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How Does Average Precipitation by Depth Affect the Crop Production Index?

Kobryn Mann
Fort Hays State University, klmann3@mail.fhsu.edu

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-Kobryn Mann, Fort Hays State University

Abstract

This study examines the relationship between the average precipitation by depth measured in millimeters (mm) per year, and the crop production index for the years 2015 through 2020. The crop production index measures the total agricultural crop productions relative to the base time period of 2014 to 2016, for countries around the world. This study uses regression analysis to examine this relationship. The regression studied 154 total observations for the total crop production for these regions. Contrary to conventional belief, this study found no statistical relationship between the average precipitation depth and the crop production index at any given level of significance.

Introduction

There are major discrepancies in the average depth of precipitation for countries around the world. These massive differences would affect crop production and the total level of agricultural production for the countries. A conventional view would be that a region receiving more rainfall would have a higher crop production. The level of crop production would have a wide effect on a region and would affect the total Gross Domestic Production (GDP). This study aims to explain the variation between average precipitation by depth measured in millimeters per year, and crop production index from countries around the world. The crop production index measures total agricultural crop production for each year relative to the base period of 2014 to 2016. I believe this is an important study to conduct because of how important crop production is around the world and since water is main requirement for all crops. This study uses data from the World Bank Database, from the years 2015 through 2020. The next section of this paper will examine descriptive statistics of the data such as: summary statistics and histograms of the variation of the data. The section following that will examine the full regression results and findings from this study.

Summary Statistics

Variable	Obs	Mean	Std. dev.	Min	Max
CRPPRO	201	102.71	8.21	78.35	152.01
PRECIP	182	1170.66	800.87	18.1	3240
LAND	209	37.3	21.92	0.55	81.26
FERT	166	194.41	344.12	0.22	2873.1
VALADD	198	10.23	10.35	0.017	59.01
CRPLND	199	4.54	7.8	0.003	60

Methodology & Model

This study uses data found on the World Bank Database and uses regression analysis to study the relationship between the crop production index and the average precipitation by depth in millimeters per year. The regression was conducted on 154 total observations and uses ordinary least squares methodology to predict the regression model. Additionally, this model adds in other control variables to help explain the total variation in the crop production index and is the logarithm of the crop production index. These control variables include the percentage of agricultural land in use (*LAND*), the fertilizer consumption in kilograms per hectare of arable land (*FERT*), agriculture, forestry, and fishing, value added as a percentage of GDP (*VALADD*), and the percentage of permanent crop land (*CRPLND*).

Regression Results

VARIABLES	lcrppro	lcrppro	lcrppro	lcrppro	lcrppro
precip	-0.000014*	-0.0000092	-0.0000056	-0.0000098	-0.000012
	-0.0000074	-0.0000077	-0.0000085	-0.0000082	-0.000009
land		0.000510*	0.000484	0.000164	0.000119
		-0.000284	-0.00031	-0.000304	-0.000322
fert			-0.000048**	-0.000023	-0.000024
			-0.000023	-0.000023	-0.000023
valadd				0.00315***	0.00314***
				-0.000716	-0.000723
crplnd					0.000789
					-0.00154
Constant	4.647***	4.622***	4.631***	4.615***	4.617***
	-0.0104	-0.0173	-0.0188	-0.0184	-0.0191
Observations	182	182	159	155	154
R-squared	0.018	0.036	0.061	0.169	0.172

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.

Results

While it would be expected that an increase in the average precipitation would have a positive relationship with the crop production index, this is not the case. Regression (1) was the only model to show any statistical relationship between the two variables. Since this model uses the logarithm of the dependent variable, we can interpret those results as for every unit increase in “x” will result in a 100% change in “y”. Thus, with the results from regression (1) the variable PRECIP has a value of -0.0000135, which would equate to a -0.00135% decrease in the crop production index. In regressions (2) through (5) more control variables are added to the model to help explain the total variation. Surprisingly, no statistical relationship was found between the crop production index and the average precipitation in any of the later regressions. This defies what most would believe to be true. Regression (5) is the result from the full model. In this regression the only variable to show any level of statistical significance was VALADD, which is agriculture, forestry, and fishing, value added as a percentage of GDP. The coefficient of determination is only .172, meaning that the model only explains roughly 17.2% of the total variation observed in the crop production index. The residuals are assumed to be normally distributed, homoskedastic, independent, and have an expected value of zero. Violating any of these assumptions will cause various issues which would violate the properties of ordinary least squares. The p-value for the Breusch-Pagan test for Heteroskedasticity was Prob > chi2 = 0.6842. This indicates that the assumption of homoskedasticity is not violated. The Shapiro-Wilk W Test however indicated a violation of the assumption of normality, but the ordinary least squares property of a consistent estimator would indicate that the study has an adequate sample size.

Conclusion

This study uses regression analysis to examine the relationship between the crop production index and the average precipitation in depth measured in millimeters for counties around the world. These results are contrary to the conventional thought that a positive statistically significant relationship exists between the variables. Very little of the total variation in the crop production index was explained by the regression results and no statistical significance was found between the crop production index and the average precipitation.

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