and on the other hand, a liquidity risk premium, and should be the highest prize for longer maturities.

Así, una curva ascendente podría reflejar:

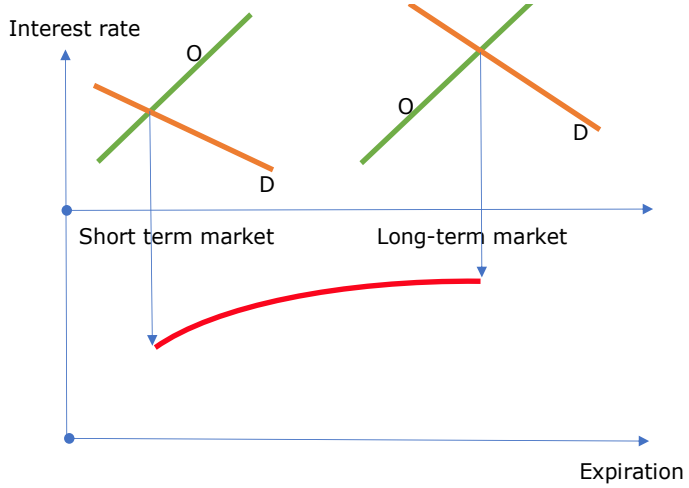
- Expectations that future interest rates will increase.
- They remain flat or even decline, but with a liquidity premium that increases at the rate of maturity, producing an upward sloping curve.

Market Segmentation Theory (TSm)

This theory was formulated by Culbertson and it assumes that lenders and borrowers are extremely risk averse, and in this context to avoid price risk and reinvestment the former and refinancing the latter, adjust their investment or demand for funds to its planned horizon [4].

Then, the TSm would recognize that the slope of the curve would be determined by the supply and demand of assets within each given maturity segment.

Graph Nº1 - Rates with market segmentation theory



Source: Author's elaboration

Preferred Habitat Theory (THp)

The THp was formulated by Modigliani & Sutch, and combines the postulates and hypotheses of the theories formulated above, in such a way that it takes into account both expectations and the interest rate risk of fixed income securities.

It is then accepted that there is a different rate structure for each of the habitats depending on the balance between supply and demand of funds for said segments, but it also suggests that an insufficient supply of funds in a certain segment or habitat could lead to that the issuers of assets make profitability prevail by offering returns higher than the expectations that exist over said term.

Then, this theory would be rejecting the assertion that the risk premium should increase uniformly with maturity. Consequently, you would be arguing that the risk premium would only increase uniformly if all investors wanted to liquidate their holdings on the shorter date, while all borrowers in this context plan to borrow longer term.

The demand and supply of funds that in a given range of maturity do not coincide, would cause that the borrowers and lenders of funds are forced to change maturities showing opposite imbalances, needing to be compensated by an appropriate risk premium whose magnitude would then reflect the aversion to the price or reinvestment risk.

Having given a reference to the four Theories that would support the forms and behavior of the Yield Curves that could be used as the basis for the projection of the Discount Rates to be used in the financial evaluation of projects, we advance in the specific analysis of the Curves of yields in the Argentine Republic (2021).

Analysis of The Yield Curves in argentina in 2021 with The Objective of Defining Flow Discount Rates in The Evaluation of Projects

At the beginning of 2020, with the impact of the Covid 19 Pandemic in the world, Argentine Bonds had shown a strong deterioration linked to the context of high volatility in international financial markets. This Pandemic marked the worsening of an international crisis that also ended up having an impact on the local market.

The demand for debt instruments was affected by the increase in risk aversion, which was also reflected in a decline in prices and in the increase in interest rates demanded by the market. Dollar sovereign bond yield curves increased in the short end of the curve, causing the slope of the curve to turn negative.

Towards the end of 2020 and the beginning of 2021, the bonds continued to show a sharp deterioration in their prices, also linked to a context of high volatility in international financial markets, and a macroeconomic situation in the Argentine Republic affected by a marked fiscal deficit financed mainly with monetary issuance given the impossibility of financing it with debt issuance and an agreement with the International Monetary Fund (IMF) still pending and unresolved as of September 2021. This greater perception of risk associated with local bonds was thus evidenced The same in the increase of the country risk, which reached its maximum of the period under study, in October 2021 of the order of 1,600 points (See Table Nº1).

Table Nº1: Argentina- Country Risk - J.P. Morgan EMBI→1.608,00
01/10/2021 - 11:10 hs.

- Previous:**1.612,00**
- Opening:**1.612,00**
- Maximum:**1.612,00**
- Minimum:**1.608,00**

Source: Rava Bursátil - October 2021

At this point, it is worth highlighting that the EMBI is the main indicator of "country risk" and results from the difference between the interest rate paid by the Bonds nominated in dollars, in this particular case issued by the Argentine Republic, and the Bonds issued by the United States Treasury, which pay a rate that is considered "risk-free" of default (See Table Nº2).

Table Nº2: Yields of short-term US Bonds
Evolution: 1-year government bond yield→01/09/2021 - 01/10/2021

Date	Latest	Opening	Maximum	Minimum	% var.
01.10.2021	0,0786	0,0812	0,0862	0,0761	-0,51%
30.09.2021	0,0790	0,0810	0,1170	0,0760	0,00%
29.09.2021	0,0790	0,0840	0,0860	0,0760	-2,47%
28.09.2021	0,0810	0,0810	0,0940	0,0760	2,53%
27.09.2021	0,0790	0,0810	0,0840	0,0790	0,51%
26.09.2021	0,0786	0,0786	0,0786	0,0786	-0,51%
24.09.2021	0,0790	0,0790	0,0840	0,0730	6,76%

Source: Trading View - October 2021

Taking the data in Table Nº1 and Nº2 as a reference, this difference in rates or "surcharge", having an approximate value of 1,608 points, would indicate that the rate required by the Argentine Bond market would be:

$$IRR=rf+r_{embi}$$

Equation Nº4: Internal rate of return or Rate required by the market for a Bond

Then, it is possible to write:

$$IRR=0,000786+0,1608$$

$$IRR=0,1615$$

Value that is in line with the yield curve in dollars developed in Graph Nº2, in the short term.

In this way, the yields of the Bonds in dollars showed an important increase, increasing the rate demanded by the markets. In an analysis as shown in Graph Nº2, it can be observed that the shorter titles were the most affected, then the negative slope flattened in the medium term, not showing a change in trend with still high yields. High levels of interest rates in the medium and long term have a negative impact on investment decisions to advance in productive projects.

The following graphs show the shifts of the yield curves of the Sovereign Bonds denominated in US dollars in April 2021.
So let's see with numbers what the dollar rate curves are currently reflecting.

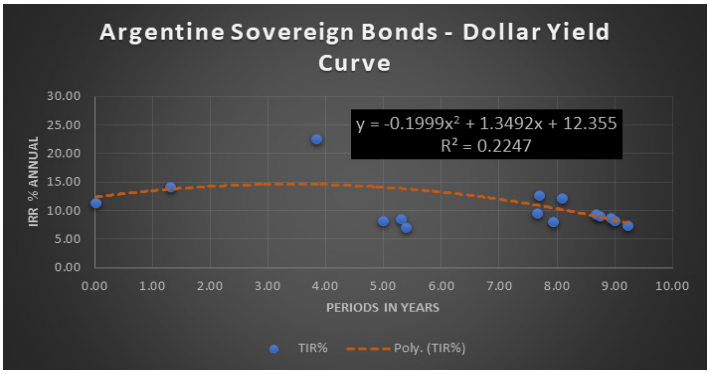
Table Nº3 - Sovereigns Bonds in dollars in argentina - Duration / annual IRR

NAME	TICKER	TIR%	MODIFIED DURATION (AÑOS)
BONO REPÚBLICA ARGENTINA LEY LOCAL 2038	AE38	9,57	7,67
BONO REPÚBLICA ARGENTINA LEY LOCAL 2029 IN...	AL29	8,24	4,99
BONO REPÚBLICA ARGENTINA LEY LOCAL 2030	AL30	8,58	5,30
BONO REPÚBLICA ARGENTINA LEY LOCAL 2035	AL35	9,40	8,68
BONO REPÚBLICA ARGENTINA LEY LOCAL 2041	AL41	8,24	9,01
BONAR 2024 L. ARG.	AY24	14,18	1,32
DISCOUNT 2033 EMISIÓN 2010 L. ARG.	DIA0	22,63	3,84
BONO REPÚBLICA ARGENTINA LEY EXTRANJERA 2030	GD30	6,95	5,39
BONO REPÚBLICA ARGENTINA LEY EXTRANJERA 2035	GD35	8,94	8,75
BONO REPÚBLICA ARGENTINA LEY EXTRANJERA 2038	GD38	8,07	7,94
BONO REPÚBLICA ARGENTINA LEY EXTRANJERA 2041	GD41	7,42	9,23
BONO REPÚBLICA ARGENTINA LEY EXTRANJERA 2046	GD46	8,75	8,93
LETE USD VTO. 14/12/2018	LTDD8	11,33	0,02
PAR 2038 C L. NY.	PAY0	12,62	7,69
PAR 2038 EMISIÓN 2010 L. ARG.	PAA0	12,09	8,10

PAR 2038 EMISIÓN 2010 L. NY.	PAY0	23,86	5,83

Source: Puente[iii]– Broker – October 2021

Graph Nº2 - Yield curve in dollars - Public Bonds – Argentina



Source: Puente / Author's elaboration – October 2021
Note ➔ IRR[3] = TIR (in Spanish)
The interpolation of the data following a polynomial curve of order 2:

$$y= -0,1999 .x^2+1,3492 .x+12,355$$

Equation Nº5: Interpolation with polynomial curve

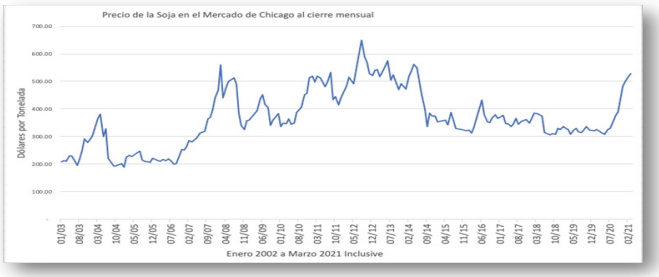
With a Coefficient of Determination[4]:

$$R^2=0,2247$$

The first thing that can be noticed in Graph Nº2 is that the curve is moderately inverted in the short term, tending to flatten in the medium / long term with a certain negative slope. This would indicate that the rates of medium and short terms should go down and then remain at high levels starting from levels of the order of 13%, passing in the medium term by values of the order of 16% per year, reaching values of 8% at 10 years (observe the independent term of 12,355 that arises from Equation No. 5, which impacts high values of the projected rates). As previously commented, the rates of return demanded by the market were increasing correlated with the international crisis associated with the Covid 19 Pandemic, which worsened as local conflicts developed, being able to observe high levels in the short term, with a displacement slightly downwards in the medium term in yields but with still high levels of rates (in the order of 12% per year), with a marked increase in the (negative) slope of the shorter bonds, the ones that have been hit the hardest by the market.

In the short term, the increase in the values of the rates could be argued in the expectations of devaluation of the Argentine Peso, which is boosted by the decrease in the income of dollars from the harvest of commodities, especially of Soja with prices of dollars which are currently exceeding US $ 450.00 per ton (October 2021).

Graph Nº3 - Historical Price of Soja in the Chicago Market



Source: Negocios del Campo[iv] (Field Businesses) – April 2021

Graph Nº3 and Table Nº4 show the historical price of Soja (Chicago CBOT CME Market Futures) from 2001 to March 2021.

Table Nº4: Soja Prices in Dollars in the Chicago Market

PRODUCT	PREVIOUS	OPENING	CLOSING	VAR
SOJA CHICAGO RX s/e 10/2021	471.70	474.00	461.50	-2,16
SOJA CHICAGO RX s/e 04/2022	479.10	469.30	470.00	-1,90
SOJA CHICAGO RX s/e 06/2022	479.90	471.00	471.00	-1,85

Source: Negocios del Campo[v] – October 2021

In this context, a drop in foreign exchange earnings is expected until March 2022, decreasing the supply of American currency (dollars), consequently expecting a devaluation of the Peso, with its correlate in the dollar futures market in the short and medium term.

Taking as a reference now the yields of the Sovereign Bonds issued in Pesos, the following values can be observed in Table Nº5.

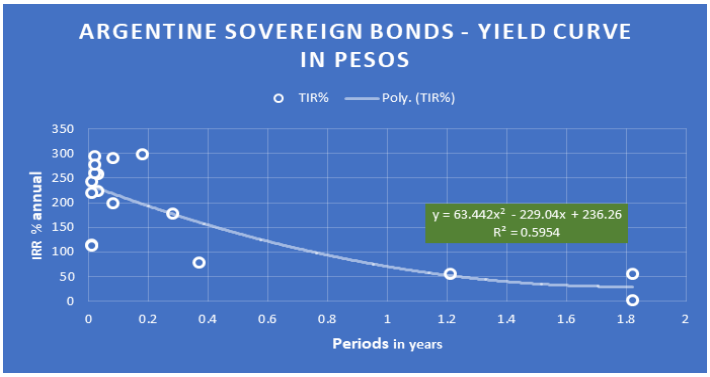
Table Nº5 - Sovereigns Bonds in pesos in Argentina - Duration / annual IRR

NAME	TICKER	TIR%	MODIFIED DURATION (AÑOS)
BOCAN 2022	AA22	79,5	0,37
BONAR 2020 B 325 L. ARG	AM20	258,98	0,03
BONOS DE CONSOLIDACION 8 SERIE $ ESC.	PR15	178,22	0,28
LECAP CUPON 11/03/2020	S11M0	115,43	0,01
LECAP CUPON 12/12/2019	S12D9	243,75	0,01
LETRA TESORO CAPITALIZABLES V.30/04/20 $	S30A0	199,07	0,08
LETRA TESORO CAPITALIZABLES V.30/04/19 $	S30A9	113,87	0,01
LETRAS DEL TESORO $ 374 D V. 30/09/2019	S30S9	259,38	0,02
LETRA TESORO CAPITALIZABLES V.31/07/20 $	S31L0	298,9	0,18
L.TESORO CAPITALIZABLES V.31/10/19 $	S31O9	294,97	0,02
LETRA DEL TESORO A DESCUENTO 31-03-2021	SM311	277,93	0,02
BONOS DEL TESORO NACIONAL EN PESOS BADLAR ...	TB21	291,02	0,08
BONO TESORO NAC ARG 2 5 $ 22/07/2021	TC21C	2,68	1,82
BONO TPM	TJ20	224,02	0,03
BONO EN PESOS TASA FIJA 2023	TO23	56,7	1,21
BONO EN PESO TASA FIJA 2026	TO26	56,55	1,82
BONO A TASA FIJA 2018 21.2	TS18	221,09	0,01

Source: Puente[vi] *– Broker – October 2021*

The shape of the yield curve demanded by the market can be analyzed in Graph Nº4.

Graph Nº4 - Yield curve in Pesos - Public Bonds – Argentina



Source: Puente / Author's elaboration– October 2021
Note ➔ IRR = TIR (in Spanish)

The polynomial interpolation equation of degree 2 would be:

$$y= 63{,}442\ .x-229{,}04\ .x+236{,}26$$

Equation Nº6: Interpolation with logarithmic curve

With a Coefficient of Determination:

$$R^2=0{,}5954$$

In the short term, taking as a reference a term of one year, it can be observed that the returns demanded by the market are in the order of 50% per year, a value that is highly correlated with the inflation projections indicated in Table Nº6 and in the Graphs Nº5 and Nº6.

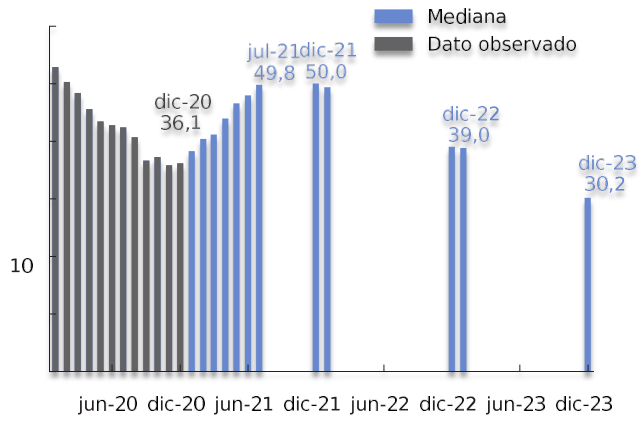
Table Nº6 - Inflation Projections- Argentina 2022

	Dollar	PBI	Inflation
Abeceb	$151	2,90%	39%
ACM	$154	2,80%	42%
Analytica	$148	2,30%	42%
Eco Go	$153	1,90%	48%
Ecolatina	$163	1,70%	35%
Econviews	$173	2,50%	48%
Equilibra	$155	2,00%	45%
FIEL	$139	2,00%	47%
LCG	$160	2,70%	45%
Tiscornia	$160	1,60%	40%

Source: Infobae with data from private consultants

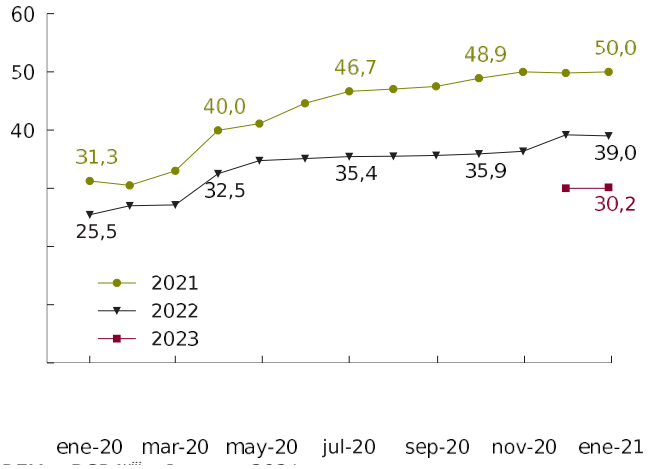
https://www.infobae.com/economia/2021/08/14/argentina-2022-otro-ano-de-alta-inflacion-bajo-crecimiento-y-mucha-incertidumbre/

Graph Nº5 - Annual inflation expectation – IPC



ɹrce: REM – BCRA[vii] - January 2021
ɨian = Mediana in Spanish

Graph Nº6 - Inflation expectations for December of each year - IPC



Source: REM – BCRA - January 2021
Median = Mediana in Spanish

In other words, with these projections indicated in Table Nº6, the average annual inflation would be around 45% (Geometric mean).

On the other hand, the one-year projected value in the curve indicated in Graph Nº4 of the order of 50% per year in Pesos, is based on the correlation between Rates and Inflation expressed through the Fisher equation:

(1+ia)= [(1+ π) x (1+ir)]

Equation No. 7: Fisher rate equivalences

Where do you have to:

ia = Nominal interest rate.
Π = Rate of inflation.
ir = Real interest rate.

Taking as a reference the projected inflation data for 2022 of the order of 45% per year (Graph Nº5 and Nº7), and the yield demanded by the market for one year of approximately 50% per year, according to Fisher's Equation Nº5:

$$(1 + 0{,}50) = [(1 + 0{,}45)\ x\ (1 + ir)]$$

$$\frac{(1 + 0{,}50)}{(1 + 0{,}45)} = (1 + ir)$$

$$1{,}0344 = (1 + ir)$$

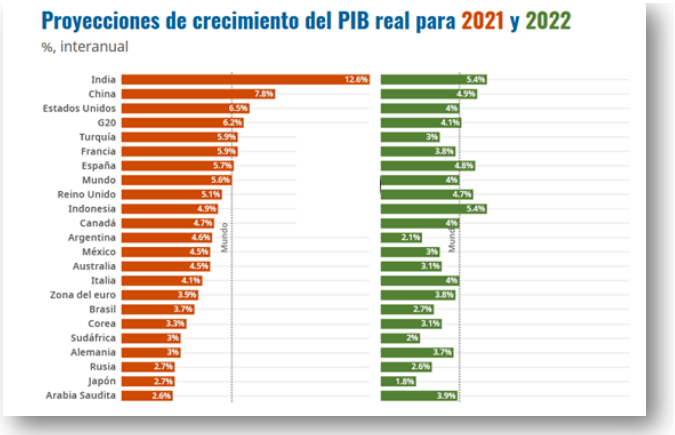
$$ir = 0{,}0344$$

$$ir = 3{,}44\%$$

And it could be said that the real yield would approximately follow the projections of the growth of the Gross Domestic Product (GDP) of Argentina for the year 2022, of the order of 3% per year as indicated in Table Nº6.

Graph Nº8 – PIB ➔ Growth projections

Graph Nº 7 - Inflation expectations for December of each year - IPC



Source: OCDE[x] – April 2021

Definition of Projection of Variable Discount Rates Based on Yield Curves

As mentioned, the objective of this work is to obtain a reference of discount rates to apply in the economic-financial evaluation of an investment project.

As a first approximation to the calculation model, it could be said that the yield curve in dollars indicated in Graph Nº2, is almost flattened with a slight negative slope, with maturity terms of up to 10 years, which would imply that the market would be hoping in the current context that rates remain at high levels. Now, taking Table Nº5 as a reference, to define the reference of a single discount rate for 10-year flow projections, considering the Geometric Average:

$$X = \sqrt[n]{X1\ .X2\ .X3\ .\ldots..Xn}$$

Equation N°8: Geometric Average of Yields

$$X = \sqrt[17]{0{,}0957 \,.\, 0{,}0824 \,.\, 0{,}0858 \,.\, 0{,}0940 \;\ldots . 0{,}2386}$$

$$X = 0{,}0962$$

It would define a single discount rate, for all flows, of 9.62% per year, for a project to be evaluated over 10 years.

Now, to project variable discount rates year by year, of projected flows in dollars, and taking as a reference the yield curve determined in Table Nº3 and Graph Nº2, with its polynomial interpolation curve of degree 2 of Equation Nº5, the values indicated in Table Nº7 of the discount rates for the next 10 years could be obtained:

Table Nº7: Projected discount rate value adjustment model for flows in dollars

Period (X)	X^2	0,0617 . X^2	0,6427 . X		Adjustment Ecuation	Period	Discount rate
0,50	0,2500	-0,0154250	0,321350	9,998900	10,304825	0,50	0,1030483
1,00	1,0000	-0,0617000	0,642700	9,998900	10,579900	1,00	0,1057990
1,50	2,2500	-0,1388250	0,964050	9,998900	10,824125	1,50	0,1082413
2,00	4,0000	-0,2468000	1,285400	9,998900	11,037500	2,00	0,1103750
2,50	6,2500	-0,3856250	1,606750	9,998900	11,220025	2,50	0,1122003
3,00	9,0000	-0,5553000	1,928100	9,998900	11,371700	3,00	0,1137170
3,50	12,2500	-0,7558250	2,249450	9,998900	11,492525	3,50	0,1149253
4,00	16,0000	-0,9872000	2,570800	9,998900	11,582500	4,00	0,1158250
4,50	20,2500	-1,2494250	2,892150	9,998900	11,641625	4,50	0,1164163
5,00	25,0000	-1,5425000	3,213500	9,998900	11,669900	5,00	0,1166990
5,50	30,2500	-1,8664250	3,534850	9,998900	11,667325	5,50	0,1166733
6,00	36,0000	-2,2212000	3,856200	9,998900	11,633900	6,00	0,1163390
6,50	42,2500	-2,6068250	4,177550	9,998900	11,569625	6,50	0,1156963
7,00	49,0000	-3,0233000	4,498900	9,998900	11,474500	7,00	0,1147450
7,50	56,2500	-3,4706250	4,820250	9,998900	11,348525	7,50	0,1134853
8,00	64,0000	-3,9488000	5,141600	9,998900	11,191700	8,00	0,1119170
8,50	72,2500	-4,4578250	5,462950	9,998900	11,004025	8,50	0,1100403
9,00	81,0000	-4,9977000	5,784300	9,998900	10,785500	9,00	0,1078550
9,50	90,2500	-5,5684250	6,105650	9,998900	10,536125	9,50	0,1053613
10,00	100,0000	-6,1700000	6,427000	9,998900	10,255900	10,00	0,1025590

Source: Author's elaboration – October 2021

In the case that the flows are projected in Pesos, and the rate adjustment model indicated in Table Nº5 and Graph Nº4, the interpolation of the data following Equation Nº6 would represent a projection of rates as indicated in Table Nº8:

Table Nº8: Variable discount rate adjustment model for flows in Pesos at 3 years

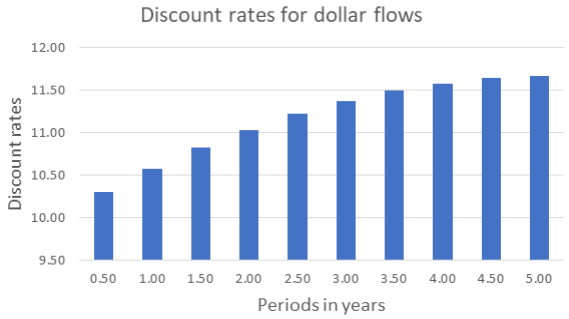
63,442 . X^2	229,04 . X	Adjustment Ecuation	Period	Discount rate
3,96512500	-57,2600000	182,9651250	0,25	1,8296513
15,86050000	-114,5200000	137,6005000	0,50	1,3760050
35,68612500	-171,7800000	100,1661250	0,75	1,0016613
63,44200000	-229,0400000	70,6620000	1,00	0,7066200
99,12812500	-286,3000000	49,0881250	1,25	0,4908813
142,74450000	-343,5600000	35,4445000	1,50	0,3544450
194,29112500	-400,8200000	29,7311250	1,75	0,2973113
253,76800000	-458,0800000	31,9480000	2,00	0,3194800
321,17512500	-515,3400000	42,0951250	2,25	0,4209512
396,51250000	-572,6000000	60,1725000	2,50	0,6017250
479,78012500	-629,8600000	86,1801250	2,75	0,8618013
570,97800000	-687,1200000	120,1180000	3,00	1,2011800

Source: Author's elaboration – October 2021

Graphics of discount rates projected for updating flows

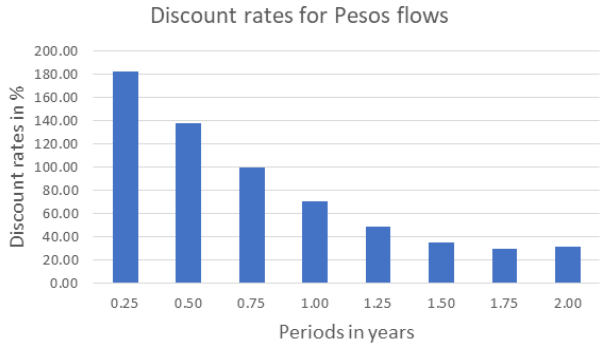
Then, in Graphs Nº8 and Nº9 that will result from the calculations made in Tables Nº7 and Nº8, the projected discount rates will be thus defined according to the currencies of the Project flows, within the framework of the definition of the yield curves. of the Bonds issued by a country (in the case of study of this work, the Argentine Republic), depending on what the market is seeing today in its interest rate projections.

Graph Nº8: Discount rates of projected flows in Dollars



Source: Author's elaboration

Graph Nº9: Discount rates of projected flows in Pesos



Source: Author's elaboration

As mentioned, the interest rates have the inflation component incorporated (see Fisher's Equation No. 7), and it explains the high levels of the projections of the flow discount rates in the case analyzed. In this context, it is worth mentioning that in the specific case that has been analyzed, the Argentine Republic could take a certain time (several years) to converge towards single-digit inflation rates (similar to the current inflation levels in the United States). 4% annual average of the countries of the South American region), a variable that directly impacts the definition of discount rates as detailed in Fisher's Equation Nº7.

In this instance, it is worth highlighting that, regarding the Exchange Rate, the yield curve in Pesos (Graph Nº4) would indicate that the expectations of devaluation of the Peso in the short term would continue in line with the levels of projected inflation rates (see Table Nº6) .

Instability and uncertainty were the aspects that marked the period 2020 - 2021, uncertainty that continues to be for the year 2022, with projected falls in commodity prices compared to 2021 (especially of Soja), expectations of devaluation of the local currency, factors that have a considerable impact on the projections made by the market, which would also try to explain the increase in discount rates at levels of around 11% in the medium term (see Graph Nº9).

Although in the present work different theories have been presented that attempt to explain the behavior of the yield curves, it can be seen that the "Expectations Theory" of the market is the main reference to consider when projecting yields. In the period under analysis, the perception of a global depression in the event of the Covid 19 Pandemic, and a local scenario such as Argentina's that has incorporated expectations of some macroeconomic instability, with an agreement with the IMF still latent and an expectation of risk defaults in the medium term framed in Country Irrigation levels above 1,600 points, highlighting that market expectations have a decisive impact on the behavior of the interest rate yield curves.

The evolution of country risk, such as the interest rate yield curves, represent important indicators for making investment decisions. It will not be easy to overcome the situation with an international market that is still convulsed by the impact of the Covid 19 Pandemic.

Conclusion

It can be seen that the prices of Argentine bonds and the interest rate yield curve are strongly affected by a combination of external and local factors, which can be summarized as:

- Covid 19 pandemic worldwide.
- International economic and financial crisis.
- Uncertainty regarding the evolution of the Argentine economy and its agreement on the debt with the IMF.
- Relative price distortions.
- Increases in Fiscal Expenditure above the expansion of the economy.
- Restrictions in the foreign exchange market.
- Nominal devaluation of the local currency.

It can be said then that the market is expecting inflation levels to remain at high double-digit levels for the next few years, and this directly impacts high levels of discount rates for future flows in the evaluation of projects.

In this instance, a central question appears for investment decisions, and refers to the capacity of the Treasury, in the case analyzed in Argentina, to reduce the existing fiscal deficit, with its consequent impact on a decrease in monetary issuance such as monetary policy of the Central Bank of the Argentine Republic (BCRA), promoting the decrease in the inflation rate, and consequently in the levels of interest rates both to finance projects, and in the definition of the levels of discount rates of the flows.

The data presented in this work can provide a significant reference in the financial evaluation analysis of a Project, since they are those that are highlighting the temporary structure of interest rates that the market is observing in a given time. These returns observed in the market will serve as a reference in the definition of a projection model of discount rates in the economic-financial evaluation of projects. The projections of the discount rates of the flows of a project to be evaluated from the financial point of view, will be directly related and in perfect correlation with the ability of the economic policy makers to correct the imbalances in fiscal and monetary policy that they have a direct impact on investment decisions, and consequently on the generation of jobs so necessary for the development of a country [5-21].

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