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How the government and private sectors in Egypt contribute to the country's environmental issues (An environmental economic approach)

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ABSTRACT

In recent decades, countries have gone through a process of economic development that has resulted in environmental challenges becoming one of the most important concerns of policy-makers. Finding the primary sources of pollution is the first step in dealing with this problem. The current study focuses on this topic, highlighting the government's responsibility (compared to the private sector), since, theoretically, both government and private economic enterprises may be regarded as sources of pollution. This predicament is seen in the majority of the less-developed and emerging nations, where the governments are heavily involved in the economy. From the perspective that governments are both the cause of pollution and, at the same time, are compelled by their sovereign obligations to safeguard the environment, this debate is worthy of consideration. The present study indicates that Egypt is not excluded from this category. Since the high share of the government in the country's economy, apart from the adverse economic consequences, has created significant environmental challenges. In this article, after stating the situation of pollutants in Egypt, considering the flow of production and release of pollution in recent years, the relative share of government enterprises in the production of pollution has been investigated. The results indicate that the government's contribution to the production of pollution is very significant.

Keywords: Air Pollution, Capital Formation, Egypt, Emission of Pollution, Environment.
Article type: Research Article.

INTRODUCTION

Since the environment is one of the key tenets of sustainable development (Apostolopoulos *et al.* 2018; Polasky *et al.* 2019; Molajou *et al.* 2021a), efforts are made to direct the development process in a way that preserves the dynamics of a balanced natural system while maximizing the added value of economic activity (Fioramonti *et al.* 2019; Rodrigues & Franco 2020; Salvo *et al.* 2021). The world around us demonstrates that there is an environmental crisis. Environmental problems that are currently present in Egypt include depletion of forests, air and water pollution, global warming and climate change, rising sea levels, mountains of urban and industrial waste, depletion of resources, destruction of pastures, a decline in biodiversity, destruction of the ozone layer, etc. (Abd Ellah 2020; Luo *et al.* 2020). In recent years, nations have become more aware of the significance of

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environmental issues and, feeling threatened by them, passing laws at the national or international levels. So, it appears that countries are attempting to lessen environmental waste while also moving through the stages of development and, depending on their circumstances, adopting various versions of the sustainable development model (Suárez-Eiroa *et al.* 2019; Molsjou *et al.* 2021b). Obviously, the success of these policies depends on the obligation of private and government companies to comply with environmental considerations. Governments normally have the responsibility of enforcing environmental laws, thus it appears that they are generally successful in getting the private sector to adhere to environmental regulations. However, they are having difficulty persuading government agencies to do their bidding, since the government polluting agencies, in theory, have a lot of negotiating power, which gives them a lot of legislative power (in the field of environment). This topic is the primary concern of the current investigation, shedding light on how the Egyptian government contributes to pollution by highlighting the contribution of government agencies to pollution emissions. Other developing nations have reported the same issue. However, it has distinctive features in Egypt. This study consists of five chapters. The first chapter is dedicated to research materials and methods. The air pollution index is discussed in the second chapter. The third chapter evaluates the government's contribution to environmental challenges in Egypt using two descriptive and quantitative methodologies. Conclusion is included in the fifth chapter.

MATERIALS AND METHODS

As previously stated, the goal of this study is to determine how much of the production and spread of pollution is attributable to the government as opposed to the private (non-governmental) sector. Obviously, in this regard, we need to be aware of the portion of pollution that is caused by the government. According to what is said in the relevant literature, in order to carry out this crucial task, the following conditions should be met (Cao & Ramirez 2020; Hill *et al.* 2020; Lopez 2017): (i) the availability of a comprehensive database listing different pollution types according to times, sources, and locations; (ii) the existence of a thorough definition and classification of economic entities apart from governmental and non-governmental (private) entities, so that it can be applied as a criterion to differentiate between economic entities that contaminate the environment in some way; (iii) choosing and utilizing the best research technique(s) to evaluate data and learn the relationship between the management style of companies and their environmental performance. Cases 1 and 2 unquestionably depend on the statistical organization of the countries, therefore the more comprehensive the country's statistical organization, the easier it will be to conduct case analysis. However, it can be observed that countries usually face limitations in the field of economic-environmental statistics. This issue has made it difficult for developing countries to select the best research methodology. In Egypt, as a developing country, the weakness of statistical systems in the field of environment is strongly observed. As mentioned, apart from the information structure, the appropriate method of information analysis is also important. In general, the possible methods for investigating the topic of the study can be divided into three general groups, which are discussed briefly below.

A system of integrated environmental and economic accounting (SEEA)

This method was developed as a satellite system of the System of National Accounts (SNA) by the United Nations, and although it has not been in practice for less than two decades, it has been implemented in many countries on a case-by-case basis during this period. The distinctive feature of this system is that in the form of Supply-Use Table (SUT), the flow of production and consumption of all goods and services (natural and unnatural) in an economy, in addition to the pollution created during their production and consumption, is included in the calculations. The methodology of this method is such that if there is information, in addition to the possibility of calculating the gross Environmental Domestic Product (EDP), the flow of consumption (and destruction) of all biological resources and the amount of damage to the environment can also be calculated. However, the point is that the implementation of this system is completely impossible even for developed countries due to the need for a large amount of information. Even the leading countries in this field have the implementation of this system in a partial and limited way (Bartelmus *et al.* 2018).

An environmental input-output table

Input-output table have been used in recent decades as one of the basic tools in the field of calculation and analysis of national accounts. During this period, according to the need and depending on the field of study, different editions of these tables have been suggested and used as the basis of practice. Input-output tables included sectorial, regional, environmental, etc. As previously mentioned, one of the input-output table editions includes

environmental data, which can be extremely varied and include the quantity of emissions of different sorts of pollution to the topic of recycling industries. In this framework, in the form of existing theoretical foundations, environmental discussions are included in the first, second and third areas of the table (including intermediate costs, final costs and primary data) and it is possible to analyze and review environmental statistics by different economic sectors. In this framework, it is obvious that the availability of information facilitates the development of environmental policy. However, the point is that this method also requires the existence of very strong databases. According to the history of this method, it seems that different countries have been able to collect the required information in the field of national accounts during the last few decades and have advanced to the level of very extensive matrices. However, there is still an information problem in the field of environmental calculations, and even in developed countries, the preparation of environmental input-output tables is only possible at the level of general headings, which is one of the implementation problems of this method (Pan & Kraines 2001).

Quantitative and descriptive methods

If we consider the first two approaches as general equilibrium states, which are less used due to the large amount of information required, the third state is a partial approach. Depending on the extent of access to statistics and information, this technique is carried out either analytically-descriptively or through a field discussion of inferential statistics and econometric methods. Basically, the third approach is employed in many circumstances, since the information needed by the previous two procedures is not available. In this approach, the necessary information is gathered in the form of certain variables related to the desired hypothesis, and the hypothesis is then tested either descriptively or quantitatively using econometric methods in accordance with the conceptual framework. A review of the existing literature and conducted studies indicates that the use of the third approach is often put on the agenda due to its statistical feasibility (Kaliyadan & Kulkarni 2019; Siedlecki 2020). In practice, the first and second two approaches are less used, and if they are implemented, many simplifying assumptions are used. In the current study, the third approach is the basis of practice.

Selecting pollution index

The category of pollution can be divided into different forms (Alhesnawi *et al.* 2022; Melnik *et al.* 2021): cumulative and non-cumulative pollutants, point-source vs. non-point source pollutants, continuous vs. episodic emissions, and the division of pollution from local, regional and global aspects. However, in general, pollution encompasses noise pollution, water pollution, air pollution, and solid waste generation. Specific types of pollution are taken into account in research activity since they differ from one another in terms of production source, absorption method, and side effects. The primary cause of action in this study is air pollution, since it affects human life more broadly and is more common than other types of pollution (water pollution, noise pollution, etc.). Air pollution mainly includes hydrocarbons (CH), carbon dioxide (CO_2), sulfur dioxide (SO_2), sulfur trioxide (SO_3), carbon monoxide (CO), nitrogen oxides (NO_X) and suspended particulate matter (SPM). Table 1 shows the emission of polluting gases from the entire country's energy sector from 1980 to 2021 (Al-Ayouty *et al.* 2021). Table 1 depicts that over the past three decades, there has been an elevation in both the production and emission of these gases, with some types of pollutants exhibiting a more pronounced trend in this direction. As it was mentioned in this study, air pollution is considered from the set of pollutions, and SO_2 has been selected as a pollution index from the total of polluting gases in Table 1. SO_2 production and emission rates are thought to be a useful measure for the total pollution still present in the economy and an indicator for the quality of the environment because of the significant correlation between SO_2 emission and other polluting gases (Table 2). This issue can also be seen in the real world, since due to the simultaneous presence of various types of pollution in the air at any point of time, it has been observed that SO_2 gas is the most abundant in the form of various compounds of all types of polluting gases (Najjar 2011). Therefore, it seems that the measured SO_2 (due to its high correlation with other pollutants) is a suitable indicator for calculating air pollution. Notably, similar studies conducted elsewhere have considered using this strategy when examining phenomena like the pollution haven, the environmental Kuznets curve (EKC), etc. (Ahmad *et al.* 2021; Li *et al.* 2022).

The role of Egyptian government towards environmental issues

Descriptive approach

Fig. 1 shows the contribution of different sectors of the economy in the emission of SO_2 gas during the years 2005-2021 (Al-Ayouty *et al.* 2021).

Table 1. Emissions of polluting and greenhouse gases from the entire country's energy sector during the years 1980-2021 (Tons).

Year	SPM	CH	CO	SO_3	CO_2	SO_2	NO_X
1980	21419	84415	310867	1514	1763116	114194	67194
1985	33097	135638	510237	2354	26010919	176898	104720
1990	74764	351573	1411277	4815	50299778	366286	243189
1995	99858	419644	1603920	6732	33489107	506393	322092
2000	161771	652768	2444593	11133	97841262	824087	513488
2005	201855	847582	3246994	12573	178615791	892965	661399
2010	248240	1118395	4476314	16068	252371105	1201510	855433
2015	285614	1488504	6288594	16436	317431427	1233692	1044145
2020	300189	1621043	6936559	16255	344506430	1225396	1109591
2021	329280	1913198	8354476	8879	374386208	751687	1227758

Table 2. Correlation coefficient of SO_2 with other pollutants during 1980-2021 (%).

Pollutant gases	SPM	CH	CO	CO_2	NO_2
SO_2	98	95	93	93	97

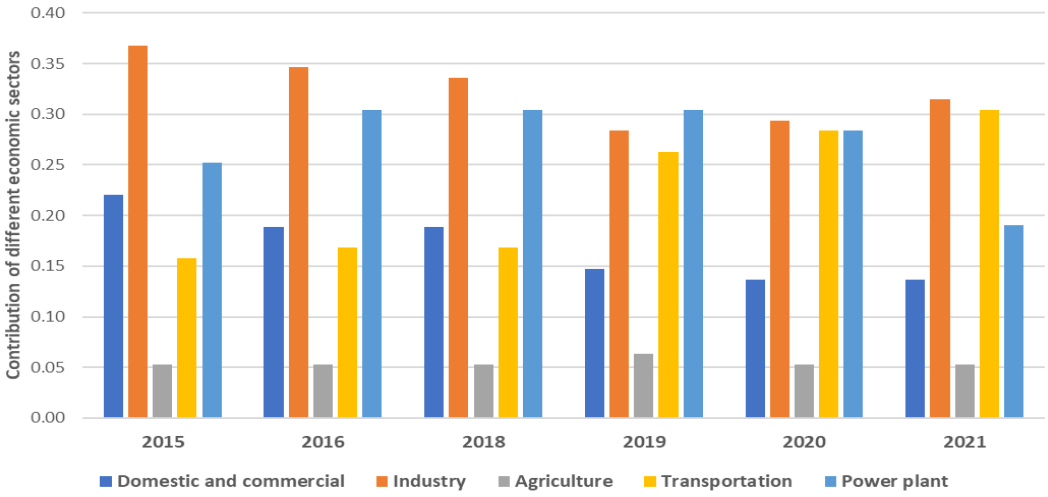

Fig. 1. The contribution of different economic sectors in the emission of SO_2 gas.

As shown in Fig. 1, among the mentioned economic sectors, (almost) the industrial sector had the largest share in the production of this gas, followed by the power plant, transportation, domestic and commercial, and finally agriculture. It is impossible to precisely separate each of these sectors, or at least the added value they produce in Egypt, since there are insufficient accurate statistics of economic activity that can be divided into governmental and private sectors. However, the estimates indicate that basically the two sectors, the domestic and the agricultural sector, are almost private in nature, and the government has a very small presence in these two sectors, which at the same time these two sectors exhibit the lowest emissions of SO_2 gas. On the other hand, there are three sectors of industries, transportation and power plants, which account for over 80% of the emission of this gas. If these three sectors are considered more carefully, it can be observed that in the industry sector, the sub-sectors of mineral industries as well as petroleum industries and products display the highest production of SO_2 by 70% and 27%, respectively (Mangla *et al.* 2021). If these sources of pollution (mining industries along with petroleum industries and products) are examined from the point of view of the type of management, it can be seen that they are mainly governmental in nature. On the other hand, Fig. 1 indicates that with the exception of 2021, power plants are in the second place after industry with an average emission of 25% SO_2, and if this sector is viewed from the management perspective, clearly, it has a governmental nature as well. Transportation produces the most SO_2 after industry and power plants, and it seems that it is impossible to divide this sector into governmental and non-governmental sub-sectors in terms of pollution. Therefore, it is not possible to provide an

accurate picture of the contribution of each in the production of SO_2. However, if the numbers are extracted from the sub-sectors of transportation that are almost governmental in nature (air, rail, and a part of sea), it can be found that at least 10% of the transportation sector, equivalent to 3% of the total production of SO_2 belongs to these three areas which are almost governmental in nature. Moreover, the government's contribution to the rest of the transportation sector (roads) can also be significant (Table 3; Al-Ayouty *et al.* 2021).

Table 3. The amount (tons) of SO_2 gas emissions in the transportation sector (2021).

	Road	**Air**	**Rail**	**Sea**	**Total**
Value	302086	15372	4327	16649	321785
Contribution (%)	93.88	4.78	1.34	5.17	100.00

It is concluded that almost the majority of SO_2 emissions are in the industry sector (with an average share equal to 30%), power plants (with an average share equal to 25%) and a part of the transportation sector that are governmental in nature. In general, according to economic literature, the private sector participates in a nation's development mostly through small- and medium sized- enterprises (SMEs), which are situated in front of larger establishments or so-called industrial complexes. The number of employees in these units is one criterion for classifying them. Typically, according to the norms and regulations in place, economic units with 50 (and occasionally as many as 100) employees are categorized as small and medium enterprises (Berisha & Pula 2015). According to the number of workers, the following is how Egypt's workshops are divided up in terms of their worker populations (Table 4).

Table 4. The number and percentage of workshops in the country according to the number of employees.

Description	**Total**	**0**	**1**	**2**	**3**	**4**	**5**	**6-9**
Number	2827906	36143	1599338	612163	206844	97366	54657	85193
%	100	1.28	56.56	21.65	7.31	3.44	1.93	3.01
Description	10-19	20-29	30-49	50-99	100-499	500-999	>1000	Unknown
Number	70251	24789	18594	9259	5181	496	229	7403
%	2.48	0.88	0.66	0.33	0.18	0.02	0.01	0.26

According to Table 4, around 92% of all workshops in the country have between 1 and 5 employees, 7% between 6 and 50, 0.33% between 50 and 100, and 0.5% over 100. Therefore, given that usually government units have more than 50 or 100 workers, their share is at most 1% (about 0.5%) of the total number of workshops. In this situation, the significant pollution of these units, along with their small number, indicates the intensity and concentration of pollution in these units, which in turn is significant.

Quantitative approach (econometric equations)

As mentioned in the previous section, according to the available information and statistics, a significant part of the pollution production is related to the units under government management. In such a way that the government can be considered as the main factor (or one of the factors) in the field of environmental challenges caused by air pollution. In this section, we attempt to provide quantitative evidence in support of the desired hypothesis using statistical and econometric techniques. This is done to assure both the accuracy of the results and their robustness. So, we need to select the necessary variables in relation to the topics discussed in this study. Regarding the pollution index, as mentioned in the previous section, the time series of the air pollution index (SO_2) is the basis of the action. In relation to the management (ownership) of the government versus the private sector, due to the lack of information and statistics on added value between the private and the government in different economic sectors and basically the lack of a precise definition of the government and the private sector, it is inevitable to use a proxy variable. According to the information structure of the country, it seems that the best variable that can separate the scope of the government and the private sector in economic activities (according to the topic discussed in this study), is the statistics related to the investments made in these two sectors, since basically, any economic activity requires capital and investment, and obviously, any sector that has a higher share in the economy requires more investment, or in other words, more capital. Therefore, the capital formed in different sectors can be considered as a suitable indicator of the volume of their economic activities. This is why we employ the time-

series of fixed capital formation in the government and private sectors to analyze the relative contributions of each to the Egyptian economy (Fig. 2; Mohamed *et al.* 2021).

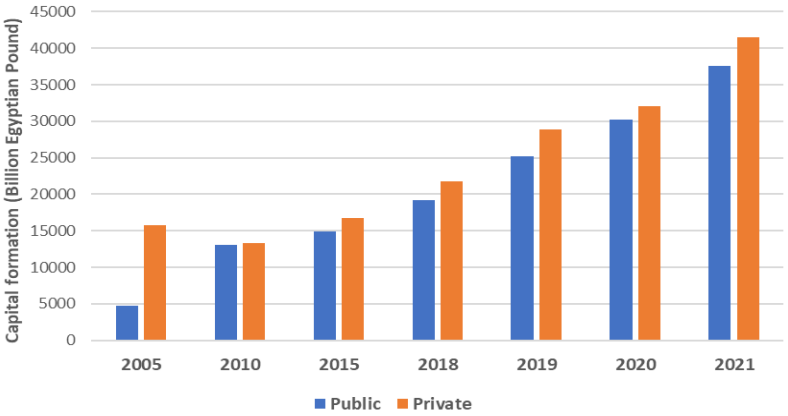

Fig. 2. Capital formation, at the constant price of the year 2015 (Billion Egyptian Pound).

The next stage is to determine whether there is a correlation between the amount of activity in the government and private sectors (measured by the variable of fixed capital formation in each of them) and pollution generation (in the form of SO_2 index). For this reason, we use the FCFGS, FCFPS, and SO_2 symbols to represent the variables fixed capital formation in the government sector, fixed capital formation in the private sector, and air pollution, respectively. Table 5 shows the correlation between these variables.

Table 5. Correlation between (logarithm) variables.

	log of SO_2	**log of FCFGS***	**log of FCFPS***
log of SO_2	1	0.299	0.883
log of FCFGS*	0.299	1	0.683
log of FCFPS*	0.883	0.683	1

*FCFGS: Fixed capital formation in the government sector; FCFPS: Fixed capital formation in the private sector.

According to Table 5, the correlation between the formation of fixed capital of the government sector and the level of pollution is much higher than that of the private sector. This issue can indicate that, basically, the fluctuations of pollution production are more affected by the activities of the government sector than the private sector. In order to ensure the above result, it is necessary to investigate the relationship of these variables in the form of more reliable quantitative methods. So, we use the regression equations available in the econometric literature. Since the formation of fixed capital in both the government and private sectors is an exogenous variable and the emission of pollution is primarily the result of economic activity, the causal relationship between these three variables is attempted in the form of a regression equation and estimated using the ordinary least squares method for the period of 2005-2021, sspecially when a lagged variable is used. Using logarithmic values of variables in regression equations indicates the existence of a significant relationship between the rate of growth of variables (apart from their absolute level), which is significant in relation to the topic of the present study. The estimated equation can be rewritten as follow:

$$LSO_2=13.47+0.09LFCFGS -0.13FCFPS+0.08LFCFGS (-1)^2= \%91\ R \quad \textbf{(1)}$$

Regarding the estimated model, two points attract attention, which somehow indicate that the results of the model match the real conditions of the economy. The first point is that although the two variables of fixed capital formation in the private and government sectors can have the same effect on pollution (since it is expected that the increase in investment and capital formation in the form of the growth of economic activities will increase the emission of pollution), However, since basically these two variables in relation to each other (relatively) are considered two substitute goods (that is, e.g., the upraised presence of the government causes a decline in the relative share of the private sector, which in economic literature is interpreted as crowding out the private sector and or vice versa), it is expected that if the effect of these two variables are estimated in one equation and side by

side on pollution, different (opposite) effects will appear, that is, they should be estimated with different signs. The positive variable coefficient of FCFGS indicates the significant contribution of the government to the spread of pollution. The (different) signs obtained indicate that in the current state of Egypt's economy, investment growth (capital formation) in the government sector has aggravated (creating) pollution. However, if the flow of investment shifts to the private sector, the rate of increase of pollution will slow down. If it stays in both sectors, the resultant of these two flows will decide the rate of growth of pollution. The second point is that since the category of investment is basically a time-consuming process, that is, the formation of capital, apart from the first year, in the following years, it can also be a source of pollution during economic activity. Therefore, the lagged variable value of FCFGS (FCFGS (-1) has also been used in the model, and the estimate obtained is acceptable at the 95% confidence level. In addition, its positive sign indicates a direct relationship between capital formation in the government sector and the creation of pollution over time. It can be seen that the explanatory power of the model is about 91%. This means that the variables of capital formation in the government and private sectors in the form of the above model have been able to explain over 91% of the fluctuations of the pollution variable.

CONCLUSION

The current study has been primarily assembled with a focus on those aspects of environmental hazards that are directly caused by the government. However, the government has other governance duties in which its inappropriate performance can also lead to adverse environmental consequences. For instance, the government's policy on fuel subsidies, which, when implemented in its current form, has led to excessive utilizing of the product due to its cheap relative price, which has significantly exacerbated the pollution situation. Obviously, this part of the analysis is not in the agenda of the present study and requires independent studies.

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