

TOURISM MODELING: A NEW APPROACH TO TOURISM

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ABSTRACT

Tourism brings obvious economic benefits. Therefore, it is no surprise that tourism is an important economic activity in many parts of the world. Given the importance of the industry, the aim of the paper is the tourism modeling. The paper is divided into four parts. The first part of the paper outlines the evolution of the tourism industry, while the second part outlines the model with pure and mix strategies and in each part discusses the results obtained from those models by example, the third part outlines the relationship between the GDP of Armenia and the incomes of tourism for annual data and quarterly data and the fourth part outlines the evaluation of the effectiveness of tours by using DEA (Data envelopment analysis).

Keywords: Armenia, economy, game model, GDP, tourism modeling

1. INTRODUCTION

In the modern world tourism is one of the largest and dynamically developing sectors of external economic activities. Its high growth and development rates, considerable volumes of foreign currency inflows actively affect various sectors of economy, which positively contributes to the development of own tourist industry. The share of tourism in international gross national income is 6%, in world investments 7%, in world customary expenditures 11%, as well as it accounts for every 16th work place. Tourism is one of world integration processes factor and tourism industry is now becoming a more important sector of economy.

For example: Tourism in Mauritius is an important component of the Mauritian economy as well as a significant Source of its foreign exchange revenues. The tourism industry is also a major economic pillar on the island of Rodriguez.

According to the WTTC (World Travel and Tourism Council), by 2014, India's travel and tourism sector is likely to generate over \$90 billion in revenues and close to 28 million jobs. There is no doubt that tourism will be one of the key drivers of Indian's economy in the 21st century[1].

The importance of tourism in the world is permanently increasing so consistently increases the influence of tourism on country's economies[2].

To have a sustainable and profitable tourism we need to perform detailed calculations. Only after this the local businessmen will be sure that tourism is the sphere where they can do less investment and get more profit. And here modeling is coming to help us.

2. GAME MODEL WITH PURE STRATEGIES

The players

In this paper We have presented tourism as a game between three players [3]. The first player is the tourist company, the second player a tourist and the third player is a local habitant who works in Tourist Company.

The model

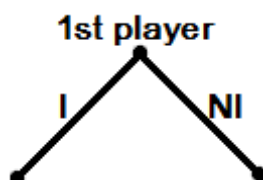
Each player has two strategies. The tourist company's strategies are to invest and not to invest, and we will present it like this $\{I, NI\}$. The strategies of tourist are to stay a long time in that place and to stay a short time which will present $\{LT, ST\}$. And the local habitant strategies are to work fully with Tourist Company and to work partly with Tourist Company $\{F, P\}$.

And each player has its own interest. Accordingly the 1st, 2nd and 3rd players' interests functions are $H_1(X_1, X_2, X_3)$, $H_2(X_1, X_2, X_3)$, $H_3(X_1, X_2, X_3)$, where $X_1 \in \{I, NI\}$, $X_2 \in \{LT, ST\}$, $X_3 \in \{F, P\}$. The tourism company interest is the profit which he can get. For tourists it is the total amount of the attractiveness factors (look at the table 1), which becomes the reason for tourists to pass a long time in that place. This table created the basis of the analysis of the tourists' survey results.

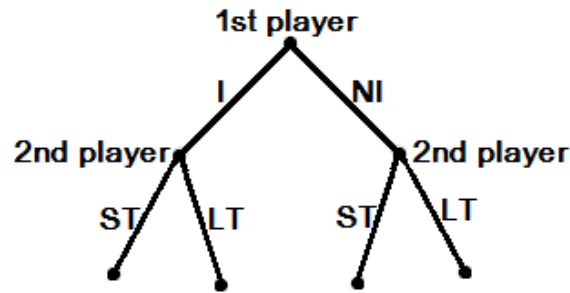
Table 1

	the attractiveness factors	unit
1.	Clean air	5
2.	Ecologically clean food	3
3.	Pure nature	4
4.	The hospitable attitude of local inhabitants	2
5.	Historical and cultural monuments in the vicinity	6
6.	Existence entertainment programs	1
7.	Availability of low costs	7

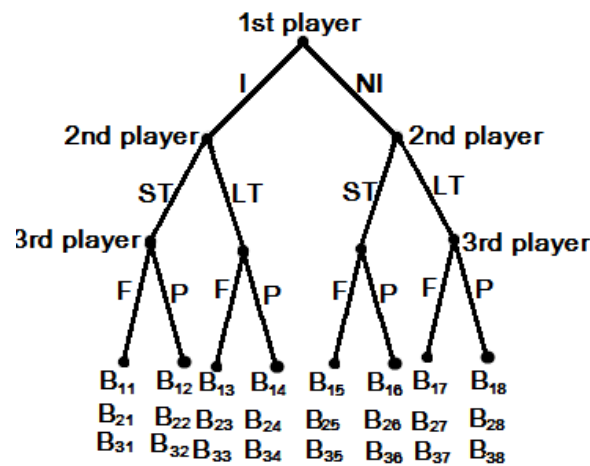
And local habitant's interest is the benefit. In this paper the game between three players is presented as a binary tree. Game starts the first player and chooses between two tree branches- to invest or not to invest.



The next player- tourist also chooses between two strategies- LT or ST and it will look as this binary tree.



At last, the last player makes his move- choosing between two F or P strategies.

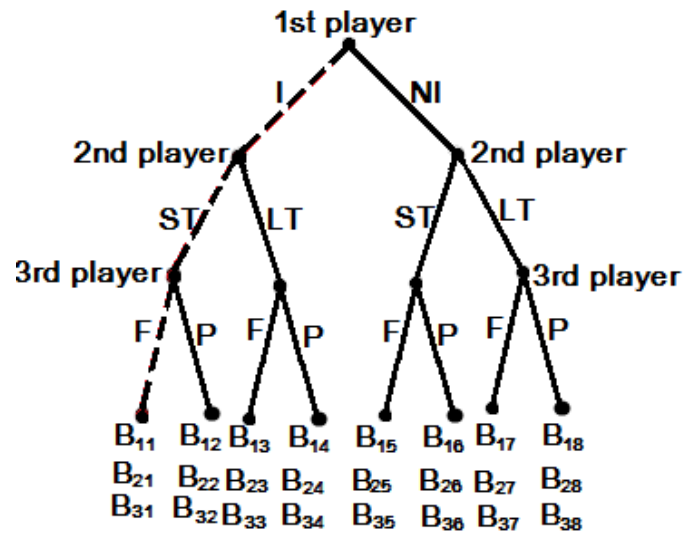


This binary tree shows all game's possible situations, where B_{ij} , $i=\{1,2,3\}$, $j=\{1,2,3,\dots,8\}$ the benefits of players in the respective situations and B_{ij} are real numbers. We can present the binary tree in the table 2.

Table 2

situations	$H_1(X_1, X_2, X_3)$	$H_2(X_1, X_2, X_3)$	$H_3(X_1, X_2, X_3)$
(I,ST,F)	B_{11}	B_{21}	B_{31}
(I,ST,P)	B_{12}	B_{22}	B_{32}
(I,LT,F)	B_{13}	B_{23}	B_{33}
(I,LT,P)	B_{14}	B_{24}	B_{34}
(NI,ST,F)	B_{15}	B_{25}	B_{35}
(NI,ST,P)	B_{16}	B_{26}	B_{36}
(NI,LT,F)	B_{17}	B_{27}	B_{37}
(NI,LT,P)	B_{18}	B_{28}	B_{38}

For example the first situation (I, ST, F) is the same as the branch of the tree by the dotted lines.



For each player we are searching solution by using Nash equilibrium[4].

Nash equilibrium, named after John Nash, is a set of strategies, one for each player; so that no player has incentive to unilaterally change her action [5]. Players are in equilibrium if a change in strategies by any one of them would lead that player to earn less than if she remained with her current strategy[6].

2.1.1 THE USE OF THE MODEL

In this table We have used the model on the basis of the data of Armenian X tourist company (table 3).

Table 3

№	situations	H ₁	H ₂	H ₃
1	(I,ST,F)	30	3	4
2	(I,ST,P)	30	5	3
3	(I,LT,F)	60	7	6
4	(I,LT,P)	60	6	4
5	(NI,ST,F)	0	7	2
6	(NI,ST,P)	0	10	1,5
7	(NI,LT,F)	-75	5	1
8	(NI,LT,P)	-75	3	1

We'll present the game solution by using the oriented graph.

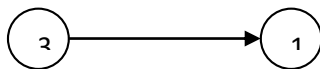
In mathematics, a graph is a representation of a set of objects where some pairs of the objects are connected by links. The interconnected objects are represented by mathematical abstractions called vertices, and the links that connect some pairs of vertices are called edges [7].

In graph theory, an orientation of an undirected graph is an assignment of a direction to each edge, making it into a directed graph.

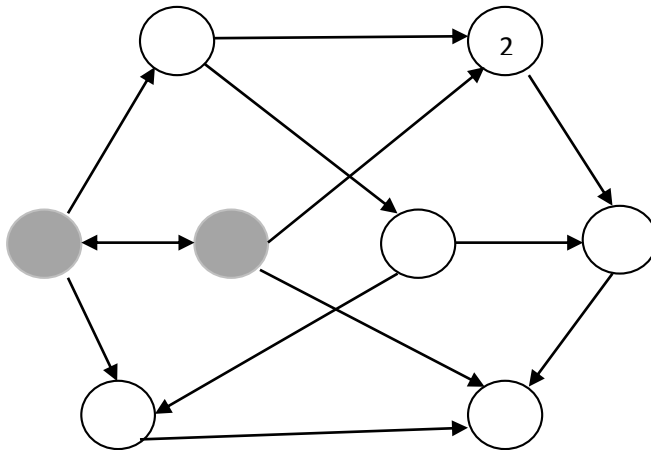
Oriented graphs are in one-to-one correspondence with complete directed graphs (graphs in which there is a directed edge in one or both directions between every pair of vertices).

For this oriented graph the game situations, which we are numbering from 1 to 8 serves as vertices. And the links that connect two strategies which differ from each other only by one strategy serve as the edges of the oriented graph (for example (I,ST,F) and (I,LT,F)).

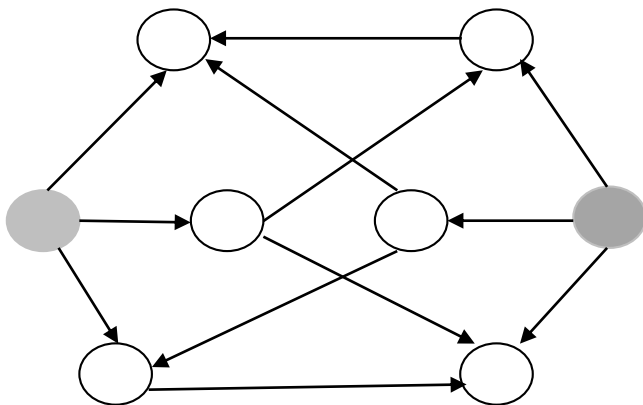
The edge starts from the vertices' which B_{ij} more than the other and going into to the vertices which has the less B_{ij} (for example $H_1(I,ST,F)=30$ and $H_1(I,LT,F)=60$ it will be like this



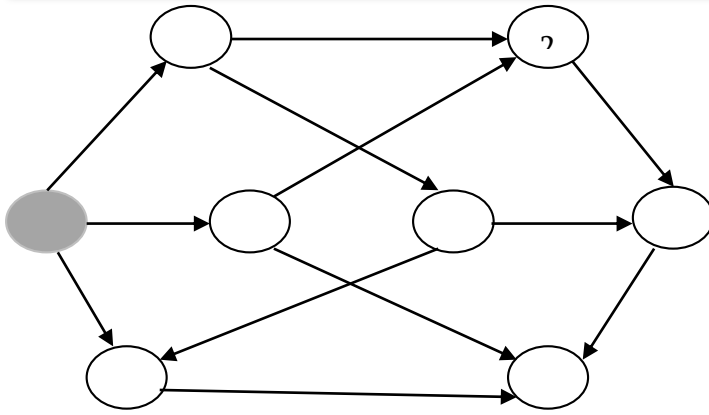
For each player the best situation will be those vertices from which all edges are only starting. This situation which all players prefer is the decision of the game. So we built for each player one oriented Graph. As the graph shows for the first player the best situations are 3 and 4.



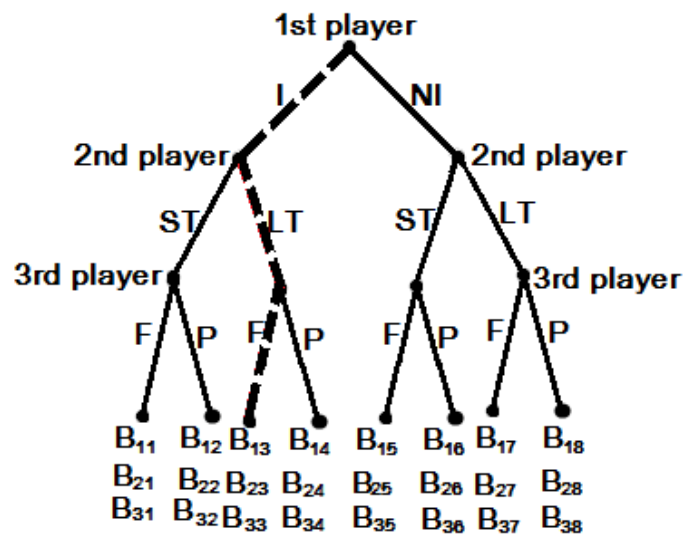
For the second player the best situations are 3 and 6.



And for the third player the best situation is 3.

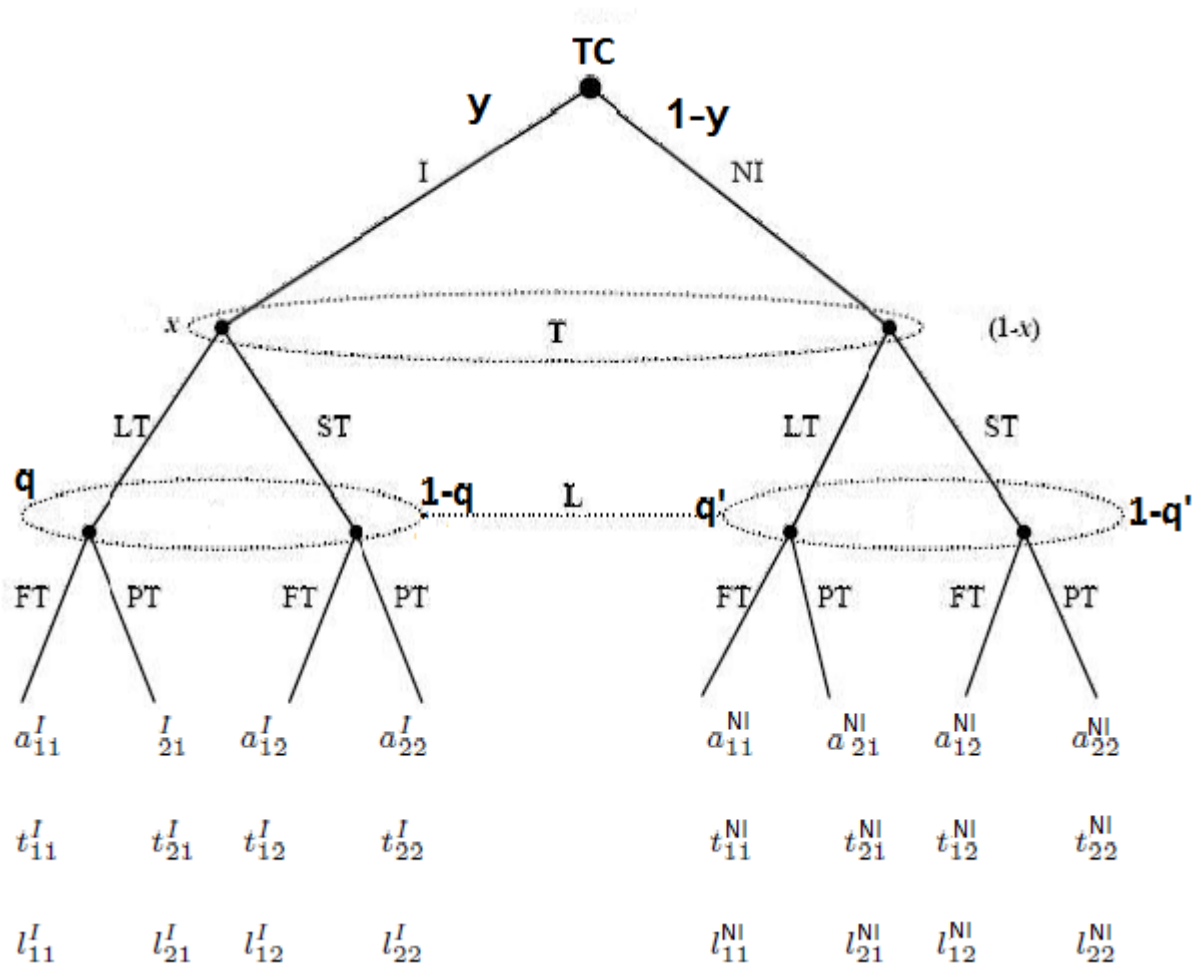


So for the game the Nash equilibrium solution is 3. This is the same as the branch of the tree represented by the dotted lines.



2.2 GAME WITH MIX STRATEGIES

Here We have presented tourism as a game between three players with mix strategies. The first player is a tourist company (TC), the second player is a tourist (T) and the third player is a local habitant (L) who works in a tourist company. TC chooses in the root of the tree between two strategies, with probability y to invest (I) and with probability $(1-y)$ not to invest (NI). With probability x tourists believe that the tourist company made the investment. And with probability $1 - x$ they believe that the tourist company did not make any investment. They have two pure strategies: *to stay a long time (LT) in that place and to stay a short time (ST) which are presented as $\{LT, ST\}$* and the third player is a local habitant who works in the tourist company. And the local habitant strategies are *to work fully with the tourist Company and to work partly with the tourist Company $\{FT, PT\}$* . The game between three players is presented as a binary tree. Game starts the first player and chooses between two tree branches- to invest or not to invest. When the player T's turn to move, and when doing so she is not informed whether player TC choose I or NI is a fact indicated in the figure by the dotted circle. And with probability x she chooses the branch I , and with $(1 - x)$ the branch NI .



This binary tree shows all game's possible situations, where a , t , l are the real numbers of players' benefits in the respective situations. The game can be represented by the matrices A^I and A^{NI}

respectively to the election I and NI.

Election I and Election NI (1)

	LT	ST
$A^I =$	$a^I_{11}, t^I_{11}, l^I_{11},$	$a^I_{12}, t^I_{12}, l^I_{12},$
	$a^I_{21}, t^I_{21}, l^I_{21},$	$a^I_{22}, t^I_{22}, l^I_{22},$

	LT	ST
$A^{NI} =$	$a^{NI}_{11}, t^{NI}_{11}, l^{NI}_{11},$	$a^{NI}_{12}, t^{NI}_{12}, l^{NI}_{12},$
	$a^{NI}_{21}, t^{NI}_{21}, l^{NI}_{21},$	$a^{NI}_{22}, t^{NI}_{22}, l^{NI}_{22},$

Where a^i_{hk} , $i \in \{I, NI\}$, $h, k \in \{1, 2\}$ represent the payoff of the TC corresponding to the different strategy profiles. Analogously t^i_{hk} and l^i_{hk} represent the payoffs corresponding to the tourists and inhabitants. With probability x tourist will play the game given by A^I and probability $1 - x$ the game given by A^{NI} . So, given the strategies $(q, 1 - q)$, $0 \leq q \leq 1$ and $(q', 1 - q')$, $0 \leq q' \leq 1$ followed for the inhabitants whether TC did the investment or not respectively, the expected value that the tourists assign to the strategy LT is:

$$E_T(LT/(q, q')) = x[q t^I_{11} + (1 - q) t^I_{21}] + (1 - x)[q t^{NI}_{11} + (1 - q') t^{NI}_{21}] \quad (2)$$

and the corresponding value for the strategy ST is

$$E_T(ST/(q, q')) = x[q t^I_{12} + (1 - q) t^I_{22}] + (1 - x)[q t^{NI}_{12} + (1 - q') t^{NI}_{22}] \quad (3)$$

So, they choose LT, if $E_T(LT/(q, q')) \geq E_T(ST/(q, q'))$, in other case they choose ST, It follows that this election depends on the values assigned to x . So, the tourist will choose this strategy in the case if $x \geq x(q, q')$, where:

$$x(q, q') = \frac{q'(t_{12}^{NI} - t_{11}^{NI}) + (1 - q')(t_{22}^{NI} - t_{21}^{NI})}{q(t_{11}^I - t_{21}^I) + (1 - q)(t_{21}^I - t_{22}^I) - q'(t_{11}^{NI} - t_{12}^{NI}) - (1 - q')(t_{21}^{NI} - t_{22}^{NI})} \quad (4)$$

(4) is the least value of x such that the tourist chooses *LT*. This value depends, in his turns, on the values of q and q' .

c is the investment for the advertising. To raise tourists beliefs has a cost for the tourist company, we assume that this cost is linear and equal to cx . The level of credibility x if the tourists choose this option, satisfy the inequality of $E_{TC(I)} \geq E_{TC(NI)}$, where:

$$E_{TC(I)} = y[x[P_x(LT)[qa_{11}^I + (1 - q)a_{21}^I] + P_x(ST)[qa_{12}^I + (1 - q)a_{22}^I] - cx] \quad (5)$$

$$E_{TC(NI)} = (1 - y)[(1 - x) \left[P_x(LT) [q'a_{11}^{NI} + (1 - q')a_{21}^{NI}] + P_x(ST) [q'a_{12}^{NI} + (1 - q')a_{22}^{NI}] \right]] \quad (6)$$

$P_x(LT)$ represents the probability that the tourist plays his strategy *LT* given that he believes that with probability x the *TC* made the investment (analogously $P'_x(LT)$ with probability $1 - x$ for *NI*), $P_x(ST) = 1 - P_x(LT)$ these values could be positive in that case if $x = x(q, q')$ because only in this case that the tourists follow a mixed strategy to make a sense.

So, the tourist company will choose this strategy in the case if $E_{TC(I)} \geq E_{TC(NI)}$, where:

$y =$

$$\frac{cx + P_x(LT)[q'a_{11}^{NI} + (1 - q')a_{21}^{NI} - q'a_{12}^{NI} - (1 - q')a_{22}^{NI}] + q'a_{12}^{NI} + (1 - q')a_{22}^{NI}}{P_x(LT)[qa_{11}^I + (1 - q)a_{21}^I + q'a_{11}^{NI} + (1 - q')a_{21}^{NI} - qa_{12}^I - (1 - q)a_{22}^I - q'a_{12}^{NI} - (1 - q')a_{22}^{NI}] + qa_{12}^I + (1 - q)a_{22}^I + q'a_{12}^{NI} + (1 - q')a_{22}^{NI}} \quad (7)$$

So the tourists choose *LT* if and only if they assign a value given by (8).

$$P_x(LT) \geq \frac{cx - qa_{12}^I + (q - 1)a_{22}^I + q'a_{12}^{NI} - (q' - 1)a_{22}^{NI}}{qa_{11}^I - qa_{12}^I + a_{21}^I - qa_{21}^I - a_{22}^I + qa_{22}^I - (q' - 1)a_{22}^{NI} - q'a_{11}^{NI} + q'a_{12}^{NI} + q'a_{21}^{NI}} \quad (8)$$

This means that x must be sufficiently large like so that the tourists decide to come for a long time and sufficiently small like so that the cost of obtain this value does not surpass the benefits associated with this level of credibility.

On the other hand, tourist prefer good services, this means that their decisions also depends on the election done by the inhabitants.

2.2.1 The Nash equilibria of the tourism game

Now we can obtain the values of q , q' and $P_x(LT)$ such that the strategy

$$S^*(x) = ((1, 0); (P_x^*(LT), P_x^*(ST)); (q^*, 1 - q^*, q'^*, 1 - q'^*))$$

is a Nash equilibrium.

The best scenario is that one in which the tourist company invest, the population have an intense participation in the tourist activities, and the tourists came for a long time (*LT*).

The worst scenario, at least from the environmental point of view is those where the tourist company choice is not to do the investment, and the tourists came for a long time. It can happen that the local population decides to work in a such strong way in the activities related to the tourism, that even in case when the central planner does not make the investment, the tourists have interest in remaining in the place by a long period. These possibilities can be represented by means of the following payoffs:

Consider for the tourist company the following payoffs in A^I and A^{NI} given in (1). Where P is the profit of the tourist company,

$$\begin{aligned} a_{11}^I &= I - cx, a_{12}^I = P - cx, a_{21}^I = I - cx, a_{22}^I = P - cx \\ a_{11}^{NI} &= -P, a_{12}^{NI} = 0, a_{21}^{NI} = -P, a_{22}^{NI} = 0, \end{aligned} \quad (9)$$

The following relations between the payoffs for the tourists and for the local inhabitants are natural:

$$\begin{aligned} t_{11}^I &> t_{12}^I, t_{21}^I > t_{22}^I \\ l_{11}^I &> l_{12}^I, l_{11}^I > l_{21}^I, l_{12}^I < l_{22}^I, l_{21}^I < l_{22}^I \\ t_{11}^{NI} &< t_{12}^{NI}, t_{21}^{NI} < t_{22}^{NI} \\ l_{11}^{NI} &< l_{12}^{NI}, l_{11}^{NI} > l_{21}^{NI}, l_{12}^{NI} < l_{22}^{NI}, l_{21}^{NI} < l_{22}^{NI} \end{aligned} \quad (10)$$

It is possible to obtain the values for q and q' such that the tourists prefer to come for a long time independently of the value of x that happens if $q \geq q^*$ and $q' \geq q'^*$ where q^* and q'^* verify the equation

$$E_{Tx}(LT) - E_{Tx}(ST) = 0.$$

This is the case if:

$$0 \leq q^* = \frac{t_{21}^{NI} - t_{22}^{NI}}{t_{11}^{NI} - t_{21}^{NI} - t_{12}^{NI} + t_{22}^{NI}} \leq 1 \quad \text{and} \quad 0 \leq q'^* = \frac{t_{21}^{NI} - 2t_{22}^{NI} + t_{12}^{NI}}{t_{11}^I - 2t_{21}^I + t_{22}^I} \leq 1$$

It means that if the settlers prefer to work hard, then the tourists can obtain a high level of pleasure independently of the action followed for the tourist company. These are not necessarily good news, because if the TC choose does not to invest and the tourists came for the country for a long time then the environment can suffer damage. In this case the local population can obtain profits in the short time and then to improve its social welfare however, this situation can revert in the long period, because if the central planner does not invest in environmental protection the welfare of the population can decrease with the loss in environmental quality.

2.2.2 THE USE OF THE MODEL

Considering the inequalities of (10), the corresponding payments are given by:

	LT	ST
$A^I =$	FT 4, 3, 3	2, 2, 1
	PT 4, 2, 2.5	2, 1.5, 2

	LT	ST
$A^{NI} =$	FT -5, 1/2, 2	0, 1, 3
	PT -5, 1/2, 1	0, 2/3, 4

With these payments, we obtain the probabilities with which a worker decides to work full time in tourist activities, this is:

$$q^* = \frac{t_{21}^{NI} - t_{22}^{NI}}{t_{11}^{NI} - t_{21}^{NI} - t_{12}^{NI} + t_{22}^{NI}} = \frac{1}{2} \quad \text{u} \quad q'^* = \frac{t_{21}^{NI} - 2t_{22}^{NI} + t_{12}^{NI}}{t_{11}^I - 2t_{21}^I + t_{22}^I} = \frac{1}{3}$$

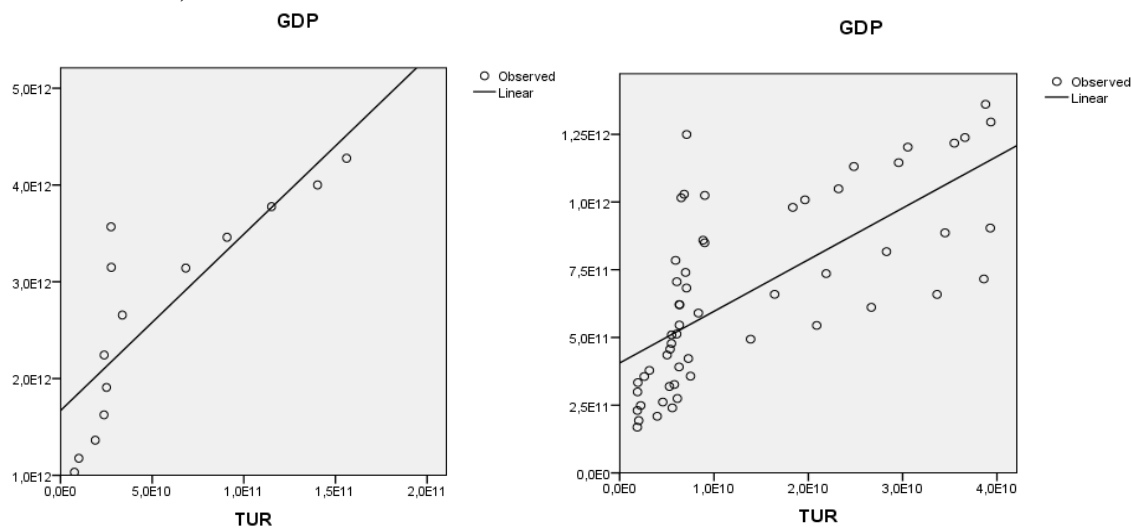
The value of q^* means that workers will be in charge of full time in tourist activities with a bigger probability or equal to 1/2 if there is a tourist investment policy. But when it didn't have the investment, with a probability of 1/3 the workers will be in charge of full time in tourist activities.

On the other hand, as we saw tourists stay long time the case if the way considering (4) and with the obtained values q and q' , we can obtain the probability that the tourists assign to that TC decides to invest, this is $x(q, q^I) = 0.22$ so they play its strategy LT. Also considering (8), the probability that the tourists play LT since they believe with probability $x(q, q^I) = 0.22$ that TC made the investment is $P_x(LT) \frac{0.22c-2}{7}$. In this numerical example c will be bigger at 10 and smaller than 45, this way, the value of x assures that the tourists prefer to make vacations for a long time ($10 < c < 45$):

3. THE RELATIONSHIP BETWEEN THE GDP OF ARMENIA AND THE INCOMES OF TOURISM

Given the importance of the tourism industry, this part of article shows the relationship between the GDP of Armenia and the incomes of tourism for annual data and quarterly data, the relationship between the GDP of Armenia and the number of tourists from different parts of the world are given by regression model.

The relationship between GDP of Armenia and the incomes of tourism for annual data is $y = 1668,7 + 18,233x$, $R^2 = 0.687$ and for quarterly data is $y = 405,9 + 19,055 \cdot x$, $R^2 = 0.482$ it means that when the incomes of tourism is growing by 1 unit then GDP will grow by 19,055. Clearly that the results of the annual and quarterly coefficients are very close: $4 \times 405,9 = 1623,6$ closer to 1668,7.



The relationship between the GDP of Armenia and the number of tourists from different parts of the world has the form $y = 919900 + 0,182X_1 + 3,917X_2 + 14,25X_3 + 0,949X_4$, $R^2 = 0.982$. Where X_1 is the number of tourists from the CIS, X_2 are tourists from the European Union, X_3 are tourists from the US and X_4 are tourists from other countries. Having this relationship we can say that the change of the number of tourists from European Union and the US has large impact on GDP of the country. And the most noteworthy thing is that the sum of the coefficients are equal of 19,29 which is about the same as in the first regression model 19,055.

4. DEA (DATA ENVELOPMENT ANALYSIS)

DEA (Data Envelopment Analysis) is a mathematical programming based method to measure empirically the efficiency and productivity of operating units using multiple inputs to secure multiple outputs. Typically the inputs and the output are incommensurate.

We are using DEA for evaluation of the effectiveness of tours. Where input1 is the cost of tour, input2 is the number of tourist who chose the tour and the output is the income from tour.

Table following on the next page

	Input1	Input2	Output	U	V1	V2	efficiency
Tour1	32	100000	26600	0,025000373	0,824764924	0,006386179	100%
Tour2	40	88000	24000	0,018749845	0,418419407	0,004923401	100%
Tour3	38	75000	11000	0,012499353	0,999567396	0,001326792	75.6%
Tour4	25	50000	8750	0,00937434	0,999587257	0,001140717	67.8%
Tour5	10	45000	4000	0,006248385	0,999797493	0,000333234	50.8%
Tour6	8	50000	4000	0,004685427	0,999852785	0,000214857	67.3%
Tour7	20	40000	6000	0,006249011	0,99957476	0,000437564	55%
Tour8	2	39000	1000	0,002335109	0,99995007	0,00000859506	60.2%

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