

ECONOMIC IMPACT OF DROUGHTS ON SECTORAL OUTCOMES IN AFRICAN COUNTRIES

AHMAD BUGAJE BASHIR^{1,2}

¹Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia.

E-mail: ahmadbug89@gmail.com

²Department of Economics, Faculty of Social and Man. Science, Bauchi State University.

Abstract:

Drought as an event exhausts the availability of water use as an input of production in agricultural activities, and reduce labor productivity through hunger and starvation; which has a potential economic spillover beyond agricultural sector to other economic sectors of the economy, based on interconnectedness of sectors and regions. Drought-induced water deficiency affects production operations in other sectors of an economy apart from agricultural sector; since water availability is characterized by pervasive spillovers effects i.e. the use by one group or region affects the water availability and security of others. This study investigates the economic impact of droughts on sectorial output in African countries. The study use Generalized Method of Moment's panel estimator and reported both one-step and two-step results. Dynamic GMM was use for estimation and system GMM was use for robustness. The dataset for the study was between the periods of 1979-2014 for 44 African countries. The results show that drought reduces both agricultural and manufacturing output in African countries. Hence, African governments must look into the inter-linkage between this this sectors in designing policies to mitigate the impact of this disasters.

Key Words: droughts, sectoral growth, agro-industries, generalized method of moments

Introduction

Since the beginning of 20th century, Emergency Events Database (EM-DAT) estimated that more than 11 million number of people have been killed as a result of droughts, 2 billion number of people have been affected as a direct result of droughts worldwide, and US\$136 billion worth of goods and services have been loss across the globe (see Table 1.1)(CRED, 2015). Drought as an event exhausts the availability of water use as input of production in agriculture activities, leading to a reduction of labor productivity through hunger, starvation, and death; which has a potential economic spillover beyond agricultural sector to other economic sectors of the economy, based on interconnectedness. This is because agro-industrial sectors, connecting agricultural activities with light manufacturing, generally account for a substantial part of industrial output in developing countries in Africa compared to industrialized ones. For instance, the share of agro-industrial sectors in total manufacturing value added is 70% in United Republic of Tanzania, 51% in Ethiopia, 35% in Kenya (UNIDO, 2009).

Table 1 Economic Impact of Drought across different continents from 1900-2016

Continent	Number of events	Number of people killed	Number of people affected	Economic Damages
Africa	297	867131	376205125	3484593
America	144	77	104310181	57773139
Asia	159	9663389	1756562029	37958065
Europe	42	1200002	15488769	25481309
Oceania	22	66	8034012	11526000
Total	664	11730665	2260600116	136223106

Source: EM-DAT database

Amidst the breakthrough on the empirics of economics of natural disaster, literature has been divided into two strand; some studies have examined the implication of natural disaster on economic growth from short run point of view (Albala Bertrand, 1993; Strobl, 2012), while other studies investigated the natural disaster- economic growth nexus from long-run perspective (Toya and Skimdore, 2002; Jaramillo, 2007; Klomp and Valckx, 2014; Klomp, 2016). So far, the literature has remained inconclusive regarding the economic impact of drought on outcomes in the medium term. Moreover, the growth effect of natural disasters in general is framed within one-sector model, using aggregate production function instead of multi-sector models that will examine different type disasters on sectoral level (Loayza et al. 2012).

Adverse supply shock theory postulates that an event may leads to a sudden reduction in the supply of input necessary for an economy to function efficiently. This could result from natural disaster such as flood, earthquake and drought; from humans, animals, or plant diseases; or from major political upheavals such as a war or revolution. For instance, to an oil importers, the sudden price increases imposed by the Organisation of Petroleum Exporting Countries (OPEC) in the 1970 appears as an adverse supply shock. Such as shock reduces the real income an economy can produce even at full employment of its available resource. In addition, it is an event that can cause an unexpected increase in the costs of production or disruption of production process. This will cause the short-run aggregate supply curve to shift to the left, leading to higher inflation and lower output. Drought-induced production losses cause negative supply shocks, but the amount of incurred economic impacts and distribution of losses depends on the market structure and interaction between the supply and demand of agricultural products.

The few studies on sectoral level that had access the economic impact of droughts on agriculture activities used different frameworks (e.g. Islam, 2003; Horridge et al., 2005; Salami et al. 2009; Howitt et al., 2014). For instance, Horridge et al. (2005) use input-output framework and show that 2002-2003 drought in Australia had significantly reduces income level in agricultural sector. The results inferred that the impact of drought on Australia's 144 Sector and 54 regions, after aggregating the sectors into 38 sectors and 45 regions is negative. Moreover, the study suggests that drought in 2005 resulted to an income loss of 20% in the short run for agricultural

workers. This is despite the relative lower share of agriculture to the total size of the economy of about 3.6%, droughts reduce the GDP by around 1.6%. Drought-induced losses are not completely borne by farmers who are the major stakeholders; instead, a portion of the losses are passed on to consumers through increased prices. The higher the price increases, the more losses will be passed on to consumers. In the same way, Salami et al. (2009) used a dynamic programming technique to examine the impact of drought in Iranian economy between the crop years of 1999-2008 and establish a negative relationship between drought and agricultural sector economic activities. In addition, the result indicates that the direct cost of US\$1,650 million was incurred in cropping sub-sector of agricultural sector, which account to around 30% of total value added to agricultural sector. Drought overall reduced the GDP of the by 4.4%.

Droughts are natural hazards may result from reduction in rainfall water and affect the water storage capacity that provides the industrial sector with input of production. EM-DAT reported that African countries have the highest occurrences of this phenomena and the second highest number of people affected in the 20th century, after Asia (see Table 1). The region is known to heavily depend on agricultural activities for employment opportunities and rely on rainfall water as input in farming activities. Thus, according to adverse supply shock theory, reduction in water availability for this activities will have economic implications in the region's activities (Freire-Gonzales et al., 2017). In addition, due to connectedness between regional supply chain between agricultural activities and agro-industrial sectors, the economic impact is likely to be dire. In other words, Drought-induced water deficiency affects production operations in other sectors of an economy. Since water is characterized by pervasive spillovers effects, the use by one group or region affects the water availability and security of others. This is sometimes called hydrological interdependence. Moreover, the focus of the literature has been on the impact of disaster on the aggregate outcomes. This is because the growth effect of natural disasters in general is framed within one-sector models using aggregate production function instead of multi-sector models that will examine different type disasters on different sectoral outcomes.

With the exception of Loayza et al. (2012) that focus on the medium-term impact of disasters on agricultural sector, industrial sector and service sector. Other studies on sectoral growth impact focused on only the short-run implication of droughts on agricultural activities. Although, Loayza et al. (2012) made a sectorial analysis, their study excluded manufacturing sector in his analysis. Thus, there is a need for panel cross country study with more disaggregate. The contribution of this work is to estimate a single disaster that is more frequented in African region on agricultural, manufacturing. The objective of this paper is to investigate the economic impact of droughts on sectorial output in African countries within a medium term framework.

The rest of the paper is organized as follows. The next section describes the

methodology of the study. Section 3 presents the results and discussion of the study. Section 4 concludes.

Methodology

The baseline model of estimation is given in Eq. 2.1

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$$\log \hat{y}_{it} = \hat{\alpha}_0 + \hat{\alpha}_1 \log y_{it-1} + \hat{\alpha}_2 DR_{it} + \hat{\alpha}_3 \log k_{it} + \hat{\alpha}_4 \log TO_{it} + \hat{\alpha}_5 INF_{it} + \hat{\alpha}_{it} \quad (2.1)$$

From Eq. 2.1, the dependent variable \hat{y}_{it} is the sectoral output per capital. DR is drought indicator, k is capital stock, let TO be trade openness indicator. INF is inflationary rate.

The empirical estimation technique used for the study is Generalized Method of Moments

$$\log y_{it} = \hat{\alpha}_0 + \hat{\alpha}_1 \log y_{it-1} + \hat{\alpha}_2 DR_{it} + \hat{\alpha}_3 \log k_{it} + \hat{\alpha}_4 \log TO_{it} + \hat{\alpha}_5 INF_{it} + \mu_t + \eta_{it} + \hat{\alpha}_{it} \quad (2.2)$$

Since a panel of countries for an average non-overlapping 5 years was used, the observations have for each cross-section is 7. The heterogeneity of African countries needs to be taken into account in line with Eq.2.2, the unobserved country specific effects η_{it} ; μ_t time specific effect allowing for differences in the rate of world output and common shock.

Data

Data for dependent variable manufacturing and agricultural sectoral output was calculated by dividing agricultural sector value added (obtained from World Development Indicator (WDI)) by the population of the country in the sample. Data for the core independent variable i.e. was obtained from (EM-DAT) of The International Disaster Database of the Centre for Research on the Epidemiology of Disasters. . Data for capital was calculated from WDI database through dividing gross capital formation by the population. Trade openness was measured as the ratio of export plus import to GDP and inflation was accessed from World Development Indicator. All the datasets was averaged in 5 years, in accordance to estimate within the GMM framework. Moreover, the control variables were also averaged in 5 years, given us 7 time periods for analysis. The sample period for this objective is between the periods of 1980 to 2014. . All dataset was obtained from WDI, under World Bank, with the exception of drought indicator that was accessed from Emergency Events Database (EM-DAT)

Results and Discussion

	Diff. GMM	Diff. GMM	System GMM	System GMM
	One-step	Two-step	One-step	Two-step
AGR _{t-1}	0.396*** (0.049)	0.137*** (0.026)	0.293*** (0.077)	0.641*** (0.035)
DR	-0.139* (0.082)	-0.128** (0.058)	-0.175* (0.105)	-0.149*** (0.018)
Log k	-0.001 (0.009)	-0.010 (0.014)	0.022** (0.010)	0.019*** (0.003)
Log TO	0.100* (0.052)	0.172* (0.096)	0.120* (0.067)	0.109*** (0.025)
INF	-0.006*** (0.002)	-0.002 (0.002)	-0.004** (0.002)	-0.005*** (0.001)
Constant			2.781*** (0.495)	1.090*** (0.267)
No of groups	44	44	44	44
No of instruments	15	15	16	36
AR1: p-value	0.001	0.786	0.299	0.148
AR2: p-value	0.007	0.195	0.250	0.439
Sargan test	0.000	0.000	0.000	0.000
Hansen test	-	0.401	-	0.675

Note: * ** *** indicate significance at 10%, 5% and 1% respectively. Figure in parentheses are standard error.

Table 3 Estimated Results of the Panel GMM with Manufacturing Sectoral Output as Dependent Variable

	Diff GMM		System GMM	
	One-step	Two-step	One-step	Two-step
MAN _{t-1}	0.694*** (0.172)	0.654*** (0.145)	0.635*** (0.050)	0.653*** (0.034)
DR	-0.292 (0.681)	-0.049 (0.542)	-0.337** (0.134)	-0.187** (0.092)
Log k	-0.057* (0.030)	-0.087*** (0.032)	-0.025 (0.018)	-0.015* (0.008)
Log TO	0.162 (0.251)	0.491** (0.238)	0.243** (0.100)	0.235*** (0.066)
INF	-0.021*** (0.008)	-0.020*** (0.005)	-0.008** (0.003)	-0.007*** (0.002)
Constant			1.246*** (0.464)	1.037** (0.420)
No of groups	44	44	44	44
No of instruments	10	10	21	21
AR1: p-value	0.014	0.115	0.000	0.153
AR2: p-value	0.553	0.977	0.421	0.498
Sargan test	0.056	0.056	0.000	0.000

Note: Hansen indicate significance at 10%, 5% and 1% respectively. Figure in parentheses are standard error.

Some specification test was conducted to ascertain the validity of the model. Hansen test of overriding restriction fails to reject over-identifying problem. The failure of Hansen test to reject over-identifying restriction reconfirms the validity of the instruments used in the model. The serial correlation test accepts the hypothesis of a first order autocorrelation and accepts the null hypothesis of no second order autocorrelation. Consequently, the null hypothesis of no second order autocorrelation and confirmation of the validity of instruments are the two sufficient conditions to ascertain the validity of the instruments used by GMM. The estimated result (as reported in Table 2) suggests that the occurrence of drought decreases agriculture sectoral output in African countries. This implies that countries that are repeatedly hit by natural disasters face the risk of medium-term setbacks to development. Repeatedly, droughts in African economy can add up to medium-term poverty trap impact, of course, come in many forms. The coefficients of the control variables used in the modelling: trade openness, inflationary and capital had the expected signs. Trade openness increases agriculture sectoral output from Table 2 Inflationary rate decreases agriculture sectoral output. On the other hand, capital stock as anticipated increases agricultural sector output.

When one sector withdraws water from river flow for irrigation, dams and water storage unit, the impact may well be reduced availability of water downstream sector like manufacturing. An upstream dam may wreak havoc on downstream economic

sectors. Estimated result (presented in Table 3) shows that drought decrease manufacturing sectoral output. The coefficient of drought indicator is negative and statistically significant. This indicates that as the occurrences of droughts increase in African countries, manufacturing sectoral output will decrease. The result may suggest at a preliminary insight that manufacturing sector derives input from agricultural sector, which is affected by drought, due to the sign of the impact. The control variables including trade openness and inflationary rate were having the expected signs.

Conclusion

The general findings of the study reveal that droughts adversely reduce agricultural, manufacturing sector output. Preliminary, the results suggest that agricultural and manufacturing sectors inter-sectorally linked. This is likely because agro-industries in manufacturing sectors such as food processing are particularly vulnerable to the impact of droughts; since the sector draws its input for activities. The study has some limitation in terms of sectors use in analyses i.e. manufacturing and agricultural sector. The study also used linear interpolation technique due to missing data points in African countries as a result of conflict and poor management of data. There is a need for more disaggregated study to be conducted on the impact of drought on utility, construction wholesale, retail, restaurant, and hotel sector separately. Moreover, further study needs to understand the optimal amount of rainfall, above which can be addressed by co-ordinated effort of governments to prepare for this natural hazard.

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