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Sensitivity Analysis and Financial Decisions

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Sensitivity analysis helps to understand the behavior of a model, the coherence between the model and the real world, it also analyzes how the different parts of the model interact, as well as the great variety of problematic configurations that can be found in the model. sensitivity analysis studies, (Saltelli & Scott 1997).

The sensitivity analysis illustrates the variation of the value or result of a model in response to changes in some of its key variables, keeping the value of the other variables constant. The sensitivity analysis is carried out considering one variable at a time and always assuming that there is independence between the different variables that influence or determine the value in the model.

The first step in performing a sensitivity analysis is to identify the main variables that affect the value or result of a model, always considering that these variables are out of our control or that they could be estimated imprecisely, immediately, for each one of the variables, positive and negative scenarios that are reasonable and well-founded must be sought. Finally, the value for each of the scenarios is determined or calculated.

In the sensitivity analysis, two different schools of thought are identified, the “Global” and the “Local”, Saltelli and others (1999):

1. In the local analysis, the response obtained from the outputs, by varying the put factors one at a time, is inverted, while keeping the others fixed at a central (nominal) value. These are partial derivatives, normalized by the nominal value of the factor or by its standard deviation. The analysis is executed in a central point, given in the space of the input factors, the volume of the explored region is null.
2. In the global school, sensitivity analysis is more ambitious in two respects: first, the space of input factors is explored within a finite (or even infinite) region, and second, the induced output variation for a factor is taken globally, that is, it is averaged over the variation of all the factors.

The local sensitivity school has generated impressive results, especially for the treatment of large systems of differential and adjoint equations by the group, (Cacuci, 1981; Oblow et al. 1986).

Sensitivity analysis is one of the most used tools by project managers to analyze, predict and present the expected results of a project to potential investors or stakeholders. Among the multiple benefits of applying sensitivity models in project management, the following are mentioned:

a) Decision making. Sensitivity analysis facilitates business planning and decision making because of data-backed forecasts. Investment decisions by management are made easier by considering all the variables and analyzing their multiple results.
b) Quality control. The sensitivity analysis allows identifying the processes that are not generating value in the product, it allows reducing the time in the elaboration of the product, it allows identifying errors early and it facilitates the generation of greater diversification.
c) Allocation of resources. Sensitivity analysis allows you to identify the strengths and weaknesses in the planning of a project, while measuring its possible impact on the results. This allows organizations to direct tangible and intangible resources to the areas that most need support.

Sensitivity analysis focused on financial aspects allows us to identify and visualize what effects would be had on an investment if certain events were to occur that we had not initially foreseen, for example, what would happen if economic growth is lower than forecast? A financial crisis occurs. How would the current scenario be affected? How is the cash flow affected? How is the NPV affected? Where does the project stop be profitable? Etc. These and many other questions are answered with the support of a sensitivity analysis.

Predicting the behavior of the variables and the results of the possible scenarios through a sensitivity analysis allows the directors of the organizations to make better decisions regarding the business in general and future investments in new projects.

Financial indicators are useful as measures of performance, charting long-term direction and proposing a clear strategy and proper execution.

Next, the evolution of some economic and financial indicators of the Mexican environment is described and shown to facilitate decision-making related to personal and business strategies in an integral manner.
1. National Consumer Price Index (INPC, Spanish)
2. The Price and Quotation Index of the Mexican Stock Exchange (IPC, Spanish)
3. Exchange rate
4. Equilibrium interbank interest rate (TIIE, Spanish)
5. CETES rate of return
6. Investment units (UDIS, Spanish)

1. NATIONAL CONSUMER PRICE INDEX (INPC)

Born in 1995 and reflecting changes in consumer prices, measures the general increase in prices in the country. It is calculated fortnightly by the Bank of Mexico and INEGI (2021). INPC is published in the Official Gazette of the Federation on the 10th and 25th of each month. The reference period is the second half of December 2010.

Table 1. Accumulated inflation in the year (Base: 2nd. Fortnight of December 2010 = 100 with data provided by Banco de México)

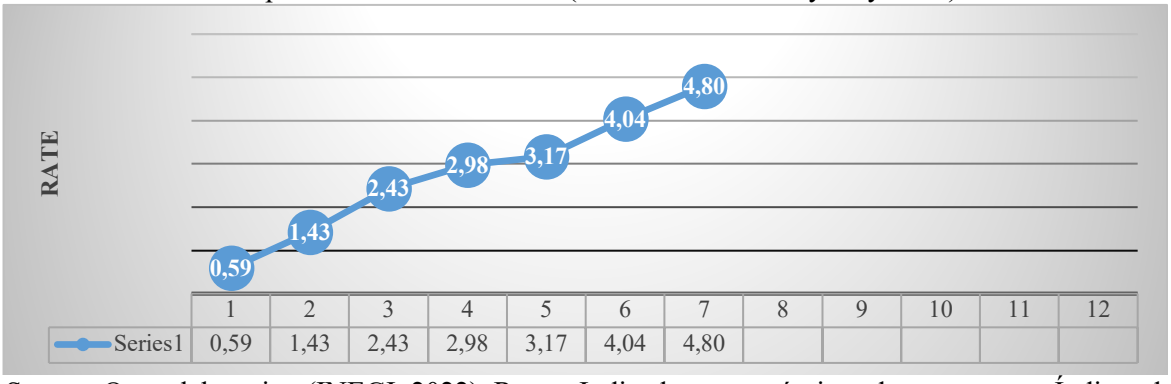
Periodo	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Enero	1.48	0.77	0.98	0.79	0.90	-0.09	0.38	1.70	0.53	0.09	0.48	0.86	0.59
Febrero	2.15	1.42	1.47	1.46	1.15	0.09	0.82	2.29	0.91	0.06	0.90	1.50	1.43
Marzo	2.52	1.84	1.55	1.99	1.43	0.51	0.97	2.92	1.24	0.44	0.85	2.34	2.43
Abril	1.98	0.72	0.69	1.81	1.24	0.25	0.65	3.04	0.90	0.50	-0.17	2.67	2.98
Mayo	0.60	-0.70	-0.65	0.95	0.91	-0.26	0.20	2.92	0.73	0.21	0.22	2.88	3.17
Junio	0.49	-0.41	-0.41	1.12	1.09	-0.09	0.31	3.18	1.12	0.27	0.76	3.43	4.04
Julio	0.56	-0.04	0.32	1.14	1.42	0.06	0.57	3.57	1.66	0.65	1.43	4.04	4.80
Agosto	0.91	0.30	0.92	1.31	1.73	0.27	0.86	4.08	2.26	0.63	1.82	4.24	
Septiembre	1.27	0.73	1.12	1.61	2.18	0.27	1.47	4.41	2.69	0.89	2.06	4.88	
Octubre	2.35	2.33	2.12	2.77	2.74	1.16	2.09	5.06	3.22	1.44	2.68	5.76	
Noviembre	3.89	4.87	3.86	4.57	3.57	1.71	2.89	6.15	4.10	2.26	2.76	6.97	
Diciembre	4.19	5.81	3.97	5.21	4.08	2.13	3.36	6.77	4.83	2.83	3.15	7.36	

Source: Own elaboration (INEGI, 2022). Route: Indicadores económicos de coyuntura > Índices de precios > Índice nacional de precios al consumidor. Base segunda quincena de julio de 2018=100 > Mensual > Índice > Índice general

Graph 1. Inflation in Mexico (2010-2021 accumulated at the end of the year)

Source: Own elaboration (INEGI, 2022). Route: Indicadores económicos de coyuntura > Índices de precios > Índice nacional de precios al consumidor. Base segunda quincena de julio de 2018=100 > Mensual > Índice > Índice general

Graph 2. Inflation in Mexico (accumulated January-July 2022)



Source: Own elaboration (INEGI, 2022). Route: Indicadores económicos de coyuntura > Índices de precios > Índice nacional de precios al consumidor. Base segunda quincena de julio de 2018=100 > Mensual > Índice > Índice general

2. THE PRICE AND QUOTATION INDEX OF THE MEXICAN STOCK EXCHANGE (IPC)

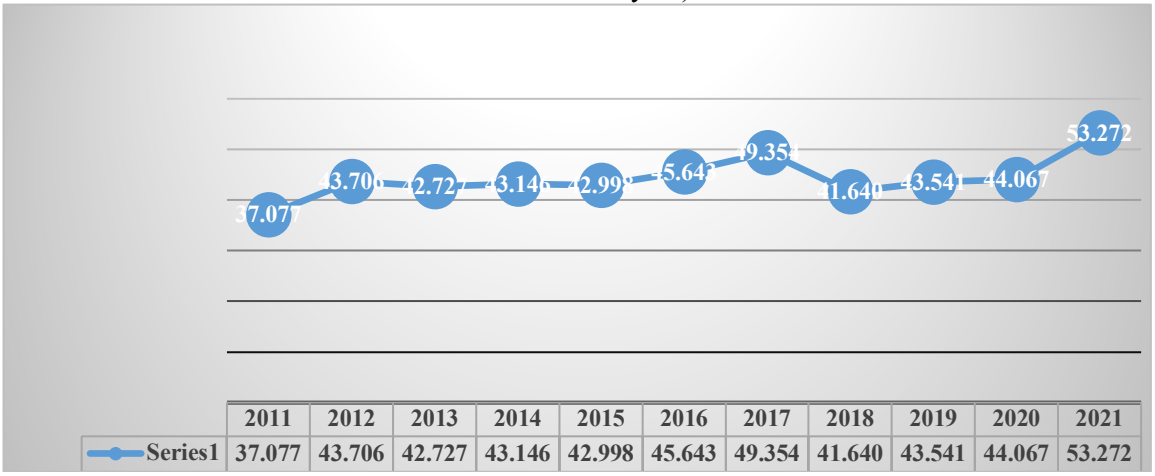
Represents the change in the values traded on the Mexican Stock Exchange concerning the previous day to determine the percentage of rising or fall of the most representative shares of the companies listed therein.

Table 2. The Price and Quotation Index of the Mexican Stock Exchange (Base: October 1978, 0.78=100)

Periodo	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Enero	36,982	37,422	45,278	40,879	40,951	43,631	47,001	50,456	43,988	44,862	42,986	51,331
Febrero	37,020	37,816	44,121	38,783	44,190	43,715	46,857	47,438	42,824	41,324	44,593	53,401
Marzo	37,441	39,521	44,077	40,462	43,725	45,881	48,542	46,125	43,281	34,554	47,246	56,537
Abril	36,963	39,461	42,263	40,712	44,582	45,785	49,261	48,354	44,597	36,470	48,010	51,418
Mayo	35,833	37,872	41,588	41,363	44,704	45,459	48,788	44,663	42,749	36,122	50,886	51,753
Junio	36,558	40,199	40,623	42,737	45,054	45,966	49,857	47,663	43,161	37,716	50,290	47,524
Julio	35,999	40,704	40,838	43,818	44,753	46,661	51,012	49,698	40,863	37,020	50,868	48,144
Agosto	35,721	39,422	39,492	45,628	43,722	47,541	51,210	49,548	42,623	36,841	53,305	44,919
Sep.	33,503	40,867	40,185	44,986	42,633	47,246	50,346	49,504	43,011	37,459	51,386	
Oct.	36,160	41,620	41,039	45,028	44,543	48,009	48,626	43,943	43,337	36,988	51,310	
Nov.	36,829	41,834	42,499	44,190	43,419	45,286	47,092	41,733	42,820	41,779	49,699	
Dic.	37,077	43,706	42,727	43,146	42,998	45,643	49,354	41,640	43,541	44,067	53,272	

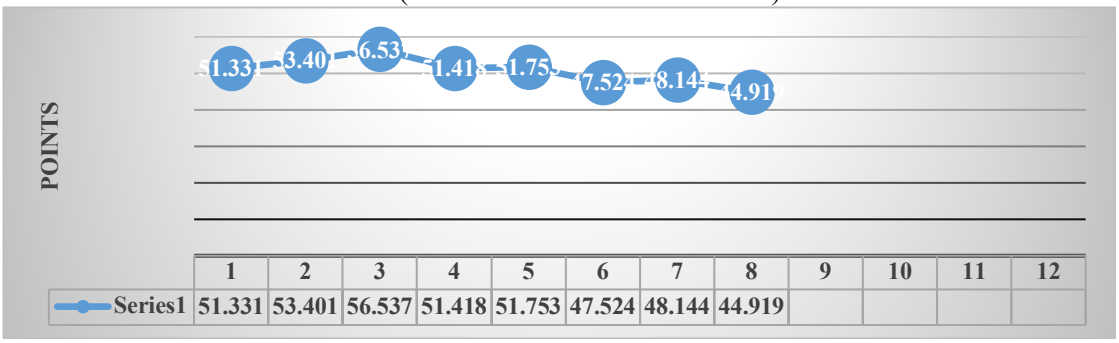
Source: Own elaboration (BANXICO, 2022).
https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?sector=7&accion=consultarCuadro&idCuadro=CF57&locale=es

Graph 3. The Price and Quotation Index of the Mexican Stock Exchange, 2010 - 2021 (Score at the end of each year)



Source: Own elaboration (BANXICO, 2022).
https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?sector=7&accion=consultarCuadro&idCuadro=CF57&locale=es

Graph 4. The Price and Quotation Index of the Mexican Stock Exchange, January-August 2022 (Score at the end of each month)



Source: Own elaboration (BANXICO, 2022).
https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?sector=7&accion=consultarCuadro&idCuadro=CF57&locale=es

3. EXCHANGE RATE

It is the value of the Mexican peso with respect to the dollar calculated with the daily average of the five most important banks in the country, which reflects the spot price (cash), negotiated between banks. It is highly related to Inflation, the interest rate, and the Mexican Stock Exchange.

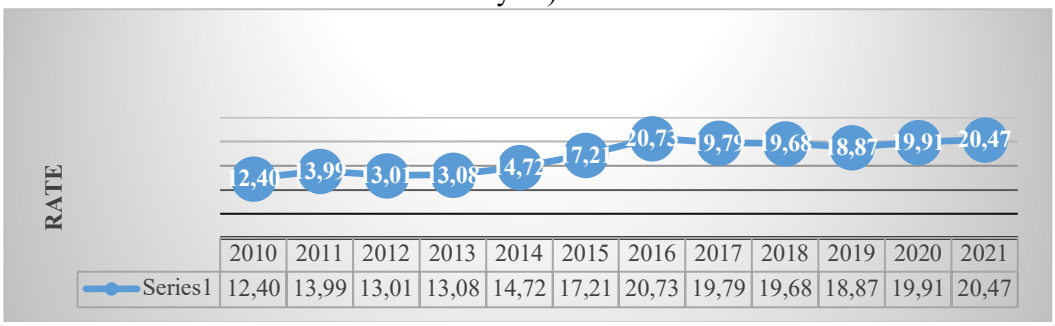
Table 3. Exchange rate (National currency per US dollar, parity at the end of each period)

Periodo	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Enero	12.81	12.02	12.95	12.71	13.37	14.69	18.45	21.02	18.62	19.04	18.91	20.22	20.74
Febrero	12.96	12.17	12.87	12.87	13.30	14.92	18.17	19.83	18.65	19.26	19.78	20.94	20.65
Marzo	12.61	11.97	12.80	12.36	13.08	15.15	17.40	18.81	18.33	19.38	23.48	20.44	19.99
Abril	12.24	11.59	13.20	12.16	13.14	15.22	19.40	19.11	18.86	19.01	23.93	20.18	20.57
Mayo	12.68	11.63	13.91	12.63	12.87	15.36	18.45	18.51	19.75	19.64	22.18	19.92	19.69
Junio	12.72	11.84	13.66	13.19	13.03	15.57	18.91	17.90	20.06	19.21	23.09	19.91	20.13
Julio	12.83	11.65	13.28	12.73	13.06	16.21	18.86	17.69	18.55	19.99	22.20	19.85	20.34
Agosto	12.73	12.41	13.27	13.25	13.08	16.89	18.58	17.88	19.07	20.07	21.89	20.06	20.09
Septiembre	12.86	13.42	12.92	13.01	13.45	17.01	19.50	18.13	18.90	19.68	22.14	20.56	
Octubre	12.45	13.20	13.09	12.89	13.42	16.45	18.84	19.15	19.80	19.16	21.25	20.53	
Noviembre	12.33	14.03	13.04	13.09	13.72	16.55	20.55	18.58	20.41	19.61	20.14	21.45	
Diciembre	12.40	13.99	13.01	13.08	14.72	17.21	20.73	19.79	19.68	18.87	19.91	20.47	

NOTE: Exchange rate FIX by The Banco de México, used for settle obligations denominated in foreign currency. Quote at the end

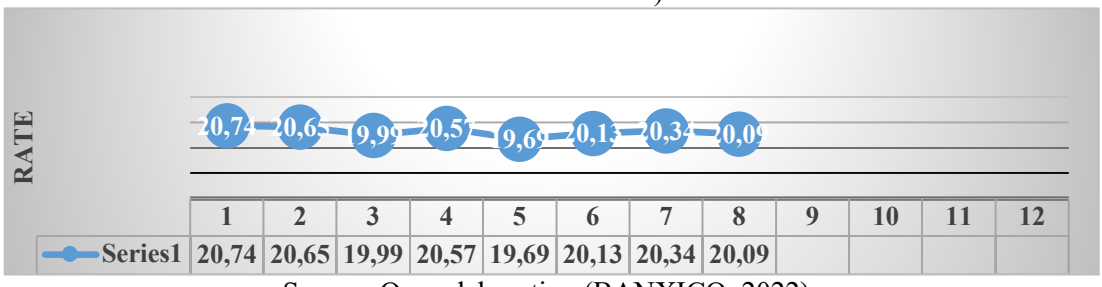
Source: Own elaboration (BANXICO, 2022).
https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?sector=6&accion=consultarCuadro&idCuadro=CF102&locale=es

Graph 5. Exchange rate (National currency per US dollar, 2010-2021, FIX parity at the end of each year)



Source: Own elaboration (BANXICO, 2022).
https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?sector=6&accion=consultarCuadro&idCuadro=CF102&locale=es

Graph 6. Exchange rate (National currency per US dollar, January-August 2022, FIX parity at the end of each month)



Source: Own elaboration (BANXICO, 2022).
https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?sector=6&accion=consultarCuadro&idCuadro=CF102&locale=es

4. EQUILIBRIUM INTERBANK INTEREST RATE (TIIE)

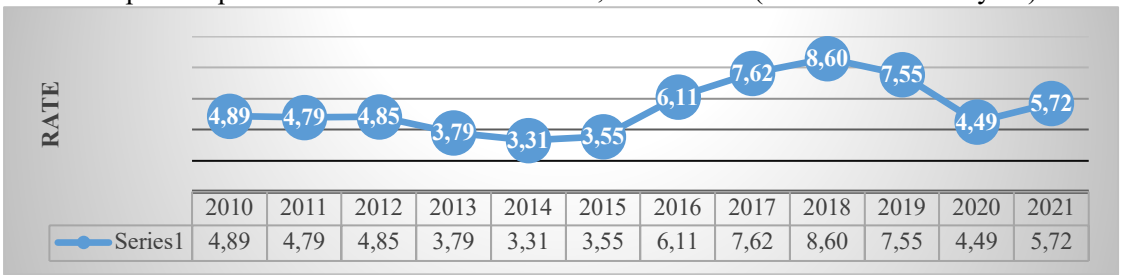
On March 23, 1995, the Bank of Mexico, to establish an interbank interest rate that better reflects market conditions, released the Interbank Equilibrium Interest Rate through the Official Gazette of the Federation.

Table 4. Equilibrium interbank interest rate (28-day quote)

Periodo	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Enero	4.91	4.86	4.79	4.84	3.78	3.29	3.56	6.15	7.66	8.59	7.50	4.47	5.72
Febrero	4.92	4.84	4.78	4.80	3.79	3.29	4.05	6.61	7.83	8.54	7.29	4.36	6.02
Marzo	4.92	4.84	4.77	4.35	3.81	3.30	4.07	6.68	7.85	8.51	6.74	4.28	6.33
Abril	4.94	4.85	4.75	4.33	3.80	3.30	4.07	6.89	7.85	8.50	6.25	4.28	6.73
Mayo	4.94	4.85	4.76	4.30	3.79	3.30	4.10	7.15	7.86	8.51	5.74	4.29	7.01
Junio	4.94	4.85	4.77	4.31	3.31	3.30	4.11	7.36	8.10	8.49	5.28	4.32	7.42
Julio	4.92	4.82	4.78	4.32	3.31	3.31	4.59	7.38	8.11	8.47	5.19	4.52	8.04
Agosto	4.90	4.81	4.79	4.30	3.30	3.33	4.60	7.38	8.10	8.26	4.76	4.65	8.50
Sep.	4.90	4.78	4.81	4.03	3.29	3.33	4.67	7.38	8.12	8.04	4.55	4.75	
Octubre	4.87	4.79	4.83	3.78	3.28	3.30	5.11	7.38	8.15	7.97	4.51	4.98	
Noviembre	4.87	4.80	4.85	3.80	3.31	3.32	5.57	7.39	8.34	7.78	4.48	5.13	
Diciembre	4.89	4.79	4.85	3.79	3.31	3.55	6.11	7.62	8.60	7.55	4.49	5.72	

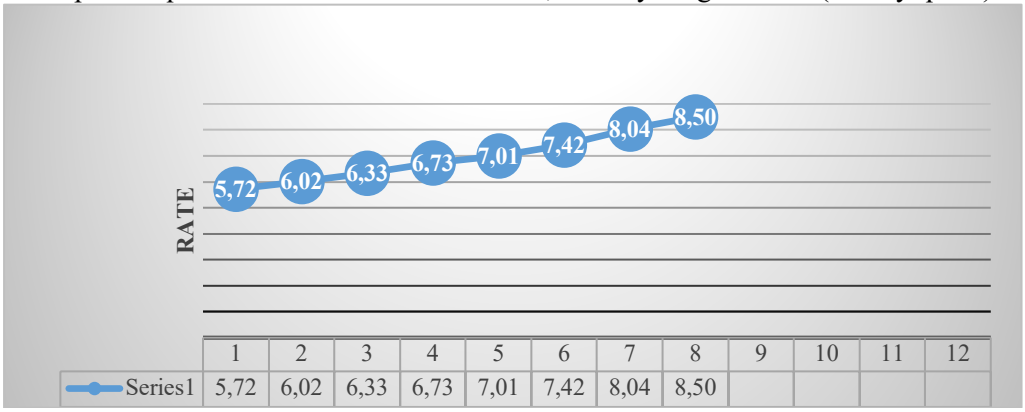
Source: Own elaboration (BANXICO, 2022).
https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?sector=18&accion=consultarCuadro&idCuadro=CF101&locale=es

Graph 7. Equilibrium interbank interest rate, 2010- 2021 (at the end of each year)



Source: Own elaboration (BANXICO, 2022).
https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?sector=18&accion=consultarCuadro&idCuadro=CF101&locale=es

Graph 8. Equilibrium interbank interest rate, January-August 2022 (28-day quote)



Source: Own elaboration (BANXICO, 2022).
https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?sector=18&accion=consultarCuadro&idCuadro=CF101&locale=es

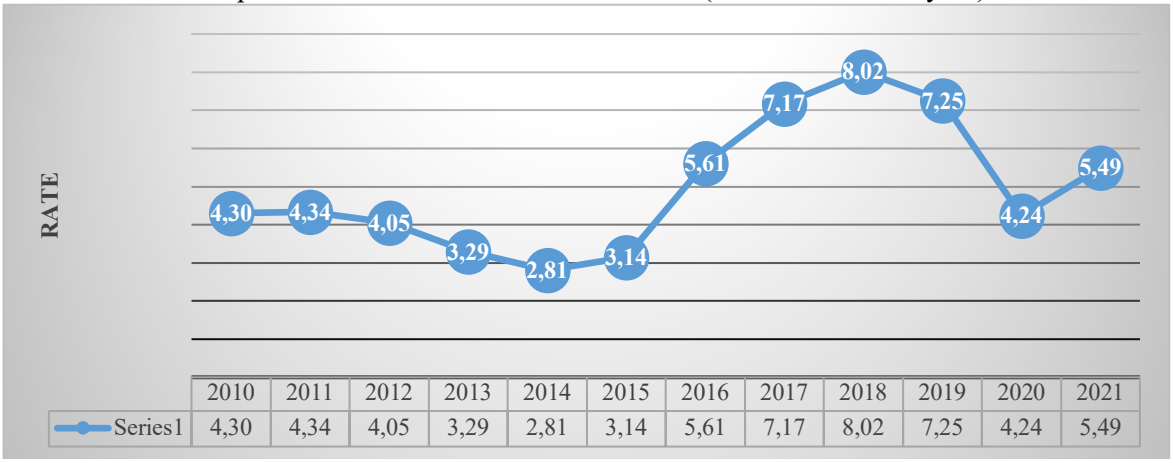
5. CETES RATE OF RETURN

Table 5. CETES rate of return (28-day)

Periodo	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Enero	4.49	4.14	4.27	4.15	3.14	2.67	3.08	5.83	7.25	7.95	7.04	4.22	5.50
Febrero	4.49	4.04	4.32	4.19	3.16	2.81	3.36	6.06	7.40	7.93	6.91	4.02	5.94
Marzo	4.45	4.27	4.24	3.98	3.17	3.04	3.80	6.32	7.47	8.02	6.59	4.08	6.52
Abril	4.44	4.28	4.29	3.82	3.23	2.97	3.74	6.50	7.46	7.78	5.84	4.06	6.68
Mayo	4.52	4.31	4.39	3.72	3.28	2.98	3.81	6.56	7.51	8.07	5.38	4.07	6.90
Junio	4.59	4.37	4.34	3.78	3.02	2.96	3.81	6.82	7.64	8.18	4.85	4.03	7.56
Julio	4.60	4.14	4.15	3.85	2.83	2.99	4.21	6.99	7.73	8.15	4.63	4.35	8.05
Agosto	4.52	4.05	4.13	3.84	2.77	3.04	4.24	6.94	7.73	7.87	4.50	4.49	8.35
Sep.	4.43	4.23	4.17	3.64	2.83	3.10	4.28	6.99	7.69	7.61	4.25	4.69	
Oct.	4.03	4.36	4.21	3.39	2.90	3.02	4.69	7.03	7.69	7.62	4.22	4.93	
Nov.	3.97	4.35	4.23	3.39	2.85	3.02	5.15	7.02	7.83	7.46	4.28	5.05	
Dic.	4.30	4.34	4.05	3.29	2.81	3.14	5.61	7.17	8.02	7.25	4.24	5.49	

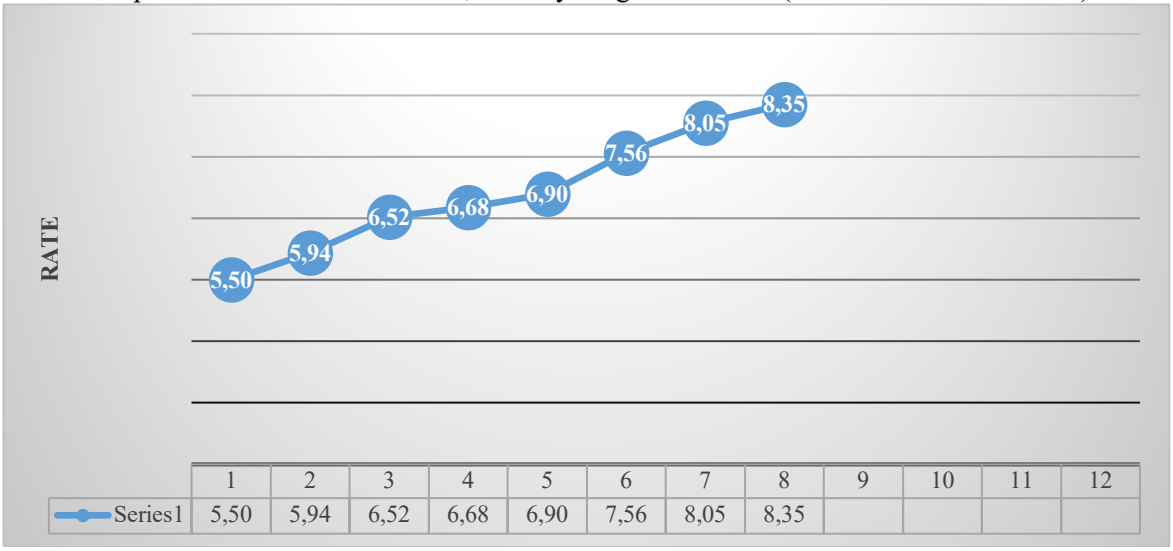
Source: Own elaboration (BANXICO, 2022).
https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?sector=22&accion=consultarCuadro&idCuadro=CF107&locale=es

Graph 9. CETES rate of return 2010- 2021 (at the end of each year)



Source: Own elaboration (BANXICO, 2022).
https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?sector=22&accion=consultarCuadro&idCuadro=CF107&locale=es

Graph 10. CETES rate of return, January-August del 2022 (at the end of each month)



Source: Own elaboration (BANXICO, 2022).
https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?sector=22&accion=consultarCuadro&idCuadro=CF107&locale=es

6. INVESTMENT UNITS (UDIS)

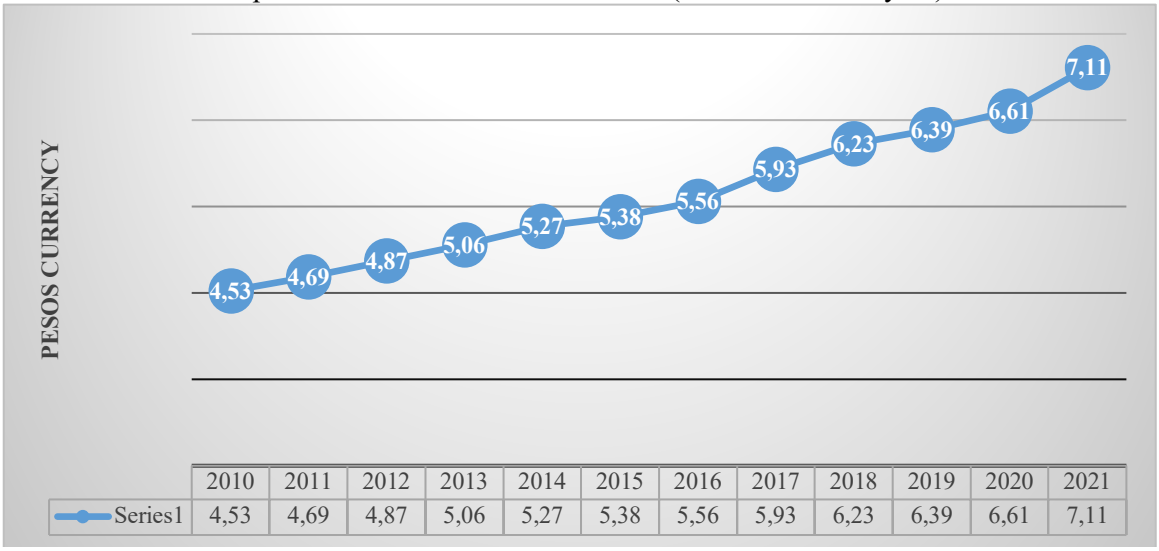
The UDI is a unit of account of constant real value to denominate credit titles. It does not apply to checks, commercial contracts, or other acts of commerce.

Table 6. Investment units (value concerning pesos)

Periodo	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Enero	4.37	4.56	4.73	4.89	5.10	5.29	5.41	5.62	5.97	6.25	6.44	6.64	7.12
Febrero	4.41	4.57	4.75	4.92	5.13	5.29	5.43	5.69	6.00	6.25	6.46	6.70	7.18
Marzo	4.44	4.59	4.75	4.94	5.15	5.30	5.44	5.71	6.02	6.26	6.49	6.75	7.24
Abril	4.46	4.59	4.75	4.97	5.15	5.32	5.45	5.75	6.03	6.28	6.43	6.79	7.31
Mayo	4.43	4.58	4.71	4.96	5.13	5.29	5.42	5.75	6.01	6.27	6.42	6.81	7.33
Junio	4.41	4.55	4.74	4.95	5.13	5.28	5.42	5.75	6.01	6.26	6.44	6.83	7.36
Julio	4.42	4.57	4.77	4.95	5.14	5.28	5.42	5.76	6.04	6.27	6.49	6.87	7.43
Agosto	4.43	4.58	4.78	4.95	5.16	5.29	5.44	5.79	6.07	6.29	6.52	6.90	7.47
Sep.	4.44	4.59	4.80	4.97	5.18	5.31	5.45	5.82	6.11	6.29	6.55	6.92	
Oct.	4.47	4.61	4.83	4.99	5.20	5.33	5.49	5.84	6.13	6.31	6.57	6.97	
Nov.	4.50	4.64	4.85	5.02	5.23	5.36	5.53	5.89	6.17	6.35	6.60	7.04	
Dic.	4.53	4.69	4.87	5.06	5.27	5.38	5.56	5.93	6.23	6.39	6.61	7.11	

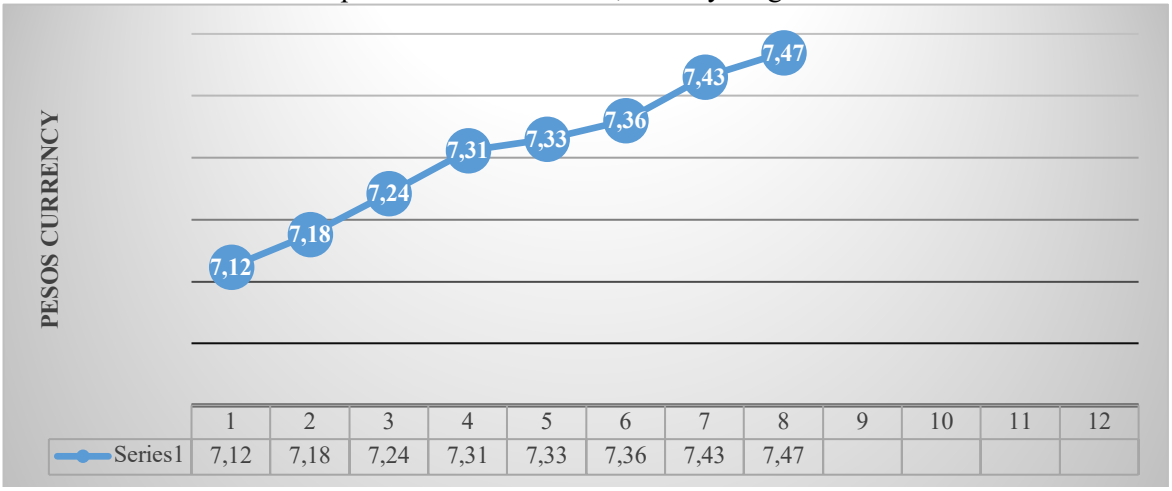
Source: Own elaboration (BANXICO, 2022).
https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?accion=consultarCuadro&idCuadro=CP150&locale=es

Graph 11. Investment units 2010-2021 (At the end of the year)



Source: Own elaboration (BANXICO, 2022).
https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?accion=consultarCuadro&idCuadro=CP150&locale=es

Graph 12. Investment units, January-August 2022



Source: Own elaboration (BANXICO, 2022).
https://www.banxico.org.mx/SieInternet/consultarDirectorioInternetAction.do?accion=consultarCuadro&idCuadro=CP150&locale=es

METHODS AND MODELS USED IN SENSITIVITY ANALYSIS

The Iman Researchers, (1990); and Helton (1993), in addition to promoting the use of global sensitivity as well, have tested robust methods based on Monte Carlo regression, correlation analysis and the use of scatter diagrams. Standardized output coefficients (SRC), measures of correlation (Pearson), and partial correlation coefficients (PCC) have also been used successfully in sensitivity models.

REFERENCES

BANXICO. (2022). Sistema de Información Económica. Mexico: Banco de México. Link: http://www.inegi.org.mx/sistemas/bie/

Cacuci, D. (1981). Teoría de la sensibilidad para sistemas no lineales. Enfoque de análisis funcional no lineal, *Journal of Mathematical Physics*, 22, 2794-2802.

Helton, J. (1993). Uncertainty and Sensitivity Analysis Techniques for Use in Performance Assessment for Radioactive Waste Disposal, *Reliability Engineering and System Safety*, 42, 327-367.

Iman, R. & Hora, S. (1990). A Robust Measure of Uncertainty Importance for Use in Fault Tree System Analysis, *Risk Analysis*, *10*(3), 401-406. https://doi.org/10.1111/j.1539-6924.1990.tb00523.x

INEGI. (2022). Banco de Información Económica. Mexico: Instituto Nacional de Geografía y Estadística. Link: http://www.inegi.org.mx/sistemas/bie/

Oblow, E., Pin, F. & Wright, R. (1986), Sensitivity Analysis Using Computer Calculus: A Nuclear Waste Isolation Application, *Nuclear Science and Engineering*, 94, 46-56.

Saltelli, A., Tarantola, S. & Chan K. (1999). A Quantitative Model-Independent Method for Global Sensitivity Analysis of Model, *Technometrics*, *41*(1). 39-56.