

Fair Dictator

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Abstract—We will show the study of the perception of EAFIT University students about which differences in an income are fair or unfair. For this, we did a version of dictator game with some students from different under-graduated programs of the university. Using those results we did a variance analysis and we found that there were not statically significant differences between the way to divide an income from different schools and the students have a meritocratic ideal. We did a linear regression to have a model that describe the behavior of EAFIT University students.

Keywords—Analysis of variance, EAFIT, linear regression, statistics, students.

I. INTRODUCTION

Some decisions that humans make are influenced by their ideas of fairness and inequality. For example, a person can think is fair that the amount that two people earn is different depending on the hours they work but she can think is unfair that the amount that they earn is different by the color of the skin. That idea influences the way that one employer pays to his employees.

The way that we use to know peoples perception about the fairness and inequality is with a dictator game. In this game, the player is the dictator, she has some points that has to divide between him and another player. In the original dictator game, the division of the income of both participant only dependent on what the dictator wants to share [1], but we are going to use a new version of this game that includes some characteristics to divide the income.

Our problem is to know if the perception of the fair inequality of EAFIT University students changes depending on the school that they are. We divided the students in two groups:

- 1) Sciences and Engineering Schools students.
- 2) Economics and Finances Schools students.

In the game, students earn some points in a production phase, in this phase they can work in a game to gain points or do another thing like see pictures and read a website, after a while, the production phase ends and the dictator know the points that she earned. Player can see how much time himself worked and how much time the other player worked, then the dictator has to divide the sum of the points that they earned between them. In the second part of the game, the points that they earn has a value, what is different for each player, so the dictator has another variable to consider where she is going to split the points.

We divided the students in three groups depending on the points they considered fair to share with the other participant, this division was made in “Fairness and the Development of Inequality Acceptance” [2].

- 1) Strict Egalitarian Ideal: dictator divided the points in equal parts.
- 2) Meritocratic Ideal: dictator divided the points depending on how much she and the another player earned.
- 3) Libertarian Ideal: dictator divided the points depending on how much she and the another player earned and the value of the points.

Moral perceptions and the change of our morality through time called the “moral development” is study in some articles, one of them is “The Philosophy of Moral Development” [3] where the author talks about the importance of studying the morality as a feature that influence human behavior. That investigation proved that is good and important to study about perception of fairness.

According to the literature review a lot of authors have to used children like their target population to research about equality and fairness perception, that happens because the popular belief says that children are fairer than adults. W. Damon in his article “The Social World of the Child” [4] described that children are altruist and egalitarian, so the popular belief seems to be right.

In the articles “The Philosophy of Moral Development” and “The Social World of the Child”, authors make some experiments with games, because the major target population are children. With games children show what they consider fair and what consider unfair and it is a different way to get data. For example, J. Piaget [5] used the “bona fide player” game to know the children’s idea of moral rules.

In “Fairness and the Development of Inequality Acceptance” a computer-based game is used to get the answer to the question about the perception of the fairness in children and teenagers. They used two new versions of the “dictator game”. In the first version, one player (the dictator) has to divided some points between him and another player, and in the second, the dictator and the another player have to get the points in a computer game and after that to divide the points.

II. METHODOLOGY

To get the data that we used in this work, we applied an adaptation of the dictator game with some randomly chose EAFIT University students. We divided them in two groups depending on where school they come from. The experiment was done on May 10th of 2016. From 9 am to 10 am, the students from Sciences and Engineering Schools was doing the game and from 10 am to 11 am, the students from Economics and Finances School. We had 26 students in each group, but

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we only could use 34 data because some students sent the information in a wrong way.

A. Dictator Game

To understand the perceptions of students we used two versions of the dictator game which were applied in “Fairness and the Development of Inequality Acceptance” [2], in that game, students have to divide one amount of money.

In this version of the game, all the students played the same game, which was an adapted version of the common Tetrís. Another difference is that in this game all the students played during the same time because the game close itself 5 minutes after they had started to play.

We assigned randomly a number for each student and in the same way we chose a partner for them. In the first phase of the game, the students were given with an amount of money and they had to divide that money between them and their partner. They did not know how much money was given to their partner. This situation is like this:

Dictator Game:
DIVISION ELECTION

You have gotten XX points and you have to choose how much do you want for you.

Your point’s value is 1 pesos.
Her point’s value is 1 pesos.

In the second phase of the game, students had to earn their points with the Tetrís game, the they could see how many points they and their partner earn. We put both points together and they had to choose how many of the sum of the points they wanted for themselves. In this phase the value of the points of every student was the same. This situation is like this:

Dictator Game:
RESULT

You got YY points.
Your point’s value is ZZ pesos.
You have YYxZZ pesos.

Dictator Game:
ELECTION

You and your assigned partner get XX pesos between both.

How many points do you want for you?

How you get the money?

YOU

You got YY points.

Your point’s value is ZZ pesos.

You have YYxZZ pesos.

YOUR PARTNER

She got YY points.

Her point’s value is ZZ pesos.

She has YYxZZ pesos.

The last phase is similar to the second one, but in this case the value of the points of the players could be different.

With each of this phases we study a different variable, in the second one we focus on the differences in the amount of money that students share depending on the self achievements, i.e. if students think that is fair to get more money depending on their effort and the quantity of points that they got in the game. In the third one we focus on how the students share the money depending on the luck, because they could have different values for their points.

This was a realistic game because the points that the students game was payed with chocolates.

After they finished to play the game, we asked them some questions to know some characteristics about them, and how they think about some situations. The questions are these:

Questions:

1. Are you a woman or a man?
2. Imagine two secretaries who are both the same age and are both doing the same job. One of them finds out that the other earns a lot more than she does. The best paid secretary is better at her job in many ways. Do you think it is fair or unfair that one secretary earns more than the other?

3. Choose a point on the scale below:

Those who work hard normally have a better life.

1 2 3 4 5

Hard work does not help, it is luck and connections that are important.

To measure the ideals, m is the amount that individual i considered fair to share. If i has an egalitarian ideal, shares $m^{E(i)}$, if has a meritocratic one, shares $m^{M(i)}$ and if has an libertarian one, shares $m^{L(i)}$.

$$m^{E(i)} = \frac{X}{2},$$

$$m^{M(i)} = \frac{a_i}{a_i + a_j} X,$$

$$m^{L(i)} = \frac{a_i p_i}{a_i p_i + a_j p_j} X,$$

where X is the total income of the two students, a_i is the points that individual i earned, and p_i is the value of the points for individual i .

B. Analysis of Variance

Our main goal was to know if there is statically significant differences between the way to divide an income from different schools, we can do that using Analysis of Variance [6].

Analysis of Variance (ANOVA) is a set of methods use to compare the mean of some data groups. This concept was develop by the statistician and evolutionary biologist Ronald Fisher. Using ANOVA we divide the sum of squares and the degrees of freedom, with this data we calculate a value of Fisher number, then we compare the real value of F-table and the F-calculated. If F-calculated \geq F-table we accept null hypothesis [7].

TABLE I. VARIABLES WE USE IN THE ANALYSIS OF VARIANCE

	Sum of squares	Degrees of freedom	Variance	F calculated
Between groups	SS_B	$K - 1$	V_B	F
Inside groups	SS_I	$N - K$	V_I	
Total	SS_T	$N - 1$	V_T	
F from table ($\alpha = 0.1, K - 1, N - K$) = F_{table}				

where,

$$SS_B = \sum_{k=1}^K n_k (\bar{x}_k - \bar{x})^2,$$

$$SS_I = \sum_{k=1}^K \sum_{j=1}^{n_k} n_k (x_{kj} - \bar{x}_k)^2,$$

$$SS_T = SS_B + SS_I,$$

$$V_B = \frac{SS_B}{K - 1},$$

$$V_I = \frac{SS_I}{N - K},$$

$$V_T = \frac{SS_T}{N - 1},$$

$$F = \frac{V_B}{V_I},$$

where, K is the number of groups and N is the number of data.

C. Linear Regression

Linear regression model finds an estimate model that described a situation where there is a “ y ” variable that it dependent on some “ x ” variables, this model suppose the relationship between the variables is linear, and “ ϵ ” is the error. This is the model structure [8]:

$$y_i = \beta_1 X_{i1} + \dots + \beta_k X_{ik} + \epsilon_i$$

where $i = 1, 2, \dots, T$ and T is the number of variables values that we have and k is the number of variables “ x ” that we have.

To have the linear regression model to our problem, we need to estimate the coefficients β_k , for that we used the following equation because with this we find the estimator of minimum variance (minimum error square).

$$\vec{\beta}_k = (\vec{x}' \vec{x})^{-1} \vec{x}' \vec{y}$$

The variable $\vec{\epsilon}$ has an uniform distribution with average=0 and variance = $\sigma^2 I_i$. We can estimate σ^2 with the following equation:

$$\sigma^2 = \frac{\vec{y}' \vec{y} - \vec{\beta}' \vec{x}' \vec{y}}{T - k}$$

III. RESULTS

The results of the questions that we asked in the experiment are these:

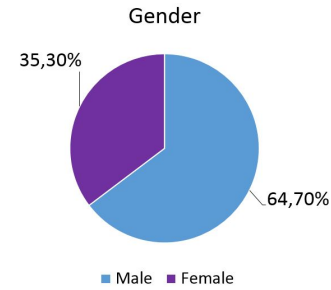


Fig. 1. Gender of the Students

In Figure I we can see that the majority of students are males, so the results describe better the behavior of men.

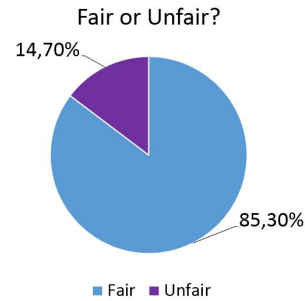


Fig. 2. Concept of fairness with question number 2

In Figure II we can see that the most students think that is fair if there is a difference in an income depending on the self achievements, that show a meritocratic ideal in students.

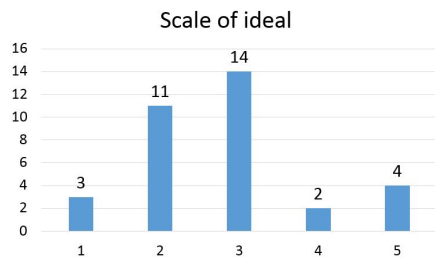


Fig. 3. Concept of fairness with question number 3

In Figure III we can see that the major part of students chose one of the firsts numbers, that shows that they think that the hard work is a variable more important than luck when we want earn an income. This confirm the idea that the students have a meritocratic ideal.

TABLE II. PARAMETERS TO CALCULATE IDEAL

	Average
X	5088.17
a_i	947.058
a_j	1022.14
p_i	3.91667
p_j	3.88889

TABLE III. PERCENT OF ERROR BETWEEN EXPECTED VALUES OF IDEALS AND REAL PROPORTION OF SHARED MONEY

	Expected Value	Error %
$m^{E(i)}$	0.5000	38.3468
$m^{M(i)}$	0.4809	35.9030
$m^{L(i)}$	0,4827	36.1389

We used the data from Table II to find the expected value of the proportion of shared money that we see in Table III, when we compared the expected value for each ideal with the real shared proportion of money, we found that the ideal with the less percent of relative error is the meritocratic ideal. So, we found that the thinking of the students is near to the concept of the thinking of a person who has a meritocratic ideal. We applied the analysis of variance between the two groups of schools and we study it depending on the phase. We work with the proportion of shared money.

The notation that we use is:

- p =proportion of shared money.
- s =quantity of points that student share.
- d =points that the student earn.
- $vald$ = value of points that the student earn.
- c =points that the student's partner earn.
- $valc$ = value of points that the student's partner earn.

In the first phase, the proportion of shared money is: $p = \frac{s}{d}$

TABLE IV. RESULTS PHASE 1

	Science and Engineering Schools	Economics and Finances Schools
Sum	6.13016	4.23256
Average	0.34056	0.26453
n	18	16
Average of every data	0.30478	
Data number	34	

TABLE V. ANOVA PHASE 1

	Sum of squares	Degrees of freedom	Variance	F calculated
Between schools	0.04896	1	0.04896	1.27812
Inside schools	1.22589	32	0.03830	
Total	1.27485	33	0.03863	
F from table ($\alpha = 0.1, 1, 32$) = 2.88				

F-calculated < F-table so we reject null hypothesis, so there are not statically significant differences between two schools in this phase.

In the second phase, the proportion of shared money is: $p = \frac{d}{d+c} s$

TABLE VI. RESULTS PHASE 2

	Science and Engineering Schools	Economics and Finances Schools
Sum	5.31472	6.18745
Average	0.29526	0.38671
n	18	16
Average of every data	0.33829	
Data number	34	

TABLE VII. ANOVA PHASE 2

	Sum of squares	Degrees of freedom	Variance	F calculated
Between schools	0.07084	1	0.07084	1.21562
Inside schools	1.86493	32	0.05827	
Total	1.93577	33	0.05865	
F from table ($\alpha = 0.1, 1, 32$) = 2.88				

F-calculated < F-table so we reject null hypothesis, so there are not statically significant differences between two schools in this phase.

In the third phase, the proportion of shared money which depend on points is: $p = \frac{d}{d+c} s$

TABLE VIII. RESULTS PHASE 3-POINTS

	Science and Engineering Schools	Economics and Finances Schools
Sum	6.52367	4.58678
Average	0.36242	0.28667
n	18	16
Average of every data	0.32677	
Data number	34	

TABLE IX. ANOVA PHASE 3-POINTS

	Sum of squares	Degrees of freedom	Variance	F calculated
Between schools	0.04860	1	0.04860	0.94148
Inside schools	1.65212	32	0.05162	
Total	1.70072	33	0.05153	
F from table ($\alpha = 0.1, 1, 32$) = 2.88				

F-calculated < F-table so we reject null hypothesis, so there are not statically significant differences between two schools in this phase.

In the third phase, the proportion of shared money which depend on the value of points is: $p = \frac{d*vald}{d*vald+c*valc} s * c$

TABLE X. RESULTS PHASE 3-VALUE OF POINTS

	Science and Engineering Schools	Economics and Finances Schools
Sum	8.93149	4.57447
Average	0.49619	0.28590
n	18	16
Average of every data	0.39723	
Data number	34	

TABLE XI. ANOVA PHASE 3-VALUE OF POINTS

	Sum of squares	Degrees of freedom	Variance	F calculated
Between schools	0.37458	1	0.37458	2.01744
Inside schools	5.94151	32	0.18567	
Total	6.31610	33	0.19139	
F from table ($\alpha = 0.1, 1, 32$) = 2.88				

F-calculated < F-table so we reject null hypothesis, so there are not statically significant differences between two schools in this phase.

The variables used in the linear regression model are:

- Quantity of points that student i share: Dependent variable " y_i ".
- Quantity of points that player i got in phase 1: Independent variable " x_{i1} ".
- Points that player i earned: Independent variable " x_{i2} ".
- Points value for player i : Independent variable " x_{i3} ".
- Points that player's partner i earned: Independent variable " x_{i4} ".
- Points value for player's partner i : Independent variable " x_{i5} ".
- School where the student i come from: Independent variable " x_{i6} ". If the student come from Science and Engineering School $x_{i6}=0$ and if the student come from Economics and Finances School $x_{i6}=1$. where $i = 1, 2, \dots, T$, T is the number of students who did the experiment.

The result model was:

$$y_i = 0.3282x_{i1} + 0.2636x_{i2} + 11.8537x_{i3} + 0.3855x_{i4} - 0.5155x_{i5} - 108.0551x_{i6} - 7.4270$$

IV. CONCLUSION

Using the results that we see in the last section, we conclude that there is not statically significant differences between the way to divide an income from different schools in any of the phases of the game. If we want to be sure that this answer is the most correct, we have to repeat the experiment with more students to have a bigger population. The results show in different ways that the students have a meritocratic ideal, i.e. for them is more important the self achievements when they have to divide an income. They think that who work more and better worth a higher income.

The variable which has a bigger impact on the linear regression model is the school where the student come from. The model say that if a student is from School of Economics or Finance, they are going to share 108.0551 pesos less. The next more important variable is the value of the points of the student. If they get a value of the points higher, they would be more generous. And in the third place of the major impact is the error, this is not very big but it is not small, that can be like that because we could not use some variables like the gender because a problem with the number of the identification of students, so the error model the behavior of variables which we do not include.

For the future work we want to repeat the experiment with a bigger quantity of students, we want to split them depending on the undergraduate program, no depending on the school, and we want to improve the game because some students made mistakes in the second and third phase in introduction of the numer of points that they shared.

REFERENCES

- [1] A. O. Gary E Bolton, ERC: A Theory of Equity, Reciprocity, and Competition, *The American Economic Review* 90 (1) (2000) 166–193.
- [2] I. Almas, A. Cappelen, E. Sorensen, B. Tungodden, Fairness and the Development of Inequality Acceptance, *Science* 328 (2010) 3.
- [3] A. Abram, *The Philosophy of Moral Development*, Spring 12 (2007) 71–86.
- [4] W. Damon, *The Social World of the Child*, Jossey-Bass Publishers (1977) 361.
- [5] J. Piaget, *The Moral Judgement of the Child*, Free Press (1965) 369.
- [6] H. N. Gudmund R. Iversen, *Analysis of Variance*, SAGE Publications 2 (1987) 3–13.
- [7] D. Massart, B. Vandeginste, L. Buydens, S. de Jong, P. Lewi, J. Smeyers-Verbeke, *Handbook of Chemometrics and Qualimetrics: Part A*, Elsevier (1997) 85–102.
- [8] D. Moore, *Estadística Aplicada Basica* 2 (2005) 120–138.