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Rute Alves da Cunha [α], Tatiane Almeida de Menezes [σ], Andrewen Felipe Santos Bezerra [ρ] & Isabel Pessoa de Arruda Raposo [ω]

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I. Introduction

Bullying is a phenomenon recognized worldwide for its perverse effects. It can be observed in different spheres where there is social interaction, such as education and work environments. Specifically focused on the school setting, there are evidences that quantify the magnitude of the negative repercussions of bullying on the academic performance of students who are victims (KIBRIYA *et al*., 2015; OLIVEIRA *et al*., 2018), pointing out its harmfulness.

Still in the context of the school environment, it is pertinent to highlight the role of friendships in the classroom. A positive association was found between the grades of the group of friends to which a student belongs and the grades of this individual (RAPOSO *et al*, 2019). This is an important indicator that suggests the potential of friendship networks as a means to achieve academic success, under the proper stimuli.

This work proposes to contribute to the thesis that the school environment and peer effects are fundamentals for their performance. Having friends or being part of a particular group can directly impact the chances of a student being bullied or not. In this sense, we seek to measure the probability of being bullied based on the context effects and peer effects. For instance, we are working with a unique dataset that comes from a survey carried out in 2017 and 2018 by the Fundação Joaquim Nabuco – FUNDAJ, a research institute that integrates the Brazilian Ministry of Education.

To deal with the reflexive problem (MANSKI, 1993) present in peer effect estimation we are applying a Spatial Lag Model of X with Instrumental Variable (SLX-IV) and as instrument we are using the lagged classroom friendships weight matrix (BRAMOULLÉ *et al.*, 2009).

In addition to this Introduction, this article consists of five more parts. The first contextualizes the topics of bullying and peer effects according to the scientific literature in the fields of Economics, Psychology and Psychiatry. In the section tree we describe the dataset and the empirical strategy. In the fourth part, the results are presented with a brief discussion about them. Finally, we present some conclusion.

II. Theoretical Framework

Bullying is defined as a form of violence (verbal or physical) that happens in a repetitive and persistent way, addressed against one or more colleagues, characterized by targeting the weakest in order to intimidate, humiliate or mistreat those who are targets of these aggressions (BULLYING, 2020). Bullying not only occurs in different ways, but can also have serious impacts on the physical integrity, psychological health and even academic performance and professional future of its victims. Studies have searched to identify the relation and the magnitude of the effect, between being bullied or performing bullying in the school environment and student achievement.

Kibriya *et. al* (2015), for example, find that being bullied weekly at school negatively influences students' math scores. Ponzo (2013) establishes a binary variable that indicates whether the student has had something stolen from him or herself or if he or she has been bullied or hurt by another student. The author also finds a negative relation between exposure to bullying and academic performance; especially in the case of those who have had something stolen from them and who, among these, have been pressured by classmates to do something they did not want to do. Additionally, a result

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that is worth pointing out is the prevalence of bullying in larger classes.

Impacts on psychic health were also investigated. Kumpulainen *et al.* (2001) found that most children actively or passively involved in bullying had some psychiatric disorder, such as depression, anxiety, fears, attention deficit disorder, and psychosomatic symptoms. It is worth noting that such disorders were more common among those who practice bullying and those who, in addition to practicing, are also victims. In the long term, Klomek *et al.* (2015) observed that victims are at high risk of developing psychological problems, and perpetrators tend to be involved in crime, specifically violent crimes and illicit drug use.

Due to its viscerally social character, it is important to explore the way in which bullying travels social interactions. Oliveira et. al (2018) highlight that social skills and emotional stability play an important role in reducing the likelihood of a student being bullied. Fekkes et al. (2006) even recommend, in their study, that children with anxiety, depression or some other factor that makes them susceptible to victimization by bullying, such as having few friends, not being popular or being under assertive, should be referred to a psychology professional to be educated in social skills as a means of preventing bullying. This recommendation is reinforced by the study by Sharp (1996), which, in addition to this strategy, exposes the importance of involving colleagues in combating and preventing bullying.

In addition to the perceptible relevance of direct social interactions, there is also the indirect factor of responding to peer pressure. It is possible to imply, based on Bursztyn *et al.* (2015), that there is a need to keep up appearances because of the expectation of classmates. Students with excellent academic performance purposely lowered their performance when they were told that their peers would know their grades (BURSZTYN *ET AL.,* 2015). This may be linked to the apprehension of being bullied and being labeled a nerd. Woods *et al.* (2004) explore bullying in two aspects: the relational, such as the exclusion an individual from the group, and the direct characterized by aggressiveness and the practice of direct violence against the victim. They find that students who experience relational bullying are nearly three times as likely to have lower-than-expected academic results.

Studies in the area of social networks and peer effects have been carried out in the field of Education Economics. Through different methods, research has often reached the same result: there is a positive impact of the academic performance of colleagues on the performance of an individual who is part of the group (CALVÓ-ARMENGOL *et al.*, 2009; HANUSHEK *et al.*, 2003; RAPOSO *et al*, 2019). In addition, Sund (2009) points out that this effect may not be linear for all types of students, since he finds that students with low academic performance benefit more from living with colleagues whose performance is higher. Similarly, Vardardottir (2013) shows that, when students are placed in classes with students who have higher average ability, this generates a positive and significant effect on the grade of these students. When low-achieving students are found together, a negative effect is perceived (LAVY; SILVA; WEINHARDT, 2012). From the perspective of the duration of friendship links, Patacchini *et al.* (2017) show that connections lasting more than a year tend to positively influence an individual's academic results in the long term.

Given all of the mentioned, then, it can be seen that the friendship networks are crucial information of an individual's social skills and susceptibility being bullied or performing bullying. For this reason, such a topic proves to be of great relevance to be studied.

III. Model

a) Data Set

Data for this study derive from a survey carried out in 2017 and 2018 by the *Fundação Joaquim Nabuco – FUNDAJ*, a research institute that integrates the Brazilian Ministry of Education. The research involved 6th and 7th graders in public schools of the city of Recife and consisted of a panel with students that were closely monitored during the two years of this survey. Students, their guardians, teachers and school principals answered a detailed questionnaire that resulted in a very complete set of information related to school and out-of-school aspects, which included information related to the practice and experience of *bullying*, as well as friendship networks in the classroom. In 2017, of the 3,274 respondents who took both tests, 21.28% answered in the affirmative to the direct question about having been *bullied* during the period in which the survey was carried out. Of the 3,170 in 2018, 19.64% reported being bullied. In order to assess school achievement, students took math and a Portuguese tests at the beginning and ate the end of the school year, for both years of the research, totaling four tests for each subject.

An important characteristic of the 6th grade of Primary and Lower secondary education is that this is the students' first year in the so-called "Middle School" (BRASIL, 2018, p.27). In the city of Recife, particularly, children are almost always relocated to new schools during the transition from 5th to 6th grade, as could be verified in the research: 87.56% of students declared that they were newcomers in 2017. This fact should be especially highlighted in this paper because it is probable that, this year, students will form new friendships and build bonds with each other; as well as they may be more susceptible to being bullied by older students, for example. In its turn, in the 7th grade, with more time of coexistence, the friendship bonds tend to be firmer and some social dynamics may be adjusted.

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In this article, only data collected in 2018 is being used due to a few reasons: it is the most complete sample in terms of the fit between answers to socioeconomic questions and those about friendships; it captures a second moment in the school life of the students who participated in both periods, and their bonds of friendship are firmer. By eliminating missing and outlier information, a total of 2,809 observations remained, a reduction of only 11.38% of the initial sample in 2018.

The control variables are described in table 1. The outcomes are Portuguese and mathematics scores (from 0 to 100) of the tests applied at the end of each year. The variable representing bullying victimization is a dummy, where it equals 1 when the student reports being bullied and 0 in another case.

Table 1: Descriptive Statistics of the Variables

Variable	Meaning	Average	Standard Deviation
N2_Portuguese	Student's Portuguese grade	37.28	18.71
N2_Mathematics	Student's Mathematics grade	36.71	20.14
dbullied	Dummy if the student claimed to be bullied	0.16	0.37
age	Student Age	12.42	0.74
male	*Dummy* if the student is male	0.51	0.50
race	*Dummy* if the student is deemed to be white	0.20	0.40
studies	Frequency of student study	3.23	1.35
security	*Dummy* if the student feels safe in the neighborhood of residence	0.70	0.46
tdisciplined	Intensity of the teacher's perception of how disciplined the class is	2.17	0.66
Number of Observations	2869		

In the survey data, the connections between students is also carried out, where they could point up to 5 other students as their friends. In this way, it is possible to link one student to another, see their characteristics and generate inferences about behaviors, influences, etc. It is worth mentioning that, even if an individual points to another as a friend, it should not necessarily be assumed that this relationship was reciprocally informed. Therefore, there is a vast and complex range of identified relationships.

b) Empirical Strategy

This paper proposes to contribute to the theory that the school environment and the students' friendship network are essential to their performance. Having friends or being part of a certain group can directly impact the chances of a student being *bullied* or not. In this sense, we seek to identify the impact of *bullying* on students' grades according to the general equation described below:

$$lnY_{i,s} = \theta + \delta Bullying_{i,s} + \sum_{k=1}^{6} \beta^k g_{ij,s} X_{j,s}^k + \sum_{k=1}^{6} \sigma^k X_{i,s}^k + \epsilon_{i,s} \quad (1)$$

where Yi,s are the educational outcomes, here, the Portuguese and mathematics grades of the student i in the class s; $Bullying_{is}$ represents the probability that the student i in the class s being bullied based on the vulnerability of their friends being bullied[1], the vector $X_{i,s}^k$, skcomprises a set of sociodemographic attributes of the student i, being k=6 is the number of control variables used, already described in the Data section: male, color, age, studies, security, and disciplined. The use of Spatial Econometrics is necessary here because, in order to measure peer effects, it is necessary to insert the characteristics of the student's friends into the equation, capturing their influence on the variable of interest. Such characteristics are represented by the element $g_{ij,s}X_{j,s}^k$, which $X_{j,s}^k$ includes the same six attributes mentioned, but for the student j and $g_{ij,s}$ is a matrix of weights, composed of ones and zeros, which links each individual to their connections in the network of friendships; that is, this term translates the characteristics the characteristics of i's j friends.

This is a model classified as Spatial Lag Model of X (SLX), where the regression coefficient linked to the weight matrix presents the effects of contextual or exogenous interactions. In this work, however, there is a difficulty regarding the endogeneity caused precisely by the nature of social interactions. The student chooses his friends for reasons of affinity according to his own individual characteristics; therefore, it is expected that such attributes affect both the grade and the probability of being bullied. And the presence of complete interaction prevents the identification of the effects of group *outcomes* from the influence of the exogenous characteristics of its members (GIBBONS *et al.*, 2014). In other words, the problem of reflection (MANSKI, 1993) exposes a reality of back-and-forth, where the individual

[1] In the survey of the network of friends in the classroom, the Fundaj Survey (2018) asked each student interviewed to list up to five best friends, who could or could not be in their class.

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influences his peers, who in turn also influence, as a group, the individual.

Following Bramoullé *et al.* (2009) our identification strategy is based on an instrumental variable using the lagged classroom friendships weight matrix as instrument. The lagged friendship matrix provides a structure of intransitive connections that are crucial for the identification of the peer effect. The intuition of this one is as follows: consider a simple network with three students A, B and C. For assumption A and B are friends with each other, as are B and C. However, A and C are not friends. So the only way C could influence A's behavior would be through B. C's characteristics are therefore good instruments for the effect of B's behavior on A because they certainly influence B's behavior, but they cannot influence directly the behavior of A (PATACCHINI & VENANZONI, 2014).

In the first stage, the estimated equation can be described as below:

$$Bullying_{i,s} = \alpha + \lambda g^2_{ij,s} Bullying_{j,s} + \sum_{k=1}^{6} \tau^k g_{ij,s} X^k_{j,s} + \sum_{k=1}^{6} \varphi^k X^k_{i,s} + \varepsilon_{i,s} \quad (2)$$

where, $g^2_{ij,s}$ denotes the indirect friendship ties, that is, the matrix of weights of zeros and ones $g_{ij,s}$, which, multiplied by itself, generates the lagged matrix used in this study. Thus, the element $g^2_{ij,s}$ Bullyingj, stranslates to the fact that friends of friends of i, who are friends of j, are bullied or not. The component $g^2_{ij,s}$ Bullying j,s of equation (2) is the instrument considered in this study for the effect of *bullying* suffered by i.

In the second stage, the impact of the probability of being bullied on the student's academic performance is measured as described in the equation below:

$$lnY_{i,s} = \theta + \delta \widehat{Bullying}_{i,s} + \sum_{k=1}^{6} \beta^k g_{ij,s} X^k_{j,s} + \sum_{k=1}^{6} \sigma^k X^k_{i,s} + \epsilon_{i,s} \quad (3)$$

In which the independent variable represents the investigated educational outcomes: the scores obtained in the Portuguese and mathematics tests applied at the end of the year. The other control variables are the same as mentioned above.

In practice, two-stage least squares regression is performed using the single *ivreg2* command in the STATA statistical software, with sample adequacy, with school-level weights, previously using the *svyset* command based on the 2017 sample. As the sample was stratified at the school level, the cluster option was used in all models presented in the next section, in order to control for heteroscedasticity and obtain robust estimates of the variances across the 87 clusters of schools, although there is a loss of efficiency.

IV. Results

Table 2 shows the correlation between the probability of a student being bullied (*dbullied*) relative to the chances of their indirect friends being exposed to bullying (G2bullied), using a linear regression in which, to each column, a control variable is added referring to characteristics of the individual's direct friends.[2] For the variable in the first row, the results show significant coefficients at 1%, varying little as new variables are added to the model. In this way, it appears that G2bullied is a strong candidate for an instrument for estimated bullying to be applied in the second stage of the methodology.

Table 2: Correlation between Instrument and First Stage Dependent Variable[2]

	Dependent Variable: *dbullied*						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
G2dbullied	0.249**	0.273**	0.305**	0.307**	0.306**	0.307**	0.311**
	(0.027)	(0.026)	(0.024)	(0.023)	(0.023)	(0.023)	(0.022)
Gmale		-0.061**	-0.022	-0.023	-0.023	-0.023	-0.022
		(0.012)	(0.017)	(0.017)	(0.017)	(0.017)	(0.018)
Gage			-0.004**	-0.005**	-0.006**	-0.007**	-0.005
			(0.001)	(0.001)	(0.002)	(0.002)	(0.003)
Grace				0.024	0.024	0.023	0.022

[2] Variables starting with "G" are the control variables, specified in the Data section, spatially lagged.

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				(0.025)	(0.025)	(0.025)	(0.025)
Gstudies					0.006	0.005	0.007
					(0.008)	(0.008)	(0.008)
Gsecurity						0.014	0.014
						(0.024)	(0.024)
Gdiscip							-0.015
							(0.012)
_cons	0.135**	0.154**	0.175**	0.175**	0.175**	0.174**	0.174**
	(0.010)	(0.011)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
N	2869	2869	2869	2869	2869	2869	2869
R^2	0.097	0.109	0.117	0.118	0.118	0.119	0.119
Statistics-F	83.47	75.48	79.65	61.13	54.16	47.66	44.99

Standard error in parentheses. Statistics-F refers to the global model.

* $p < 5\%$, ** $p < 1\%$.

For both stages, robustness tests were applied to the model and its results. The first is the model under-identification test, where the rejection of the null hypothesis suggests that the model equation is correctly identified. For the model proposed in this work, the null hypothesis was rejected in both regressions against the dependent variables. There is also the weak identification test, where the null hypothesis translates that the instrumental variables used to estimate the endogenous variable are not really adequate to fulfill this role. Here, in none of the regressions of the IV-SLX model, the Cragg-Donald Wald F statistic was less than the Stock-Yogo critical values. Therefore, the instrument G2dbullied is a good predictor for the endogenous variable Wdbullied. Then there is the weak instrument robust inference test, which seeks to assess whether there are regressors that are not endogenous and that there is orthogonality. For this test, the results do not reject the 5% significance level.

In addition, the Generalized Method of Moments in Two Steps was used, with the option *gmm2* in the estimation, in order to ensure more robust and efficient tests regarding heteroscedasticity and autocorrelation. The results reinforce those of the tests mentioned above. And, in the second stage specifically, Hansen's J statistic test is applied, in which the null hypothesis seeks to identify whether the controls and instruments are valid, that is, not correlated with the error term; the result here being that the equation is exactly identified.

Tables 3 and 4 describe the impact of the *bullying variable* on grades in Portuguese and Mathematics, respectively. In both tables, column (1) corresponds to the result of the regression by OLS, this estimator being theoretically biased. In column (3), the characteristics of the friends are inserted into the model, making it an SLX. In columns (2) and (4), the instrument for the probability of being *bullied* according to indirect friendships is applied; differing from the model of column (4) by the integration between the instrumental variable and contextual effects (IV-SLX), which is the model proposed in this work. In all models, the characteristics of the individual enter as control variables.

Table 3: Results for the outcome of the Portuguese grade

	Dependent Variable: ln N2_Portugues			
	(1) OLS	(2) IV	(3) SLX	(4) IV-SLX
dbullied	-0.169**	-0.286*	-0.168**	-0.223*
	(0.051)	(0.113)	(0.050)	(0.110)
male	-0.068*	-0.068*	-0.054	-0.053
	(0.033)	(0.033)	(0.038)	(0.037)
race	-0.011	-0.018	-0.009	-0.012
	(0.036)	(0.037)	(0.037)	(0.038)
age	-0.066**	-0.066**	-0.066**	-0.065**
	(0.022)	(0.021)	(0.021)	(0.022)
studies	0.034*	0.035**	0.033*	0.034*

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Table 3: Results for the outcome of the Portuguese grade

	Dependent Variable: ln N2_Portugues			
	(1) OLS	(2) IV	(3) SLX	(4) IV-SLX
	(0.013)	(0.013)	(0.013)	(0.014)
security	-0.003	-0.014	-0.000	-0.006
	(0.034)	(0.035)	(0.033)	(0.034)
tdisciplined	-0.067*	-0.067*	-0.049	-0.049
	(0.031)	(0.030)	(0.039)	(0.040)
Gdbullied			-0.087	
			(0.062)	
Gmale			-0.028	-0.028
			(0.025)	(0.026)
Gage			-0.001	-0.002
			(0.005)	(0.005)
Gstudies			0.010	0.010
			(0.014)	(0.014)
Gsecurity			0.064	0.073
			(0.057)	(0.053)
Grace			-0.028	-0.022
			(0.048)	(0.048)
Gdiscip			-0.022	-0.024
			(0.024)	(0.024)
_cons	4.405**	4.424**	4.370**	4.368**
	(0.318)	(0.310)	(0.329)	(0.324)
N	2803	2803	2803	2803
R^2	0.039	0.033	0.047	0.043
Statistics-F	10.72	8.12	10.96	6.49

Standard error in parentheses. Statistics-F refers to the global model. Regression corrected for school-level clustering.
**p< 5%, **p< 1%.*

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The results in column (4) of Table 3 indicate that having an incremental increase of 10% in the probability of being *bullied* can reduce the student's Portuguese grade by 2.23%, as the dbullied variable can assume values between 0 and 1. This reflects the thesis that being *bullied* is linked not only to the characteristics of the individual, but to his/her network of friends as a whole: having friends or being part of the socially appreciated or disappreciated circle of friends influences the chances of becoming a victim of bullying that , in turn, impacts academic performance.

In Table 4, which describes the impact of being *bullied* on the math grade, column (4) informs the coefficient value for the complete model, where increasing the chances of being *bullied* by 10% reduces the student's math grade by 2.75%. Such evidence reinforces that there is a very strong social factor on the probability of becoming a victim of *bullying*, and that it goes beyond the exogenous characteristics of the individual himself

Table 4: Results for the outcome of the Mathematics grade

	Dependent Variable: ln N2_Mathematics			
	(1) OLS	(2) IV	(3) SLX	(4) IV-SLX
dbullied	-0.036	-0.247*	-0.037	-0.275*
	(0.050)	(0.108)	(0.051)	(0.113)
male	-0.019	-0.021	-0.008	-0.006
	(0.046)	(0.044)	(0.051)	(0.049)
race	-0.004	-0.016	-0.002	-0.017
	(0.050)	(0.052)	(0.051)	(0.053)
age	-0.028	-0.026	-0.025	-0.022
	(0.020)	(0.022)	(0.021)	(0.024)
studies	0.011	0.013	0.009	0.012
	(0.013)	(0.012)	(0.013)	(0.012)
safety	0.095*	0.076	0.096*	0.074
	(0.045)	(0.043)	(0.044)	(0.042)
tdisciplined	-0.085*	-0.084*	-0.083	-0.086
	(0.037)	(0.038)	(0.046)	(0.048)
Gdbullied			-0.041	
			(0.062)	
Gmale			-0.023	-0.031
			(0.027)	(0.026)
Gage			-0.005	-0.006
			(0.006)	(0.006)
Gstudies			0.008	0.009
			(0.011)	(0.011)
Gsecurity			0.088*	0.092*
			(0.040)	(0.043)
Grace			-0.024	-0.018
			(0.050)	(0.047)
Gdiscip			-0.000	0.003
			(0.028)	(0.030)
_cons	3.890**	3.917**	3.844**	3.869**
	(0.260)	(0.271)	(0.285)	(0.303)
N	2809	2809	2809	2809
R^2	0.013	-0.002	0.017	-0.002
Statistics-F	3.10	4.49	5.04	4.75

Standard error in parentheses. Statistics-F refers to the global model. Regression corrected for school-level clustering.
** $p < 5\%$, ** $p < 1\%$.*

The results measured here are in the same direction as the evidence found in the literature: Oliveira *et. al* (2018) also find a negative impact of being *bullied* on the math grade of students in the same age group as the one considered here; as well as Kibriya *et. al* (2015), but taking into account students of an older age group. From the perspective of performance in linguistic knowledge, Ponzo (2013) identifies a negative relationship between the ability to interpret texts and being a victim of bullying.

It is noted that in both results, the OLS model has a significant positive bias on the Portuguese score compared to the other specifications; however, this does not make use of the instrumented variable, but of the data informed by the individual about being *bullied* or not. Such a bias may suggest a few things: there is

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an omitted variable, such as some physical characteristic not taken into account in this case, as well as being *bullied* as an individual may be less harmful than having friends who are also victims.

In addition, we see a more intense perverse effect on the math grade than on the Portuguese grade. In the survey, Portuguese is one of the subjects that students say they like more than they don't, unlike mathematics. It is possible to speculate that being a good student in Portuguese may be more socially acceptable than in Mathematics, since this subject is closely associated with being a *nerd*, a characteristic commonly linked to victims of bullying.

V. Conclusion

Given the evidence in the literature about the negative impact of the consequences of being bullied, both in the short term and throughout an individual's life, we emphasized the need to investigate not only the magnitude of this on the outcomes of success, but also through which paths it permeates. As it is an essentially social phenomenon, it makes sense to observe its effects through networks of relationships.

In this study, we sought to measure, via a two stages least squares IV-SLX model, the effect of the probability of being bullied based on the characteristics of the friendship networks of lower secondary education students in the city of Recife, on two outcomes: Portuguese and Mathematics grades. The spatial lagged friendship matrix was used as an instrument to deal with endogeneity that come from reflexive problem (MANSKI, 1993).

Significant and robust results were found in several tests that indicate a negative impact of *bullying* on the student's school performance: by increasing the probability of being bullied by 10%, it decreases the Portuguese and Math grades by 2.33% and 2.75%, respectively. Such indicators reinforce the argument of the degree of importance given to relationship networks, and not just the characteristics of the individual, on the probability of being a victim of bullying and suffering from the impact of its consequences in other areas of life.

Finally, this research tested the spatial lagged friendship matrix as an instrumental variable to identify the impact of peer effects on the student's probability of being bullied and its effect on Portuguese and Math scores. Indeed, this paper reinforces the necessity for a joint effort from areas such as Economics and Psychology, to investigate and trace in detail the mechanisms that justify the results obtained here.

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