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DEGLI STUDI
DI URBINO
CARLO BO

Ph.D. Program: Global studies. Economy, Society and Low
Candidate: Lisa Frollichi

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1. Title of the Research Project and keywords

Green economy and green crimes: evolutionary model implementations.

Keywords: Green economy, green crimes, corruption, evolutionary model, offset compensation, accountability, economic growth

2. Research Area

SECS-S/06 - Mathematical methods of economy, finance, and actuarial sciences

3. General presentation of the project and state of the art

The project development started in 2022 in occurrence with the master's thesis, and it has as aim to study the connection between the green economy and corruption. This interest has arisen with the increment of cases concerning the malfunctioning of policies for the implementation of the green economy. Specifically, the cases of Diesel Gate, the unsustainability of fast fashion, and the lack of certification controls have been studied. The latest research showed that even large certification groups (such as Rain Forest Alliance, UTZ, or Fair Trade) have shown a non-effective control system on the associations that they certify and, sometimes, even the bodies themselves do not guarantee adequate clarity on their way of work (Bellano et al., 2017). The concept of green economy has had a large improvement in the last few years. More and more companies and enterprises are now aware of what is happening to the Planet and have understood the importance of conscious production. The idea of green economy describes all the actions that permit the achievement of the creation of goods in different sectors, but especially in the industrial one, that respects the environment. Since awareness of and interest in the green economy over the last decade, about 2% of the annual GDP of countries has been invested to achieve objectives connected to this economy by 2050, an example a greater use of renewable resources (UNEP, 2011). This huge increment in the economic value of green actions also brings a rise in the number of so-called green crimes. Within this term are defined all the activities against the environment (e.g., air, water, animal, and plant life forms). According to G20 shortly, these activities will include a larger typology of crimes jeopardizing the economic system and its evolution (Segato et al., 2013). As brought out by Segato et al., it is possible to see how this crime net is becoming bigger now involving transnational and organised crimes. This enlargement now embraces more and more subjects involved in the political sphere, police force, and entrepreneurship. Crimes against the environment are relatively easier to commit also because of the lack of laws that regulate this field. Moreover, in comparison to other types of violations, these are considered without victims, so the attention to them is lower. Talk about corruption is difficult, as it is to identify when there is a presence of corruption for different reasons such as consensual nature,

the absence of direct victims, long-term effects, a solid and huge base of people, a combination of corruption and maladministration (Transparency International and RiSSC 2013). Specifically, the green economy evolution allowed the birth of a new typology of crimes: the green ones. This new misconduct is characterized by an organized crime form, the taking advantage of the public maladministration and a criminal combination of public and private interest.

Corruption is directly connected with the development of the economic net of a country, and thanks to different studies it is clear that also sustainable development is jeopardised by it. According to Ho (2000), in a Nation characterized by bribery, the impact of this practice on its growth is important. The research found out that for a corruption increment of 1%, the growth of the country will decrease, settling at a level of about -0.72%. This analysis was based on a huge panel of countries with different levels of corruption, but that affected distinct sectors, however, 53% of the Nations taken under evaluation were characterized by political instability. Thanks to Ho's research another interesting data is studied i.e., phenomena that permit the development of bribery are institutional inefficiency and weak legislative and judicial systems. Later studies confirmed that some countries are stuck in a vicious circle when characterized by corruption, but at the same time, others can grow even if impacted by it. The different structural characteristics of countries, such as economic level and other endogenous elements show that each nation could have different outcomes and distinct consequences brought about by corruption (Blackburn et al., 2005). However, as conveyed by Meon and Weill (2010) in the long run a Country with a low corruption rate tends to see an incremental rise in bribery that over the years will flow into bad governance and low efficiency.

The second part of the project is focused on an evolutionary model: "(Dis)honest bureaucrats and (non)compliant firms in an evolutionary game" (Antoci et al. 2021). The model analyses especially the corruption connected with the lack of controls that allowed the growth of bribery in the certification system. The increasing number of products and activities that obtain certifications have raised questions for researchers who have tried to identify how many ethics and effective compliance with the rules there is in this system. Pollution increment, corruption, and the expansion of green crimes are inevitably strictly connected with the right application of ethical and green laws that do not always work. The model focuses on the interaction between certified firms and bureaucrats, representing the body that controls the effectiveness of rules and laws. The reasons for this non-compliance can be identified in different circumstances: lack of adequate rules and control system; the company deviation; or the bureaucrats' corruption. The model analyses the connection which there is between companies and bureaucrats. The firms can choose between being compliant with the law, acquiring certifications, and respecting them, or being non-compliant. On the other side, the

bureaucrats can choose to be honest or not. The intersection between the two actors' choices can create two different crimes: if a compliant firm matches with a dishonest bureaucrat the extortion crime will incur, if a non-compliant firm encounters a dishonest bureaucrat, a corruption bribe will be paid. Explained the model and the actors the outcomes were studied.

The model results are two: bi-stable dynamics and oscillatory dynamics.

In the case of bi-stable dynamics, five equilibria will be shown: four are the model's external points (that can be attractors or repulsors according to the starting point of the analysis) and one is an internal point, which is always a saddle, that direct the trajectories to one of the model's attractor point.

The second dynamic that can be observed is an oscillatory one. This case defines a model in which there are continuous fluctuations on the compliant firm and honest bureaucrats' levels, describing a system similar to the model "Prey-predator" by Lotka and Volterra (1926).

4. Research Objectives

The project aims to implement the evolutive model presented in the previous section, so to find solutions that can join the certification system to reduce the possibility of corruption in the green economy and sustainable development fields. Two hypotheses were already been mentioned in the conclusion part of the master thesis with the purpose to include them in the model as new parameters, to investigate if the assumed results can be confirmed or not.

Offset compensation:

The first development is based on the so-called *offset compensation*. The idea is based on the proactive behaviour of the pollutive companies that can have a choice regarding the action to put in place to reduce their emissions. The procedure aims at reimbursing the level of pollution emitted during the production phase. This practice is taking hold all over the World because it permits a return on social, economic, and environmental levels simultaneously. It is based on the idea of defining the pollution level that an enterprise produce, affecting all three sustainability pillars, and then deciding on how to compensate for it. Nowadays, the most widespread activities are the ones based on CO₂ rebalancing, e.g.:

- The creation of certificates that give carbon credits and that can be sold on a voluntary market.
- Or simplest, the offset compensation concerning any activity that allows the balance of CO₂, such as reforestation.

- Some of these actions also concern the economic sphere i.e., paying an amount of money that will be invested in a sustainable program or similar activities.

The limit of the suggested procedure is the quantification regarding the actions to put in place. In other words, how can the actions that compensate for that amount be defined, knowing a company's pollution level? This is probably one of the first problems to solve, but also some solutions are arriving. To cite one, Zening W. et al.'s study (2018) tried to develop an empirical formula that helps to understand the amount of money necessary to compensate a Chinese river pollution. The application of this practice can be seen as an incentive to respect the rules and limit, or at least balance, enterprises' pollution levels. Organizations are not sanctioned if they pollute too much but, on the contrary, they have a tool to decide how to settle this negative externality. This system may also not lead to positive developments, but giving companies a way to remedy their pollution levels could be welcomed more positively than having, as the only other option, a sanction for high pollution levels.

Accountability:

Focusing on the Diesel Gate, one of the cases that motivates this study, is impressive how much the whistleblowing practice was fundamental to ascertaining the veracity of the emissions scandal. Analysing Volkswagen's cultural background is possible to confirm that this company is firmly based on a strong identity and a non-error philosophy (Bovens, L., 2016). This brought the organization not to stop the production and selling of cars even if they were aware of the pollution problems that they were creating. The organization decided to bypass the problem by modifying the emissions control software. This practice was revealed thanks to various analyses, but at the same time, it was confirmed also thanks to some whistle-blowers. Due to this statement, an element that can be studied and could implement the model is accountability. This term indicates the process of calling someone to their responsibilities or exposing someone when their acts are harmful to society or the environment. In general, accountability means making people, businesses, and society all responsible for their actions and the positive or negative results they create. In the environmental and social fields, anybody is entitled to make someone else accountable just because such infringements harm them. This second model development is more focused on the social level and on the analysis of national and supranational policies that could be imposed to achieve a type of industry as respectful as possible of sustainability.

To sum up, the project aims to introduce new parameters that can implement the study on all three sustainability pillars, and then study the quantitative results through the evolutive model.

5. Methodology and Expected Results

The project is going to be based on both quantitative and qualitative analysis. A quantitative analysis is going to understand if the implementations proposed in the previous section can be effective in the fight against corruption, and if they lead to a reduction of the level of corruption. In the master thesis conclusion, hypotheses were made regarding the offset compensation worth. An increase in the number of compliant companies was assumed, being the offset compensation able to be a positive alternative to paying taxes related to the levels of pollution produced by companies.

Moving the focus to the qualitative analysis, the research will first investigate how much accountability is widespread in companies, as it is now a fairly extensive activity. Then, after obtaining data on this practice they will be traduced in parameters to be included in the evolutionary model and the assumptions made in the conclusion of the thesis will be tested. As for the offset compensation, even the accountability implementation assumes an increase in the level of compliant firms.

Through the qualitative study another goal is set i.e., find additional strategies to fight corruption and green crimes. This aim will try to understand what can facilitate economic growth especially through a decrease in the level of corruption. This part of the research will also focus on already existing national and supranational policies issued to limit corruption related to the green economy and how they can be implemented for more effective outcomes.

To sum up, the research has two major goals: to understand if the hypothesis will be confirmed or not by introducing the two new parameters in the evolutive model (offset compensation and accountability) and detect new trends that can improve economic growth limiting corruption and green crimes.

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7. Description of the research in the three-year period (feasibility)

The project is going to be spread over three years. To start during the first year the focus will be on the qualitative analysis. Thanks to workshops and lessons the aim is to capture the new policy trends that characterize Europe and the World in general. Due to the data that can be collected, the target is to analyse the corruption tendency and understand how it influences society on the sustainability development level. The outcome forecast for this first period is to find new elements that can be studied to implement the evolutionary model but more specifically to understand how much corruption and green crimes can affect a country's economic growth. According to this research program, later it could be possible to suggest further methods to reduce, or at least combat, corruption in the specific area of the green economy. During this period, a more specific study will be carried out on policies that can implement accountability.

Approximately during the second year, the focus is going to be on quantitative analysis having more data to develop and a wide qualitative base. All the new trends, parameters, and methods already suggested are going to be investigated. The challenge in this project step is to understand how to coherently include the new parameters in the model to obtain satisfying and rational results. Then the effectiveness of implementations is tested.

To conclude, merging qualitative and quantitative analysis should lead to a model that can simplify reality while considering new aspects to contrast corruption and green crimes, and study how they affect economic growth and sustainable development.