RESEARCH ARTICLE

The Ecological Impact of Turkish Official Development Assistant in Africa

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ABSTRACT

Global warming, climate change and the increase in environmental disasters have caused attention to be turned to these areas recently. In line with the Sustainable Development Goals of the United Nations, the environment has gained great importance and new investments have started to be made in this field, especially in developed countries. However, in developing and undeveloped countries, these investments are secondary to growth targets. For this reason, foreign aid is needed to realize green transformation in developing and underdeveloped countries. In particular, directing development aid to this area can be a solution for green transformation. Accordingly, the current study examines the impact of Turkey's official development assistance to Africa

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on the ecological footprint of these countries. The impact of Turkey's aid to Africa in the period 2006-2022 is analyzed with the panel-ARDL PMG estimator. A two-stage analysis was used. First, general African countries were analyzed, and then the countries to which Turkey regularly provides aid every year, but the total amount of aid provided during the analysis period was over 10 million dollars, were analyzed. According to the results of the analysis, while aid to Africa in general increases the ecological footprint, it decreases it in the countries that receive the most aid. This result shows that concentrating aid in certain regions can positively affect the environment.

Keywords: Official Development Assistance, Ecological Footprint, Turkey, Africa

JEL Codes: Q5, Q56, F35

INTRODUCTION

Biodiversity is the variety of life and interactions between living things at all levels on land, in water, at sea and in the air. They also regulate climate, natural hazards and extreme events, air quality, freshwater quantity and quality, pollination and seed dispersal, pests and diseases, soil and ocean acidification, and the creation and maintenance of habitats. Recently, however, biodiversity has been rapidly changing and decreasing all over the world. The direct drivers of this situation are increasing demands for energy, food and other materials because of rapid economic growth, population growth, international trade and technology choices, especially in the last 50 years. Today, one million plants and animals are threatened with extinction. 1-2.5% of birds, mammals, amphibians, reptiles and fish have already gone extinct, population abundance and genetic diversity have declined, and species have lost their climatically determined habitats (WWF, 2022).

The Earth has warmed by 1.2ºC since pre-industrial times. While climate change has not been a major cause of biodiversity loss to date, unless warming is limited to below 2ºC, climate change is likely to become a major cause of biodiversity loss and degradation of ecosystem services in the coming decades (WWF, 2022). Global warming also poses a significant threat to African countries. Even at temperatures of 1.5ºC below pre-industrial levels, the Western Sahel region will see a significant increase in the maximum length of dry spells. Central Africa is expected to experience a decrease in the duration of wet periods and a slight increase in extreme rainfall. In West Africa, climate change is expected to reduce agricultural yields and production. The western part of southern Africa is likely to become drier towards the end of the 21st century, with increased frequency of droughts and more heat waves (UNDP, 2024).

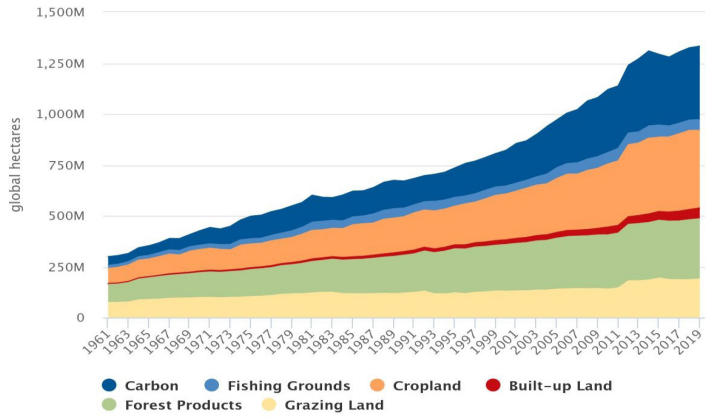
Africa accounts for less than 4% of global carbon emissions but is highly exposed to their effects. Around 52% of African countries are affected by climate change. More than 110 million people are directly affected by climate, air and water-

related hazards, with an estimated economic loss of $8.5 billion in 2022. The impact of climate change is reflected in the loss of agricultural productivity, disruptions in production and supply chains, and income losses from trade, especially for countries whose economies are heavily dependent on climate-sensitive sectors, such as agricultural commodity exports (UNDP, 2024).

Two metrics are calculated to measure ecological balance: ecological footprint and bio-capacity. First, ecological footprint measures how much bio-productive space (land or water) a population would need to sustainably produce the renewable resources it consumes and absorb the waste it produces using existing technology. Second, bio-capacity measures the supply of bio-products available in a given area (e.g., arable land, pasture, forest, or productive sea). When the ecological footprint is greater than the bio-capacity, there is a deficit in the stock of renewable resources. A national ecological deficit can be compensated to some extent through trade with countries with high ecological reserves or through the liquidation of national ecological assets. A country with ecological reserves can still experience a local deficit. Conversely, if the ecological footprint is smaller than the bio-capacity, an ecological reserve is mentioned. The ecological footprint can be reduced by a smaller population size for a given area, less consumption per capita, and higher resource efficiency (Schaefer et al., 2006).

The ecological footprint has more than doubled worldwide because of economic activities since 1961 and currently exceeds the planet's regenerative capacity by approximately 50%. This situation is no different for Africa. In Figure 1, the ecological footprint of all African countries increased by approximately 440% between 1961 and 2019. This increase is the result of increasing populations and increasing per capita consumption in a few countries. There was a 39% decrease in animal populations in Africa between 1970 and 2008. The erosion of natural capital endangers future prosperity and undermines efforts to lift Africa's growing population out of poverty (WWF, 2012). Figure 1 also examines Africa's ecological footprint under six different land type categories: carbon, fishing grounds, cropland, built-up land, forest products, and grazing land. Africa, which is largely based on agricultural production in its economy, also has a very high agricultural land footprint. Carbon footprint is the other source that increases the ecological footprint the most.

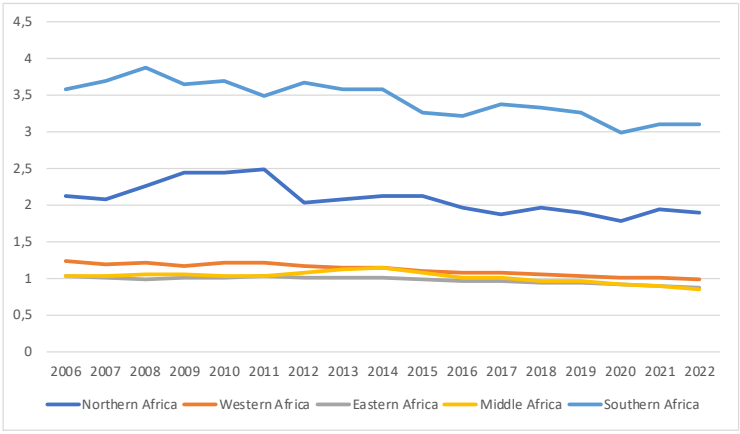
Figure 1: Africa's Ecological Footprint



Source: Global Footprint Network

The ecological footprint varies across regions in Africa. Figure 2 shows the distribution of regional ecological footprint per capita. The figure shows that the southern and northern regions of Africa differ significantly from other regions. Figure 1 shows that the ecological footprint is increasing rapidly in Africa. The downward trend in Figure 2 is because of the rapid increase in population during this period. Just as there are differences in the average footprint per capita between countries, there are also significant differences between individuals within countries. The ecological footprint of many African citizens reflects a level of consumption that is insufficient to meet their needs (WWF, 2012).

Figure 2: Regional Ecological Footprint in Africa



Source: Author's own drawing

For the first three decades of the post-World War II period, foreign aid played a central role in financing infrastructure for development. However, in the mid-1980s, the World Bank became associated with environmental disasters in various regions, which led the Bank to establish environmental departments and require environmental impact assessments for all projects with the potential to cause significant environmental damage. After this date, aid for environmental disasters started to be provided in various countries (Roberts et al., 2009).

Developing countries are particularly vulnerable to climate change because of their high climate sensitivity and relatively low adaptive capacity (Arndt and Tarp, 2017). Although developing and underdeveloped countries contribute less to environmental degradation, they have to contribute to the solution process by reducing carbon emissions. However, this often has to be done at the expense of economic development. Developing countries are already struggling with many problems, such as poverty, lack of adequate health care, food insecurity, high unemployment and gender inequality. Climate change can exacerbate existing development challenges. But climate change requires united and urgent global action. The only way out of this problem is to green the growth process of developing and underdeveloped countries. Foreign aid for the promotion of green growth offers a reasonable solution in that it not only helps developing countries but also supports the interests of developed countries. This aid is particularly necessary to ensure the creation of frameworks that promote green technology transfers and support green growth (Chen and He, 2013). Traditional development and responses to environmental problems, such as expanding the use of various inputs in agriculture, may not be consistent with each other (Arndt and Tarp, 2017). Therefore, environmental problems need to be considered when achieving development.

This study aims to examine the impact of Turkey's official development assistance to Africa on the ecological footprint of African countries. In this context, first Africa as a whole and then the countries receiving the most aid are analyzed for the period 2006-2022. Although the impact of assistance to Africa on ecology was examined, the unique value of the study is that the impact of assistance from Turkey has not been examined empirically before. Turkey has recently significantly accelerated its aid to Africa. In addition, although Turkey is one of the countries that provide large amounts of regular aid to Africa, it is

an important gap that this area is not analyzed in the literature. The present study aims to fill this gap in the literature. The next section will focus on official development assistance to Africa and its effectiveness, and then Turkey's official development assistance will be analyzed. In the following sections, the analysis and conclusion will be emphasized.

OFFICIAL DEVELOPMENT ASSISTANCE TO AFRICA AND ITS EFFECTIVENESS

Recent shocks and crises have blocked nearly 30 years of progress in poverty eradication. The impacts of the climate crisis and rising poverty and inequalities are cumulative, and where they converge, the situation worsens. The world's poorest people and regions bear the greatest burden and cost of climate disasters, losing their livelihoods and savings. The world's 46 least developed countries are home to around 1.1 billion people and contribute minimally to CO2 emissions. Yet 69% of all deaths worldwide from climate-related disasters in the last 50 years have occurred in these countries. In contrast, countries in the richest 1% produced 15% of global emissions in 2019 (OECD, 2024).

By 2030, extreme poverty is projected to be largely concentrated in Sub-Saharan Africa. It is estimated that over 450 million people will live below the extreme poverty line of $2.15 per day and around 850 million people below the absolute poverty line of $3.65 per day. Sub-Saharan Africa is also home to the largest number of people exposed to high risk from extreme weather events, while African countries are the most vulnerable to climate shocks due to their low incomes, lack of social protection and other dimensions of poverty (OECD, 2024).

Africa is increasingly exposed to the devastating effects of climate change due to rapid population growth and urbanization. According to one estimate, if in 40 years' time Africa's annual per capita emissions reach the current levels of countries such as Egypt (2.5 tons) and Botswana (3 tons), the increase in CO2 emissions on the continent will only be offset by a 60% reduction from current levels in China. Nonetheless, climate adaptation costs in developing countries are rising significantly and are now 10 to 18 times higher than international adaptation finance (OECD, 2024).

The growing gap between developed and developing countries has become a dominant issue in relations between countries. This has led to a steady flow of capital from developed countries to reduce the gap (Andrews, 2009). Official development assistance (ODA), as a stable and reliable source of financing for developing countries, plays an important role in reducing poverty and accelerating development, supporting climate change adaptation, and harnessing the green transformation to promote resilient, sustainable, and inclusive growth. Both official development assistance and climate finance to developing countries have reached record levels despite significant pressure on public budgets. In 2023, they reached $223.7 billion, setting a record for four consecutive years (OECD, 2024).

Official development assistance to Africa is crucial to fighting both poverty and climate change. A comparison of aid allocations across regions shows that providers collectively allocate the largest share (average for 2020-22) to Sub-Saharan Africa, where poverty and inequality are highest (OECD, 2024). Aid to Africa increased by 2% in real terms in 2023 compared to 2022. However, the aid total represents 0.37% of the combined GDP of the Development Assistance Committee (DAC) donors. This is below the UN's long-term target of 0.7% aid/GDP. In 2021, only five DAC members met or exceeded this target. An estimated additional $1.3 trillion in annual aid is needed to meet the growing financing gap for the SDGs in Africa. Investment and aid to the agricultural sector fell by 2.69% in Africa. In East Africa, there was a significant decline of 3.58%. Aid to agriculture in Africa increased in the 2015-2020 period but declined from $5.98 billion to $4.673 billion at constant prices in 2021 (UNDP, 2024). However, agricultural activities constitute the livelihood of a significant portion of the African population. As can be seen in Figure 1, agriculture is one of the main economic sectors that directly threatens the environment. Activities in this sector can cause environmental degradation through land conversion, biodiversity loss, land degradation, and fragmentation of natural ecosystems (Muchapondwa, 2014).

Official development assistance can improve environmental quality in several ways. First, it can be used to support the development of renewable energy technologies such as solar, wind, and hydropower, which reduce dependence on fossil fuels and lower CO2 emissions. In addition, ensuring energy efficiency will

reduce emissions. In addition, training activities, such as raising environmental awareness and providing support for technical issues, can also be implemented with this aid. Therefore, with the human capital provided, individuals become more sensitive to the environment (Barkat et al., 2024).

However, there is evidence that external aid has had little effect on changing the fate of many African countries, most of which currently have low growth rates. This indicates, to some extent, that the problem in Africa is not merely about sending money, as this alone will not reverse the situation. Furthermore, economic growth by itself does not hold much meaning. The achievement of development, which includes economic, social, and cultural components, is the key factor that will change the fate of these countries (Andrews, 2009). Although aid has positive effects, it has not enabled African countries to free themselves from debt and achieve stable growth. Studies have shown that official development assistance is positively and significantly correlated with budget deficits and the increase in public debt. This evidence suggests that most African countries are trapped in an aid syndrome, which leads to either an increase in spending, less effort to mobilize domestic resources, or both. Therefore, official development assistance to African countries needs to be reconsidered if it is to achieve the goal of freeing recipient countries from aid dependency (AfDB, 2024). African countries are so dependent on aid that they can hardly fulfill half of their annual budget commitments without it. This makes them dependent on donor countries. Aid in the form of loans, in particular, forces African countries to continuously pay off debts. As a result, long-term indebtedness makes these countries vulnerable. Additionally, such aid can lead to corruption in some countries (Andrews, 2009). The constant portrayal of the region as being in perpetual need of aid causes moral decay. In addition, developed countries aim to reduce poverty in order to provide a bulwark against terrorism rather than to develop Africa, which obstructs real development (Akonor, 2007).

The impact of external aid necessary for Africa's development depends on both its quantity and quality. Therefore, a targeted aid approach should be adopted. After independence, foreign aid in Africa has been largely wasted, mismanaged, or misdirected. With a targeted aid approach, more focus should be placed on intercontinental projects such as highways, telecommunications, and power plants. Such projects will transform Africa's fragmented infrastructure

and improve the continent's global position (Akonor, 2022). To ensure Africa's development process, the current aid model needs to be reconsidered, and more focus should be placed on supporting investments in sectors that generate growth and employment. International support should focus more on technology and skills transfer, as well as developing the capacity to mobilize local resources. To increase the ability to mobilize domestic resources, more focus should be placed on skills and technology transfer. Donors should also place greater emphasis on ensuring that aid is used effectively and efficiently, which will also be impactful (AfDB, 2024).

Aid can be used very well, but it can also have undesirable consequences. The ongoing problems in Sub-Saharan Africa are not due to external aid, but to all the negative factors and internal problems that come into play. Sub-Saharan African countries are experiencing problems despite aid, not because of it. With all the problems that African countries have had to deal with since their independence, their situation would have been even worse without aid. Indeed, when aid decreases, there is more conflict, political instability, uncertainty, and despair (Park, 2019).

Donor countries are tightening control mechanisms to prevent corruption. On one hand, there is budget support that directly transfers money to recipient governments, while on the other hand, there are large-scale programs such as capacity building, which are either completely under donor control or tightly monitored in terms of fund usage (Park, 2019). The ability of both sides to fulfill their commitments should be closely examined, and a results-based approach with an agreement for tracking outcomes or targets should be adopted. In this process, all key stakeholders, including local people, civil society, and the private sector, should be involved in monitoring commitments to raise awareness. Additionally, monitoring should be designed and implemented globally, regionally, and sub-regionally in a complementary and reinforcing manner (Wangwe, 2006).

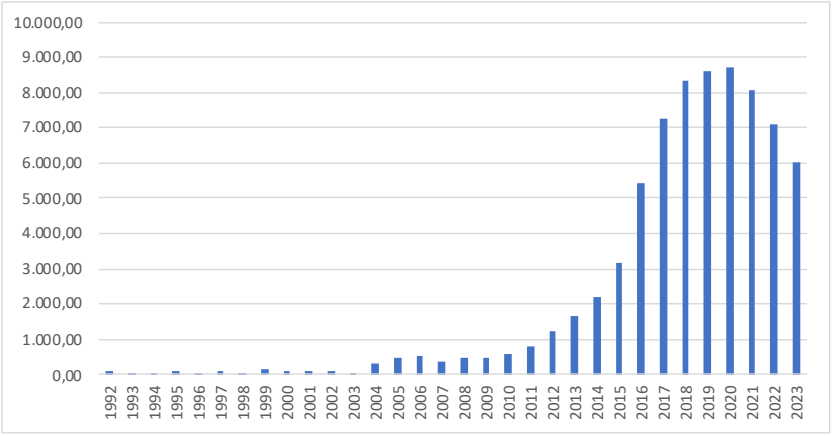
TURKEY'S OFFICIAL DEVELOPMENT ASSISTANCE

Turkey launched its own foreign aid program on June 5, 1985, when the State Planning Organization prepared a comprehensive aid package worth 10 million US dollars targeting institutional capacity building in the Gambia, Guinea, Guinea-Bissau, Mauritania, Senegal, Somalia, and Sudan. With the establishment of new republics in Central Asia and the Caucasus in the late 1980s, aid programs were also established for these regions. During this period, the primary goal was to support the construction and economic transformation of newly established states. This process was carried out by TIKA, which was established in 1992 and is responsible for the implementation of Turkey's development cooperation policy. TIKA is also responsible for ensuring coordination with international organizations and bilateral donors. In this context, TIKA has carried out nearly 25,000 projects/activities since 1992 (MFA, 2018).

Turkey's total development assistance for the year 2022 amounted to 7,892.61 million dollars. Thus, it ranked among the top five countries in the world with a ratio of official development assistance to national income of 0.79%. Among these assistances, the first five include emergency and humanitarian assistance, assistance to refugees, education, water and water hygiene (sanitation), and other social infrastructure and services. The top ten countries that benefit the most from Turkey's bilateral official development assistance are Syria, Somalia, Kazakhstan, Kyrgyz Republic, Palestine, Afghanistan, Bosnia and Herzegovina, Pakistan, Lebanon, and Azerbaijan (TİKA, 2022).

Figure 3 shows the distribution of development aid provided by Turkey throughout the world over the years. The aid presented here only includes grants, and the loans provided are not included. It is seen that the aid provided gained momentum from the beginning of the 2000s and increased rapidly until 2020. This situation is due to Turkey's aim to be more visible on a global scale and to its multifaceted policy that it has started to follow since the beginning of the 2000s (Tepeciklioğlu, 2018). The increase in aid provided to the region with the start of the Syrian civil war in 2011 had a significant impact on this leap. In 2022, Syria was still the country that received the highest amount of aid by far. However, it is seen that grants decreased from 2020 onwards because of the economic conditions in Turkey.

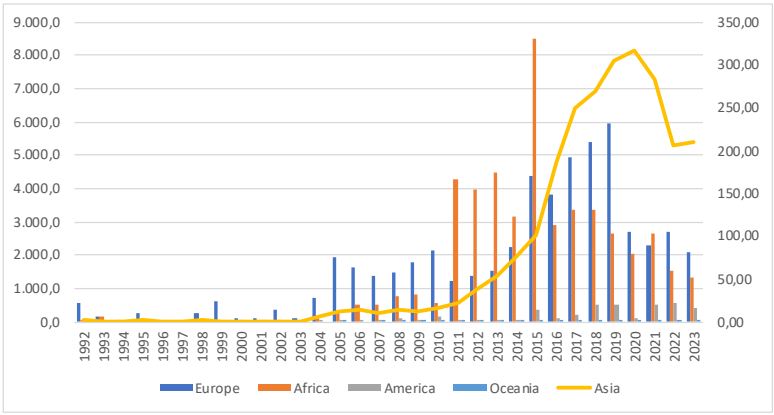
Figure 3: Turkey's Official Development Assistance Around the World



Source: Author's own drawing

Figure 4 shows the distribution of development aid provided by Turkey among the continents. The aid presented here only includes grants, and the loans provided are not included. The Asian continent is shown as a line and represented by the left axis. Europe, Africa, America, and Oceania are shown as a column chart and represented by the right axis. The reason for the division of the chart is that Asia receives significantly more aid than all other regions. The largest portion of this aid is provided to Syria. Apart from this, Turkish states in Asia also benefited greatly from the aid. It is seen that investments made in Africa gained momentum in the 2000s. After being neglected for a long time in foreign policy, the Turkish foreign policy, known as the "Africa Initiative", aims to increase the country's visibility on the international stage and become a more effective actor, while also aiming to raise awareness among the peoples of the continent. With the 'African Initiative Action Plan' adopted in 1998, political, economic, and humanitarian steps were taken towards Africa (Tepeciklioğlu, 2018). Turkey was accepted as an "observer" to the African Union in 2002. 2005 was declared the "Year of Africa" in Turkey, and the same year TIKA opened its first office in Africa in Ethiopia. The "Turkey-Africa Cooperation Summit" was held in Turkey in 2008, and the African Union declared Turkey a "strategic partner" in the same year. Turkey operates in the region, particularly in the fields of agriculture, health, education, water and sanitation, vocational training, institutional capacity development, and humanitarian aid (MFA, 2018).

Figure 4: Regional Distribution of Turkey's Official Development Assistance



Source: Author's own drawing

LITERATURE REVIEW

The impact of official development assistance on the environment has been analyzed in different countries. Various environmental indicators have been used in these studies. Apart from the ecological footprint, the effects of official development assistance on CO2 emissions have been studied in developing countries. According to the study, while the aid shows limited effectiveness in reducing emissions in low-income countries, its impact becomes significant in middle-income countries (Barkat et al., 2024). The effect of China's aid to African countries on environmental quality has been studied, and it was found that these aids simultaneously improved local air quality and economic development (Xu and Zhang, 2023). In another study on China's aid to African countries, it was found that in some countries with strong local institutions, the aid helped reduce pollution (Boamah et al., 2022). The impact of economic incentives, such as international transfers targeting biodiversity and tourism revenues, on biodiversity conservation policies in Sub-Saharan Africa has been examined. It was found that, besides international financial aid, tourism also had an impact on biodiversity conservation policies (Amin, 2016). The impact of aid to African countries on combating climate change has been examined, and a comprehensive quantitative mapping of financial flows was made. The analysis revealed that most of the aid focused on agriculture, water supply, and sanitation, while these aids were found to be well below the required level (Savvidou et

al., 2021). Additionally, the environmental impact of aid to certain regions of Africa has been examined theoretically (Kahyarara, 2014; Muchapondwa, 2014; Abeselom, 2018).

The effects of official development assistance on the ecological footprint in Africa have been studied in a limited number of studies. The impact of aid on the ecological deficit has been examined for Sub-Saharan African countries. According to the study, aid in countries with good national governance systems and governance capabilities has a much better impact than in countries with weak national governance systems and governance capabilities (Li et al., 2022).

When the studies in the literature are examined, it is seen that the impact of aid on the environment cannot be clearly seen. It is seen that the effects vary according to the specific situations of countries. In addition, most of the studies have used indicators focusing on one dimension of environmental quality instead of using a comprehensive index as in the present study. Although there are numerous books and articles on environmental aid to developing countries, most of these studies are based on qualitative case studies or small sample sizes. The lack of comprehensive and reliable data on aid projects from bilateral and multilateral donors also limits this field (Roberts et al., 2009). There are very few empirical studies focused on African countries. Furthermore, studies that specifically examine donor countries are also quite limited. Apart from China, the effects of individual countries' aid to Africa have not been empirically examined. Turkey's aid to Africa has only been analyzed from a political perspective. Therefore, this study aims to fill this gap in the literature. Both the fact that it focuses on Turkey as an important donor for Africa and the fact that it is an empirical study make the present article unique.

ANALYSIS

The aim of this study is to examine the impact of Turkey's official development assistance to Africa on the ecological footprint of Africa. Two different datasets covering the period from 2006 to 2022 have been used in the analysis. In the first analysis, 27 African countries that Turkey regularly provided grants to each year and for which data was available were examined. In the second dataset, 19 countries, which Turkey also regularly provided grants to each year and for

which the total grant amount during the analysis period exceeded 10 million dollars, were selected. This allowed for the examination of countries that received a significant amount of aid. The list of the countries examined in the analysis is provided in the Appendix. These countries were selected among the African countries for which data were available during the analysis period. Countries with missing data are excluded from the analysis. The variables used in the analysis were selected from those most frequently found in the literature as having an impact on the ecological footprint. Official development assistance includes both loans and grants. In this article, only grants were considered for the analysis. The reason for excluding loans from the analysis is that they are mostly repayable with interest, rather than being direct aid, and although they can contribute to a country's development, they also push Africa into debt. It is thought that this situation may prioritize development and leave environmental conditions even further behind. A detailed explanation of this situation is presented in section 2. In addition, since this data set is organized in a way that includes repayments, it causes very large gaps between periods. Therefore, for the sake of analysis, loans are not included in the data set. All other variables belong to African countries. The logarithms of the variables were taken, and the analysis was conducted using a full logarithmic form. Detailed information about the variables is provided in Table 1.

Table 1: Variables Used in the Analysis

Variables	Definitions	Source
logeco	log of ecological footprint	Global Footprint Network
logoda	log of ODA-grants	OECD
logbirth	log of birth rate, crude (per 1,000 people)	World Bank Data
logelectricity	log of access to electricity (% of population)	World Bank Data
logunemployment	log of unemployment, total (% of total labor force)	World Bank Data
logimport	log of import unit value index (2015 = 100)	World Bank Data

logexport	log of export unit value index (2015 = 100)	World Bank Data
logexpimp	log of export unit value index/ import unit value index	World Bank Data
logempagri	log of employment in agriculture (% of total employment)	World Bank Data
loglife	log of life expectancy at birth, total (years)	World Bank Data
logyeild	Log of cereal yield (kg per hectare)	World Bank Data

In the analysis, the results for the general African countries are presented first. Initially, the stationarity of the variables used in the model was examined. The cross-sectional augmented Dickey-Fuller (CADF) Test developed by Pesaran (2007) was applied. According to this test, the variable is considered stationary at the 5% significance level if the absolute value of the t-statistic is greater than the absolute value of the 5% critical value. The results of the unit root test are presented in Table 2.

Table 2: Unit Root Test Results

	Level		First Difference	
Variables	t statistic	cv5	t statistic	cv5
logeco	-1.956	-2.150	-4.550	-2.150**
logoda	-3.533	-2.150**		
logbirth	-0.991	-2.150	-2.615	-2.150**
logelectricity	-3.122	-2.150**		
logunemployment	-1.208	-2.150	-3.376	-2.150**
logimport	-1.152	-2.150	-3.232	-2.150**
logexport	-1.985	-2.150	-3.198	-2.150**
logexpimp	-2.353	-2.150**		
logempagri	-1.578	-2.150	-2.620	-2.150**
loglife	-2.244	-2.150**		

Note: ** indicates significance at 5% significance level.

According to the unit root test results, it was observed that all variables, except for logoda, logelectricity, logexpimp, and loglife, are stationary at the first difference. Due to the variables being stationary at different levels, the panel ARDL model, which provides consistent results at different levels of stationarity, has been preferred.

For hypothesis testing, the panel-ARDL long-term PMG estimation was used. The fundamental assumption of the PMG estimation method, also known as the error correction method, is the existence of cointegration, and for this, separate cointegration and unit root tests need to be performed on the panel data (Zaidi & Saidi, 2018). Pesaran et al. (1999) did not propose a specific cointegration test, but derived asymptotic properties for estimating the regressors of both stationary and non-stationary series. The PMG estimator is an appropriate technique for forecasting dynamic heterogeneous panel data models. Given that the countries used in the model differ in terms of development levels and ecological footprints, this model is suitable. The PMG approach also provides the error correction coefficient, which validates the existence of a long-term relationship. The coefficient of the lagged error correction term measures the rate at which the dependent variable adjusts to changes in the dependent variable before converging to the equilibrium level. If the coefficient of the error correction term is significantly negative, it suggests the presence of a long-term relationship (Zaidi & Saidi, 2018). The model to be used in the PMG analysis was selected based on the Akaike criterion. Accordingly, the model with the smallest Akaike criterion was preferred. The Akaike criterion graph for each model is presented in the Appendix. Additionally, robustness checks were conducted by setting up different models to examine the direction of the variables. The long-term PMG model results are presented in Table 3.

Table 3: Panel ARDL Long-Term PMG Model Results

Variables	Coefficients	Standard Error	t Statistic	prob
Model 1				
logoda	0.010	0.001	7.595	0.000*
logbirth	0.842	0.057	14.784	0.000*
logelectricity	0.203	0.019	10.646	0.000*
logunemployment	0.038	0.004	9.349	0.000*
Model 2				
logoda	0.016	0.001	18.466	0.000*
loglife	0.643	0.094	6.837	0.000*
logunemployment	0.233	0.008	27.675	0.000*
logexpimp	0.144	0.015	9.505	0.000*
Model 3				
logoda	0.004	0.003	1.395	0.164
logimport	-0.386	0.095	-4.044	0.000*
logexport	0.295	0.066	4.449	0.000*
logunemployment	0.100	0.014	7.299	0.000*
logelectricity	0.057	0.020	2.802	0.005*
Model 4				
logoda	0.003	0.003	0.996	0.320
logunemployment	0.089	0.013	6.809	0.000*
logexpimp	0.368	0.070	5.229	0.000*
logelectricity	0.042	0.021	1.980	0.049**
Model 5				
logoda	0.014	0.007	1.959	0.052**
logempagri	0.382	0.055	6.978	0.000*
logelectricity	0.526	0.124	4.230	0.000*

Note: * and ** denote significance at 1% and 5% significance levels, respectively.

When the long-term analysis results are examined, it is found that official development assistance increases the ecological footprint in all models. When the literature is examined, the effect of assistance on the environment cannot be clearly demonstrated. While a positive effect is seen in some situations and country groups, a negative effect can be seen in others. However, the fact that the effect increases the ecological footprint in all five models is supportive. Aid provided to African countries has not generally provided sufficient support for the development of the countries. This situation also prevents the incoming assistance from positively affecting the environment (Akonor, 2007; Andrews, 2009). Apart from this, it has been found in the literature that the effect of assistance on the ecological deficit varies according to the governance systems and governance capabilities of the countries (Liv et al., 2022).

Another variable, logelectricity, was found to be positive and significant in all models. The oil and natural gas used in the production of electrical energy are obtained from natural resources, and as the demand for and consumption of electricity increase, the demand for oil and natural gas also increases, leading to environmental degradation (Langnel and Amegavi, 2020). Although renewable energy sources are not analyzed in the present study, on the contrary, it has been determined in the literature that the increase in electricity consumption resulting from green electricity consumption reduces the ecological footprint because it does not harm nature (Dai et al., 2023).

It was found that the logunemployment variable has a positive effect on the ecological footprint. In the literature, there are models where unemployment has both positive (Ayad and Djedaiet, 2024) and negative (Ng., 2022) effects on the ecological footprint of different country groups. An increase in unemployment tends to lower individuals' quality of life and hinders development. This situation prevents the formation of environmental concerns and awareness among individuals. In regions with low development, such as Africa, the difficulties in sustaining life push environmental problems to the background.

In the analysis, the effect of imports was found to be negative, while the effect of exports was positive. Additionally, the ratio of exports to imports also has a positive effect. This could be due to the increase in trade, which stimulates economic growth and raises resource usage. The impact of exports and imports on the ecological footprint has not been clearly defined in the literature. The

effects of these variables vary depending on the country groups and data set. Consistent with the results of this study, there are other studies showing that exports reduce the ecological footprint while imports increase it (Topcu, 2021). There are also studies showing that both variables increase the ecological footprint (Zhou et al., 2024). Furthermore, it has been found in the literature that exports negatively affect biodiversity (Amin, 2016).

The loglife and logbirth variables used in the analysis are both associated with population growth. It is frequently observed in the literature that both variables have a positive effect on the ecological footprint (Aktürk and Gültekin, 2024). Furthermore, the coefficients of these variables are among the highest in the models. An increasing population leads to a rise in the use of natural resources, including vital products such as energy and food. This results in an increased environmental burden, which ultimately leads to the erosion of environmental quality and the intensification of the ecological deficit (Udemba, 2021).

Finally, it has been determined that the increase in the agricultural labor force raises the ecological footprint. This is an expected outcome, especially in African countries, where agriculture is the primary source of livelihood. In regions where environmentally sensitive agriculture is not practiced, the increase in agricultural production can lead to deforestation, excessive irrigation, and soil contamination because of fertilizer use (Ozturk et al., 2024).

The cointegration relationship established by the short-term forecast and error correction model is shown in Table 4. In equilibrium, the negative and significant error correction coefficient statistically confirms the existence of a long-term relationship (Zaidi & Saidi, 2018). In all models, the error correction coefficient is negative and significant. Apart from this, it was determined that most of the variables were insignificant in the short term. There was no effect of aid on the ecological footprint in the short term.

Table 4: Panel ARDL Short-Term PMG Model Results

Variables	Coefficients	Standard Error	t Statistic	prob
Model 1				
Cointeq01	-0.521	0.144	-3.613	0.000*
D(logeco(-1))	-0.101	0.108	-0.938	0.350
D(logoda)	-0.001	0.006	-0.117	0.907
D(logoda(-1))	0.006	0.006	1.064	0.289
D(logbirth)	2.873	1.890	1.520	0.131
D(logbirth(-1))	-1.418	0.964	-1.471	0.143
D(logelectricity)	0.393	0.600	0.654	0.514
D(logelectricity(-1))	-0.483	0.765	-0.631	0.529
D(logunemployment)	-0.009	0.062	-0.150	0.881
D(logunemployment(-1))	0.198	0.332	0.595	0.553
c	-0.758	0.223	-3.402	0.001*
Model 2				
Cointeq01	-0.246	0.095	-2.583	0.011*
D(logeco(-1))	-0.191	0.069	-2.766	0.006*
D(logoda)	0.001	0.005	0.232	0.817
D(logoda(-1))	0.004	0.006	0.767	0.444
D(loglife)	1.077	1.084	0.994	0.322
D(loglife(-1))	2.772	1.269	2.185	0.030**
D(logunemployment)	0.066	0.204	0.323	0.747
D(logunemployment(-1))	0.280	0.464	0.605	0.546
D(logexpimp)	-0.237	0.163	-1.449	0.149
D(logexpimp(-1))	0.012	0.139	0.089	0.929
c	-0.295	0.115	-2.565	0.011*
Model 3				
Cointeq01	-0.252	0.062	-4.051	0.000*
D(logoda)	0.001	0.003	0.401	0.689

D(logimport)	0.004	0.148	0.029	0.977
D(logexport)	-0.146	0.086	-1.696	0.091***
D(logunemployment)	-0.038	0.083	-0.456	0.649
D(logelectricity)	2.123	1.617	1.313	0.191
c	0.041	0.015	2.673	0.008*
Model 4				
Cointeq01	-0.259	0.058	-4.437	0.000*
D(logoda)	0.002	0.003	0.661	0.509
D(logunemployment)	0.003	0.111	0.028	0.977
D(logexpimp)	-0.165	0.079	-2.091	0.037**
D(logelectricity)	1.553	1.271	1.222	0.223
c	0.004	0.013	0.286	0.775
Model 5				
Cointeq01	-0.200	0.076	-2.651	0.009*
D(logeco(-1))	-0.158	0.079	-1.998	0.047**
D(logoda)	-0.002	0.005	-0.324	0.746
D(logoda(-1))	0.003	0.005	0.567	0.571
D(logempagri)	0.345	0.416	0.828	0.409
D(logempagri(-1))	-1.025	0.583	-1.757	0.080
D(logelectricity)	1.683	1.851	0.909	0.364
D(logelectricity(-1))	0.3503	0.665	0.527	0.599
c	-0.255	0.101	-2.515	0.013*

Note: *, ** and *** indicate significance at 1%, 5% and 10% significance levels, respectively.

Subsequently, the analyses conducted for the 19 African countries to which Turkey provided the most grants between 2006 and 2022 were presented. First, the stationarity of the variables used in the model was examined. The cross-sectionally augmented Dickey-Fuller (CADF) Test developed by Pesaran (2007) was used. The unit root test results are presented in Table 5.

Table 5: Unit Root Test Results

	Level		First Difference	
Variables	t statistic	cv5	Variables	t statistic
logeco	-1.951	-2.210	-4.741	-2.210**
logoda	-4.177	-2.210**		
logbirth	-1.224	-2.210	-2.739	-2.210**
logelectricity	-2.821	-2.210**		
logunemployment	-1.365	-2.210	-3.496	-2.210**
logimport	-1.424	-2.210	-3.366	-2.210**
logexport	-1.860	-2.210	-3.196	-2.210**
logexpimp	-1.624	-2.210	-2.819	-2.210**
logempagri	-1.604	-2.210	-2.919	-2.210**
logyield	-2.839	-2.210**		

Note: ** indicates significance at 5% significance level.

According to the unit root test results, it has been observed that all variables, except for logoda, logelectricity, and logyeild, are stationary at the first difference. Due to the variables being stationary at different levels, the panel-ARDL long-term PMG estimator, which provides consistent results at different stationarity levels, was preferred. In the PMG analysis, the model to be used was selected based on the Akaike criterion. Accordingly, the model with the smallest Akaike criterion was preferred. The Akaike criterion graph for each model is presented in the Appendix. Additionally, for robustness checks, different models were constructed to control the direction of the variables. The long-term PMG model results are presented in Table 6.

Table 6: Panel ARDL Long-Term PMG Model Results

Variables	Coefficients	Standard Error	t Statistic	prob
Model 1				
logoda	-0.006	0.005	-1.182	0.240
logyield	0.080	0.034	2.352	0.021**
logimport	-0.802	0.108	-7.446	0.000*
logexport	0.821	0.081	10.138	0.000*
Model 2				
logoda	-0.060	0.017	-3.487	0.001*
logunemployment	0.287	0.066	4.339	0.000*
logexpimp	1.849	0.245	7.555	0.000*
logelectricity	0.447	0.188	2.384	0.019**
Model 3				
logoda	-0.011	0.004	-2.670	0.009*
logempagri	-0.096	0.034	-2.812	0.006*
logbirth	1.117	0.061	18.180	0.000*
logelectricity	0.336	0.035	9.525	0.000*
Model 4				
logoda	-0.027	0.010	-2.845	0.005*
logelectricity	0.279	0.101	2.763	0.007*
logyield	0.121	0.031	3.922	0.000*
logexpimp	1.328	0.123	10.789	0.000*

Note: * and ** denote significance at 1% and 5% significance levels, respectively.

When Table 3 and Table 6 are compared in terms of results, it can be seen that all variables, except for logoda and logempagri, have the same direction. The most important difference here is that the concentration of aid has a reducing effect on the ecological footprint. This result suggests that if aid is focused on specific countries, regulations can be made to create a difference in those countries. Instead of distributing donors' aid across the entire continent, allocating specific regions to each donor could provide a solution in this regard. This way,

a concentration can be achieved that will reverse environmental degradation in those regions. This concentration even reverses the impact of the increase in agricultural labor on the ecological footprint.

Additionally, the effect of the logyield variable was found to be positive. This result indicates that as crop yield increases, the ecological footprint also increases. Similar results can be found in the literature (Zhai et al., 2021). This situation may have arisen because of the intensification of inputs used in agricultural activities to increase yield in certain regions.

The cointegration relationship established by the short-term forecast and error correction model is shown in Table 7. In all models, the negative and significant error correction coefficient indicates the existence of a long-term relationship. Apart from this, it was determined that most of the variables were insignificant in the short term. There was no effect of aid on the ecological footprint in the short term.

Table 7: Panel ARDL Short-Term PMG Model Results

Variables	Coefficients	Standard Error	t Statistic	prob
Model 1				
Cointeq01	-0.214	0.095	-2.269	0.025*
D(logeco(-1))	-0.163	0.102	-1.591	0.115
D(logoda)	-0.001	0.006	-0.193	0.848
D(logoda(-1))	0.000	0.003	0.079	0.938
D(logyield)	0.033	0.179	0.184	0.854
D(logyield(-1))	0.224	0.319	0.702	0.484
D(logimport)	0.259	0.217	1.195	0.235
D(logimport(-1))	0.427	0.304	1.405	0.163
D(logexport)	-0.302	0.159	-1.894	0.061***
D(logexport(-1))	-0.201	0.169	-1.193	0.236
c	-0.035	0.025	-1.421	0.158
Model 2				
Cointeq01	-0.098	0.048	-2.027	0.045**
D(logeco(-1))	-0.316	0.096	-3.305	0.001*
D(logoda)	0.002	0.007	0.316	0.753

D(logoda(-1))	0.004	0.005	0.895	0.373
D(logunemployment)	-0.236	0.115	-2.052	0.043**
D(logunemploy-ment(-1))	-0.346	0.191	-1.810	0.073***
D(logexpimp)	-0.227	0.145	-1.566	0.120
D(logexpimp(-1))	-0.107	0.188	-0.570	0.570
D(logelectricity)	-0.067	2.011	-0.033	0.974
D(logelectricity(-1))	-0.506	0.631	-0.802	0.425
c	-0.088	0.046	-1.937	0.055***
Model 3				
Cointeq01	-0.587	0.160	-3.669	0.000*
D(logeco(-1))	-0.207	0.129	-1.612	0.110
D(logoda)	0.003	0.005	0.626	0.533
D(logoda(-1))	0.014	0.006	2.176	0.032**
D(logempagri)	0.472	0.414	1.141	0.256
D(logempagri(-1))	0.238	0.523	0.455	0.650
D(logbirth)	4.754	2.286	2.079	0.040**
D(logbirth(-1))	-2.257	1.360	-1.659	0.100
D(logelectricity)	3.077	2.032	1.514	0.133
D(logelectricity(-1))	0.379	1.075	0.352	0.725
c	-1.118	0.331	-3.375	0.001*
Model 4				
Cointeq01	-0.140	0.083	-1.691	0.094***
D(logeco(-1))	-0.281	0.125	-2.250	0.026**
D(logoda)	-0.004	0.008	-0.507	0.613
D(logoda(-1))	0.003	0.005	0.571	0.569
D(logelectricity)	1.249	2.393	0.522	0.603
D(logelectricity(-1))	-0.366	0.404	-0.906	0.367
D(logyield)	0.137	0.104	1.315	0.191
D(logyield(-1))	0.324	0.323	1.003	0.318
D(logexpimp)	-0.158	0.101	-1.555	0.123
D(logexpimp(-1))	-0.193	0.174	-1.109	0.270
c	-0.108	0.069	-1.559	0.122

Note: *, ** and *** indicate significance at 1%, 5% and 10% significance levels, respectively.

DISCUSSION

Recently, Turkey has gained significant visibility on the international stage with its official development assistance. These aids, on the other hand, have contributed to the development of bilateral relations and increased its effectiveness in foreign policy. The aid efforts that have gained great momentum in Africa recently are effective in various aspects. Turkey's aid also affects Africa's ecological footprint. According to the results of the study, while aid to Africa in general increases the ecological footprint, it has a reducing effect in the countries where Turkey provides the most aid. This highlights the importance of increasing aid and focusing it on specific regions. The findings suggest that targeted and region-specific aid strategies may enhance environmental outcomes. If donor countries are allocated countries and regions to receive aid, or if aid is distributed in a planned and focused manner by a higher authority, it is expected to be easier to reach the target. According to the results, the increase in the amount of aid decreases the ecological footprint of the countries in the secondgroup. This means that as the amount of aid increases, countries pay more attention to environmental quality. Therefore, concentration is of great importance. Moreover, it is crucial that the aid supports the overall development process. As seen in Table 6, variables such as electricity use and trade, which are indicators of economic growth, increase the ecological footprint. Focusing development aid solely on economic growth would have a destructive impact on the environment. However, it is not possible to put economic growth in the background in these underdeveloped and developing countries. Therefore, it is important that aid both promotes economic growth and be directed towards environmental improvement.

The highest coefficients in the analysis results generally belong to the variables of birth rate and life expectancy at birth, which have a population-increasing effect. The rapidly increasing population causes a rapid increase in demand for natural resources. At the same time, it is expected that the pollution resulting from the consumption of this population will be absorbed by natural resources. Therefore, it is necessary to raise public awareness about the environment, promote recycling, and make waste management more environmentally sensitive. Additionally, the analysis revealed the negative environmental impact of agricultural production. In order to feed the rapidly growing population, there

is a continuous need to open new agricultural land, use more fertilizers and water, and further pollute the soil. Therefore, it is essential to prioritize making agricultural production environmentally sensitive through aid.

The current study has several limitations. Firstly, not all countries to which Turkey provides aid were included; only those countries that receive regular aid each year were included in the analysis. In addition, due to the difficulty of accessing data from African countries, the data set had to start with certain variables from 2006. It was also not possible to find long data sets for other variables. Finally, the lack of sufficient literature in this field also limits the comparison of study results. In ongoing studies, it is aimed to examine specific regions of Africa.

Ethics Statement

This study did not include human participants and therefore did not require ethical approval.

Use of Generative AI

The author used ChatGPT to translate the manuscript into English. After using this tool, the content was reviewed and edited by the author, who takes full responsibility for the final manuscript.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization: S.G., E.A.; Data Collection: S.G.; Methodology Design: S.G.; Formal Analysis: S.G.; Software Use: S.G.; Manuscript Drafting: S.G.; Critical Revisions: S.G., E.A.; Supervision: S.G., E.A.

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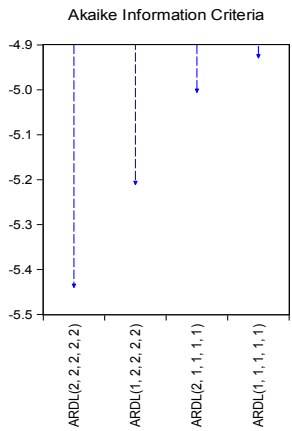
APPENDIX

General African Countries: Algeria, Egypt, Libya, Morocco, Tunisia, Comoros, Djibouti, Ethiopia, Kenya, Somalia, Sierra Leone, Tanzania, Uganda, Zambia, Cameroon, Congo, South Africa, Burkina Faso, Côte d'İvoire, Gambia, Ghana, Guinea, Liberia, Mali, Niger, Nigeria, Senegal

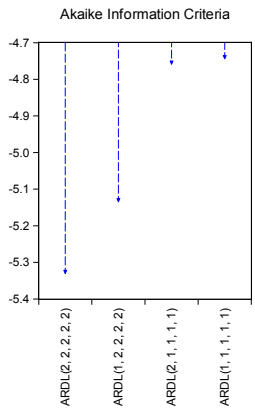
Selected African Countries: Somalia, Tunisia, Libya, Niger, Egypt, Djibouti, Ethiopia, Gambia, Senegal, Algeria, Guinea, Kenya, Mali, Ghana, Morocco, Cameroon, Uganda, Tanzania, Burkina Faso

General African Countries Model Selection Akaike Criteria

Model 1



Model 2



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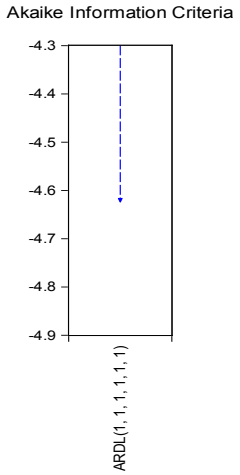

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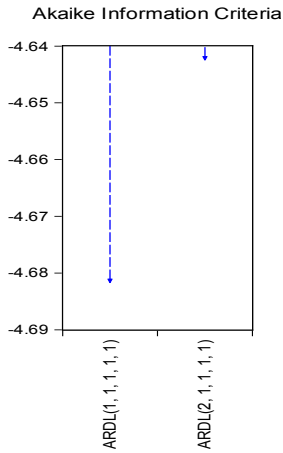

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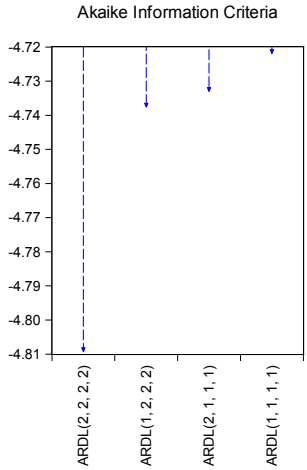
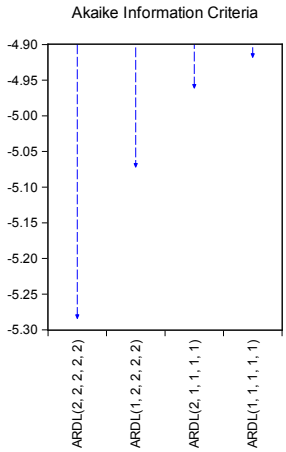


Selected African Countries Model Selection Akaike Criteria

Model 1



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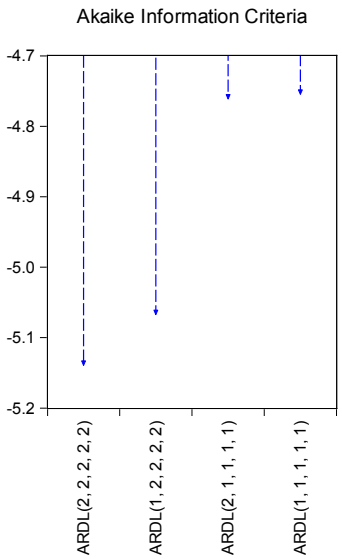
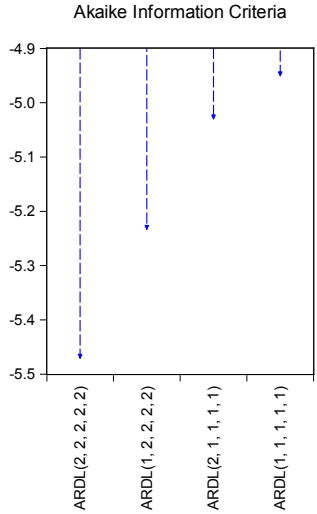


Model 3



Model 4