CHAPTER 116

Solver as a financial asset allocation tool

10.56238/pacfdnsv1-116

André Rodrigues Matsumoto
Highest academic background: Corporate Finance Specialist
Current institution: Must University – Florida - USA
Full address (can be institutional or personal, as you prefer): Rua Tranquilo Noro, 642 – Condomínio Terra Nova Cascavel III – Zip code 85.807-860 – Cascavel/PR
Email: andre.matsumoto@hotmail.com

Giovanni Bruno Lopes de Souza Brito
Highest academic background: Specialist in quality administration and management
Current institution: Must University – Florida - USA
Full address (can be institutional or personal, as you prefer): Rua Desembargador Mota, 1015, Monte Castelo, Teresina/PI
Email: gb.brito@outlook.com

Marcio Luz da Conceição
Highest academic background: Specialist in Retail and Market Management ON LINE
Current working institution (Course or Work): Must University – Florida - USA
Full address (can be institutional or personal, as you prefer): Avenida Abdias Neves 1850, Bloco E, AP. 104. Cristo Rei – Teresina/PI
Email: adm.marcioluz@gmail.com

Waldecy Ferreira de Oliveira Junior
Highest academic background: Bachelor of Business Administration
Current institution: Brasil Bio Fuels
Full address (can be institutional or personal, as you prefer): Conjunto Ipaupixuna Rua 2 Quadra BN 38, Belém/PA, 66820-860
Email: tenwaldejunior@hotmail.com

Paola Aragão Ferreira Silva
Highest academic background: Specialist in People Management
Current institution: UNESC - Universidade do Extremo Sul Catarinense
Full address (can be institutional or personal, as you prefer): Rua Coronel José Inácio N 686 - Centro, Sobral/CE
Email: paolaaragao.m@gmail.com

Genifer Yani Figueira de Holanda
Highest academic background: Specialist in Higher Education Methodology and ODL
Current institution: Federal University of Rondônia Foundation - UNIR
Full address (can be institutional or personal, as you prefer): Avenida Alonso Eugênio de Melo, 2915 - João Francisco Clímaco - Nova Mamoré/ RO
Email: yaniholanda@gmail.com

Dayanne Cavalcante Saldanha
Highest academic background: Marketing specialist
Current institution: UNIR- Federal University of Rondônia
Full address (can be institutional or personal, as you prefer): Rodovia Isaac Bennesby, s/n. B. Emerald Garden. Guajará-Mirim/RO
Email: Dayanne@unir.br

Cláudio Filipe Lima Raposo
Highest academic background: Project Management Specialist
Current institution: UAA – Universidad Autónoma de Asunción
Full address: Rua Antônio Valdevino da Costa, 280 - Bloco 5, Apto 603, Cordeiro - Recife/PE
Email: engcfraposo@gmail.com

ABSTRACT
The definition of an investment portfolio usually depends on the elaboration of a strategy, which may or may not be successful in its results. Obviously, in this context, there will be an arrangement with the allocated assets, according to the idealized strategy. That said, naturally arises the need to have good instruments to assist in the configuration of this investment portfolio. To fulfill this purpose, Microsoft Excel's Solver tool emerges as an interesting candidate to meet this demand, being able to facilitate the search for the best combination of financial assets, given a certain level of risk, or Beta. The objective of the study was to verify the feasibility of using the solver tool in the construction of an investment portfolio, seeking to reduce or even eliminate the diversifiable risk. This study is characterized as an experiment, of an exploratory nature, of a quantitative nature, and the results were obtained through simulation in Microsoft's software. The information that guided the research was obtained from an electronic site, scientific article and newspaper. It was found that Solver was able to meet the objective, according to the adoption of the desired parameters, however, to

strengthen the understanding, it is still necessary to increase the set of financial assets, which have negative correlations with each other as a characteristic.

Keywords : Investment portfolio. Diversifiable risk. Solver.

1 INTRODUCTION

In current times, having computerized calculation instruments that offer some form of automation represents great value, given the speed and efficiency it can provide to the user. To this end, Microsoft (2021), through Excel, more specifically through the Solver feature, brings on its website that this supplement can be used to test hypotheses. Furthermore, it offers the possibility of finding an ideal value, according to the formula in a cell, and according to the restrictions and limits imposed on the values of other cells.

The solver add-in presents a structure capable of adapting to different variable calculation challenges. Among the various possibilities, within the financial field, the opportunity of application for investors, who operate mainly in the capital market, arises. It is through a thorough analysis of their investment portfolio that allocation decisions, or even the best combination of asset arrangement, corroborates the individual's need to obtain the appropriate instruments for such.

The central point of modern portfolio theory is the presentation of the efficient frontier concept, which advocates the use of diversification as a means of reducing the risk of a portfolio of financial assets (Markowitz, 1952). Assaf (2007), understands that there are three important phases to evaluate an investment portfolio, based on Markowitz's theory, which would be: Analysis of securities, Analysis of portfolios and Selection of portfolios. The last phase is based on the best combination of assets, within a perspective of maximizing investor satisfaction. Second, Markowitz (1952), satisfaction refers to the rational investor, who craves the lowest possible risk for a certain level of return.

The present research activity had experimental research as its methodology, and through a quantitative approach, we sought to answer about the feasibility of using Solver as a tool for allocating financial assets, according to theoretical assumptions.

2 OBJECTIVE

This work aims to demonstrate the use of the Solver tool of the Microsoft Excel Application for the application of the portfolio model, especially for the selection of portfolios for decision making.

3 METHODOLOGY

Given the existence of a portfolio of financial assets, it is important to understand that there will always be risks involved in the operation, whether to a lesser or greater degree of scale. Using Kerr's (2011) concept, the total risk can be divided into two parts: One of them is the diversifiable risk or specific risk, which can be eliminated. The other is called market risk, or systemic risk, which cannot be suppressed.

Given the rating of risk, it is important to clarify the logic that permeates this component, which can be observed by the indicator Beta (β). Arai (2015), similarly, explains that, with the market β equal to 1, as an example, and the other assets having β > 1, it is understood that these securities are riskier than the market, and the opposite is also true. real. Since the asset has a high β, there is greater sensitivity to systemic risk, therefore, it is recommended that risk-averse investors avoid them.

Also, the measurement of the risk of a portfolio of financial assets, according to Markowitz's theory, brings the following risk equation, for two hypothetical assets: $\sigma p = \sqrt{(w^2A\ X\ \sigma^2A) + (w^2B\ X\ \sigma^2B) + 2\ X\ wa\ X\ wb\ X\ COVA,B)}$. In the notation, σp is the risk, or standard deviation; w is the weight of the asset, that is, the percentage share in relation to the total portfolio; σ^2 is the asset variance and COVA,B is the covariance of asset A with asset B. It follows that the insertion of more assets in an investment portfolio, given a risk and expected return, acting together, can demonstrate greater efficiency as opposed to an isolated investment (Sharpe, 1964).

For the experiment, the closing prices of four assets listed on B3 were collected, referring to the period from January to December 2018, namely, the *Tickers* : PETR4, SAPR4, VALE3 and CMIG4, as shown in Table 1. In addition, the IBOVESPA was defined as the *Benchmark* for comparing the variance of the set of selected assets.

Table 1: Closing values of the study variables for the months of 2018

	IBOVESPA	PETR4	SAPR4	VALE3	CMIG4
01/31/2018	84913	17.80	3.11	33.60	5.28
02/28/2018	85354	19,39	3,03	36,52	5,78
29/03/2018	85366	19,34	3,17	34,60	6,03
30/04/2018	86116	20,75	3,13	39,90	5,96
30/05/2018	76754	17,18	2,61	41,50	5,74
29/06/2018	72763	15,56	2,63	40,65	5,46
31/07/2018	79220	17,85	2,51	44,96	6,16
31/08/2018	76678	17,48	2,57	45,22	5,58
28/09/2018	79342	19,14	2,52	50,45	5,36
31/10/2018	87421	25,06	3,05	47,83	8,25
30/11/2018	89552	23,20	3,16	44,53	9,51
28/12/2018	87887	21,36	3,24	43.01	10.48

Source: Adapted by the authors based on consultation with B3

4 RESULTS

The compilation of the result of the percentage variations of the sample variables can be verified through Table 2, being, therefore, the main database for the intended calculation, from the use of the solver tool. Therefore, Table 3 reproduces the β of the assets in the sample, with the aforementioned weights and the β of the portfolio still set to zero in the initial phase.

Table 2: Monthly percentage variation of the study variables

	IBOVESPA	PETR4	SAPR4	VALE3	CMIG4
01/31/2018	-	-	-	-	-
28/02/2018	1%	9%	-3%	9%	9%
29/03/2018	0%	0%	5%	-5%	4%
30/04/2018	1%	7%	-1%	15%	-1%
30/05/2018	-11%	-17%	-17%	4%	-4%
29/06/2018	-5%	-9%	1%	-2%	-5%
31/07/2018	9%	15%	-5%	11%	13%
31/08/2018	-3%	-2%	2%	1%	-9%
28/09/2018	3%	9%	-2%	12%	-4%
31/10/2018	10%	31%	21%	-5%	54%
30/11/2018	2%	-7%	4%	-7%	15%
28/12/2018	-2%	-8%	3%	-3%	10%

Source: Adapted by the authors

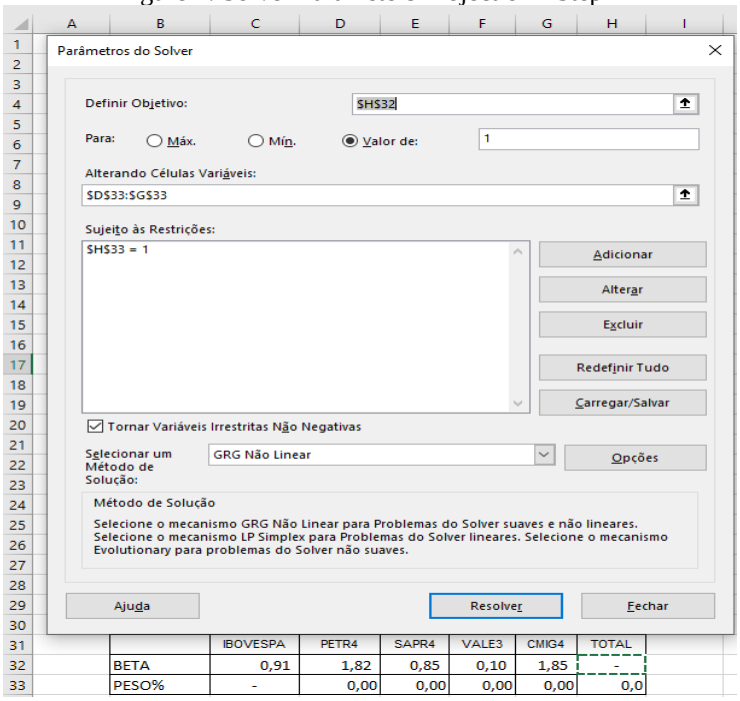
Table 3: Beta calculation for sample assets

	IBOVESPA	PETR4	SAPR4	VALE3	CMIG4	TOTAL
Beta Index	0.91	1.82	0.85	0.10	1.85	0.00
Weight %	-	0.00	0.00	0.00	0.00	0.00

Source: Adapted by the authors

Once the β index of the variables is obtained, the solver tool is activated in the Microsoft Excel application. Figure 1 demonstrates step 1, that is, the initial activity with the configuration of the parameters and the necessary rules, to reach the desired objective. Note that the objective defined in "1", represents the interest in establishing a portfolio of assets that contains neutrality in order to follow, on average, the fluctuation of its *Benchmark* . Finally, there is a restriction that conditions the weights of the assets to total 100% at the end of the allocated resources. This is necessary, since the total beta index depends on the product of each asset with that weight.

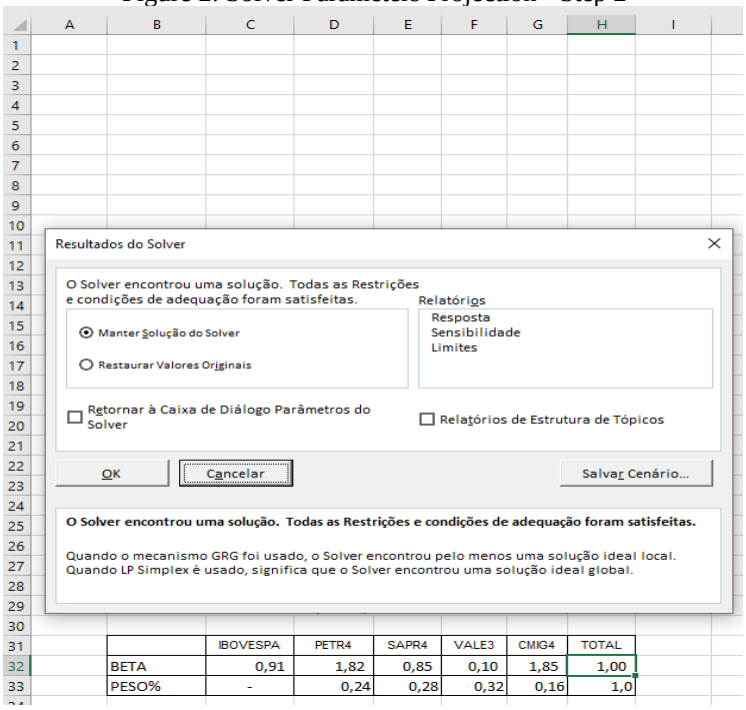
Figure 1: Solver Parameters Projection - Step 1



Source: Adapted by the authors

After defining the parameters and rules necessary for the calculation, there is the automated resolution of the calculation, which can be verified through Figure 2, which represents step 2. The result is automatically generated in the cells, which were initially zeroed.

Figure 2: Solver Parameters Projection - Step 2



	IBOVESPA	PETR4	SAPR4	VALE3	CMIG4	TOTAL
BETA	0,91	1,82	0,85	0,10	1,85	1,00
PESO%	-	0,24	0,28	0,32	0,16	1,0

Source: Adapted by the authors

As a result, during the simulation, it was found that as the portfolio combination is diversified, choosing assets that have different correlations between them, there is a percentage reduction in the exposure of assets with higher β, given the flexibility to be able to define the neutral β (β = 1). Thus, in this simulation, Solver offered the following ideal weights as a response, according to the previously generated indicators: 24% for PETR4, 28% for SAPR4, 32% for VALE3 and 16% for CMIG4.

5 FINAL CONSIDERATIONS

It was demonstrated through the application, that the modeling undertaken through the Solver tool, could enable the possibility of comparing different allocations of financial assets. This feature made it possible to establish a target in the objective field with relative ease, generating in turn the corresponding weight for each financial asset. However, it is important to note that the definition of the numeral in the objective field of the Solver application, reflects in a simplified way the investor profile. Once the index "1" is established in the β indicator of the investment portfolio, it must be agreed that this is an investment with a conservative profile. Therefore, this indicator ends up being flexible, within a perspective conceived by an investing agent, whether moderate, aggressive or even conservative. For future research, it is recommended to expand the set of assets in the sample, as well as to select only variables that present a

negative correlation with each other , in order to effectively observe the possibility of distributing the diversifiable risk in the asset portfolio.

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