A game theory model applied to the program: young people building the future in Mexico

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Abstract

Unemployment and poverty rates have impacted society in recent years, especially in the most vulnerable population. Governments have established programs that try to eradicate these problems. In this case, this work focuses on analyze, based on the game theory methodology, a viable option that allows the contract of the "Jóvenes Construyendo el Futuro" program to be made official, giving a new possibility of insertion into the labor market to the interns. The results obtained show that the Nash equilibrium is found when the company decides to formalize the contract that was previously had, and the intern decides to accept. This taking into account 2 conditions; that the company offers a balanced salary, and the intern provides production that meets the expectations established by the company. The study was oriented towards the identification and solution of the aforementioned problems, focusing particularly on poverty and unemployment. The general goal was to design effective measures that contribute to the progressive eradication of these socioeconomic challenges.

Key Words

Introduction

Addressing the issue of poverty is complicated, as understanding its components requires more than just knowing the economic level of those identifying as poor. According to Ortiz and Ríos (2018), poverty is not only a social issue; other factors like geographic and cultural aspects must be considered. Therefore, it is essential to assess whether a population or community has the ability to lead fulfilling lives to determine if it is impoverished. In this context, Sen (1999) emphasizes the relevance of individual capabilities in determining their own existence, underscoring that control over income is just one aspect of this broader picture.

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"A game theory model applied to the program: 'Jóvenes Construyendo el Futuro' in Mexico."

One of the origins of such poverty is the level of unemployment, which can arise when there are more people seeking work (labor demand) than available job positions (job supply). In developing nations, the focus on unemployment primarily centers on the formal labor market, which is usually more limited than the informal sector, sometimes leading to significant differences in size (PIIE, 2014). Particularly, Rosas and Jiménez-Bandala (2018) note the positive correlation between the level of unemployment and the likelihood of falling into a poverty trap, concluding that there is a significant relationship between poverty and unemployment.

According to the International Labour Organization (ILO, 2003), the concept of unemployment is structured on three criteria, where "Unemployed Persons" include all those of working age who are: a) "without work," meaning they do not have paid employment or are self-employed; b) "currently available for work," meaning they are available for paid employment or self-employment; c) "seeking work," meaning they have taken key actions in a recent period to find paid employment or self-employment.

Due to increasing unemployment rates, the youth has started exploring various strategies to contribute to their household incomes. These solutions include seeking support through government programs like "Jóvenes Construyendo el Futuro" and non-governmental organizations. Similarly, many young people opt for informal jobs or even venture into entrepreneurship out of necessity. In Mexico, the "Jóvenes Construyendo el Futuro" program, considered one of the flagship programs of the federal government, is designed in the context of poverty and unemployment. It aims to train young people for the labor market, thereby reducing unemployment (Miquel, 2022). According to the Government of Mexico (2021), "Jóvenes Construyendo el Futuro" is an Executive-driven program with the main objective of providing work-related training to young people aged 18 to 29 who are neither working nor studying. The training provided by companies lasts for 12 months, and participants receive a monthly scholarship that started at $3,600 and has increased in relation to the minimum wage. Currently, young people receive a monthly scholarship of $6,310.

Currently, the program has 2,491,595 beneficiaries, of which 1,053,151 are men and 1,438,444 are women (Government of Mexico, 2023). Although the program aims to train young people and support them during their job search, it has not been conclusively proven that it ensures successful integration into the labor market after the training. Many participants fail to find employment after completing the training (Miquel, 2022), meaning these young people return to being part of the unemployed statistics.

Based on the above, this work aims to find agreements (equilibriums) between the government and companies, such that young beneficiaries remain employed after completing their training. The analysis to achieve this objective is through game theory, where the conditions to reach the proposed end are reported.

In addition to the introduction, the work presents a review of the literature on agreements and strategies in the labor market. Subsequently, the methodology on game theory is presented; in the following section, the analysis of these, as well as the results, is shown. In the penultimate section, the literature is compared with our results, concluding with conclusions, limitations, and future work.

Literature Review

The literature on government intervention to reduce unemployment is extensive. For example, García and Cruz (2017) analyze the causes of the decrease in unemployment in Latin America between 2000 and 2013, posing the question of whether the reduction in unemployment is due to labor market reforms or increased capital accumulation. They conclude that capital accumulation is the main factor in reducing unemployment, supporting the idea that complementing and promoting government programs that encourage investment and stimulate effective demand can be an effective decision to reduce unemployment in society.

Aragón et al. (2021) highlight the importance of household well-being and its connection to the development of financial markets. They analyze how families use financial instruments to meet their needs and goals, pointing out that the financial stability of households in Mexico is affected by factors such as credit management and household composition.

Thus, the information provided by Aragón et al. (2021) and García and Cruz (2017) in the context of government policies is considered to improve the economic situation of young people and, consequently, that of families. Both approaches support the creation of a broader economic and labor welfare strategy, where investment, job creation, and financial education combine to benefit families and society as a whole.

The "Jóvenes Construyendo el Futuro" program is directly related to the fundamental principles of the National Development Plan (NDP), which emphasizes the importance of understanding economic growth and increased productivity as means to achieve the general well-being of the population. The NDP, in its 2018-2024 edition, establishes that community development is a higher goal (Quiroz, 2021). In this scenario, the main success of the program lies in its comprehensive approach to promoting the development of communities. This program stands out by addressing various areas, such as economic, social, educational, health, artistic, and cultural aspects, in different regions of the country. An additional merit is that these programs are designed to systematically and effectively address the fundamental issues affecting community development. Thus, the "Jóvenes Construyendo el Futuro" program significantly contributes to achieving the goals of the NDP, establishing a direct connection between strengthening youth and the overall well-being of society.

The program holds significant relevance in relation to the National Development Plan (NDP) in three crucial areas. 1) As a novel program, it is necessary to evaluate if, during its first year of implementation, it has undergone significant changes in its design and operation, following the General Guidelines for the Evaluation of Federal Programs. 2) In assessing its contribution to national goals and objectives, it seeks to confirm the alignment of the program's purpose with the current NDP and its cross-cutting strategies. In this context, it is essential to identify shared concepts between the purpose of the "Jóvenes Construyendo el Futuro" Program and the objectives of sectoral, special, or institutional programs, ensuring that achieving the purpose directly contributes to the program's goals. 3) Finally, the integration of Results-Based

Budgeting (RBB) in the program is positioned as a fundamental component to allocate resources efficiently and correct possible deficiencies in its design, thus promoting the effectiveness and continuous improvement of the program for the benefit of the participating young population (Juarico et al., 2021).

This work analyzes the employment situation of young beneficiaries in the "Jóvenes Construyendo el Futuro" program. Analysis regarding the employment situation of young people can be found in Majed (2018), which highlights the difficult situation that youth in Lebanon face, especially regarding employment opportunities and social marginalization. It points out the lack of job opportunities and structural inequalities in access to quality education, factors that have led to profound marginalization of youth in the country.

In this regard, Leston (2022) mentions that individuals with greater opportunities for job placement are those with better quality education, residing in developed territories. In Mexico, more than two decades ago, a process of restructuring began, resulting in job losses for thousands of workers. The reason behind this relationship is that this transformation left many people who previously worked in the industrial sector in a vulnerable situation, with difficulties reintegrating into the labor market (Silva, 2016).

Often, young people face the challenge of finding employment, largely due to the limited network of professional contacts they usually have. In this sense, Vacchiano et al. (2018), based on a sample of 250 young people aged 20 to 34 in the metropolitan area of Barcelona, highlight the significant influence of personal contacts in job searching, a fundamental characteristic in the labor market. The authors point out that such influence becomes more relevant during periods of economic crisis, emphasizing its importance in the success of job searching and job retention in various sectors and situations.

Regarding the training involving young beneficiaries of our analysis, Rivera-Aguilera et al. (2020), through an analysis of a fast-food company in 2019, divided into a four-month period; analyze the organizational spaces of a training program to understand its effects on the production of young workers. The results were presented through two axes: 1) dimensions of organizational space and 2) from space to the subject; the results show a postmodern young worker molded from a logic associated with their self-esteem. Finally, the importance of these training and job placement processes is highlighted, aiding in the consolidation of functional young individuals.

On the other hand, Alvarez-Sousa (2019) points out the factors that prevent the young working population of the European Union from not only staying employed but also becoming entrepreneurs. Among these factors are entrepreneurial spirit, the image of entrepreneurs, risk propensity, gender, age, education, perception of the household's economic situation. Added to contextual aspects: unemployment rate, labor relations system, and the country's development where they live.

Maintaining constant or stable employment is a signal for any company's work environment, which can help its positioning in the labor market. In this regard, Zenteno-Hidalgo and Silva (2016) analyze the relationship between the work environment and its effect on the productivity of workers for a Chilean natural resources company. Key factors for a better organizational climate include remuneration and

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fairness, teamwork and leadership, quality and effectiveness, communication, reduction of fear and increased trust, job security, and support for performance. They conclude that such a work environment reinforces the performance of workers and thereby the company's position in the market.

The analysis of labor productivity in small and medium-sized enterprises (SMEs) in Mexico highlights the importance of government programs to boost this aspect. Baltodano and Leyva (2020) emphasize the need to increase participation in these programs and improve their dissemination, noting the limited evidence on the real impact of current policies. In this context, the Mexican government's "Jóvenes Construyendo el Futuro" program seeks to provide work experience through training in companies, which plays a significant role in the context of SMEs. This program has a positive impact by offering companies access to talented and well-trained young individuals, while also providing young people with concrete opportunities to improve their experience and labor productivity.

Materiales y métodos

In this work, the decisions of young employees and the company are analyzed. Based on this, we will identify the conditions that confirm that it is in the best interest of both parties for young individuals to remain employed and for the company to continue hiring them. The analysis will be conducted using concepts from game theory, and for this purpose, it is helpful to define the following concepts.

Definition 1 (Kreps, 1990): A game is a strategic interaction between two economic agents, referred to as players, represented as follows:

$$\Gamma = \{N, A_i \times A_j, U_i(a_i, a_j)\},$$

where N is the number of players, A_i is the set of strategies for player i, $a_i \in A_i$, is the strategy of player i, $a_j \in A_j$ is the strategy of player j and $U_i(a_i, a_j)$ is the payoff function for player i.

Faced with the different decisions that player j, can choose, player i should, through deductions or previous behaviors, have a better response. That is,

Definition 2 (Mas-Colell et al., 1995): Let $\Gamma = \{N, A_i \times A_j, U_i(a_i, a_j)\}$ be a simultaneous game, a strategy a_i is a better response from player i a_j of player j, if,

$$U_i(a_i, a_j) \geq U_i(a_i', a_j), \forall\, a_i' \in A_i \qquad\qquad (1)$$

The better response can be denoted as $a_i = MR_i(a_j)$. In this way, we have the following fundamental concept in game theory,

Definition 3. A Nash equilibrium is a profile of strategies $(a_1^*, a_2^*, \ldots, a_n^*)$, such that for each player $i = 1, 2, \ldots, n$, a_i^* is a better response to the best responses of player $a_j^*, j \neq i$, That is, $a_i^* = MR_i(a_j^*)$ and $a_j^* = MR_j(a_i^*)$ for all $j \neq i$. In particular, for two players, a Nash equilibrium (a_1^*, a_2^*) satisfies that a_1^* is a better response to a_2^* and a_2^* is a better response to a_1^*.

To get a realistic approach to the hiring and training situation of young employees, 15 interviews were conducted with young interns from the Huauchinango region, Puebla, who are currently participating or have been part of the program. In addition, the questionnaire helps to better understand the behavior, effectiveness in entering the job market, and the willingness of respondents to work in training companies.

Based on the presented methodology, a game theory scenario will be deduced, where the players are the Intern and the Training Company.

On the part of the company, there are two options: to hire and not to hire.

On the part of the intern, there are the options to accept and not accept, as shown in Table 1.

Table 1. Relationship between Interns and Companies regarding hiring and salary

		Intern	
		Accepts	Does not accept
Company	Hires	U_{Em1} / U_{Be1}	U_{Em2} / U_{Be2}
	Does not hire	U_{Em3} / U_{Em3}	U_{Em4} / U_{Em4}

Source: Own elaboration

Where:

U_{Em1} = Company's utility if it hires and intern accepts

U_{Em2} = Company's utility if it hires and intern does not accept

U_{Em3} = Company's utility if it does not hire and intern accepts

U_{Em4} = Company's utility if it does not hire and intern does not accept

U_{Be1} = Intern's utility if accepts and the company hires

U_{Be2} = Intern's utility if does not accept and the company hires

U_{Be3} = Intern's utility if accepts and the company does not hire

U_{Be4} = Intern's utility if does not accept and the company does not hire

Utility functions for the company,

$$U_{Em1}(Hire, Accept) = P_b - W_b \qquad (2)$$

$$U_{Em2}(Hire, Do\ not\ accept) = P_{Pr} - W_{Pr} \qquad (3)$$

Where:

P_b = Labor productivity of the intern

P_{Pr} = Labor productivity of the professional

W_b = Intern's salary

W_{Pr} = Professional's salary

Utility functions for the intern,

$$U_{Be1}(Hire, Accept) = W_{Em} - 0 \qquad (4)$$

$$U_{Be2}(Hire, Do\ not\ accept) = W_{o\ e} - t \qquad (5)$$

Donde:

W_{Em} = Salary in the training company

$W_{o\ e}$ = Salary in another company

t = time in search (monetary)

The value of t can be interpreted as an opportunity cost for the worker to take the job. Thus, the conditions for the intern to decide in favor of the company's proposal are,

$$W_{Em} - 0 > W_{o\ e} - t \qquad (6)$$

Therefore, to approach the specific value of the opportunity cost (t), we have,

$$t > W_{o\ e} - W_{Em} \qquad (7)$$

Another condition for the company to decide to hire the intern is,

$$P_b = P_{Pr} \qquad (8)$$

Analysis:

Labor productivity (P) was taken from OECD information (2022), which indicates that the GDP per hour worked in Mexico is 94.1 USD, equivalent to 16,675 Mexican pesos.

The information gathered during the interviews was used to establish the Intern's Salary (W_b) of $6,350, as interns are willing to reduce their salary to $4,500 despite being willing to go even lower (Figure 1).
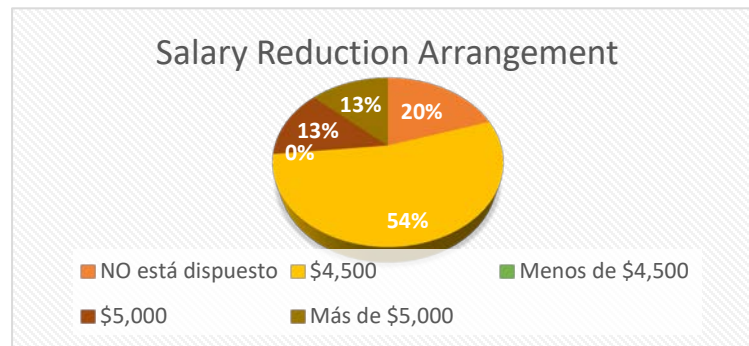
Figure 1: Percentages obtained from the 15 interviews conducted regarding respondents' willingness to accept a salary reduction. Source: Own elaboration

The General Labor Law (1970) indicates that the minimum wage is the smallest amount that a worker must receive in cash for services rendered during a working day. Thus, by substituting the values obtained into expression (2), we have,

$$U_{Em1}(Hire, Accept) = 16,675 - 6,350 = 10,325$$

The salary paid to a professional (W_{Pr}) was obtained according to Forbes (2023), which mentions that a sufficient salary is 8,600 pesos (464 dollars) per month. Based on expression (8), we have

$$P_{Pr} = 16,675$$

Then, substituting these values into (3),

$$U_{Em2}(Hire, Do\ not\ accept): 16,675 - 8,600 = 8,075$$

The company's utility (U_{Em3}) if it does not hire the intern and the intern accepts is obtained from the difference in utilities between hiring the intern or the professional.

$$U_{Em3}(Does\ not\ hire, accepts): 8,075 - 10,325 = -2,250$$

In the case where the company does not hire and the intern does not accept, there is a utility of 0, as there is no expected labor productivity or salary to be paid.

$$U_{Em4}(Does\ not\ hire, Does\ not\ accept): 0 - 0 = 0$$

When the company hires the intern and the intern accepts, the intern has a utility equal to the Intern's Salary (W_b), because there is no opportunity cost (t) to consider. Therefore, substituting the values into (4), we have,

$$U_{Be1}(Hire, Accept): 6,350 - 0 = 6,350$$

The salary that the intern could obtain in another company ($W_{o\,e}$) was based on the premise that the increase would allow going from a daily salary of \$172.87 to \$207.44, which would be equivalent to \$6,310

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monthly according to the Government of Mexico (2022). Thus, based on expression (5), we have the following,

$$U_{Be2}(Hire, Do\ not\ accept): 6{,}310 - 19{,}050 = -12{,}740$$

The variable t was obtained considering the journalistic article by Mendoza (2022), where it was reported that 77% of the unemployed, almost eight out of ten people, spent between one and three months unsuccessfully searching for job opportunities. During three months of search, the person would be foregoing a salary of $6,350 that the training company would be paying. By multiplying that salary by the months of search, we get a result of $19,050; a value where expressions (6) and (7) are satisfied. Additionally,

$$U_{Be3}(Does\ not\ hire, Accepts): 0 - 6{,}350 * 3 = -19{,}050$$

If the company decides not to hire and the intern chooses not to accept, the obtained utility (U_{Be4}) is 0. This is because the intern has no salary (income), and there is no expected salary, meaning there is no loss.

$$U_{Be4}(Does\ not\ hire, Does\ not\ accept): 0 - 0 = 0$$

Resultados

By substituting all the intern's and company's utility expressions (See Table 2), we have the conditions to generate equilibrium. In this case, if the company decides to hire, then the best the intern can do is to Accept. If the intern decides to Accept, then the best the company can do is to Hire. Therefore, (Hire, Accept) is the equilibrium for both players.

Table 2. Relationship between Interns and Companies regarding hiring and salary (Numerical data)

		Intern	
		Accepts	Does not accept
	Hires	11,275/5,400	8,075/-9,890
Company	Does not hires	-3,200/-16,200	0/0

Source: Own elaboration.

According to the above, the main objective of this research is to find an option that allows companies to formalize the hiring of interns once their training is completed, preventing them from becoming

unemployed. According to the data obtained from respondents, it was found that 60% of interns were unable to find employment after completing their training (Figure 2)."
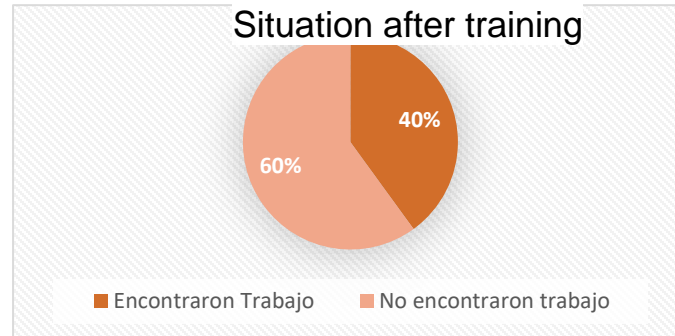

Figure 2. Outcome of the 15 survey respondents regarding their situation after completing their training.
Source: Own elaboration.

This is because, in case the trainee is not hired by the training center, they will be offered a menu of options such as the 'Month 13,' as indicated by the Government of Mexico (2020). However, incorporation into the labor market is not always achieved in these cases.

The search for these conditions defined an equilibrium between the company's situation and the intern, thereby implying the reduction of unemployment at the national level. Finally, in relation to the Sustainable Development Goals (SDGs), this research covers the following objectives:

1) End poverty; the model deduces that young interns do not remain unemployed, achieved through the formalization of a contract at the end of training.

8) Decent work and economic growth; in this model, by formalizing the contract, it seeks to do so with an adequate salary so that the intern is willing to be hired; moreover, such a contract should comply with established laws.

10) Reduction of inequalities; this model helped reduce the inequality faced by young interns in the absence of hiring compared to professionals who are hired in their place.

17) Partnerships to achieve goals; this model can be adopted and applied in various companies that train and can hire interns.

Additionally, the proposed hypothesis was fulfilled: finding a fair salary will contribute to reducing unemployment, which, in turn, will decrease poverty rates, allowing interns to attain decent jobs. To achieve the expected goals, it is crucial for companies to work together in establishing an appropriate salary.

Discussion of Results

The model deduced that, upon completion of the intern's training, the company should provide them with a job. This job should be dignified and decent, meaning a job where the worker's human dignity is fully respected, with no discrimination, access to social security, and continuous training. Such characteristics will increase productivity, and the benefits could be shared. Dignified or decent work also includes unconditional respect for the collective rights of workers, such as freedom of association, autonomy, the right to strike, and collective bargaining (Chamber of Deputies of the H. Congress of the Union, 1970).

In Mexico, the Jóvenes Construyendo el Futuro program is focused on young people who are neither working nor studying, aiming to prevent the risk of dropping out of school. This approach is supported by Robles and Valle (2016), who highlight a strong association between student employment and labor conditions (salary, working hours, and economic activity) with school dropout in Mexico. In this line, Rodríguez et al. (2016) find a relationship and benefit between study and labor market integration. The authors emphasize the social vulnerability of the young population, as they face the challenge of transitioning to the working world, and their training is essential for labor market integration.

This study used a game theory model to represent possible scenarios in the hiring of young interns participating in the Jóvenes Construyendo el Futuro program. These scenarios deduced conditions to reach an equilibrium between labor supply and demand, i.e., decisions of acceptance and hiring between companies that train and hire and young people who train and learn. Equilibrium models can be found in Roth and Wilson (2019), who mention that market design has come to consider models, such as complementary approaches to examine different ways markets operate within an economic environment. They are focused on the labor market belonging to economic models, where their agents operate and interact rationally.

In this article, the players are companies and young interns who rationally seek to maximize their expected utility. Companies seek a certain labor productivity from interns, while young people expect adequate remuneration that allows them to stay in the workforce. According to Munck (2001), rational choice theory in interdependent decision-making is a set of theoretical principles and formal methodology known as game theory. Within this methodology, emphasis is placed on actors, strategic choices, and their ability to generate predictions in a logical and consistent manner.

Lin et al. (2019) address a cooperative game theory model between one player, which is the energy factory, and another player: the suppliers. The authors consider different conditions as scenarios within the game: full coalition, no coalition, and partially coalition. The Nash equilibrium found in their case explains the stabilization between the pricing strategy of the energy factory and that suppliers can conspire to control the price. This justifies our position regarding analyzing scenarios that allow the formalization of the contract for young interns. Such game scenarios are; (Hire, Do Not Accept), (Do Not Hire, Accept), (Do Not Hire, Do Not Accept), and (Hire, Accept).

In particular, our model deduces the scenario (Hire, Accept) as the Nash equilibrium. The objective was formulated through the analysis of the current situation in the labor market and various current problems.

A relation on the use of the methodology can be found in the research conducted by Roth (1984), where he provides an analysis of game theory on some contemporary problems facing the market at that time. Within his article, he secondarily mentions the problems encountered in the organization of this market and some of the solutions that were reached.

Conclusions

The study applied a game theory model to the labor market, specifically to young people between 18 and 29 years old who are neither working nor studying and who are part of the Jóvenes Construyendo el Futuro program. This was done with the aim that, upon completing the program's training, the insertion of interns into the labor market would not be guaranteed.

In this context, it was considered a viable option for registered training companies in the program with financial capacity to keep such interns on their staff. Our analysis considered two fundamental conditions; first, that the intern provides production equivalent to what a professional could contribute, and second, that the company provides a balanced salary of $6,300. These conditions achieve a Nash equilibrium (Hire, Accept), where the most favorable utilities are obtained for each player.

By offering young people meaningful opportunities, one can contribute to a more promising and equitable future, which, in turn, can have a positive impact on society as a whole. It can be concluded that training programs for young people can play an essential role in shaping functional skilled workers. Thus, emphasizing the importance of such programs for the effective integration of such populations into the labor market. In this context, it is strongly recommended to continue the program, as it was identified as a viable solution to address the mentioned problems. This program has not only proven to be effective but also provides a solid framework for creating meaningful job opportunities. Favorable conditions were found that, when integrated into the program, can further enhance its positive impact.

It is important to note that this option could have repercussions in other sectors of the labor market. For example, it may cause a scarcity of job opportunities for professionals or individuals with more experience. Analyzing a population different from young interns is left for future work. Finally, involving macroeconomic effects and poverty issues mentioned in the study are part of the limitations of our analysis, which are also left for future research.

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