

Article

Simulation of Corruption Decisions—An Agent-Based Approach

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Abstract: Corruption is one of the biggest barriers to sustainable development. Several objectives of the Sustainable Development Goals (SDGs) are directly linked with the fight against corruption, as it has an influence on the achievement of every single development goal. The aim of this research is to examine decision-making patterns in a typical corruption situation. The following research questions have been formulated: (1) what kind of decision-making approaches are effective against partners maintaining different strategies, and how do these relate to certain generations? (2) Is there a difference between the behavior patterns of employees of SMEs, large corporations, and the public sector in a situation that provides the opportunity for corruption? To answer these research questions, an agent-based corruption experiment was conducted, building on the prisoner's dilemma. The relationship between cooperation and corruption was examined through the analysis of decision-making situations to uncover when and with which partners (artificial agents) the participants first start to cooperate or become corrupt. The results show that there is a significant difference in the propensity to cheat among different generations. Furthermore, the behavior patterns of employees of large corporations, SMEs, and the public sector also show deviation in a corruption situation.

Keywords: sustainability; UN sustainable development goals; corruption; fraud; public procurement; agent-based experiment



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1. Introduction

The relationship between sustainable development and corruption has been well covered in the scientific literature, since corruption has a significant effect on the economy, the environment, and society [1]. Corruption can be considered as the barrier to sustainable development [2], especially in the case of developing countries [3,4]. Due to corruption, the failure of maintaining laws and regulations weakens environmental well-being [5] and is harmful to environmental sustainability [6–8]. Corruption also has a negative impact on the human capital sustainable development index (HCSDI) [9]. By analyzing the 10-year data of 185 countries, Hoinaru et al. [10] concluded that there is a clear correlation between high-level corruption and low-quality economic and sustainable development, while the undesirable effect of corruption is more negative in high-income countries. Corruption threatens the implementation of sustainable development goals in all sectors [11] and is harmful not only to single economies, countries, and regions, but also regarding humanity as a whole [12].

Among the Sustainable Development Goals, SDG16 (‘Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels’) integrates several sub-targets that are directly linked with the fight against corruption. These sub-targets are 16.4 (by 2030, to significantly reduce illicit financial and arms flows, strengthen the recovery and return of stolen assets, and combat all forms of organized crime), 16.5 (to substantially reduce corruption and bribery in all their forms), 16.6 (to develop effective, accountable, and transparent institutions at all levels), 16.7 (to ensure responsive, inclusive, participatory

and representative decision-making at all levels), and 16.10 (to ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements) [13].

Decreasing corruption is key in enabling the success of the complete Agenda 2030 [14]. It has a significant impact on achieving SDG 9 (build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation), SDG 11 (make cities and human settlements inclusive, safe, resilient, and sustainable), SDG 12 (ensure sustainable consumption and production patterns), SDG 14 (conserve and sustainably use the oceans, seas, and marine resources for sustainable development), SDG 15 (protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss), and SDG 17 (strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development) [1,14].

Regarding the determination of sustainable development goals, referring to the public and private sector, corruption appears particularly within two indicators of the SDG 16.5 goal: 16.5.1 and 16.5.2: the proportion of persons (or businesses) who had at least one contact with a public official and who paid a bribe or were asked to bribe during the previous 12 months (p. 19, [13]).

This research aims to investigate the decisions of the private and public sector in a typical corruption situation, with the following research questions: (1) what kind of decision-making approaches are effective against partners maintaining different strategies, and how are these related to certain generations? (2) What are the behavior patterns of SMEs in a situation facilitating corruption?

2. Material and Methods

2.1. Corruption in Relation to the Private and Public Sector

The factors that influence the propensity of companies to be corrupt have not been well discussed, although the company's size and other characteristics also influence corrupt behavior. It is legitimate to ask why some firms (employees) are more prone to corruption than others. These questions were informed by the work of Arnold et al. [15] who, based on the principal-agent theory and the fraud triangle, found that the presence or absence of mechanisms to control and prevent corruption is one of the most critical characteristics of firms in the fight against corruption. For this reason, it is crucial to consider the corporate environment in which individual decisions are made, as the complexity of the organisational structure affects the effectiveness of these control and prevention mechanism. Ferris et al. [16] studied the persistence of corporate corruption in a sample of privately owned companies in 12 Central and Eastern European countries between 2001 and 2015. They found that corruption increases firms' profitability, which may thus be a motivating factor.

Corporate corruption, in other words the corrupt behavior of enterprises, belongs amongst the serious problems of today's global societies. Corporate corruption is "the misuse of formal power by a corporate representative for organizational or private benefit" (p. 960, [17]). The corruptive and corrupted actors can be individuals, groups, or institutions. The actors can be part of the private/business sector or the public sector (governmental and local governmental sector). Furthermore, Castro et al. [17] suggest investigating the corruption within corporations, among corporations, and in the relationship between corporations and the government. However, due to mergers and concentrations, it is difficult to separate these cases [18]. The main manifestations of corporate corruption are kickbacks, fraud, and bribery, but embezzlement, nepotism, patronage, collusion, ghosting, bid rigging, and price fixing can also be included [19]. The wide definition of corruption by Bahoo et al. [20], based on an extensive literature review, is accepted as "an illegal activity (. . .) conducted through misuse of authority or power by public (government) or private (firms) officeholders for private gain and benefit, financial or otherwise" (p. 2). According to this definition, corruption can be interpreted in both the public as well as the private

sector, including a wide range of activities. On a macro-level, high-quality and extensive empirical research examines the effects of corruption on GDP, morality, and human capital; however, the perspective of the relevant corporate level is a less researched area [21–23].

Corruption in the private and public sector occurs if a “quid pro quo” exists among state officials and representatives of firms. Concerning the firms, active corruption, or in the case of public officials, passive corruption, is more common. According to the international examination of the World Bank [24], the most common forms of corruption between the private and public sector involve the attainment of governmental contracts, the acquisition of construction contracts, and presents given to public officials in return for “taking care of things”. Thirty percent of the examined companies consider corruption as a major limiting factor. While governmental corruption afflicts poorer countries the most, corruption in the private sector affects richer nations instead [25].

Regarding the impact of corruption on firm performance, almost two thirds of micro-level studies find that corruption has a detrimental effect on firm performance, i.e., a “sand on the wheel” or “grabbing hand” effect, while one third of studies find that it “greases the wheels” [26]. The detrimental effect is predominantly for established firms, while the greasing the wheels effect is specific to start-up and expanding firms [27]. For companies, corruption means a serious legal, financial, operational, and reputational risk; it hinders fair competition and impedes development [28]. Furthermore, it is a major factor in deterring responsible management [29]. Corruption is a vicious circle, since companies might be forced to become corrupt due to a corporate environment with an existing high level of corruption, thus further increasing the phenomenon [30].

2.2. Individual and Organisational Influential Factors of Corruption

From a theoretical point of view, psychological, criminological, and economic frameworks can explain why individuals commit corrupt acts [31]. Attitudes towards corruption have the greatest influence on a desire for corrupt activities, but the perceived choice also has a negative impact [32–34]. Empirical research supports the close relationship between the attributes of individuals (as well as their social relations) and corrupt behavior [35]. Dong et al. [36] underlined that corruption is not an isolated behavior; it depends on the behavior of partners (peers) and other individuals. Among the individual determinants of corruption, the literature suggests that age, gender, education, marital status, income, employment status or type of settlement, and region are relevant factors, although the results are not always clear [22,37]. Criminological findings show a negative correlation between age and non-compliance and this is also evident in the case of corruption [37,38]. Several studies have found that older people are less tolerant of corruption [39,40]. There is an inverted U-shaped relationship between age and involvement in corruption [22,41]. Torgler and Valev [38] found no significant relationship between the justifiability of corruption and the self-employment and unemployment status of individuals.

The younger generation’s perception of corruption differs from that of the older generation, which is also due to the fact that they identify and define corruption differently [42]. This is interesting because accepting that culture influences our behavior and values, accepted norms and behaviors are passed down from generation to generation, but this does not mean that they do not have an influence on perception [43,44]. One of the most important policy tools in reforms to reduce endemic corruption is to gradually instil in the younger generation a set of anti-corruption attitudes and norms against corrupt practices and their consequences [44]. In this context, the attitudes of generations X, Y, and Z towards corruption are critical issues. Education is the way to achieve intolerance towards corruption and its harmful consequences in the younger generation.

In respect to organisations, there are contradictory results in the literature as to whether bigger or smaller companies are more characterized by corruption. Baucus and Near [45] pointed out that large enterprises operate in a dynamic competitive environment, and therefore, they are more prone to corruption. However, they also have more to lose, since corruption in their cases can bring serious consequences both from a reputational [46]

and financial point of view. Typical corruption situations of multinational companies include examples such as: if they cannot transact business without bribery in the recipient country due to cultural and economic reasons; if the legislation of the recipient country is weak; or if the company is involved in corrupt activities anyway, even in its domestic environment [20].

According to Martin et al. [47], smaller local enterprises are more vulnerable than large corporations; therefore, they are more prone to corruption. Small- and medium-sized enterprises are more likely to be affected by corruption, since they are focusing on short-term survival, their financial resources are limited, they have a weak ability for advocacy, they rarely enter the stock exchange that requires compliance with strict regulations, and the tighter relations among SME employees might create a more tolerant culture towards corruption [48]. The research dealing with the relationship between the SME sector and corruption highlights that corruption and bribery hinder SMEs' access to financial sources [24] and the development of small enterprises in general. However, SMEs become involved in bribery for strategic reasons, in order to overcome administrative and market-related obstacles [49]. Other authors argue that if SMEs do not want to engage in corruption, they are forced to do so, and the performance of SMEs is negatively affected by bribery [50]. In their examination focusing on public servants and private sector employees, Gorsira et al. [31] determined that there is no difference in the motivation factors for corruption among these groups. The most important influential factors both in active as well as in passive corruption are social norms, in particular the behavior of close colleagues, individual norms, i.e., the individual's ethical belief in corruption, and the observed potential for applying corruption rules.

The different strategies are based on the competitive procurement methodology described by Wang [51]. As the consequences of decisions are delayed before they reach the participant's knowledge, they may be more prone to fraud. With the low chance of being caught out, individuals benefit significantly from cheating as it ensures they achieve the expected results [52]. People with higher education and income are also more likely to cheat. It is also significantly influenced by social dynamics, which otherwise lead to a kind of "social exclusion". There is often a perception that because the system is corrupt, nothing can be done to eliminate corruption at the individual level until the system is changed.

In general, there is a trade-off between perceptions of inefficient systems, the beliefs of the population, the social environment, and individual behavior [53].

2.3. Methodology of Corruption Research

Corruption is not easy to observe, and its measurement also presents difficulties [54]. According to the classic economic view, corruption can be considered as part of a rational cost-benefit analysis. It is often deeply integrated (especially in developing countries) into social and economic decision-making processes and has profit-based motivations, thus turning corruption into a glue of social attitudes and institutionalizing the grey zone of the economy, as well as the evasion of bureaucracy, generating short-term growth in developing countries [55–57]. The prior driver of these transactions is mutual trust. However, the operational analogies of the normal business sector cannot be mapped to the grey economy. Uncertainty and risk remain at the core of corruption-economy research [58].

Corruption research under the classic approach is based on econometric models. López and Mitra (2000) modelled corruption between the government and companies in a cooperative and non-cooperative situation. Edison et al. [59] built a macroeconomic model based on secondary macro-indicators. The model was grounded on linear correlation, using a well-established methodology (OLS—ordinary least squares), using governmental corruption as one of the explanatory variables. The "neoclassic" approach of corruption research places the central focus on the determination of corruption costs (transactional extra costs) [60]. The main driver of corruption is the minimization of risks alongside the maximization of expected utility. These studies are mainly built on secondary macro data, occasionally supported by the results of primary questionnaire analyses.

The corruption research derived from game theory is often related to (quasi) artificial intelligence approaches, as the individual behaviors in a corruption situation are often examined through agent-based algorithms. Although these models presume individual decision-makers, through a minor abstraction, these can be transposed to the corporate environment. The most well-known models are: Schelling's model [61] based on segregation, Axelrod's approach [62] with the prisoner's dilemma, and the cobweb model of Arifovic [63]. Compared to the previous models, the novelty of these methodologies lies in the ability for simulations and algorithmization, thus making it possible to assign more complex decision-making graphs and mechanisms to the participants. In real business decisions, actors do not operate in isolation but can communicate with each other, so Polowczyk [64] proposes the use of the hunter's dilemma, which fits in well with the concept of evolution. It is the idea that hunters cooperating in a hunt could together take more prey. However, if after the hunt one hunter stopped cooperating and took all the prey, the other hunter had to consider whether it was worth cooperating with his/her partner next time.

Following the review of empirical research focusing on corruption, the forthcoming consequences can be drawn: (1) most studies dealing with corruption at the macro-level rely on simple regression models based on secondary data analysis. (2) Those empirical studies that address the micro-level are limited to content analysis using financial data or non-financial reports, corruption-related documents of the firms, or interviewing them about their activities and actions within the grey economy [20]. (3) By determining any kind of methodology for the examination of corruption, it is very difficult to obtain reliable data. The available secondary data handle company-level corruption only with difficulty, while the reliability of inquiry-based primary data is also questionable, although they are based on voluntary admissions due to the sensitiveness of the topic.

3. Methodology

Considering the sensitiveness of the topic, as well as the isolation of the participants [65–67] and researching the relevant literature [68–72], it has been concluded that the most effective examination method of corporate (organisational) corruption is an experimental agent-based decision-making simulation built on algorithms as many studies highlight it [73–79]. Considering the interpretation of corruption, the most obvious starting point is a prisoner's dilemma with only two players, thus making full use of the special circumstance that the Nash equilibrium will not lead automatically to an optimal result for both parties. Through the decision-making situations extended to the relation of cooperation and defection (corruption), the following can be examined: how the trial participants behave in different situations and with different partners (artificial agents); when they first start to corrupt or cooperate; and how long this strategy is maintained.

Experiment-based methodologies offer several benefits and advantages in researching corruption [80–82]:

1. Control: Experiments allow researchers to control the variables that might affect the outcome of the study, which helps to isolate the effect of a particular factor on corruption.
2. Replicability: Experimental results can be easily replicated by other researchers, which helps to increase the reliability and validity of the findings.
3. External validity: Experiments can be designed to be representative of real-world situations, which increases the external validity of the results.
4. Objectivity: Experimental designs can minimize the influence of personal bias on the results, which increases the objectivity of the findings.
5. Precision: Experiments can provide precise measures of the relationships between variables, which allows researchers to make more accurate conclusions about the causes of corruption.

Overall, experiment-based methodologies can provide valuable insights into the underlying causes of corruption and help policymakers develop more effective strategies for combating it. However, this methodology also has some disadvantages as well such

as ethical considerations (experiments involving human participants may raise ethical concerns, especially if the study involves manipulating or exposing participants to potentially harmful conditions); limited generalizability (the results of an experiment may not necessarily generalize to other populations or contexts, as the study is typically conducted under controlled conditions); time and cost (experiments can be time-consuming and costly to design and conduct, especially if they involve multiple stages or large sample sizes); complexity (experiments can be complex to design and analyze and may require specialized skills and expertise); and demand characteristics (participants in an experiment may alter their behavior in response to being in an experiment, which can affect the validity of the results [82]).

For the study, the following situation was established: the government is announcing a construction procurement procedure. The companies taking part in the process need to possess special knowledge, since there has not been a previous example in the construction of a new, multifunctional building in the country. The number of those companies that meet these conditions is very low; therefore, all of the participants need to consider whether they undertake the procurement procedure alone or if they are applying for the tender in a consortium with their rivals. In possession of the exchanged information, the partners can decide to cooperate (adhere to the preliminary agreement and compete in a consortium) or to commit fraud (they steal their partner's idea and compete alone). In this sense committing fraud is considered as a corrupt behavior.

During the development of the experiment, five agents were determined, and all of them were given a typical name: (1) the 'copying agent' cooperates first and then executes the same actions as the trial participant. (2) The 'fraud agent' defrauds continuously regardless of the decision of the participant. (3) The 'cooperative agent' cooperates continuously regardless of the decision of the participant. (4) The 'avenger agent' cooperates at first, then continues to cooperate while the participant does so, but as soon as the participant starts to defraud, the agent will also defraud and from that point on defrauds continuously. (5) The 'detective agent' cooperates first, then defrauds, then cooperates and cooperates once again. If in the meantime the participant defrauds, the detective agent turns into a 'copying agent'; however, if the participant never defrauds, the 'detective agent' turns into a 'fraud agent' and takes advantage of the participant.

For the simulation, a web-based application was developed with two actors: the participant and the agent. The agent makes its decisions according to the pre-determined objective functions, taking into account the decisions of the participant. In terms of the research questions, the decisions of the participants were examined; they could either chose to cooperate or commit fraud.

The experiment consists of four steps: (1) the experiment starts with a practice round, where the participant can reveal the decision-making situation and the context of the experiment. (2) The practice round is followed by five experimental rounds with five different agents. The players do not know in advance how the single partners are going to behave and how many rounds they are going to play with a single agent. Every participant plays 10 decision-making rounds with all of the agents, resulting in 50 decisions (besides the first training round) on whether to cooperate or commit fraud. After the end of the experimental rounds, the players acquire information on who the agents are and what their characteristics are. (3) After this, the participants face a new decision-making situation. They acquire the information that all of the agents are going to play with each other; during the simulation, 10 competition tournaments are run with 10 decision-making rounds per tournament. Based on their previous experiences, the participants need to guess which agent is going to win the most in these competition rounds. Their guesses relate to how much they have understood the experiment and their feelings about which strategy they consider as an absolute winning approach in a situation such as this. (4) After this, the participants are asked to answer the relevant demographic and corruption-related questions.

Regarding the pay-off of the game, we followed the concept of the canonical representation of the prisoner's dilemma [83]: T (temptation) = +3 pay-off, R (reward) = +2 pay-off, P (punishment) = 0 pay-off, and S (sucker's) = −1 pay-off, thus $T > R$ and $P > S$ and $2R > T + S$. In the terminology of our experiment, the competition has to be a player who should cooperate. Betrayal or defection means that one (or both) participant(s) of the two has stolen the other's idea, while cooperation means that they add up what they have and start the "race". The latter is cooperation, while the former is fraud in the terminology of the prisoner's dilemma.

The game takes about 15 min. The game is available through the following link: <https://korrupt.me/>, accessed on 18 January 2023. Individual decisions in a cooperative situation are challenged by the fact that the individuals need to make decisions in a complex environment, analyze the situation, and take into account the optimal strategy [62]. Therefore, they are constantly forced to adapt their strategies according to the given situation. Examples of these adaptation strategies can be observed in biological evolution. However, in a complex environment, the decisions and attitudes of individuals are also influenced by the nature of (co)operating further with participants [84]. There is an important difference in whether the transactions between the participants occur only once, on an ad hoc basis, or they are characterized by some sort of regularity and repetition, which the actors might—or might not—be able to recognize. Another crucial factor in determining the behavior is what advantages and/or what risks the cooperation or the breaking of cooperation mean for the individuals [62]. Based on the above, Nick Casey developed a game ("The Evolution of Trust"), which operates as a demonstrative simulation, not collecting answers—therefore not useable for research purposes. The authors of the paper have adapted and transformed the game (at some points making simplifications, at other points making it more complex), and most importantly, this application collects and saves the answers of participants in an exportable format and can be supplemented by further demographic or other types of questions.

Based on the literature, the following hypotheses have been formulated:

Hypothesis 1 (H1). *Against the agents with more complicated strategies (avenger and detective), the respondents' adaptation is more difficult.*

Hypothesis 2 (H2). *The generational deviation in decision changes against agents depends on the type of algorithm.*

Hypothesis 3 (H3). *The employment status deviation in decision changes against agents depends on the type of algorithm.*

To control for out-of-the-hypothesis covariates, we also performed a univariate analysis of variance (general linear model) when investigating the fraud behavior of the subjects to be able to draw causal conclusions based on age. For this, we tested the model parameters (fixed factors and covariates) with an F-test and calculated the partial eta squared to measure the effect size of the control variables (company type where the subject is employed, employment type, and gender).

Data Collection, Sample, and Methodology of Analysis

Altogether, 499 participants played the game between 1 January and 30 November 2021. The game was freely available to anyone, and the tool has been actively disseminated at conferences for university students and for employees in business, as well as in the private sector. Accepting the classification of Strauss and Howe [85], most of the participants belong to Generation Z (45%) or Generation Y (37%), while 15% of them are part of Generation X and 3% are baby boomers.

Twenty-six percent of the respondents are employed by a large corporation, 19% of them work at a state/public company, 18% are employed by SMEs, 9% work in their own companies, and 28% of the participants are not employed. Regarding ownership, the

sample was a composite: 28% of the respondents work at a multinational company, while 25% are employed at a national firm and 19% work at a state-owned organisation.

During the data collection, representativeness was not a key consideration, since the main aim was not the description of the corruption phenomena within society/the economy, but to reveal patterns and explain connections, which could be achieved through the experimental method [86,87].

To test our hypothesis, the following proxy measures were calculated for each demographic group for each agent:

- Ratio of defects as first decision (%)
- Place (among the 10-decision round in each tournament) of first change in decision pattern (strategy) (mean and mode)
- Number of changes in a tournament (mean and mode)
- Number of stable (no change in strategy) decisions after the first change (mean and mode)
- These measures were tested with the following methods for more than two independent samples formed by the demographic groups:
- Stochastic homogeneity of ratios: Kruskal-Wallis H-test (H_0 : the means of groups based on ratios are all equal; H_1 : at least one group is different).
- Mode equality: Kruskal-Wallis mode equality test (H_0 : the modes of groups based on subsample ratios are all equal; H_1 : at least one mode is different).
- Mean difference test: Homogeneity of variances: one-way ANOVA F-test and Levene statistics (H_0 : the means of the subsamples are all equal; H_1 : not all of the means are equal).
- Symmetric measures for nominal associations: Pearson's χ^2 -test
- All of the tests' acceptance significance level criteria are $p < 0.05$.

4. Results

While demonstrating the results, we will first introduce the followed strategies against the agents and then the characteristics of the decision strategies of the single generations. This is followed by the analysis of the decision-making strategies of single organisational types and the analysis of predicting the most successful strategy.

The decisions of the participants were examined based on their strategies followed against the single agents, i.e., (1) what was the first decision of the participant, were they cooperating or cheating? (2) When (in which round) did they first change their decision? (3) How many times did the participant change their decision? (4) After the first strategy change, for how many decisions did they remain consistent on average?

4.1. Typical Decision Patterns of Single Generations in a Corruption Situation

The overwhelming majority of the simulation participants started with cooperation; the share of those who started out with fraud, remained under 30%. Table 1 shows that mostly Generation Z started with cheating, and in the case of the avenger and detective agent, so did the baby boomers and Generation Y. By looking at the share starting with fraud, based on the K-W test it can be established that the generations are significantly heterogeneous in the case of the copying, fraud, and cooperative agents. However, in the case of the avenger and detective agents, they can be considered as homogenous.

To eliminate the effects of certain variables and to be able to draw casual findings, we performed univariate analysis of variance controlled for company type, employment type, and gender. We found that these variables have no significant effect on the casual relationship between the share of starting with fraud and age.

In order to test the hypotheses, F and K-W tests were conducted, which clearly indicated that there were no significant changes within the strategies followed by the single generations; most of the participants changed strategy first at their 3rd decision, but in many cases, it was extended until the 4th decision. Based on the averages, in the case of the copying, fraud and avenger agents, there were no substantial differences;

nevertheless, for the longest time, the participants maintained a stable strategy against the cooperative agent.

Table 1. Share of starting with fraud per generation—Kruskal-Wallis homogeneity test and univariate ANOVA results.

Statistics		Copying Agent	Fraud Agent	Cooperative Agent	Avenger Agent	Detective Agent
Share of starting with fraud	BB-gen	0.00%	26.70%	13.30%	26.70%	13.30%
	X-gen	10.50%	15.80%	10.50%	13.20%	9.20%
	Y-gen	19.90%	19.40%	24.70%	22.60%	17.20%
	Z-gen	27.90%	30.60%	33.30%	25.20%	13.50%
Kruskal-Wallis	Chi-Square	15.248	10.383	17.013	4.897	3.015
	Asymp. Sig.	0.002	0.016	0.001	0.179	0.389
Control for.						
Company type	F sig.	0.484	0.731	0.466	0.722	0.422
	Effect size *	0.001	0.000	0.001	0.000	0.001
Employment	F sig.	0.498	0.807	0.446	0.861	0.192
	Effect size *	0.001	0.000	0.001	0.000	0.003
Gender	F sig.	0.724	0.042	0.809	0.609	0.168
	Effect size *	0.000	0.008	0.000	0.001	0.004

Effect size *: Partial Eta Squared; bold: subsamples are significantly homogenous.

The testing of the mode, however, depicts a more interesting picture; with the reduction in age, the players change strategy earlier, and these are significant deviations. Mostly baby boomers and Generation X hold onto their first decision and stick with it the longest as it can be seen in Tables 2 and 3.

Table 2. Point of the first strategy change against the single agents.

Statistics		Copying Agent	Fraud Agent	Cooperative Agent	Avenger Agent	Detective Agent
Mean	BB-gen	4.833	3.800	4.200	4.571	4.455
	X-gen	4.632	2.742	5.846	4.333	4.048
	Y-gen	4.212	2.677	5.063	4.861	3.747
	Z-gen	4.090	2.738	4.882	4.864	3.547
ANOVA	F	0.392	2.754	0.619	0.202	2.3
	Sig.	0.759	0.042	0.604	0.895	0.077
Mode	BB-gen	4	3	3	4	3
	X-gen	5	2	8	2	3
	Y-gen	2	2	2	2	3
	Z-gen	2	2	2	2	3
Kruskal-Wallis	Chi-Square	4.393	7.267	2.519	2.3	8.126
	Asymp. Sig.	0.222	0.064	0.472	0.512	0.043

ANOVA p bold: means are significantly equal; Kruskal-Wallis p bold: modes are significantly equal.

Table 3. Number of strategy changes against the single agents.

Statistics		Copying Agent	Fraud Agent	Cooperative Agent	Avenger Agent	Detective Agent
Mean	BB-gen	1.400	1.667	0.400	1.067	1.867
	X-gen	0.711	1.750	0.526	0.592	1.711
	Y-gen	1.247	1.925	0.726	1.011	2.059
	Z-gen	1.838	1.901	0.905	1.171	2.041
ANOVA	F	7.978	0.33	1.861	2.917	1.147
	Sig.	0	0.803	0.135	0.034	0.33
Mode	BB-gen	0	0	0	0	0
	X-gen	0	1	0	0	2
	Y-gen	0	1	0	0	1
	Z-gen	0	1	0	0	1
Kruskal-Wallis	Chi-Square	28.433	1.612	16.991	12.537	3.451
	Asymp. Sig.	0	0.657	0.001	0.006	0.327

ANOVA p bold: means are significantly equal; Kruskal-Wallis p bold: modes are significantly equal.

It was examined after the first shift how long the participants remained stable in their decisions. By analyzing the means, it is visible in Table 4, that against the copying agent Generation X remained consistent, and against the fraud agent, Generation Y remained consistent, while against the cooperative agent, the members of Generation Z remained consistent for the longest time. These are not significant deviations; nevertheless, it can be determined that older participants had more trust in the copying agent, while younger players had more trust in the cooperative agent. In the case of the avenger and detective agents, there were significant differences among the generations; in the case of the avenger, the younger the player was, the faster they changed strategy; in the case of detective, the younger they were, the slower they shifted their decision (except for the oldest, who remained stable for the longest period).

Table 4. Number of stable decisions after the first strategy change.

Statistics		Copying Agent	Fraud Agent	Cooperative Agent	Avenger Agent	Detective Agent
Mean	BB-gen	0.200	1.429	0.000	1.000	1.857
	X-gen	1.308	1.179	0.444	0.933	0.405
	Y-gen	0.967	1.506	0.971	0.423	0.528
	Z-gen	0.686	1.158	1.022	0.329	0.743
ANOVA	F	1.119	0.786	0.437	3.179	3.59
	Sig.	0.343	0.503	0.727	0.026	0.014
Mode	BB-gen	0	0	0	0	0
	X-gen	0	1	0	0	0
	Y-gen	0	0	0	0	0
	Z-gen	0	0	0	0	0
Kruskal-Wallis	Chi-Square	2.439	2.585	1.135	5.908	5.423
	Asymp. Sig.	0.486	0.46	0.769	0.116	0.143

ANOVA p bold: means are significantly equal; Kruskal-Wallis p bold: modes are significantly equal.

Overall, the generational disparities show the same patterns in all cases except for the last agent, and therefore, the younger generation acts more distrustful and is more prone to fraud. The various findings can be considered as significant. The most interesting statement is that the older generations (BB and X) changed their behavior patterns at the latest stage against all of the agents compared to the other generations. At the same time, it is also visible that they are the ones who are least likely to change their decisions and less likely to revise their strategy.

4.2. Typical Decision Patterns of Certain Organisational Forms in a Corruption Situation

Similar to the above, the characteristics in terms of the employees in different organisational structures when facing a corruption situation were examined, as shown in Table 5. The deviations are outlined in the case of the fraud and cooperative agents; in both cases, the unemployed participants start with fraud in the largest proportion, and the entrepreneurs start with fraud in the smallest proportion.

Table 5. Share of starting with fraud per employment status—Kruskal-Wallis homogeneity test.

Statistics		Copying Agent	Fraud Agent	Cooperative Agent	Avenger Agent	Detective Agent
Share of starting with fraud	public sector	15.1%	20.4%	18.3%	20.4%	11.8%
	large	23.3%	22.5%	28.7%	23.3%	11.6%
	sme	20.4%	20.4%	26.9%	24.7%	21.5%
	entrepreneur	15.9%	13.6%	11.4%	13.6%	9.1%
	unemployed	26.4%	33.6%	32.9%	24.3%	15.0%
Kruskal-Wallis	Chi-Square	5.417	11.047	11.682	2.773	6.197
	Asymp. Sig.	0.247	0.026	0.02	0.596	0.185

Bold: subsamples are significantly homogenous.

Regarding the place of the first strategy shifts, the analysis is coherent; based on the F-probe, the participants do not differ against any of the agents. In the case of the copying

agent, they typically changed during the 4–5th decision; in the case of the fraud agent, they changed during the 2–3rd decision; in the case of cooperative agent, they changed during the 4–6th decision; in the case of the avenger agent, they changed during the 4–5th decision (except for the entrepreneurs, who already changed in the 3rd decision); and in the case of the detective agent, they changed during the 3–4th decision. However, the calculation of modes alters these results. In the case of the copying agent, the entrepreneurs shift at the latest stage; in the case of cooperative agent, the employees of SMEs shift significantly later, while in the case of avenger agents, the employees from the public sector change their decisions at the latest point (Table 6).

Table 6. Point of the first strategy change against the single agents.

Statistics		Copying Agent	Fraud Agent	Cooperative Agent	Avenger Agent	Detective Agent
Mean	public sector	4.756	2.797	5.280	5.029	3.892
	large	3.803	2.667	4.574	5.068	3.861
	sme	4.130	2.561	5.731	4.556	3.556
	entrepreneur	4.833	2.844	4.400	3.000	3.829
	unemployed	4.145	2.862	5.029	4.890	3.545
ANOVA	F	1.084	0.969	0.966	1.372	1.03
	Sig.	0.365	0.425	0.428	0.245	0.391
Mode	public sector	2	2	3	3	3
	large	2	2	2	2	3
	sme	2	2	5	2	3
	entrepreneur	3	2	2	2	3
	unemployed	2	2	2	2	3
Kruskal-Wallis	Chi-Square	5.593	2.398	4.964	7.78	8.719
	Asymp. Sig.	0.232	0.663	0.291	0.1	0.069

ANOVA p bold: means are significantly equal; Kruskal-Wallis p bold: modes are significantly equal.

The number of strategy changes shows significant differences in the case of the tournament against the copying agent; the entrepreneurs shifted their strategy one third/one quarter times less than the other participants. However, this is the case only regarding the copying agent. The K-W test indicates that, in the case of the fraud agent, the mode of all groups is 1; however, the number of individuals related to the mode shows great disparities. The entrepreneurs stick out with significantly more stable strategies; however, in the case of the detective agent, the unemployed and the public servants changed strategies by a higher proportion than the others did (Table 7).

Table 7. Number of strategy changes against the single agents.

Statistics		Copying Agent	Fraud Agent	Cooperative Agent	Avenger Agent	Detective Agent
Mean	public sector	1.301	1.935	0.634	0.914	2.032
	large	1.442	1.930	0.891	1.031	1.837
	sme	1.237	1.817	0.570	0.892	1.892
	entrepreneur	0.523	1.409	0.500	0.705	1.864
	unemployed	1.929	1.986	0.950	1.264	2.214
ANOVA	F	5.485	1.259	1.918	1.75	1.335
	Sig.	0	0.285	0.106	0.138	0.256
Mode	public sector	0	1	0	0	1
	Large	0	1	0	0	1
	sme	0	1	0	0	1
	entrepreneur	0	1	0	0	1
	unemployed	0	1	0	0	1
Kruskal-Wallis	Chi-Square	20.346	6.009	19.376	10.162	3.679
	Asymp. Sig.	0	0.199	0.001	0.038	0.451

ANOVA p bold: means are significantly equal; Kruskal-Wallis p bold: modes are significantly equal.

After the first change, the number of stable decisions shows a completely diverse picture; this value is the highest in the case of SMEs against the copying agent, in the case of entrepreneurs, against the fraud and avenger agents, in the case of large enterprises,

against the cooperative agent, and in the case of the unemployed, against the detective agent (Table 8).

Table 8. Number of stable decisions after the first strategy change.

Statistics		Copying Agent	Fraud Agent	Cooperative Agent	Avenger Agent	Detective Agent
Mean	public sector	0.815	1.000	0.667	0.560	0.648
	large	0.830	1.435	1.120	0.541	0.541
	sme	1.000	1.571	0.600	0.417	0.431
	entrepreneur	0.500	1.667	0.500	0.600	0.583
	unemployed	0.719	1.119	1.091	0.319	0.846
ANOVA	F	0.249	1.121	0.472	0.585	1.068
	Sig.	0.91	0.348	0.756	0.674	0.373
Mode	public sector	0	0	0	0	0
	large	0	0	0	0	0
	sme	0	1	0	0	0
	entrepreneur	0	0	0	0	0
	unemployed	0	0	0	0	0
Kruskal-Wallis	Chi-Square	0.535	4.767	0.272	2.159	1.89
	Asymp. Sig.	0.97	0.312	0.992	0.707	0.756

ANOVA p bold: means are significantly equal; Kruskal-Wallis p bold: modes are significantly equal.

It is visible that after recognizing the strategies of the agents, the participants typically strive to change to a strategy that serves their own interests. This varies based on the complexity of the decision algorithm of the agent and takes more time. In addition, regarding the SMEs, it can be stated that if the agent strategy negatively affects the effectiveness of the participant, they do not only change their strategy, but they are more likely to further shift their decisions, thus trying to optimize their own profits.

On the basis of the results, it can be established that the participants of the experiment show a stable behavior against the predictable agents (fraud and cooperative), they maintain their strategy in the long term regardless of the organisational form. However, in the case of less recognizable agents (the detective), they tend to persist more in their initial strategy. It seems that participants take a ‘wait and see’ attitude until the applied strategy of the agent becomes clear.

In the case of entrepreneurs with their own businesses, the cooperation rate was the highest against all agent types; however, they were the ones who reacted the fastest to the strategy of the agent and changed quickly. This correlates well with the fact that also in real life, they are the most flexible during their operations.

The most interesting part of the results is that the highest share of fraud can be experienced in the case of unemployed participants, and they are the ones who changed their strategies the most often against all of the agents. The data suggest that those who are not involved in the labour market are guided by their as-yet unformulated moral principles in their decisions, which places a large emphasis on the importance of education.

5. Discussion

The applied experimental methodology revealed that besides its unethicalness [88], corruption also means a particular cooperation, with the precondition of a certain confidential relationship among the participants, namely the corruptive and corrupted parties [89]. Within this relationship both parties (or even more participants) benefit, and the victims of corruption fall by the wayside in this corrupt activity [33].

The results confirm the findings of previous studies, that there is a correlation between the willingness for corruption and the age [38], the younger generations are more likely to commit fraud [37,90]. By verifying that it is typical for the younger generation to change their decision-strategy more often, the high importance of educating the ethical values [91] at different levels of education [42], and generally the training of responsible future managers and professionals can be well supported (Principles for Responsible Management Education [92]). However, other personal characteristics (for example gender,

cultural differences) have not been examined, which according to previous studies can also have an influence on the behavior of participants [33,93,94].

According to Gosira et al. [31], there is no difference in the propensity to become corrupt among public servants and employees of the business sector. Our results do not support this, since the employees of large enterprises and multinationals are more likely to commit fraud, than the employees of the state-owned companies or the public sector. This is in line with the statement of Baucus and Near [45] that large enterprises are more likely to be involved in corruption due to the dynamic competitive environment. This research did not focus on whether there are any differences in the behavior patterns of employees of single industries, although previous studies have revealed that there are certain sectors, where the effect of corruption on sustainable development is particularly high, such as the building industry [95], the mining industry [96], the energy industry [97], the fishery [98], health care [99] and education [9].

The results are thought-provoking in the sense that if the employees of large corporations and multinationals are more likely to commit fraud in their everyday business decisions, then it is feared that they failed to sufficiently recognize the danger of corruption, the importance of integrity, and the role of fight against corruption in the frame of sustainable development. Based on the survey of the World Economic Forum, the acceptance of SDG16 (Peace, Justice and Strong Institution), which also integrates the topic of corruption, is disproportionate among companies [100]. In the prevention of business corruption, the increasing respect of laws and regulations [101], transparency [102] and the development of an appropriate organisational culture [103] and an integrated and sustainable management model are crucial [104].

The presented empirical analyses and agent-based simulations have justified all of the three hypotheses.

6. Conclusions

This article draws attention to the strong relationship between corruption and sustainable development.

Theoretical implications: This research has found that the experimental method is a potential and suitable methodology for corruption analysis, which might decrease the research problems arising from the sensitivity of the topic. The results contribute to corruption studies in the business sector.

Managerial implications: In connection with the topic of sustainable development, it is worth placing a higher emphasis on corruption and raise awareness of companies that fight against corruption both directly and indirectly in SDGs, and how corruption is one of the biggest barriers of sustainable development. Raising the individual awareness of leaders and colleagues is also important, with particular emphasis on the younger generation. Likewise, it is essential to pay attention to the SME partners of large corporations, for whom the behavior of the large enterprise serves as an example.

On the basis of the data analysis, it can be concluded that the behavior patterns concerning the copying agent show characteristic features. The significance of this lies in the recognition that this strategy is fundamentally based on adaptation. Therefore, under complex environmental conditions, the elementary part of understanding the relations among participants is the learning process based on previous behaviors. The results indicate that the older generation has more trust in the copying algorithm, so the place of changing decisions in their cases stretched until a later stage, compared to the younger generation. This may be due to the fact that the recognition of the copying behavior is delayed, and therefore, they try strategy change later, if they intend to shift at all. They trust the accuracy of their strategy more. Compared to that, the basis of the cooperative algorithm is that the agent takes a decision in line with trust in cooperation under all of the circumstances. Against the copying agent, in the patterns of the younger generations we can observe the opposite contemporary behavior forms. One explanation of this attitude is the “hope” in

cooperation, which is maintained to the extreme, even if the series of decisions is mixed with fraudulent and deviant behavior [84,105].

Since the avenger and detective algorithms mean more complex strategies, for the participants, it is obviously more difficult to recognize and react to the strategy. The main difference between the two agents is that, while within the avenger algorithm the decision change of the programmed actor is a direct consequence of the respondent's behavior, in the case of the detective agent due to the pre-programmed decision changes, the strategy is much more difficult to identify. Due to these differences in the algorithm, the discrepancy of the age patterns is recognizable. The younger generation acts more confidently against the strategies involving less complicated algorithms, changes more quickly, and keeps these changes; while in the case of a more complicated algorithm, greater hesitancy is observable. For them, it is harder to recognize the effective strategy against the pre-programmed indirect changes. In contrast, the older generation solidly persists in their only alteration against both types of algorithms; there is no significant difference in the behavior patterns.

Besides the generational differences, a significant divergence was also revealed in the analysis according to the employment status, in particular among the unemployed and entrepreneur respondents. The former more often started their decision with fraud compared to the other groups, which means that their effective strategy results from the violation of actual rules and/or the distrust towards the partner. The latter ones, on the contrary, provide a good example that utilizing the synergies existing in cooperation can be considered as an important element of self-advocacy. Consequently, it is not surprising that against the different partners (agents), almost without exception, the entrepreneurs are those who change their decision the least often. It is logical in the sense that in their cases, the level of trust in cooperation is higher than for the other respondents. Furthermore, within the different algorithms, the decisions occur as a direct or indirect consequence of the decision changes of the participants. Although the recognition of complicated strategies takes more time also in the case of entrepreneurs, the number of their decision changes is fewer compared to the other respondents. SMEs typically continue a stable decision-making strategy; they hold onto their initial decision for a relatively long time, especially if the partner is also cooperating. However, if they are facing a copying or a detective partner investigating their own strategy, they are more likely to cheat.

7. Future Research and Limitations

Based on the findings, it is recommended to examine whether there are any differences between certain industries. This experiment has analyzed participants from a single country and so the findings have limitations. It is worth analyzing whether the behavior patterns of the participants are dependent on different national or organizational cultures. Further research could also examine whether the behavior of participants changes, depending on the organisational forms (public or private, large enterprise or small company) they are facing. A further development of the model could be a game between the actors themselves, in which they communicate with each other to model the hunter's dilemma (HD) situation [64].

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