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RESEARCH ARTICLE

A RISK ANALYSIS ALGORITHM FOR BUDGET ALLOCATION ON ECONOMIC SECTORS AND BUSINESS AREAS: APPLICATION TO ANGOLAN CRISIS SITUATION

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ABSTRACT

Angola have been allocating budget to many high-risk business areas. The return of the investments is so far down from the expected values. This paper deals on developing a risk analysis algorithm for responding the question *How to allocate the interests to each economics sectors and business areas?* We considered three economic sectors and thirty business areas, including Markowitz quadratic programming model in the algorithm. We considered high-risk business area when the interest take values until 1%, moderate-risk when taking values above 1% until 10% and law-risk when taking values bigger than 10%. For risk minimization Until 2030 Angola have to allocate 22,4% of General Budget to the Primary sector, 39,3% to the Secondary and 38,3% to the Tertiary. The good business areas will be Clothing and footwear industry, Materials industry, Forest, Maintenance, Diamond extraction, Iron extraction, Other minerals extraction, Culture and sports, Hotel and tourism, Universities, Fisheries, Livestock, Bank and insurance and Transports. Moderate investment will be done on Mechanic, Information technology and Real estate which are Moderate risk business areas. Else, investor will find high-risks when making business.

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INTRODUCTION

Risk budgeting models set risk diversification as objective in portfolio allocation or selection is mainly promoted once taking decisions under risks or uncertainties (Unger, 2015), (Markowitz, 1959). Algorithm for Non-linear Optimization in Economic Modeling (Gellecon, 2014) and risk analysis procedure (BanK, Guddat, Klatte, Kummer, & Tammer, 1983), (Martani, 2015), (Chen, 2016) have been helping decision makers on financial risk analysis. Complex problems of bank credit (Neto, 2008) and Multiple criteria Portfolio Management (Xidonas, Mavrotas, Krintas, Psarras, & Zopounidis, 2012), Probabilistic Portfolio Analysis (Huang, 2010) have also consider algorithm procedure and optimization models and IBM-ILOG-CPLEX is a software widely used to solve optimization models, persistent object base (Meichun & Cheatham, 2005), (Suzuki & Torezzan, 2013). Statistical test can be comparison criteria of measuring risk levels of the random variables (Fang, Lay, & Wang, 2008) and (Bolder, 2015), being *high risk* when the interest take values until 1%, *moderate risk* when taking values above 1% until 10% and law risk when taking values bigger than 10%. The crisis is affecting several countries since 2008 because of financial risks (Reinhart & Rogoff, 2008). A lot of made business did not bring back invested money (CEICUCAN C. d., 2014). The big question to answer at the time of planning investments is "How much interest of the investment budget must be allocated to each kind of business?" Therefore, our research question was

"*How to affect the interests (percentages) to each economics sectors and areas of business?*"

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This paper deals on developing risk analysis algorithm for budget allocation on the economic sectors and business areas, for helping the governments, companies, embassies, business mans and whoever, to take the best decisions under risk when planning investments or business on each area of the Primary, Secondary and Tertiary sectors. The results and discussion of its applications in Angola are presented in this research.

MATERIALS AND METHODS

Keywords definition

Flux gram: schematic representation of sequential precision instructions for calculi or for solving specific problem.

Algorithm: set of precision instructions for calculi or for solving specific problem. Consider many properties: 1) Input, 2) Output, 3) Definition, 4) Corrections, 5) Finite duration, 6) Effectiveness, and 7) Generality (Rosen, 2004).

Risk: Situation which unknown events may cause unexpected negative results.

Risk measure: magnitude risk determination of any event applying some statistics like Variance, Value at Risk (VAR), Conditional Value at Risk (CVAR), Men Value At Risk (MeanVAR) etc. Include classifying if the risk is high, moderate or law.

Risk analysis: Process of identifying and controlling events may cause negative unexpected results. Portfolio selection: Process of interest allocation to a set of businesses and risks. Multiple criteria optimization model: Given the functions $f_1(x_1)$, $f_2(x_2)$,..., $f_i(x_i)$,..., $f_n(x_n)$ and the constraints $g(x_1,x_2,\ldots, x_i \ldots, x_n) \leq 0$, or $h(x_1,x_2,\ldots, x_i \ldots, x_n) \geq 0$, Multiple criteria optimization model is the expression written as the following forms:

$$Max\ f_1(x),\ Max\ f_2(x_2), \ldots, Min\ f_i(x_i),$$

$$\ldots, Max\ f_n(x_n)$$

$$Sujeito\ a:$$

$$g(x_1,x_2,\ldots,x_i \ldots,x_n) \leq 0$$

$$h(x_1,x_2,\ldots,x_i \ldots,x_n) \geq 0$$

$$x \geq 0, x_2 \geq 0,\ldots,x_i \geq 0 \ldots,x_n \geq 0$$

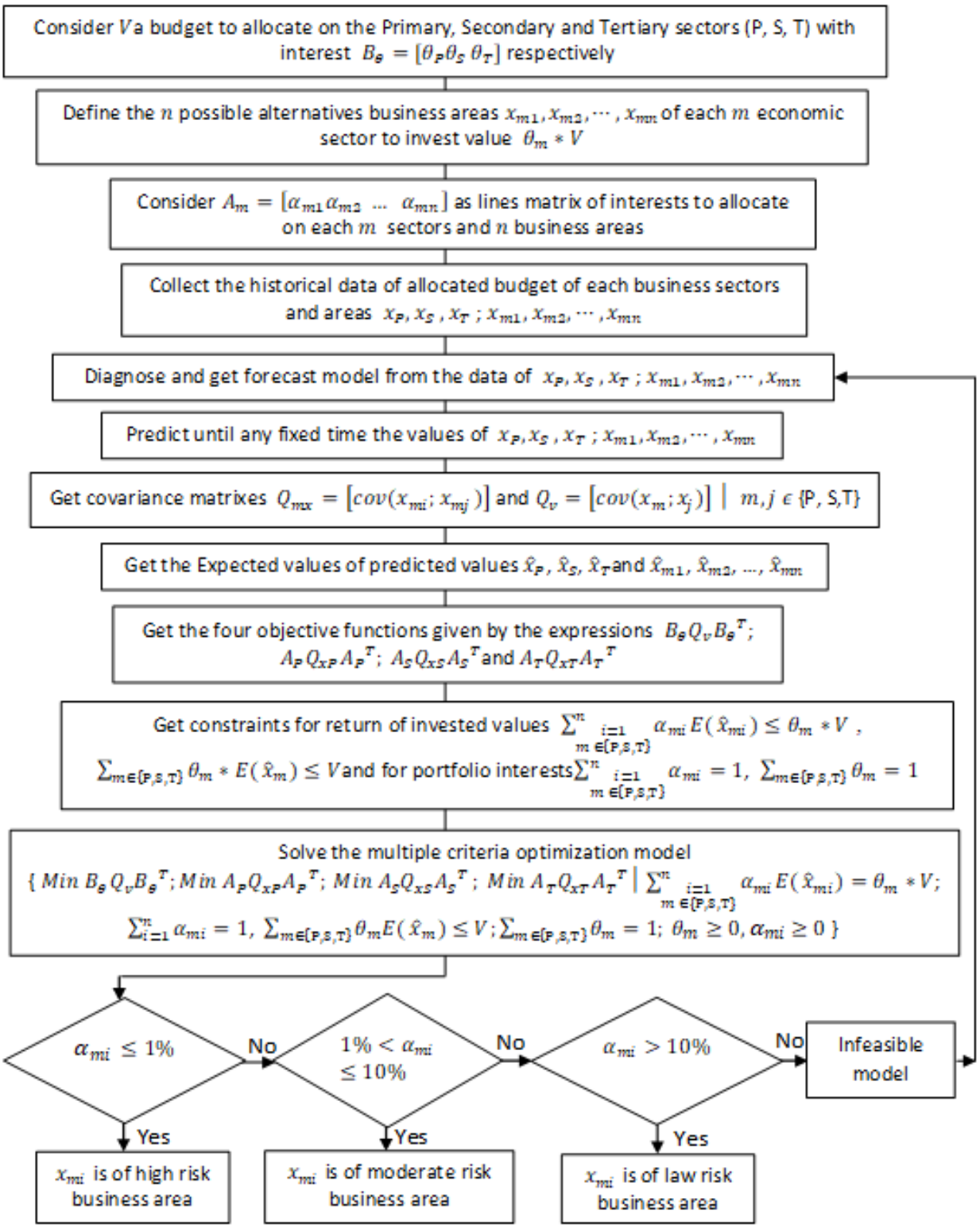
Where $x_1,x_2,\ldots,x_i \ldots,x_n$ are decision variables (Sixto Ríos, 1993).

METHODOLOGY

The algorithm has 12 steps as shown in the flux gram. Include forecasting values of allocated budget to the economic sectors and business areas for getting the expected values of decision parameters of the multiple criteria quadratic programming model of Markowitz and solving it minimizing risks for portfolio selection. We used OPL-CPLEX optimization tool of IBM to solve the model.

For its application on Angolan crisis until 2030, data from the years 2008 to 2018 of government budget allocation to economic sectors and its business areas were collected, like OGE (General Budget of the State) from MINFIN (Angolan Ministers of Finance), of Planning (MP) and from the institutions like, Study and Scientific Research Centre of Catholic University of Angola (CEICUCAN). To classify the level of risk we considered *high risk business area* when the interest (Decision variable of the model) had take values until 1%, *moderate risk business area* if above 1% until 10% and *law risk* if bigger than 10%.

Flux gram of the Algorithm: The sequential steps of the risk analysis algorithm are represented on the following flux gram:



Source: Designed by Author

Figure 1. Flux gram of the algorithm

Application to analyze Angolan Crisis Situation: Crisis is affecting Angola since the second semester of 2008, delaying the government financial decentralization program (CEICUCAN C. d., 2011). Efforts have been developed to reduce the negative impact to the economic and financial system, but the results of investments do not bring significant risks reduction (CEICUCAN C. d., 2014) because the economic studies and the government decisions making staff did not take in account the risk aversion strategy, the optimization model and several steps and elements we considered on the algorithm even expecting to invest 604 billion of USD from 2015 to 2025 to minimize the crisis. This section shows in details the implementation of the algorithm and the optimization model for Angolan crisis risk analysis situation and how the government would allocate the OGE to different economic sectors and business area from 2008 to 2030.

Risk Minimization Modeling

A) *Economic sectors*: Primary (1), Secondary (2) and Tertiary (3)

1.*Decision variables (*interest): θ_1= Interest for Primary sector; θ_2= Interest for Secondary sector; θ_3= Interest for Tertiary sector. The interest matrix is $B_\theta = [\theta_1 \quad \theta_2 \quad \theta_3]$.

2. *Decision parameters*: x_1 = historical amounts invested on Primary sector; x_2 = historical amounts invested on Secondary sector; x_3 = historical amounts invested on Tertiary sector.

Table 1. Expected Value to allocate on the three economic sectors from 2019 until 2030

Parameter	Billions of USD
$\boldsymbol{E(\hat{x}_1)}$	**12**
$\boldsymbol{E(\hat{x}_2)}$	**17,4**
$\boldsymbol{E(\hat{x}_3)}$	**10,8**
$\boldsymbol{V}$	40,2

Covariance matrix of amount invested on three economic sectors (Q_θ):

$$Q_\theta = \begin{bmatrix} 0{,}756 & 0{,}33 & -0{,}612 \\ 0{,}33 & 0{,}666 & -0.708 \\ -0{,}612 & -0{,}708 & 1{,}254 \end{bmatrix}$$

Source: Calculated from historical data (2008-2018)

Objective Function:

$$B_\theta \cdot Q_\theta \cdot {B_\theta}^T = \begin{bmatrix} \theta_1 \\ \theta_2 \\ \theta_3 \end{bmatrix}^T \cdot \begin{bmatrix} 0{,}756 & 0{,}33 & -0{,}612 \\ 0{,}33 & 0{,}666 & -0.708 \\ -0{,}612 & -0{,}708 & 1{,}254 \end{bmatrix} \cdot \begin{bmatrix} \theta_1 \\ \theta_2 \\ \theta_3 \end{bmatrix} =$$

$$= 0{,}756{\theta_1}^2 + 0{,}66\theta_1\theta_2 - 1{,}224\theta_1\theta_3 + 0{,}666{\theta_2}^2 - 1{,}416\theta_2\theta_3 + 1{,}254{\theta_3}^2$$

Constraints of the three economics sector

$$12\theta_1 + 17{,}4\theta_2 + 10{,}8\theta_3 \leq 40{,}2$$
$$\theta_1 + \theta_2 + \theta_3 = 1$$
$$\theta_1 \geq 0; \theta_2 \geq 0; \theta_3 \geq 0$$

Business areas of each sector:

***Primary sector*:**

Decision Variables (Interest): α_{11}= Interest for Agriculture, α_{12}= Interest for Forests, α_{13}= Interest for Fisheries; α_{14}= Interest for livestock, α_{15}= Interest for Oil and Gas, α_{16}= Interest for Diamonds α_{17}= Interest for iron, Interest for Fisheries and α_{18}= Interest for other minerals. The interest matrix is

$$A_{x1} = [\alpha_{11} \quad \alpha_{12} \quad \alpha_{13} \quad \alpha_{14} \quad \alpha_{15} \quad \alpha_{16} \quad \alpha_{17} \quad \alpha_{18}]$$

2.Decision Parameters: x_{11}= historical amounts invested on Agriculture, x_{12} = historical amounts invested on Forests, x_{13} = historical amounts invested on Fisheries; x_{14} = historical amounts invested on livestock, x_{15} = historical amounts invested on Oil and Gas, x_{16} = historical amounts invested on Diamonds, x_{17} = historical amounts invested on iron and x_{18} = historical amounts invested on other minerals;

Table 2. Expected Values to allocate on the primary sector business areas from 2019 until 2030

Parameter	Billions of USD
$\boldsymbol{E(\hat{x}_{11})}$	0,85
$\boldsymbol{E(\hat{x}_{12})}$	0,08
$\boldsymbol{E(\hat{x}_{13})}$	0,46
$\boldsymbol{E(\hat{x}_{14})}$	0,52
$\boldsymbol{E(\hat{x}_{15})}$	23,72
$\boldsymbol{E(\hat{x}_{16})}$	0,3
$\boldsymbol{E(\hat{x}_{17})}$	0,09
$\boldsymbol{E(\hat{x}_{18})}$	0,04

Source: Obtained from forecast values

The Covariance Matrix of historical amounts invested on business areas of the Primary sector is given below:

$$Q_{x1} = \begin{bmatrix} 0{,}1879 & 0{,}0004 & 0{,}0041 & 0{,}0076 & 2{,}6759 & 0{,}0027 & 0{,}0008 & 0{,}0004 \\ 0{,}0004 & 0{,}0005 & -0{,}0004 & 0{,}0021 & 0{,}2000 & -0{,}0025 & -0{,}0007 & -0{,}0004 \\ 0{,}0041 & -0{,}0004 & 0{,}0081 & 0{,}0032 & -0{,}3204 & -0{,}0002 & -0{,}0001 & 0{,}0000 \\ 0{,}0076 & 0{,}0021 & 0{,}0032 & 0{,}0177 & 0{,}6452 & -0{,}0113 & -0{,}0032 & -0{,}0016 \\ 2{,}6759 & 0{,}2000 & -0{,}3204 & 0{,}6452 & 125{,}93 & -0{,}8243 & -0{,}2355 & -0{,}1178 \\ 0{,}0027 & -0{,}0025 & -0{,}0002 & -0{,}0113 & -0{,}8243 & 0{,}0171 & 0{,}0049 & 0{,}0024 \\ 0{,}0008 & -0{,}0007 & -0{,}0001 & -0{,}0032 & -0{,}2355 & 0{,}0049 & 0{,}0014 & 0{,}0007 \\ 0{,}0004 & -0{,}0004 & 0{,}0000 & -0{,}0016 & -0{,}1178 & 0{,}0024 & 0{,}0007 & 0{,}0003 \end{bmatrix}$$

Source: Calculated from historical data (2008-2018)

Constraints of the Primary sector

$$0{,}85\alpha_{11} + 0{,}08\alpha_{12} + 0{,}46\alpha_{13} + 0{,}52\alpha_{14} + 23{,}72\alpha_{15} + 0{,}3\alpha_{16} + 0{,}09\alpha_{17} + 0{,}04\alpha_{18} \leq 40{,}2\,\theta_1$$

$$\alpha_{11} + \alpha_{12} + \alpha_{13} + \alpha_{14} + \alpha_{15} + \alpha_{16} + \alpha_{17} + \alpha_{18} = 1$$

$$\alpha_{11} \geq 0;\ \alpha_{12} \geq 0;\ \alpha_{13} \geq 0;\ \alpha_{14} \geq 0;\ \alpha_{15} \geq 0;\ \alpha_{16} \geq 0;\ \alpha_{17} \geq 0;\ \alpha_{18} \geq 0$$

Objective function

$$\begin{aligned} A_{\alpha 1} \cdot Q_{x1} \cdot {A_{\alpha 1}}^T = {} & 0{,}1879{\alpha_{11}}^2 + 0{,}0005{\alpha_{12}}^2 + 0{,}0081{\alpha_{13}}^2 + 0{,}0177{\alpha_{14}}^2 + 125{,}93{\alpha_{15}}^2 + 0{,}0171{\alpha_{16}}^2 + 0{,}0014{\alpha_{17}}^2 \\ & + 0{,}0003{\alpha_{18}}^2 + 0{,}0008\alpha_{12}\alpha_{11} + 0{,}00082\alpha_{13}\,\alpha_{P1} + 0{,}0152\alpha_{14}\alpha_{11} + 5{,}3518\alpha_{15}\alpha_{11} + 0{,}0054\alpha_{16}\alpha_{11} \\ & + 0{,}0016\alpha_{11}\alpha_{17} + 0{,}0008\alpha_{11}\alpha_{18} - 0{,}0008\alpha_{13}\,\alpha_{12} + 0{,}0042\alpha_{14}\alpha_{12} + 0{,}4\alpha_{15}\alpha_{12} - 0{,}005\alpha_{16}\alpha_{12} \\ & - 0{,}0014\alpha_{17}\alpha_{12} - 0{,}0008\alpha_{18}\alpha_{12} + 0{,}0064\alpha_{14}\alpha_{13} - 0{,}6408\alpha_{15}\alpha_{13} - 0{,}0004\alpha_{16}\alpha_{13} - 0{,}0002\alpha_{17}\alpha_{13} \\ & + 1{,}2904\alpha_{15}\alpha_{14} - 0{,}0226\alpha_{16}\alpha_{14} - 0{,}0064\alpha_{17}\alpha_{14} - 0{,}0032\alpha_{18}\alpha_{14} - 1{,}6486\alpha_{16}\alpha_{15} - 0{,}471\alpha_{15}\alpha_{17} \\ & - 0{,}2356\alpha_{15}\alpha_{18} + 0{,}0098\alpha_{16}\alpha_{17} + 0{,}0048\alpha_{16}\alpha_{18} + 0{,}0014\alpha_{17}\alpha_{18} \end{aligned}$$

***Secondary sector*:** *Decision Variables (Interest):* α_{S1}= Interest for Food industry, α_{22} = Interest for beverages industry, α_{23} = Interest for Clothing and footwear industry; α_{24} = Interest for Materials industry, α_{25} = Interest for Chemistry industry; α_{26} = Interest for Fuel and energy; α_{27} = Interest for Electricity;

The interest matrix is:

$$A_{xs} = [\alpha_{21} \quad \alpha_{22} \quad \alpha_{23} \quad \alpha_{24} \quad \alpha_{25} \quad \alpha_{26} \quad \alpha_{27}]$$

Decision Parameters: x_{21} = historical amounts invested on food industry, x_{22} = historical amounts invested on beverages industry, x_{23} = historical amounts invested on Clothing and footwear; x_{24} = historical amounts invested on Materials industry, x_{25} = historical amounts invested on Chemistry industry; x_{26} = historical amounts invested on Fuel and energy; x_{27} = historical amounts invested on Electricity;

Covariance Matrix of historical amounts invested on business areas of the Secondary sector:

$$Q_{x2} = 10^{-5} \cdot \begin{bmatrix} 23{,}6 & 110{,}9 & -0{,}45 & -0{,}103 & 3{,}122 & 202{,}8 & -155{,}94 \\ 110{,}9 & 2.956{,}2 & -9{,}02 & -0{,}21 & 1.200{,}8 & 3.857{,}1 & -1.364{,}9 \\ -0{,}45 & -9{,}02 & 0{,}102 & -0{,}0003 & 0{,}476 & -5{,}04 & 5{,}7 \\ -0{,}1 & -0{,}21 & -0{,}0003 & 0{,}0037 & -0{,}307 & -1{,}19 & -1{,}855 \\ 3{,}1 & 1.201 & 0{,}48 & -0{,}307 & 1.791 & 2.788{,}8 & 656{,}54 \\ 202{,}8 & 3.857{,}1 & -5{,}04 & -1{,}19 & 2.788{,}8 & 7.884{,}1 & -462{,}7 \\ -156 & -1.364{,}9 & 5{,}7 & -1{,}855 & 656{,}54 & -462{,}7 & 5.356{,}8 \end{bmatrix}$$

Source: Calculated from historical data (2008-2018)

Constraints of the secondary sector:

$$0{,}624\alpha_{21} + 0{,}95\alpha_{22} + 0{,}018\alpha_{23} + 0{,}001\alpha_{24} + 0{,}464\alpha_{25} + 1{,}175\alpha_{26} + 3{,}513\alpha_{27} \leq 40{,}2\theta_2$$

$$\alpha_{21} + \alpha_{22} + \alpha_{23} + \alpha_{24} + \alpha_{25} + \alpha_{26} + \alpha_{27} = 1$$

$$\alpha_{21} \geq 0;\ \alpha_{22} \geq 0;\ \alpha_{23} \geq 0;\ \alpha_{24} \geq 0;\ \alpha_{25} \geq 0;\ \alpha_{26} \geq 0;\ \alpha_{27} \geq 0$$

Objective function

$$A_{2x} \cdot Q_{x2} \cdot {A_{2x}}^T = 10^{-5} \cdot (23{,}6{\alpha_{21}}^2 + 221{,}8\alpha_{21}\alpha_{22} - 0{,}9\alpha_{21}\alpha_{23} - 0{,}206\alpha_{21}\alpha_{24} + 6{,}244\alpha_{21}\alpha_{25} + 405{,}6\alpha_{21}\alpha_{26} - 312\alpha_{21}\alpha_{27} + 2.956{,}2{\alpha_{22}}^2 - 18{,}04\alpha_{22}\alpha_{23} - 0{,}42\alpha_{22}\alpha_{24} + 2.402\alpha_{22}\alpha_{25} + 7.714{,}2\alpha_{22}\alpha_{26} - 2.729{,}8\alpha_{22}\alpha_{27} + 0{,}102{\alpha_{23}}^2 - 0{,}0006\alpha_{23}\alpha_{24} + 0{,}952\alpha_{23}\alpha_{25} - 10{,}08\alpha_{23}\alpha_{26} + 11{,}4\alpha_{23}\alpha_{27} - 0{,}0037{\alpha_{24}}^2 - 0{,}614\alpha_{24}\alpha_{25} - 2{,}38\alpha_{24}\alpha_{26} - 3{,}71\alpha_{24}\alpha_{27} + 1.791{\alpha_{25}}^2 + 5.577{,}6\alpha_{25}\alpha_{26} + 1.313{,}08\alpha_{25}\alpha_{27} + 7.884{,}1{\alpha_{26}}^2 - 925{,}4\alpha_{26}\alpha_{27} + 5.356{,}8{\alpha_{27}}^2)$$

***Tertiary sector*:**

Decision Variables (Interest): α_{31} = Interest for Health, α_{32} = Interest for Education, α_{33}= Interest for Culture and sports, α_{34}= Interest for Universities, α_{35} = Interest for Defense and Security; α_{36} = Interest for Bank and Insurance, α_{37} = Interest for Hotel and Tourism, α_{38} = Interest for Commerce, α_{39}= Interest for Tax inspections, α_{310}= Interest for Infrastructures construction, α_{311}= Interest for Transports, α_{312}= Interest for Maintenance; α_{313}= Interest for Mechanic, α_{314}=Interest for Information technologies; α_{315}= Interest for Real estate.

The interest matrix is:

$$A_{xT} = [\alpha_{31} \quad \alpha_{32} \quad \alpha_{33} \quad \alpha_{34} \quad \alpha_{35} \quad \alpha_{36} \quad \alpha_{37} \quad \alpha_{38} \quad \alpha_{39} \quad \alpha_{310} \quad \alpha_{311} \quad \alpha_{312} \quad \alpha_{313} \quad \alpha_{314} \quad \alpha_{315}]$$

Decision Parameters: x_{31}= historical amounts invested on Health, x_{32} = historical amounts invested on Education, x_{33}= historical amounts invested on Culture and sports, x_{34}= historical amounts invested on Universities, x_{35}= historical amounts invested on Defense and Security; x_{36}= historical amounts invested on Bank and Insurance, x_{37}= historical amounts invested on Hotel and Tourism, x_{38}= historical amounts invested on Commerce, x_{39}= historical amounts invested on for Tax inspections, x_{310}= historical amounts invested on Infrastructures construction, x_{311}= historical amounts invested on Transports, x_{312}= historical amounts invested on Maintenance and mechanic, x_{313}= historical amounts invested on Information technologies, x_{314}= historical amounts invested on Fuel, x_{315}= historical amounts invested on Real estate.

Table 4. Expected Values to allocate on the Tertiary sector business areas from 2019 until 2030

Parameter	Billions of USD
$E(\hat{x}_{31})$	2,62
$E(\hat{x}_{32})$	3,11
$E(\hat{x}_{33})$	0,09
$E(\hat{x}_{34})$	0,42
$E(\hat{x}_{35})$	8,36
$E(\hat{x}_{36})$	0,53
$E(\hat{x}_{37})$	0,21
$E(\hat{x}_{38})$	2,05
$E(\hat{x}_{39})$	32,09
$E(\hat{x}_{310})$	2,54
$E(\hat{x}_{311})$	0,7
$E(\hat{x}_{312})$	0,004
$E(\hat{x}_{313})$	0,99
$E(\hat{x}_{314})$	1,17
$E(\hat{x}_{315})$	1,38

Source: Calculated from forecast values

Covariance Matrix of historical amounts invested on business areas of the Tertiary sector (Q_{3x}):

1,2	0,554	−0,0012	0,07	1,7	−0,073	−0,022	0,194	8,014	0,37	−0,02	$-3 \cdot 10^{-5}$	−0,06	0,17	0,11
0,6	0,64	0,0111	0,073	0,612	−0,07	−0,015	0,044	4,42	0,174	−0,6	0,0001	−0,061	0,197	0,0123
−0,0012	0,0111	0,003	0,0012	−0,0341	−0,0024	0,002	−0,01	−0,082	−0,002	−0,001	$0{,}3 \cdot 10^{-5}$	0,0005	0,008	0,001
0,07	0,073	0,0012	0,0102	0,131	−0,011	−0,002	0,0011	0,785	0,032	−0,0085	$0{,}7 \cdot 10^{-5}$	−0,006	0,027	0,0035
1,7	0,612	−0,0341	0,131	5,31	−0,21	−0,04	−0,04	18,9	0,93	−0,2	$-8{,}9 \cdot 10^{-5}$	−0,0013	0,25	0,17
−0,073	−0,07	−0,0024	−0,011	−0,21	0,0252	0,0002	0,03	−1,16	−0,05	0,0125	$-0{,}4 \cdot 10^{-5}$	0,011	−0,03	−0,002
−0,022	−0,015	0,002	−0,002	−0,04	0,0002	0,003	−0,025	−0,23	−0,005	0,0012	$0{,}4 \cdot 10^{-5}$	0,01	−0,002	0,0035
0,194	0,044	−0,01	0,0011	−0,04	0,03	−0,025	0,303	0,4121	−0,025	0,02	$-7{,}4 \cdot 10^{-5}$	−0,1	−0,02	−0,03
8,014	4,42	−0,082	0,785	18,9	−1,16	−0,23	0,412	124	4,622	−0,22	$-36{,}1 \cdot 10^{-5}$	−0,4	1,73	0,63
0,37	0,174	−0,002	0,032	0,93	−0,05	−0,005	−0,025	4,623	0,223	−0,022	$0{,}3 \cdot 10^{-5}$	0,01	0,074	0,049
−0,02	−0,6	−0,001	−0,0085	−0,2	0,0125	0,0012	0,02	−0,22	−0,022	0,03	$-1{,}7 \cdot 10^{-5}$	0,006	−0,0222	0,007
$-3 \cdot 10^{-5}$	0,0001	$0{,}3 \cdot 10^{-5}$	$0{,}7 \cdot 10^{-5}$	$-8{,}9 \cdot 10^{-5}$	$-0{,}4 \cdot 10^{-5}$	$0{,}4 \cdot 10^{-5}$	$-7{,}4 \cdot 10^{-5}$	$-36{,}1 \cdot 10^{-5}$	$0{,}3 \cdot 10^{-5}$	$-1{,}7 \cdot 10^{-5}$	$0{,}01 \cdot 10^{-5}$	$2 \cdot 10^{-5}$	$2{,}2 \cdot 10^{-5}$	$-1{,}2 \cdot 10^{-5}$
−0,06	−0,061	0,0005	−0,006	−0,0013	0,011	0,01	−0,1	−0,4	0,01	0,006	$2 \cdot 10^{-5}$	0,061	−0,0132	0,03
0,17	0,197	0,008	0,027	0,25	−0,03	−0,002	−0,02	1,73	0,074	−0,0222	$2{,}2 \cdot 10^{-5}$	−0,0132	0,08	0,01
0,11	0,0123	0,001	0,0035	0,17	−0,002	0,0035	−0,03	0,63	0,049	0,007	$-1{,}2 \cdot 10^{-5}$	0,03	0,01	0,038

$$A_{3x} \cdot Q_{3x} \cdot A_{3x}{}^{T} = 1{,}2\alpha_{31}{}^{2} + 1{,}2\alpha_{31}\alpha_{32} - 0{,}0024\alpha_{31}\alpha_{33} + 0{,}14\alpha_{31}\alpha_{34} + 3{,}4\alpha_{31}\alpha_{35} - 0{,}146\alpha_{31}\alpha_{36} - 0{,}044\alpha_{31}\alpha_{37} + 0{,}388\alpha_{31}\alpha_{38} + 16{,}028\alpha_{31}\alpha_{39} + 1{,}48\alpha_{31}\alpha_{310} - 0{,}04\alpha_{31}\alpha_{311} - 6 \cdot 10^{-5}\alpha_{31}\alpha_{312} - 0{,}12\alpha_{31}\alpha_{313} + 0{,}34\alpha_{31}\alpha_{314} + 0{,}22\alpha_{31}\alpha_{315} + 0{,}64\alpha_{32}{}^{2} + 0{,}022\alpha_{32}\alpha_{33} + 0{,}146\alpha_{32}\alpha_{34} + 1{,}224\alpha_{32}\alpha_{35} - 0{,}14\alpha_{32}\alpha_{36} - 0{,}06\alpha_{32}\alpha_{37} + 0{,}088\alpha_{32}\alpha_{38} + 8{,}84\alpha_{32}\alpha_{39} + 0{,}348\alpha_{32}\alpha_{310} - 1{,}2\alpha_{32}\alpha_{311} + 0{,}0002\alpha_{32}\alpha_{312} - 0{,}122\alpha_{32}\alpha_{313} + 0{,}394\alpha_{32}\alpha_{314} + 0{,}0246\alpha_{32}\alpha_{315} + 0{,}003\alpha_{33}{}^{2} + 0{,}0024\alpha_{33}\alpha_{34} - 0{,}0682\alpha_{33}\alpha_{35} - 0{,}0048\alpha_{33}\alpha_{36} + 0{,}004\alpha_{33}\alpha_{37} - 0{,}02\alpha_{33}\alpha_{38} - 0{,}164\alpha_{33}\alpha_{39} - 0{,}004\alpha_{33}\alpha_{310} - 0{,}002\alpha_{33}\alpha_{311} + 0{,}6 \cdot 10^{-5}\alpha_{33}\alpha_{312} + 0{,}001\alpha_{33}\alpha_{313} + 0{,}016\alpha_{33}\alpha_{314} + 0{,}002\alpha_{33}\alpha_{315} + 0{,}0102\alpha_{34}{}^{2} + 0{,}262\alpha_{34}\alpha_{35} - 0{,}022\alpha_{34}\alpha_{36} - 0{,}004\alpha_{34}\alpha_{37} + 0{,}0022\alpha_{34}\alpha_{38} + 1{,}57\alpha_{34}\alpha_{39} + 0{,}064\alpha_{34}\alpha_{310} - 0{,}017\alpha_{34}\alpha_{311} + 1{,}4 \cdot 10^{-5}\alpha_{34}\alpha_{312} - 0{,}012\alpha_{34}\alpha_{313} + 0{,}054\alpha_{34}\alpha_{314} + 0{,}007\alpha_{34}\alpha_{315} + 5{,}312\alpha_{35}{}^{2} - 0{,}42\alpha_{35}\alpha_{36} - 0{,}08\alpha_{35}\alpha_{37} - 0{,}08\alpha_{35}\alpha_{38} + 37{,}8\alpha_{35}\alpha_{39} + 1{,}86\alpha_{35}\alpha_{310} - 0{,}4\alpha_{35}\alpha_{311} - 17{,}8 \cdot 10^{-5}\alpha_{35}\alpha_{312} - 0{,}0026\alpha_{35}\alpha_{313} + 0{,}5\alpha_{35}\alpha_{314} + 0{,}007\alpha_{35}\alpha_{315} + 0{,}0252\alpha_{36}{}^{2} + 0{,}0004\alpha_{36}\alpha_{37} + 0{,}06\alpha_{36}\alpha_{38} - 2{,}32\alpha_{36}\alpha_{39} - 0{,}1\alpha_{36}\alpha_{310} + 0{,}025\alpha_{36}\alpha_{311} - 0{,}8 \cdot 10^{-5}\alpha_{36}\alpha_{312} + 0{,}022\alpha_{36}\alpha_{313} - 0{,}06\alpha_{36}\alpha_{314} - 0{,}004\alpha_{36}\alpha_{315} + 0{,}003\alpha_{37}{}^{2} - 0{,}05\alpha_{37}\alpha_{38} - 0{,}46\alpha_{37}\alpha_{39} - 0{,}01\alpha_{37}\alpha_{310} + 0{,}0024\alpha_{37}\alpha_{311} + 0{,}8 \cdot 10^{-5}\alpha_{37}\alpha_{312} + 0{,}02\alpha_{37}\alpha_{313} + +0{,}007\alpha_{37}\alpha_{315} + 0{,}303\alpha_{38}{}^{2} + 0{,}824\alpha_{38}\alpha_{39} - 0{,}05\alpha_{38}\alpha_{310} + 0{,}04\alpha_{38}\alpha_{311} - 14{,}8 \cdot 10^{-5}\alpha_{38}\alpha_{312} - 0{,}2\alpha_{38}\alpha_{313} - 0{,}04\alpha_{38}\alpha_{314} - 0{,}06\alpha_{38}\alpha_{315} + 124\alpha_{39}{}^{2} + 9{,}246\alpha_{39}\alpha_{310} - 0{,}44\alpha_{39}\alpha_{311} - 72{,}2 \cdot 10^{-5}\alpha_{39}\alpha_{312} - 0{,}8\alpha_{39}\alpha_{313} + 3{,}46\alpha_{39}\alpha_{314} + 1{,}26\alpha_{39}\alpha_{315} + 0{,}223\alpha_{310}{}^{2} - 0{,}088\alpha_{310}\alpha_{311} + 0{,}6 \cdot 10^{-5}\alpha_{310}\alpha_{312} + 0{,}02\alpha_{310}\alpha_{313} + 0{,}148\alpha_{310}\alpha_{314} + 0{,}098\alpha_{310}\alpha_{315} + 0{,}03\alpha_{311}{}^{2} - 3{,}4 \cdot 10^{-5}\alpha_{311}\alpha_{312} + 0{,}012\alpha_{311}\alpha_{313} - 0{,}0444\alpha_{311}\alpha_{314} + 0{,}014\alpha_{311}\alpha_{315} + 0{,}01 \cdot 10^{-5}\alpha_{312}{}^{2} + 4 \cdot 10^{-5}\alpha_{312}\alpha_{313} + 4{,}4 \cdot 10^{-5}\alpha_{312}\alpha_{314} - 2{,}4 \cdot 10^{-5}\alpha_{312}\alpha_{315} + 0{,}061\alpha_{313}{}^{2} - 0{,}0264\alpha_{313}\alpha_{314} + 0{,}06\alpha_{313}\alpha_{315} + 0{,}08\alpha_{314}{}^{2} + 0{,}02\alpha_{314}\alpha_{315} + 0{,}038\alpha_{315}{}^{2}$$

Constraints of the tertiary sector:

$$2{,}62\alpha_{31} + 3{,}11\alpha_{32} + 0{,}09\alpha_{33} + 0{,}42\alpha_{34} + 8{,}36\alpha_{35} + 0{,}53\alpha_{36} + 0{,}21\alpha_{37} + 2{,}05\alpha_{38} + 32{,}09\alpha_{39} + 2{,}54\alpha_{310} + 0{,}7\alpha_{311} + 0{,}004\alpha_{312} + 0{,}99\alpha_{313} + 1{,}17\alpha_{314} + 1{,}38\alpha_{315} \leq 40{,}2\theta_3$$

$$\alpha_{31} + \alpha_{32} + \alpha_{33} + \alpha_{34} + \alpha_{35} + \alpha_{36} + \alpha_{37} + \alpha_{38} + \alpha_{39} + \alpha_{310} + \alpha_{311} + \alpha_{312} + \alpha_{313} + \alpha_{314} + \alpha_{315} = 1$$

$$\alpha_{31} \geq 0;\ \alpha_{32} \geq 0;\ \alpha_{33} \geq 0;\ \alpha_{34} \geq 0;\ \alpha_{35} \geq 0;\ \alpha_{36} \geq 0;\ \alpha_{37} \geq 0;\ \alpha_{38} \geq 0;\ \alpha_{39} \geq 0;\ \alpha_{310} \geq 0;\ \alpha_{311} \geq 0;\ \alpha_{312} \geq 0\ \alpha_{313} \geq 0;\ \alpha_{314} \geq 0;$$
$$\alpha_{315} \geq 0$$

General Risk Multiple objective Minimization Model for Angola

Taking the four objective functions and its constraints, the multiple objective minimization risk model for Angola is the given by the following expression:

$$Min\ 0{,}756\theta_1{}^{2} + 0{,}66\theta_1\theta_2 - 1{,}224\theta_1\theta_3 + 0{,}666\theta_2{}^{2} - 1{,}416\theta_2\theta_3 + 1{,}254\theta_3{}^{2}$$

$$Min\ 0{,}1879\alpha_{11}{}^{2} + 0{,}0005\alpha_{12}{}^{2} + 0{,}0081\alpha_{13}{}^{2} + 0{,}0177\alpha_{14}{}^{2} + 125{,}93\alpha_{15}{}^{2} + 0{,}0171\alpha_{16}{}^{2} + 0{,}0014\alpha_{17}{}^{2} + 0{,}0003\alpha_{18}{}^{2} + 0{,}0008\alpha_{12}\alpha_{11} + 0{,}00082\alpha_{13}\alpha_{P1} + 0{,}0152\alpha_{14}\alpha_{11} + 5{,}3518\alpha_{15}\alpha_{11} + 0{,}0054\alpha_{16}\alpha_{11} + 0{,}0016\alpha_{11}\alpha_{17} + 0{,}0008\alpha_{11}\alpha_{18} - 0{,}0008\alpha_{13}\alpha_{12} + 0{,}0042\alpha_{14}\alpha_{12} + 0{,}4\alpha_{15}\alpha_{12} - 0{,}005\alpha_{16}\alpha_{12} - 0{,}0014\alpha_{17}\alpha_{12} - 0{,}0008\alpha_{18}\alpha_{12} + 0{,}0064\alpha_{14}\alpha_{13} - 0{,}6408\alpha_{15}\alpha_{13} - 0{,}0004\alpha_{16}\alpha_{13} - 0{,}0002\alpha_{17}\alpha_{13} + 1{,}2904\alpha_{15}\alpha_{14} - 0{,}0226\alpha_{16}\alpha_{14} - 0{,}0064\alpha_{17}\alpha_{14} - 0{,}0032\alpha_{18}\alpha_{14} - 1{,}6486\alpha_{16}\alpha_{15} - 0{,}471\alpha_{15}\alpha_{17} - 0{,}2356\alpha_{15}\alpha_{18} + 0{,}0098\alpha_{16}\alpha_{17} + 0{,}0048\alpha_{16}\alpha_{18} + 0{,}0014\alpha_{17}\alpha_{18}$$

$$Min\ 10^{-5} \cdot (23{,}6\alpha_{21}{}^{2} + 221{,}8\alpha_{21}\alpha_{22} - 0{,}9\alpha_{21}\alpha_{23} - 0{,}206\alpha_{21}\alpha_{24} + 6{,}244\alpha_{21}\alpha_{25} + 405{,}6\alpha_{21}\alpha_{26} - 312\alpha_{21}\alpha_{27} + 2.956{,}2\alpha_{22}{}^{2} - 18{,}04\alpha_{22}\alpha_{23} - 0{,}42\alpha_{22}\alpha_{24} + 2.402\alpha_{22}\alpha_{25} + 7.714{,}2\alpha_{22}\alpha_{26} - 2.729{,}8\alpha_{22}\alpha_{27} + 0{,}102\alpha_{23}{}^{2} - 0{,}0006\alpha_{23}\alpha_{24} + 0{,}952\alpha_{23}\alpha_{25} - 10{,}08\alpha_{23}\alpha_{26} + 11{,}4\alpha_{23}\alpha_{27} - 0{,}0037\alpha_{24}{}^{2} - 0{,}614\alpha_{24}\alpha_{25} - 2{,}38\alpha_{24}\alpha_{26} - 3{,}71\alpha_{24}\alpha_{27} + 1.791\alpha_{25}{}^{2} + 5.577{,}6\alpha_{25}\alpha_{26} + 1.313{,}08\alpha_{25}\alpha_{27} + 7.884{,}1\alpha_{26}{}^{2} - 925{,}4\alpha_{26}\alpha_{27} + 5.356{,}8\alpha_{27}{}^{2})$$

$$
\begin{aligned}
Min\ & 1{,}2\alpha_{31}{}^2 + 1{,}2\alpha_{31}\alpha_{32} - 0{,}0024\alpha_{31}\alpha_{33} + 0{,}14\alpha_{31}\alpha_{34} + 3{,}4\alpha_{31}\alpha_{35} - 0{,}146\alpha_{31}\alpha_{36} - 0{,}044\alpha_{31}\alpha_{37} \\
& + 0{,}388\alpha_{31}\alpha_{38} + 16{,}028\alpha_{31}\alpha_{39} + 1{,}48\alpha_{31}\alpha_{310} - 0{,}04\alpha_{31}\alpha_{311} - 6\cdot 10^{-5}\alpha_{31}\alpha_{312} \\
& - 0{,}12\alpha_{31}\alpha_{313} + 0{,}34\alpha_{31}\alpha_{314} + 0{,}22\alpha_{31}\alpha_{315} + 0{,}64\alpha_{32}{}^2 + 0{,}022\alpha_{32}\alpha_{33} + 0{,}146\alpha_{32}\alpha_{34} \\
& + 1{,}224\alpha_{32}\alpha_{35} - 0{,}14\alpha_{32}\alpha_{36} - 0{,}06\alpha_{32}\alpha_{37} + 0{,}088\alpha_{32}\alpha_{38} + 8{,}84\alpha_{32}\alpha_{39} + 0{,}348\alpha_{32}\alpha_{310} \\
& - 1{,}2\alpha_{32}\alpha_{311} + 0{,}0002\alpha_{32}\alpha_{312} - 0{,}122\alpha_{32}\alpha_{313} + 0{,}394\alpha_{32}\alpha_{314} + 0{,}0246\alpha_{32}\alpha_{315} \\
& + 0{,}003\alpha_{33}{}^2 + 0{,}0024\alpha_{33}\alpha_{34} - 0{,}0682\alpha_{33}\alpha_{35} - 0{,}0048\alpha_{33}\alpha_{36} + 0{,}004\alpha_{33}\alpha_{37} - 0{,}02\alpha_{33}\alpha_{38} \\
& - 0{,}164\alpha_{33}\alpha_{39} - 0{,}004\alpha_{33}\alpha_{310} - 0{,}002\alpha_{33}\alpha_{311} + 0{,}6\cdot 10^{-5}\alpha_{33}\alpha_{312} + 0{,}001\alpha_{33}\alpha_{313} \\
& + 0{,}016\alpha_{33}\alpha_{314} + 0{,}002\alpha_{33}\alpha_{315} + 0{,}0102\alpha_{34}{}^2 + 0{,}262\alpha_{34}\alpha_{35} - 0{,}022\alpha_{34}\alpha_{36} \\
& - 0{,}004\alpha_{34}\alpha_{37} + 0{,}0022\alpha_{34}\alpha_{38} + 1{,}57\alpha_{34}\alpha_{39} + 0{,}064\alpha_{34}\alpha_{310} - 0{,}017\alpha_{34}\alpha_{311} \\
& + 1{,}4\cdot 10^{-5}\alpha_{34}\alpha_{312} - 0{,}012\alpha_{34}\alpha_{313} + 0{,}054\alpha_{34}\alpha_{314} + 0{,}007\alpha_{34}\alpha_{315} + 5{,}312\alpha_{35}{}^2 \\
& - 0{,}42\alpha_{35}\alpha_{36} - 0{,}08\alpha_{35}\alpha_{37} - 0{,}08\alpha_{35}\alpha_{38} + 37{,}8\alpha_{35}\alpha_{39} + 1{,}86\alpha_{35}\alpha_{310} - 0{,}4\alpha_{35}\alpha_{311} - 17{,}8 \\
& \cdot 10^{-5}\alpha_{35}\alpha_{312} - 0{,}0026\alpha_{35}\alpha_{313} + 0{,}5\alpha_{35}\alpha_{314} + 0{,}007\alpha_{35}\alpha_{315} + 0{,}0252\alpha_{36}{}^2 + 0{,}0004\alpha_{36}\alpha_{37} \\
& + 0{,}06\alpha_{36}\alpha_{38} - 2{,}32\alpha_{36}\alpha_{39} - 0{,}1\alpha_{36}\alpha_{310} + 0{,}025\alpha_{36}\alpha_{311} - 0{,}8\cdot 10^{-5}\alpha_{36}\alpha_{312} \\
& + 0{,}022\alpha_{36}\alpha_{313} - 0{,}06\alpha_{36}\alpha_{314} - 0{,}004\alpha_{36}\alpha_{315} + 0{,}003\alpha_{37}{}^2 - 0{,}05\alpha_{37}\alpha_{38} - 0{,}46\alpha_{37}\alpha_{39} \\
& - 0{,}01\alpha_{37}\alpha_{310} + 0{,}0024\alpha_{37}\alpha_{311} + 0{,}8\cdot 10^{-5}\alpha_{37}\alpha_{312} + 0{,}02\alpha_{37}\alpha_{313} + +0{,}007\alpha_{37}\alpha_{315} \\
& + 0{,}303\alpha_{38}{}^2 + 0{,}824\alpha_{38}\alpha_{39} - 0{,}05\alpha_{38}\alpha_{310} + 0{,}04\alpha_{38}\alpha_{311} - 14{,}8\cdot 10^{-5}\alpha_{38}\alpha_{312} - 0{,}2\alpha_{38}\alpha_{313} \\
& - 0{,}04\alpha_{38}\alpha_{314} - 0{,}06\alpha_{38}\alpha_{315} + 124\alpha_{39}{}^2 + 9{,}246\alpha_{39}\alpha_{310} - 0{,}44\alpha_{39}\alpha_{311} - 72{,}2\cdot 10^{-5}\alpha_{39}\alpha_{312} \\
& - 0{,}8\alpha_{39}\alpha_{313} + 3{,}46\alpha_{39}\alpha_{314} + 1{,}26\alpha_{39}\alpha_{315} + 0{,}223\alpha_{310}{}^2 - 0{,}088\alpha_{310}\alpha_{311} + 0{,}6 \\
& \cdot 10^{-5}\alpha_{310}\alpha_{312} + 0{,}02\alpha_{310}\alpha_{313} + 0{,}148\alpha_{310}\alpha_{314} + 0{,}098\alpha_{310}\alpha_{315} + 0{,}03\alpha_{311}{}^2 - 3{,}4 \\
& \cdot 10^{-5}\alpha_{311}\alpha_{312} + 0{,}012\alpha_{311}\alpha_{313} - 0{,}0444\alpha_{311}\alpha_{314} \\
& + 0{,}014\alpha_{311}\alpha_{315} + 0{,}01\cdot 10^{-5}\alpha_{312}{}^2 + 4\cdot 10^{-5}\alpha_{312}\alpha_{313} + 4{,}4\cdot 10^{-5}\alpha_{312}\alpha_{314} \\
& - 2{,}4\cdot 10^{-5}\alpha_{312}\alpha_{315} + 0{,}061\alpha_{313}{}^2 - 0{,}0264\alpha_{313}\alpha_{314} + 0{,}06\alpha_{313}\alpha_{315} \\
& + 0{,}08\alpha_{314}{}^2 + 0{,}02\alpha_{314}\alpha_{315} + 0{,}038\alpha_{315}{}^2
\end{aligned}
$$

***Subject to*:**

$$
\begin{gathered}
12\theta_1 + 17{,}4\theta_2 + 10{,}8\theta_3 \le 40{,}2 \\
\theta_1 + \theta_2 + \theta_3 = 1 \\
0{,}85\alpha_{11} + 0{,}08\alpha_{12} + 0{,}46\alpha_{13} + 0{,}52\alpha_{14} + 23{,}72\alpha_{15} + 0{,}3\alpha_{16} + 0{,}09\alpha_{17} + 0{,}04\alpha_{18} \le 40{,}2\ \theta_1 \\
\alpha_{11} + \alpha_{12} + \alpha_{13} + \alpha_{14} + \alpha_{15} + \alpha_{16} + \alpha_{17} + \alpha_{18} = 1 \\
0{,}624\alpha_{21} + 0{,}95\alpha_{22} + 0{,}018\alpha_{23} + 0{,}001\alpha_{24} + 0{,}464\alpha_{25} + 1{,}175\alpha_{26} + 3{,}513\alpha_{27} \le 40{,}2\theta_2 \\
\alpha_{21} + \alpha_{22} + \alpha_{23} + \alpha_{24} + \alpha_{25} + \alpha_{26} + \alpha_{27} = 1 \\
2{,}62\alpha_{31} + 3{,}11\alpha_{32} + 0{,}09\alpha_{33} + 0{,}42\alpha_{34} + 8{,}36\alpha_{35} + 0{,}53\alpha_{36} + 0{,}21\alpha_{37} + 2{,}05\alpha_{38} + 32{,}09\alpha_{39} + 2{,}54\alpha_{310} \\
+ 0{,}7\alpha_{311} + 0{,}004\alpha_{312} + 0{,}99\alpha_{313} + 1{,}17\alpha_{314} + 1{,}38\alpha_{315} \le 40{,}2\theta_3 \\
\alpha_{31} + \alpha_{32} + \alpha_{33} + \alpha_{34} + \alpha_{35} + \alpha_{36} + \alpha_{37} + \alpha_{38} + \alpha_{39} + \alpha_{310} + \alpha_{311} + \alpha_{312} + \alpha_{313} + \alpha_{314} + \alpha_{315} = 1 \\
\alpha_{11} \ge 0;\ \alpha_{12} \ge 0;\ \alpha_{13} \ge 0;\ \alpha_{14} \ge 0;\ \alpha_{15} \ge 0;\ \alpha_{16} \ge 0;\ \alpha_{17} \ge 0;\ \alpha_{18} \ge 0 \\
\alpha_{21} \ge 0;\ \alpha_{22} \ge 0;\ \alpha_{23} \ge 0;\ \alpha_{24} \ge 0;\ \alpha_{25} \ge 0;\ \alpha_{26} \ge 0;\ \alpha_{27} \ge 0 \\
\alpha_{31} \ge 0;\ \alpha_{32} \ge 0;\ \alpha_{33} \ge 0;\ \alpha_{34} \ge 0;\ \alpha_{35} \ge 0;\ \alpha_{36} \ge 0;\ \alpha_{37} \ge 0;\ \alpha_{38} \ge 0;\ \alpha_{39} \ge 0; \\
\alpha_{310} \ge 0; \alpha_{311} \ge 0; \alpha_{312} \ge 0;\ \alpha_{313} \ge 0; \alpha_{314} \ge 0; \alpha_{315} \ge 0; \theta_1 \ge 0;\ \theta_2 \ge 0; \theta_3 \ge 0
\end{gathered}
$$

RESULTS

Table 5: Results by the three economic sectors of the financial risk minimization model included on the algorithm for Angola

Table 5. Results by the three economic sectors of the financial risk minimization model included on the algorithm for Angola

Sectors	θ_i
Primary	22,4%
Secondary	39,3%
Tertiary	38,3%
TOTAL	100%

Table 6. Results by the business areas of the financial risk minimization model included on the algorithm for Angola

Ord.	Law risk business areas			Moderate risk business areas			High risk business areas		
	x_{mi}	m	α_{mi}	x_{mi}	m	α_{mi}	x_{mi}	m	α_{mi}
1st	Clothing and footwear	2	49,5%	Mechanic	3	7%	Food industry	2	1%
2nd	Materials industry	2	49,3%	Information technology	3	5,1%	Education	3	0,53%
3th	Forest	1	26,5%	Real estate	2	3%	Beverages industry	2	0,13%
4th	Maintenance	3	18%				Electricity	2	0,03%
5th	Other minerals	1	17,6%				Oil and Gas	1	0,0001%
6th	Iron extraction	1	16,5%				Fuel and energy	3	0%
7th	Culture and sports	3	16%				Commerce	3	0%
8th	Hotel and tourism	3	15,4%				Health	3	0%
9th	Diamond extraction	1	14%				Chemistry industry	2	0%
10th	Universities	3	13,1%				Tax inspections	3	0%
11th	Fisheries	1	13%				Infrastructures construction	3	0%
12th	Livestock	1	12,4%				Agriculture	1	0%
13th	Bank and insurance	3	12%				Defense and security	3	0%
14th	Transports	3	10,1%						

DISCUSSION

Markowitz optimizations model of the algorithm show that, for financial risk minimization, when allocating budget for investments in Angola, is necessary to equilibrate the three economic sectors. Primary sector should benefit 22,4% of the budget from the government and the private investors. Secondary sector would benefit 39,3% and tertiary sector with 38,3%. The major part of the primal resources is exported. This situation does not help the growing of Angolan economy. Government has been allocating to this sector only 17% of the budget (CEICUCAN C. , 2016). We think that this sector is the one can bring to much money for the government, companies and will be the support of secondary sector to develop industries. The very good business areas to make investments (with low risk) would include Clothing and footwear industry, Materials industry, Forest, Maintenance, Other minerals extraction, Iron extraction, Culture and sports, Hotel and tourism, Diamond extraction, Universities, Fisheries, Livestock, Bank and insurance and Transports. Mechanic, Information technology and Real estate, would be included in Moderate risk business areas. High risk business areas would involve Food industry, Education, Beverages industry, Electricity, Oil and Gas, Fuel and energy, Commerce, Health, Chemistry industry, Tax inspections, Infrastructures construction, Agriculture, Defense and security. Unfortunately Angola has been allocating significant budget to Defense and security, Electricity, Oil and Gas, Fuel and energy, Tax inspections. This situation does not help to return the expected values of the investment amount as referred (CEICUCAN C. d., 2014). In the high risk business areas we remarks that, the lake development of transformer industry in Angola, obviously do not help Agriculture to become a very rental business area. Beverages industry is being affected by its law prices in the Angolan market. Oil and Gas are also affected by the international market law prices. The Angolan Commerce is living strong difficulties because the major of products came from abroad and the access to the USD is very limited. The government imports more than 75% of Fuel with international market prices and sells it in Angola with the local law prices (Simbo, 2011). Defense and security receives too much money from the government but does not generate any money back.

Conclusion

Algorithms and optimization models help the decision making once selecting portfolio or allocating budget on several business areas taking to account the financial risks. Also help to reduce the impact of the crisis. Angola must equilibrate the three economic sectors for financial risk minimization, allocating 22,4% of the investments budget to the Primary sector, 39,3% to the Secondary sector and 38,3% to the Tertiary. Until 2030, the very good business areas for making investments in Angola will be Clothing and footwear industry, Materials industry, Forest, Maintenance, Other minerals extraction, Iron extraction, Culture and sports, Hotel and tourism, Diamond extraction, Universities, Fisheries, Livestock, Bank and insurance and Transports. We also can invest in Mechanic, Information technology and Real estate which are Moderate financial risk business areas. Very attention must be taken investing on Food industry, Education, Beverages industry, Electricity, Oil and Gas, Fuel and energy, Commerce, Health, Chemistry industry, Tax inspections, Infrastructures construction, Agriculture, Defense and security which are the High risk business areas.

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