R, Python, Excel, SPSS, SAS, and MINITAB in Banking Research

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This paper discusses how R, Python, SPSS, SAS, and MINITAB can be used to predict bank failures and benefits that it would have to company's futures. By using stable forecasting, investors can predict the future bank failures. By using these software's, organizations can govern the life cycles of their inquiries and be strategic in their future financial stability in the bank. We provide an example of how companies can calculate internal rate of return (IRR) and use this to determine future bank failures while also discussing how each software can be used in different manners to determine future financial stability.

Keywords: Banking, Failures, Programs, Software, Financial, Stability

1. Introduction

R, Excel, SAS, SPSS, Python and MINITAB are six software programs designed to run statistical analyses and output graphics and can also be used for banking research. R can run on any operating system, is open-source, and reflects many of the changing field preferences while also being highly standardized. SAS is a paid software system that provides high performance analytics for banking research. Organizations can identify, investigate, and govern the life cycle of their inquiries. When it comes to data science one of the most common points of debate is R vs SAS vs Python vs Excel vs SPSS vs MINITAB. It is a well-known fact that R, Python, Excel, SPSS, SAS and MINITAB are the most important six languages to be learned for data analysis.

When it comes to data science one of the most common points of debate is R vs SAS vs SPSS vs. Python. We should also include Excel, because it does all of the functions that the other five programing languages provide. It is a well-known fact that R Python SPSS, MINITAB, and SAS are the most important 5 programming languages to be learned for data analysis by data scientists. However, we can also utilize Excel, to perform most of the operations, especially the simple ones. Excel can be purchased when you purchase or download from Microsoft windows website.

In banking research, there are many software packages that are being used including R, Python, SPSS, MINITAB, and SAS. Among these packages Python and R are open source, which indicate they are a free of charge software programming language. However, SAS, MINITAB, and SPSS are paid for by licensing companies or universities (C. Ozgur et.al 2017).

2. SAS Programming Language

2.1 What is SAS Programming Language?

SAS is a programming language where the input language common spreadsheets are inserted as input mechanisms to generate output based on the results of statistical analysis. These analyses are usually generated in the form of Tables and graphs as RTF PDF, HTML documents. It is an expensive language that is not affordable by most data scientists. The cost of SAS Programming language is $8,700 for the first year. Afterwards, this SAS renewal fee generally run 25-30% of the first-year fee (Quora, 2019). Unless the organization helps individuals with financial aid, they will not be able to use SAS. However, both R and Python are free of charge, they could be accessed by anyone, anywhere. This is a biggest advantage to all data scientists for using both R and Python.

2.2 How do you Obtain a Certification for SAS Programming Language?

Classroom and Online Training for Certifications can be found at: *https://www.edupristine.com/.*

3. SPSS Programming Language

3.1 What is SPSS Programming Language?

SPSS is also a programming language where the input language common spreadsheets as input mechanisms to generate output based on the results of statistical analysis. However, we are able to solve large scale problems. The difference from SAS is that the programming language for SPSS is easier to learn and more like Excel. However, just like SAS, it is not free of charge. The SPSS Programming language costs $1,188 annually or $99 a month (IBM.com, 2019).

3.2 How Do You Obtain a Certification for SPSS Programming Language?

Classroom and Online Training for Certifications can be found at: *https://www.edupristine.com/.*

4. Python Programming Language

4.1 What is Python Programming Language?

Python is another programming language free of charge like R. It is another open source programming language, free to access by everyone. Its code and language are easier to learn than R, SPSS, and SAS, making Python an easier programming language to learn.

4.2 How Do You Obtain a Certification for Python Programming Language?

Classroom and Online Training for Certifications can be found at: *https://www.edupristine.com/.*

5. R Programming Language

5.1 What is R Programming Language?

R is an open source programming language, free to access and pen to all to perform data analysis tasks. It is supported by the R Foundation for basic Statistical Computing. The R language is widely used among data miners for developing statistical software

and data analysis. The source code for the R software environment is written primarily in C, FORTRAN, and R. Language R is freely available under the GNU General Public License and is pre-compiled binary versions that are provided for various operating systems. While R has a command line interface, there are several graphical front-ends also available.

5.2 How Do You Obtain a Certification for R Programming Language?

Classroom and Online Training for Certifications can be found at: *https://www.edupristine.com/.*

6. Excel

6.1 What is Excel?

Excel is another programming language created by Microsoft that also can be used to solve simple problems that other programs can solve. We can also utilize Excel, to perform most of the operations, especially the simple ones. Excel can be purchased when you purchase or download from the Microsoft windows website, which typically costs $75 per person (Microsoft, 2019).

7. Minitab

7.1 What is MINITAB?

MINITAB (MINITAB, 2018) is a powerful statistical (Karafilowska, 2004) software that has a wide range of statistical procedures and graphic capabilities. In MINITAB, macros for many statistical procedures, experimental designs and algorithms can be handled (Arminian et al., 2008). MINITAB macros are easily edited, customized, and maintained, and can be made more powerful with a higher-level MINITAB macro programming environment (Mathews, 2005) (Arminian 2021). In this paper, we utilized the MINITAB software to generate answers to three problems as exampled later on. MINITAB is another software programming language that can utilize all of the benefits of other programming languages such as R, Python, Excel, SAS and SPSS. Currently MINITAB is at its 18th edition. Similarly, using MINITAB is also a good additional teaching tool. We can utilize this basic software that is similar to Excel because it has similar instructions. As opposed to R and Python being free of charge, MINITAB costs a modest amount more specifically $100 non-renewing price for instructors and a 6-month rental for $29.99 total. However, a 12-month rental for $49.99 is the total for students. Not only are we able to utilize the software by providing Excel-like instructions, with MINITAB, we can create macros that can be used in teaching or research.

Table 1 *Comparison of Software Programming Languages*

	SPSS	**SAS**	**R Studio**	**Python**	**MINITAB**	**Excel**
Ease of use 1-6 (1 being the easiest)	4	6	5	3	2	1
Difficulty	Moderately Difficult	Most Difficult	Not difficult if user	Moderately Difficult	Not Difficult if codes are known	Not Difficult

			knows of package plan assistance.			
Storage	2 GB of Hard Drive space, 4 GB of RAM	Requires 10-15 Gb to ownload	250 Gb. R will not need as much scratch space as SAS.	2 Gb	Minimum: 3.5 GB. Typically, 5-8 Gb used	1GB of RAM is the minimum system requirement for the 32-bit version of Windows 10
Availability to students and researchers 1-5 (1 being the least prevalent)	2 (moderate)	1	2 (moderate) depending on if package programs are used.	2 (moderate) users must know software language to operate.	2 (moderate) users must know software language to operate.	3
Cost	$99.00 / month subscription	$8,000 / year	Free Download Available	$0-$8.00/month /user	$95.00 /home user	Free with the purchase of Microsoft
Application	2nd Most Applicable.	Most Applicable.	Very Applicable with knowledge of package programs.	Applicability is to be determined by user.	Applicability is to be determined by user.	Only Applicable for small to medium sized problems.

8. Python vs Minitab: Their Benefits and Disadvantages

Python code is more compact and easier to read than MINITAB code. Unlike MINITAB, which uses end statement to indicate the end of a block, Python determines block size based on indentation. Along with this, Python uses square brackets for indexing and parentheses for functions and methods, whereas MINITAB uses parentheses for both, making MINITAB more difficult to differentiate and understand. Python's better readability leads to fewer bugs and faster debugging. While most programming languages, including Python, use zero-based indexing, and MINITAB uses one-based indexing, making it more confusing for users to translate. The object-oriented programming (OOP) in Python is simple and flexible while MINITAB's OOP scheme is more complex and confusing to learn. Also, MINITAB is commonly utilized in teaching practices. As for the cost effectiveness of Python, it is free and open source programming while much of MINITAB is closed. The developers of Python encourage users to input suggestions of the software, while the developers of MINITAB offer no such interaction with its users. There is no MINITAB counterpart to Python's import statement and Python offers a wider set of choices in graphics package and toolsets (Ozgur, 2017).

9. R in Finance

9.1 Advantages and Disadvantages of R

The software grew in popularity in response to the increasing overall demands on big data analytics and the need for programs which could handle massive data files. This changed how computational finance was done; the availability of a new and versatile tool is apt to reframe at least a portion of the discussions around calculation and application. Rickert (2014) notes that there were at least 70 separate finance packages available in 2014.

R's flexibility as a software means that it is fully able to perform the necessary tasks for financial analytics. There have been several programs written to facilitate the usage of R in such a setting; one of the most popular is jrv Finance (Trajanov, 2017). This package, alongside the standard tools of R and the bundle package Rmetrics (Trajanov, 2017), allows users to perform the necessary standard financial computations in the software. The largest advantage of this program is that it is set up to mimic the Excel format, allowing familiarity with the system.

9.2 Internal Rate of Return in R Programming

As Varma (2016) notes in his overview of the jrv Finance package, there are several specific commands to ensure that the correct operations are being performed. Jrv Finance specifically allows for the Internal Rate of Return (IRR) operations within R. Once loading R's syntax, the next step would be to load the package in the current R session (as packages are not stored from session to session). The syntax would be written as (where cf is the cash flow):

Internal Rate of Return: *irr (cf)*
Internal Rate of Return example: *irr (cf=c (-10, 3, 4, 5, 6))*

The example would compute an IRR of 0.2488813 for the cash flow specified in the function. The presented example is a fairly simple string of code to learn.

9.3 R's Growth and Comparison to other Software

R's growth in the data analytics field has come to surpass SAS, SPSS, Python and MINITAB, leading to an increase in job postings where applicants must know how to use R. The overall trend of R is observable in Figure 1, stated from Muenchen (2017).

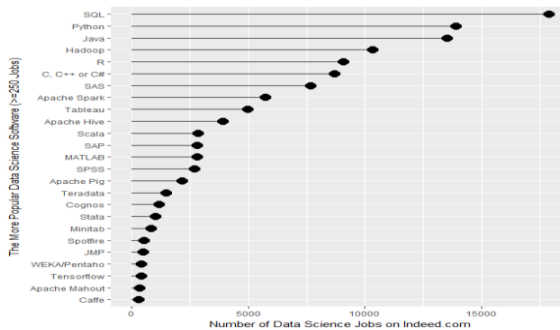


Figure 1 *Number of Data Science Jobs Posted on a Job Search Website with Over 250 Job Hits*

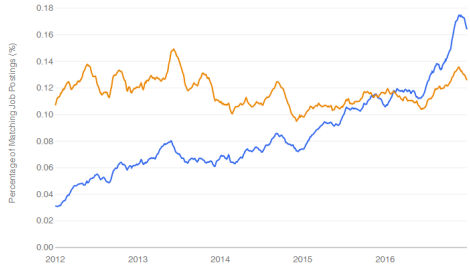


Figure 2 *The Job Posting Trends for SAS (Orange) and R (Blue)*

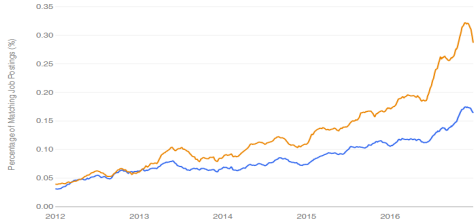


Figure 3 *The Job Posting Trends for Python (Orange) and R (Blue)*

All three Figures above demonstrate the usage of the job posting trends between Python, R and SAS. You can see that there are more job postings that are requiring software programming knowledge in order to obtain employment. This second diagram shows that the usage of Python and R are increasing more than the usage of SAS overall. This trend can be related to the fact that SAS is not free of charge like Python and R is, but rather more expensive to obtain an individual copy (Ozgur 2017).

10. SAS & R for Banking and Finance

Analysts named SAS a leader in predictive and advanced analytics, customer intelligence, data management, data integration and data quality. According to IDC, SAS holds a 31.6 percent share of the advanced and predictive analytics market and SAS has also been recognized by industry analysts as a leader in fraud detection, risk and retail analytics (Cary, 2017).

Maintaining this leadership is heavily dependent upon innovation. Year after year, SAS reinvests about twice the average of major technology firms into R&D – 26 percent in 2016. This unwavering commitment to innovation is behind the ground-breaking new SAS Viya technology – dubbed by analysts as changing the industry. SAS continues to introduce new innovation around this open and cloud-ready high-performance analytics and visualization platform – most recently with SAS Visual Investigator, which marries advanced analytics with dynamic and interactive visual workspaces. With it, organizations can identify, investigate and govern the entire life cycle of an investigation, search or inquiry. SAS plans to introduce even more to the SAS Viya family in the first quarter of 2017 (Cary, 2017).

Looking further ahead in 2017, SAS will continue innovation in its core focus areas, including analytics, visualization, data management, customer intelligence, risk and

fraud. Additionally, SAS Viya, artificial intelligence, cloud and IoT will be strong investment areas for SAS (Cary, 2017).

11. Minitab in Banking

MINITAB macros are a very useful program to use in teaching and research in banking. MINITAB is not too difficult to learn, but a consequence of this is that it is widely used by teachers and researchers. It is also widely available. As it is vector based, it is easily used for constructing multivariate analysis macros (Bassett 1996).

Table 2 *SAS vs R vs Python vs SPSS*

SAS	R	Python	SPSS
614	509	1170	20

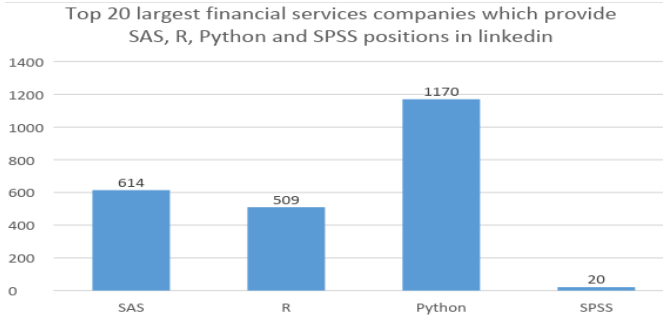


Figure 4 *Top 20 Largest Financial; Services Companies With SAS, Python, R & SPSS*

12. Examples of Programs in Banking

Example 1

Dear Loan Applicant,

The following program provides the basic issue dealing with how one would try to program or code issues dealing with how each individual would approach a bank. This involves the bank waiting time for each customer.

Problem 1

The waiting time (in minutes) for bank customers wanting to sign up for a loan was measured at four banks for all customers who arrived between 2:00 and 2:30 p.m. on a certain Wednesday. The results are shown below.

Bank Waiting Time (minutes)

Bank 1 (5	Bank 2 (4	Bank 3 (7	Bank 4 (6
10	8	5	1
19	25	11	20
5	17	24	9
26	36	16	5
11		18	10
		29	12
		15	

Research Question:
Are the mean waiting times for the bank customers the same for all four banks?

Answer: (Using MINITAB)
The mean waiting times for the bank customers are the same for all four banks because the F-value calculated is 1.76, which is less than 3.16 from the F-Table. Therefore, there is no significant difference of waiting times between the four banks.

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Factor	**3**	**377.7**	**125.89**	**1.76**	**0.191**
Error	**18**	**1288.2**	**71.56**		
Total	21	1665.8			

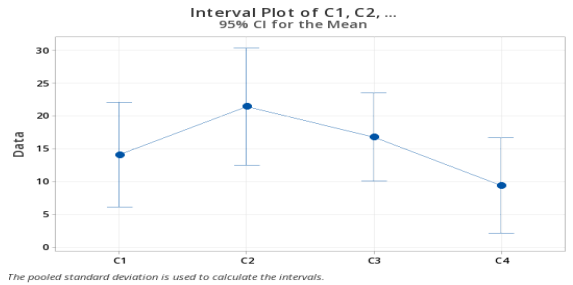
Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
8.45957	22.67%	9.78%	0.00%

Means

Factor	N	Mean	St Dev	95% CI
C1	5	14.20	8.29	(6.25, 22.15)
C2	4	21.50	11.90	(12.61, 30.39)
C3	7	16.86	7.95	(10.14, 23.57)
C4	6	9.50	6.47	(2.24, 16.76)

Pooled St Dev = 8.45957



Example 2
Dear Financial Institution Manager,
The following program provides the basic issues dealing with the real estate purchases for customers involving different purchasing situations

Problem 2

A real estate appraiser is developing a regression model to predict selling price in a certain neighborhood. She is planning to use square footage as a variable, but she also wishes to incorporate the type of house (Colonial=0, Tudor=1, or Contemporary=1) and whether the house has a brick front (brick=1, no brick=0). She obtains the following data:

Area (sq. ft.)	Type	Brick	Price ($000)
2100	Contemporary	No	85
2400	Tudor	Yes	110
2396	Colonial	Yes	115
3000	Tudor	Yes	175
2850	Tudor	Yes	160
2500	Contemporary	No	135
2000	Colonial	No	79
2200	Colonial	No	89
2600	Contemporary	No	98
2400	Colonial	No	105
2900	Tudor	Yes	154

Research Question

1. State the model that uses indicator variables.
2. Estimate the model, using the given data.
3. Interpret the values of the coefficients and constant term.

Answer: (Using MINITAB)

- Variable Definitions:

Y= Price
X1= 1, if contemporary
X1=0, otherwise
X2= 1, if Tudor
X2=0, otherwise
X3=1, if brick
X3=0, if not brick
X4= Area

- Y=-85.7, C1=0.0803, C2=-1.1, C3=3.3, C4=8.3
- Constant term is -85.7, Contemporary houses have an expected price increase of 0.0803, Tudor houses has an expected price increase of 1.1, the houses with as brick front has an expected price increase of 3.3 and each square foot increases the expected price of the house by 8.3.

Regression Equation

C2	C3	C4			
0	0	0	C5	=	-85.7 + 0.0803 C1
0	0	1	C5	=	-77.4 + 0.0803 C1
0	1	0	C5	=	-82.4 + 0.0803 C1
0	1	1	C5	=	-74.1 + 0.0803 C1
1	0	0	C5	=	-86.8 + 0.0803 C1
1	0	1	C5	=	-78.5 + 0.0803 C1
1	1	0	C5	=	-83.5 + 0.0803 C1
1	1	1	C5	=	-75.2 + 0.0803 C1

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-85.7	48.9	-1.75	0.130	
C1	0.0803	0.0219	3.66	0.011	2.48
C2					
1	-1.1	12.6	-0.08	0.935	1.66
C3					
1	3.3	18.2	0.18	0.862	4.09
C4					
1	8.3	17.2	0.48	0.648	3.88

Model Summary

45	R-sq	R-sq(adj)	R-sq(pred)
14.4032	88.35%	80.59%	*

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	4	9441.8	2360.46	11.38	0.006
C1	1	2786.0	2786.04	13.43	0.011
C2	1	1.5	1.49	0.01	0.935
C3	1	6.8	6.81	0.03	0.862
C4	1	47.9	47.94	0.23	0.648
Error	6	1244.7	207.45		
Total	10	10686.5			

Fits and Diagnostics for Unusual Observations

Obs	C5	Fit	Resid	Std Resid		
3	115.0	115.0	-0.0	*		X
9	98.0	122.1	-24.1	-2.21	R	

Example 3

A researcher has used a Randomized Block Design model to test whether the average salaries differ among the recent graduates from nursing, engineering, business, and education. Let the treatment be the graduating discipline and the block variable be the GPA of the student. She has randomly selected four graduates from each of the four areas. The first graduate from each area has a GPA between 2.00 and 2.50, the second graduate from each area has a GPA between 2.51 and 3.00, the third graduate from each area has a GPA between 3.01 and 3.50, and the fourth graduate from each area has a GPA between 3.51 and 4.00. If MSE=4, and SS (Treatment) =30, SS Total= 120, complete the following ANOVA Table.

Source	Sum of Squares	Degrees of Freedom	Mean Square (Variance)	F
Treatments				
Blocks				
Error				
Total				

Research Question

- Is there a significant difference in the starting salaries among the disciplines?
- Is there a significant difference in the starting salaries among the student GPAs?

Answer

Source	Sum of Squares	Degrees of Freedom	Mean Square (Variance)	F
Treatments	30	4-1=3	30/3=10	10/4=2.5
Blocks	4	4-1=3	4/3= 1.333	1.333/4= .333
Error	120-4-30=86	86/4=21.5	4	
Total	120			

- Since the F-value calculated is equal to 2.5 and the F-Table values for F3, 21.5 is 2.36, this is greater than the F- Table value of 2.36. Therefore, this is a significant difference among the starting salaries in the disciplines.
- Since the F-value calculated is equal to .333 and the F- Table values for F3, 21.5 is 2.36, this is less than the F- Table value of 2.36. Therefore, there is no significant difference in the starting salaries among the student GPAs.

13. Deposit Insurance

Deposit insurance is a key element in modern banking, it guarantees the financial safety and stability of the depository financial institutions. If an insured depository institution fails to fulfill its obligations to its depositors, the insuring agency will step in to honor the principal and accrued interests. (Dar-Yeh Hwang Cheng F. Lee K. Thomas Liaw)

Table 3 *World's Largest 20 Banking & Insurance Companies*

Rank	Company	Industry	Headquarters
1	Berkshire Hathaway	Conglomerate	United States
2	AXA	Insurance	France
3	Allianz	Insurance	Germany
4	ICBC	Banking	China
5	Fannie Mae	Investment Services	United States
6	BNP Paribas	Banking	France
7	Generali Group	Insurance	Italy
8	China Construction Bank	Banking	China
9	Banco Santander	Banking	Spain
10	JP Morgan Chase	Banking	United States
11	Société Générale	Banking	France
12	HSBC	Banking	United Kingdom
13	Agricultural Bank of China	Banking	China
14	Bank of America	Banking	United States
15	Bank of China	Banking	China
16	Wells Fargo	Banking	United States
17	Citigroup	Banking	United States
18	Prudential	Insurance	United Kingdom
19	Munich Re	Insurance	Germany
20	Prudential Financial	Insurance	United States

14. Forecasting Bank Failures

There has been major concern throughout economists that there will be a recession by 2020 in the United States. Specifically, a survey from J.P. Morgan found that 75 percent of ultra-high net worth investors predict that the US economy will fall into a recession by that time (Turak, 2018). Although there is concern regarding ultra-net investors, there is not as much concern in the realm of the banking industry. For instance, the International Monetary Fund recently upped its U.S. growth forecast for 2018 to 2, 9 percent. This increase was caused by Tax Cuts and Job Acts that enlarged the federal spending package. Although this has present benefits, in the long run it is likely that the banks will not benefit from the tax cuts (Turak, 2018).

15. What are other Opinions of these Programming Languages?

There are some of these articles that are published that explain the disadvantages, advantages and the descriptions of these same programming languages. Some of these articles relate to the quality of the publication in terms of software statistical tools used, such as Python, SAS, SPSS, R, Excel, MINITAB and some of these software statistics are free of charge, but some of them requires payments. The ones that are free of charge are Python, and R. The ones that have to be paid for include SAS, SPSS,

Excel, and MINITAB, but Excel and MINITAB are fairly inexpensive compared to SAS and SPSS. (Dhiaf 2021). For example, if you're using modeling software in your research, you can utilize statistical software such as R, SPSS, and SAS (Bahrou, 2019). In particular, as service-dominant logic is being proposed and tested in several industries, studies have been conducted toward the investigation of this theory and provides insights for both researchers and practitioners. Also, this advances the understanding of customer switching intention by assessing the relative strength of product quality and service quality (Peng 2014). With the increasing use and availability of computing power, there comes the need in competitive markets to produce and offer products and services that provide as precisely as possible. These features offer services that match customer requirements, with as little waste as possible. Further, customers have different thresholds of willingness to pay for sets of features, such as R, Python, SPSS, SAS, Excel, and MINITAB (Wacker 2021). As a large number of companies are turning to increased product variety and customization, a growing need is being put on the design and management of systems. Recent works have proved the effectiveness of systems and policies, which consist in using multiple policies in the same assembly system. In this context, the assembly line problem refers to the selection of a suitable policy for each part. The assembly system is addressed either by developing optimization models or by categorizing the parts and assigning these parts to policies based on some characteristics of the parts and the manufacturing system (Moretti 2021). Along with this, it presents a conceptual framework for Project Management on supply chains in the context of the Fourth Industrial Revolution (Supply Chains 4.0), taking in the fact that there is a gap that exists regarding this software. An analysis of the software such as SAS, SPSS, R, Excel, MINITAB and Python, indicating this gap has been conducted using the Web of Science as well as the SAS, SPSS, Python, R, Excel, and MINITAB software for a deeper analysis (Frederico 2021).

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