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Agricultural Aid, Agricultural Productivity and its Volatility: A Note

Eskander Alvi[1], Debasri Mukherjee[1] and James Squires[2]

Abstract

We examine the effectiveness of multilateral foreign-aid that can potentially enhance agricultural production from various angles. Our analysis reveals that although such aid does not always enhance agricultural productivity, volatility of such aid seems to have strong association with the volatility of production. Also volatility adjusted agricultural aid can enhance volatility adjusted mean agricultural output.

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1 Introduction

Agricultural development is crucial in developing countries for addressing rural poverty as well as fostering overall economic growth. The role of finance and the impact of foreign-aid (in particular) on GDP growth and poverty have been well scrutinized in the literature. In this paper we focus on the impact of agricultural aid (sectoral component of multilateral foreign-aid) on agricultural productivity, as well as on production volatility (a sector that presumably suffers from inherent volatility due to climatic and other factors). We also assess the roles of aid volatility and country's own financial strength (credit to GDP ratio) in the context. Our findings show that agricultural aid does not always seem to benefit productivity, and that is partly due to volatility in aid disbursement. Once adjusted for volatility factor, aid seems to benefit productivity. We also find a significant association between production volatility and aid disbursement volatility, suggesting that stability in agricultural aid contributes in stabilizing the volatility of agricultural production. Additionally, risk adjusted aid (to be explained) seems to have positive effect on risk adjusted agricultural output.

Literature has found a link between volatilities in total aid disbursements and overall GDP growth of developing countries. Lensink and Morrissey (2000), measuring aid uncertainty as the deviations away from time trends, find that aid uncertainty has a negative effect on GDP per capita growth. When accounting for total aid volatility using the residuals of a Hodrick-Prescott filter, Hudson and Mosley (2008), find that the possibly positive effect of aid on GDP growth can be

[1] Western Michigan University, USA
[2] DeVos Graduate School at Northwood University, USA

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negated by the volatility of total aid. Kaya, Kaya and Gunter (2012) and Kaya, Kaya, and Gunter (2013) find beneficial effects of agricultural aid on GDP growth and poverty. Islam (2011) discusses how disbursement of aid to agriculture has evolved over the recent past both within the sector and compared to other sectors. [3] That a broadening of scope to include institutions, training, food security, and poverty has altered the aid received by various subsectors within agriculture, and that considerable gap and uncertainty remain about commitment and disbursement and its timing. Our study does not attempt to capture any within-sector effects of agriculture aid, however. Such a study would be interesting but the data needed at the sub-aggregated level is difficult to find. Our results do suggest lowering aid volatility elevates agricultural productivity, somewhat endorsing the negative effects of gaps and uncertainties referenced above. Beck, Demirguc-Kunt, and Levine (2007) show that financial development, measured as the private credit decreases poverty. Through allocating resources, mobilizing savings, and facilitating trade, financial development in general can have positive effect on the agricultural sector. Numerous cross-country longitudinal studies (undertaken in the last two decades) have failed to establish any robust positive impact of total aid of GDP growth or poverty, shifting researchers' attention towards examining targeted aid's impact on various sectors. In this paper we assess the impacts of agricultural aid on this sector from various angles.

2 Data and regression models

2.1 Data

This paper uses annual level data from 111 countries for 2005-2012. The data sources are the World Development Indicators, 2016 and OECD database. Several outcome variables have been examined. We consider (1) agricultural value added per worker in constant 2005 USD which is a measure of labor productivity, and includes cultivation of crops, livestock, forestry, hunting and fishing while excluding intermediary goods used. We also use (2) standard deviation of agricultural output per worker (over 8 year period in our study) as a measure of its volatility. We further use (3) risk adjusted agricultural output (to be explained). We add (4) the average labor productivity (over the entire period) as an outcome variable as well. While the first outcome variable is analyzed in longitudinal framework, other three can only be assessed in cross-sectional framework, by construction. The major explanatory (policy variables) considered are (1) agricultural foreign aid per worker in 2005 United State Dollars, and (2) standard deviation of agricultural aid over time (to measure volatility in aid giving). Agriculture aid data been obtained from the Organization for Economic Co-operation and Development's Credit Reporting System database. This aid meets the ODA (Official Development Aid) criteria of aid flows that are concessional which includes loans and grants, all loans contain grant elements of at least 25%. Aid to agriculture includes agriculture, forestry, and fishing but excludes emergency food aid.

Another crucial explanatory variable is private credit to GDP ratio. This includes credit from banks and other financial institutions as well but excludes credit from the central bank and other development banks as well as credit given to government agency. This is a measure of overall financial depth, and is used to proxy for the overall level of financial development within a country. It is sourced from the November 2013 Financial Development and Structure Dataset. This depth variable is commonly used in the financial development literature (Levine 1997, Beck, Demirgüç-Kunt, and Levine 2001, and others). A measure of financial access for proxying for financial development, such as percentage of citizen with a bank account would have been more suitable but such data are not available for developing countries considered.

[3] We are grateful to the Editor of the journal for bringing our attention to this important paper.

Other control variables include GDP per capita, measure of poverty (the percentage of total population living on less than a $1.25), fertilizer per hectare and the percentage of rural population with improved water source. Improved water source includes piped water to premises, public taps, protected wells, protected springs and rainwater collections. The expected relationship between the fertilizer and improved water source variables and agricultural productivity might not be so clear because some countries may have low levels of both the rural water access and the fertilizer variables but have adequate levels of rain fall and high soil quality. Nevertheless, both variables are included as important control covariates. We also consider square terms and interaction terms of some of the covariates to capture possible effects of nonlinearities. Table 1 presents descriptive statistics of the variables used in this paper. The variables are in 2005 constant US dollar we consider log transformations of output and aid in the regression.

2.2 Models

The regression models based on several measures of performances of agricultural sector are as follows:

1. $(Agricultural\ Value\ added\ per\ Worker)_{i,t} = \alpha_0 + \alpha_1(Ag\ Aid\ per\ Worker)_{i,t} + \gamma X_{i,t} + error$
2. $STD(\ Ag\ Value\ added\ per\ Worker)_i = \eta_0 +\ \eta_1 STD(Ag\ Aid\ per\ worker)_i + \pi W_i +\ error$
3. $(Output/its\ volatility)_i = \beta_0 + \beta_1(Aid/its\ volatility)_i + \phi Z_i + error$
4. $Mean(Ag\ Value\ added\ per\ Worker)_i = \lambda_0 +\ \lambda_1 Mean(Ag\ Aid\ per\ worker)_i + \lambda_2 STD(Ag\ Aid\ per\ worker)_i + \mu R_i +\ error$

Note, the above ratios (in line with "Sharpe ratio" in finance literature) in Model 3 are the mean (over time) divided by the standard deviation (over time) measures of the agricultural output or the agricultural aid. The ratios are risk adjusted measures of output, or aid where the associated standard deviation measures the risk. This is basically (inverse of) coefficient of variance which is a scale free statistic of agricultural performance. X, W, R and Z represent vectors of control covariates in each regression.

3 Results

Results are reported in Tables 2-6. Note that our data sets have some missing observations due to data unavailability of some variables for some countries. In Tables 2 and 3 we report results from panel data fixed effect estimations when agricultural value added per worker is the dependent variable. Table 2 reports the base regression results whereas Table 3 includes various squared terms and interaction terms of the covariates for robustness check. Hausman tests for fixed effect vs. random effects support fixed effect estimations for all estimations, except one. In one case, the Hausman test implied misspecification and fixed effect was used due to it being the safer option to avoid possible endogeneity bias (otherwise arising due to omitted variables). We also ran test for multicollinearity and the only two variables that seem to have some moderate collinearity are the measures of fertilizer and its square term. Based on Tables 2 & 3 we can conclude that credit to GDP ratio remains statistically significant at 5% level or less in all specifications. This positive relationship testifies important role that financial development can have in the agricultural sector. We also find GDP per capita to have significantly positive impact (possibly capturing correlation) with the agricultural output although the poverty variable seems to have no impact. A plausible reason might be, more poverty (in a country) leads to more dependence on agriculture sector in terms of volume (leading to positive correlation), but it may also be detrimental to output growth in this sector due to lack of required infrastructure (leading to a negative correlation). We also find positive impact or rural water access on agricultural productivity in many cases as expected. The interaction term between rural water access and agricultural aid is insignificant in all estimations, indicating lack of complementarity. We find no robust and significant impact of fertilizer and this may be because of the possibility that higher fertilizer usage could be associated with poor soil conditions, which is detrimental to agricultural growth. Interestingly, we find no statistically significant effect of agricultural aid on agricultural productivity, which is quite consistent with the existing literature.

We then investigate the effect of the volatility of agricultural aid on agricultural output volatility. Results are reported in Table 4. The volatility in aid giving seems to have significantly positive association with volatility of agricultural productivity, as expected and it is robust to many control covariates considered. For the output volatility regressions, financial development variable loses its significance and so does the GDP variable (both in terms of their levels as well as standard error measures). The water access seems to help reduce the output volatility. We have also examined the impact of the *level* of agricultural aid on agricultural volatility and find no significant effect. All these robustness check results can be provided upon request, and are not reported for brevity.

We also try another interesting specification as reported in Table 5. The mean to standard deviation ratio (calculated over the entire period of study) of agricultural output is regressed on similar measures for the other important variables such as aid, GDP, and poverty, along with credit to GDP ratio and infrastructural variables (water, fertilizer) as such. This is our risk adjusted measure of agricultural output similar to “Sharpe ratio,” widely used in stock market literature indicating pay-off per risk. Here we again find strong association between risk adjusted measures of aid and agricultural output. The credit/GDP loses its significance for this measure also.

Given the importance of aid volatility that surfaces, we (see, Table 6) assess the impact of average aid on average production (over the entire period of study), after controlling for volatility of aid directly in the regression. We find that, once controlled for aid volatility, mean level of aid has significantly (at 10% level) positive impact on mean level of agricultural productivity. Volatility in aid disbursement itself seems to have negative (as expected), though not significant impact of output. We do not find significant effect of finance variable on the new response variable under scrutiny.

4 Concluding Discussion

Our overall results indicate that aid volatility is an important predictor of agricultural outcome, and aid can only have positive and significant impact only after this aspect is given appropriate consideration. Endogeneity may be an issue in the analysis, as is the case in majority of macro-development studies. Note, it is well established in aid literature that it is almost impossible to find appropriate instruments for sectoral aid that are not “weak”. One may argue that while aid may benefit production, it is also given more to the countries that are less productive, thus canceling out any positive impact on production in a causal inference analysis. This however, indicates such countries will suffer more if aid is not disbursed. A counterfactual experimental analysis at a micro level, appropriately designed, conditioned and randomized may tease out such effects for aid. However, given that we are interested in macro level cross-country analysis of multilateral aid, such techniques are not appropriate for our study. In terms of volatility, on one hand one may argue that more aid is disbursed to countries with relatively higher production volatilities (for mitigating climatic or other shocks), resulting in positive correlation between aid volatility and output volatility. On the other hand, one can also argue that stability in aid flow can achieve stability in agricultural production. Both arguments however, indicate that aid volatility is a significantly strong predictor of output volatility in the agricultural sector and a meaningful analysis of agricultural aid-agricultural production nexus can only be made after this factor is taken into account.

References

Beck T, Demirgüç-Kunt A, Levine R. 2007 Finance, inequality and the poor. Journal of Economic Growth 12: 27 – 49.

Beck T, Demirgüç-Kunt A, Levine R. 2001 Legal theories of financial development. Oxford Review of Economic Policy 17: 483 – 501.

Hudson J, Mosley P 2008 Aid volatility, policy and development. World Development 36: 2082 – 2102.

Islam, N. (2011). Foreign aid to agriculture: Review of facts and analysis (No. 01053). International Food Policy Research Institute (IFPRI).

Kayo O, Kaya I, Gunter L. 2012 Development aid to agriculture and economic growth. Review of Development Economics 16: 230 – 242.

Kayo O, Kaya I, Gunter L. 2013 Foreign aid and the quest for poverty reduction: Is aid to agriculture effective? Journal of Agricultural Economics 64 (3): 583 – 596.

Lensink R, Morriseey O. 2000 Aid Instability as a measure of uncertainty and the positive impact of aid on growth. The Journal of Development Studies 36: 31 – 49.

Levine R. 1997 Financial development and economic growth: Views and agenda. The Journal of Economic Literature 35: 688 – 726.

Table1: Descriptive Statistics

	Mean	Median	Standard Deviation	Min	Max
Log of Per Worker Value Added	7.34	7.58	1.22	4.77	10.48
Log of Total Agricultural Value Added	21.29	21.36	1.90	15.59	26.64
Log of Agricultural Aid Per Worker	1.88	1.98	1.76	-3.41	7.60
Log of Total Agricultural Aid	15.83	15.99	1.98	9.05	20.20
Private Credit to GDP Ratio	36.15	27.85	28.13	0.01	149.78
Log of GDP per Capita	7.43	7.57	1.14	4.89	9.62
% of population living below $1.25	13.84	6.31	18.95	0.02	87.72
Log of Fertilizer per Hectare	3.50	3.63	1.93	-7.76	7.69
Rural Water Access (%)	76.50	81.80	19.54	27.80	100.00

Table 2: Panel Data (FE) estimations where the Dependent Variable = Log of Ag Value added per Worker

	(1)	(2)	(3)	(4)
Log of Ag Aid per Worker	.003 (.550)	-.001 (.906)	.001 (.850)	-.020 (.255)
(Log of Ag Aid per Worker)^2			.0004 (.815)	.004 (.102)
Private Credit to GDP Ratio	.003 (.011)**	.005 (.003)***	.003 (.011)**	.005 (.003)***
Log of GDP Per Cap	.552 (.000)***		.552 (.000)***	
% of population living below $1.25		.001 (.701)		.001 (.709)
Log Fertilizer per Hectare	-.008 (.331)	.011 (.860)	-.008 (.340)	.010 (.870)
Rural Water Access	-.002 (.619)	.010 (.024)**	-.002 (.617)	.010 (.019)**
Constant	3.297 (.000)***	6.592 (.000)***	3.301 (.000)***	6.585 (.000)***
OBS	600	201	600	201
Number of Countries	104	72	104	72
R^2 Overall	.619	.236	.619	.233

P-Values in Parenthesis, *, **, *** Indicate significance at 10%, 5% and 1% level respectively. Heteroscedaticity corrected robust standard errors are reported. Note that there are missing observations for certain variables and countries or across years making number of observations different across regressions.

Table 3: Panel Data (FE) estimations where dependent Variable = Log of Ag Value added per Worker

	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Log of Ag Aid per Worker	.006 (.710)	-.018 (.820)	.007 (.691)	-.024 (.775)	.003 (.530)	-.001 (.852)	.002 (.831)	-.022 (.196)
(Log of Ag Aid per Worker)^2			.0005 (.735)	.004 (.103)			.0003 (.819)	.004 (.075)*
Private Credit to GDP Ratio	.003 (.011)**	.005 (.003)***	.003 (.011)**	.005 (.002)***	.003 (.011)**	.005 (.002)***	.003 (.011)**	.005 (.001)***
Log of GDP Per Cap	.552 (.000)***		.551 (.000)***		.550 (.000)***		.550 (.000)***	
% of population living below $1.25		.001 (.714)		.001 (.715)		.002 (.646)		.002 (.611)
Log Fertilizer per Hectare	-.008 (.305)	.012 (.850)	-.008 (.312)	.011 (.868)	-.008 (.311)	.044 (.686)	-.008 (.319)	.075 (.520)
(Log Fertilizer per Hectare)^2					.0004 (.776)	-.004 (.813)	.0004 (.779)	-.008 (.650)
Rural Water Access	-.002 (.600)	.013 (.286)	-.003 (.537)	.011 (.352)	-.002 (.616)	.010 (.027)**	-.002 (.614)	.011 (.020)**
(Ag Aid)*Water	-.00004 (.852)	.0002 (.825)	-.0001 (.733)	.0001 (.954)				
Constant	3.291 (.000)***	6.624 (.000)***	3.291 (.000)***	6.594 (.000)***	3.307 (.000)***	6.512 (.000)***	3.311 (.000)***	6.428 (.000)***
OBS	600	201	600	201	600	201	600	201
R^2 Overall	.619	.236	.619	.233	.620	.239	.620	.237

P-Values in Parenthesis, * , **, *** Indicate significance at 10%, 5% and 1% level respectively Heteroscedaticity corrected robust standard errors are reported. Note that there are missing observations for certain variables and countries or across years making number of observations different across regressions.

Table 4: Cross-country estimation. Dependent Variable: The Standard Deviation of Log of Agriculture Value Added per Worker

	(1)	(2)
STD(Log Ag Aid per Worker)	.047 (.000)***	.046 (.024)**
STD(Credit to GDP Ratio)	.001 (.432)	.001 (.314)
St. Dev. of GDP Per Cap	.087 (.406)	
St. Dev. of % of population living below $1.25		-.003 (.175)
Log Fertilizer per Hectare	.007 (.022)**	.003 (.458)
Rural Water Access	-.0004 (.199)	-.0003 (.512)
Constant	.053 (.012)**	.071 (.049)**
Number of Countries	95	49
R^2	.245	.238

P-Values in Parenthesis, * , **, *** Indicate significance at 10%, 5% and 1% level respectively. Heteroscedaticity corrected robust standard errors are reported. Note that there are missing observations for certain variables and countries or across years making number of observations different across regressions.

$$\text{Sharpe Ratio of Agricultural Value Added} = \frac{Mean\ of\ Agricultural\ Value\ Added}{Standard\ Deviation\ of\ Agricultural\ Value\ Added}$$

Table 5: Cross Country Estimations with Sharpe Ratio of Agriculture Value Added

	(1)	(2)
Sharpe Ratio of Agriculture Aid	3.408 (.007)***	3.215 (.000)***
Private Credit to GDP ratio	-.018 (.637)	-.032 (.180)
Sharpe Ratio of GDP Per Cap	.021 (.333)	
Sharpe Ratio of % of population living below $1.25		-.034 (.574)
Log Fertilizer per Hectare	.136 (.796)	-.519 (.397)
Rural Water Access	.153 (.023)**	.078 (.197)
Constant	-6.47 (.428)	5.12 (.226)
Number of Countries	97	50
R^2	.142	.311

P-Values in Parenthesis, * , **, *** Indicate significance at 10%, 5% and 1% level respectively. Heteroscedaticity corrected robust standard errors are reported. Note that there are missing observations for certain variables and countries or across years making number of observations different across regressions.

Table 6: Cross Country Estimations with Mean Agriculture Value Added

	(1)	(2)
Log Ag Aid per Worker	.093 (.078)*	.067 (.325)
SD(Log of Aid per Worker)	-.093 (.593)	.364 (.170)
Private Credit to GDP Ratio	-.003 (.460)	-.0002 (.968)
Log GDP per Cap	.747 (.000)***	
% of population living below $1.25		-.033 (.000)***
Log Fertilizer per Hectare	.110 (.026)**	.136 (.060)*
Rural Water Access	.006 (.283)	.001 (.876)
Constant	.954 (.143)	6.989 (.000)***
Number of Countries	97	73
R^2	.676	.603

P-Values in Parenthesis, *, **, *** Indicate significance at 10%, 5% and 1% level respectively. Heteroscedaticity corrected robust standard errors are reported. Note that there are missing observations for certain variables and countries or across years making number of observations different across regressions.