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How Macroeconomic Factors May Influence Agricultural Program Sustainability

Evidence from Cross River State, Nigeria

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TABLE OF CONTENTS

Abstract	1
1. Introduction.....	2
2. Relationships between Public Expenditures on Agriculture in Nigeria and the Global Oil Price	2
3. Economic Model: Key Features	6
4. Data and Model Simulation Values	8
Cross River State Fiscal Data	8
Household Data	9
Economy-wide Variables	12
Model Simulation Values	12
5. Simulation Scenarios and Results.....	13
6. Conclusions and policy Implications.....	17
References.....	18
Appendices	20
Appendix A: List of variables and parameters in the model.....	20
Appendix B: Outline of the full economic model.....	21
Appendix C: Parameter and exogenous variable initial values.....	22

LIST OF TABLES

Table 2.1. Global oil price with recurrent, capital, and total expenditures for the Federal Ministry of Agriculture and Rural Development and the federal government, 2011 to 2017, billions of Naira except where noted	3
Table 2.2. Correlation coefficients for annual average global oil price with annual recurrent, capital, and total expenditures for the Federal Ministry of Agriculture and Rural Development and the federal government, 2011 to 2017	4
Table 2.3. Global oil price with total recurrent, capital, and total expenditures by state governments of Nigeria on agriculture and aggregate for all operations, 2002 to 2015, billions of Naira except where noted.....	5
Table 2.4. Correlation coefficients for annual average global oil price with annual recurrent, capital, and total expenditures by state governments of Nigeria on agriculture and aggregate for all operations, 2002 to 2015.....	5
Table 2.5. Agriculture expenditures as share of total expenditures for federal government of Nigeria, state governments, and combined, 2011 to 2015.....	6
Table 4.1. Cross River government fiscal conditions, correlation of Cross River government revenues with global oil price, and allocations to the CRMANR, 2009 to 2016	8
Table 4.2. Cross River State Ministry of Agriculture and Natural Resources and Cross River Agricultural Development Programme budgets, 2010 to 2013, billions of Naira	9
Table 4.3. Annual expenditures by households in Cross River state on food and other categories of goods by household type, thousands of Naira.....	10
Table 4.4. Annual income for households in Cross River state by source, by household type, thousands of Naira	10
Table 4.5. Average farm production by farm type	11

Table 4.6. Annual farm input and labor expenditures by farm type, thousands of Naira	11
Table 4.7. Labor endowments and labor share of total farm input expenditures, by farm type	11
Table 4.8. Cross River state total expenditures on durable goods, VAT tax rates, and loan interest rates.....	12
Table 5.1. Change in variable values for Cross River state due to decreases in the global oil price.....	14
Table 5.2. Change in variable values for Cross River state due to increases in the global oil price.....	15
Table 5.3. Change in variable values for Cross River state due to decreases in donor funds.....	16
Table 5.4. Change in variable values for Cross River state due to reductions in the loan interest rate for small farmers.....	16

ABSTRACT

This paper expands on our previous analysis of the effects of macroeconomic factors on agricultural program sustainability in Kaduna state (see Hatzenbuehler and Mavrotas 2017) in several ways that are relevant for that analysis and that provide insights for further extensions. First, we include a detailed assessment of data on expenditures on agricultural programs at the federal level and aggregate state level. We also form ratios of these agriculture-based expenditures with total public expenditures to estimate agriculture expenditure shares for Nigeria in recent years. The relationships between these expenditures and the global oil price are assessed, which provides the needed dual side of the analysis to that in Hatzenbuehler and Mavrotas (2017), which estimated the strength of the relationship between revenues and the global oil price. The agricultural expenditure shares were then compared to the 10 percent agricultural expenditure share obligation to which Nigeria pledged as a signatory to the Comprehensive Africa Agriculture Development Programme (CAADP). These show that substantially higher expenditures are needed to meet that obligation. Federal agricultural expenditures and total expenditures were found to be either independent or countercyclical to the global oil price, while aggregate state level expenditures, both for agriculture alone and in total, move closely with the global oil price. Thus, there is a much higher pass-through of changes in the global oil price to fiscal conditions at the state level than at the federal level, plausibly due to the limited ability for states to issue debt relative to the federal government.

Focusing on Cross River state in the South-South geopolitical zone of Nigeria, the large gap in recent years between agricultural expenditure shares and the CAADP obligation is understood on a more detailed basis through examination of fiscal data from the state. The Cross River government has lower agriculture expenditure shares than the average for all states in aggregate. The empirical exercise implemented in Hatzenbuehler and Mavrotas (2017) for Kaduna state was applied for Cross River state, providing opportunities for comparison. A policy mechanism for the Federal Ministry of Agriculture and Rural Development (FMARD) of providing temporary funding during periods of negative fiscal shocks appears plausible, especially for states such as Cross River that currently have low expenditure levels, based on the observed FMARD budgetary autonomy and the size of the FMARD budget relative to the aggregate state Ministry of Agriculture budgets.

Keywords: public expenditures; oil price; agricultural programs; Nigeria; Cross River.

1. INTRODUCTION

This paper builds in several ways on the analogous paper by Hatzenbuehler and Mavrotas (2017), which implemented an empirical analysis of the effects of macroeconomic factors on agricultural program sustainability in Kaduna State in North-Central zone of Nigeria. We examine the linkages between government institutions within the Nigerian federal government system; the historical funding levels for agricultural programs in the country; the influence of key macroeconomic variables, such as the global oil price, on the fiscal conditions for various government institutions; and the extent to which the effects of those changes are passed-through between levels of government. We use these findings to explore potential mechanisms that can increase the likelihood of sustaining funding for agricultural programs over time. However, in this paper we include a more detailed analysis on public expenditures at federal and state levels, which allows for a clearer determination of how expenditures have adjusted over time, considering the observation in Hatzenbuehler and Mavrotas (2017) of a tight linkage between federal government revenues and the global oil price. Additionally, we assess aggregate state level total expenditures and expenditures on agriculture, and their relationships with the global oil price. The aggregate expenditures on agriculture at the federal and state levels are then compared to total expenditures at those levels to form agricultural expenditure share ratios. We also compare these values to the 10 percent pledge for agriculture expenditure shares which Nigeria agreed to as a signatory to the Comprehensive Africa Agriculture Development Programme (CAADP).

These additional data and exploratory analysis provide insights into the degree of fiscal autonomy among government institutions in Nigeria. The ability of federal and state governments to sustain funding for agricultural programs during downturns in fiscal conditions is influenced by their respective fiscal autonomy. The results also show that the federal government and the Federal Ministry of Agriculture and Rural Development (FMARD) have historically had much more discretion regarding expenditures than have state governments and state Ministries of Agriculture. Thus, FMARD plausibly could collaborate with state Ministries of Agriculture on the funding of state programs that are aligned with federal agricultural policy goals, especially during periods of poor fiscal conditions.

At state level, focusing on Cross River state in the South-South geopolitical zone, we implement the same empirical analysis for Cross River as was done for Kaduna in Hatzenbuehler and Mavrotas (2017) to provide comparative evidence that the effects of macroeconomic factors on the sustainability of agricultural programs differ in varying contexts. Since the Cross River state government has not allocated much public funds for agriculture in recent years relative to other states, it is plausible that increases in agricultural expenditures in the state would only occur with larger provisions of funds from external entities, such as FMARD or donors, unless there was a clear change in state policymaker preferences from those of the past decade. The low base of agricultural expenditures in Cross River means that FMARD could plausibly provide supplementary budgetary support to the Cross River Ministry of Agriculture and Natural Resources in periods of particularly poor fiscal conditions without much strain on the FMARD budget.

2. RELATIONSHIPS BETWEEN PUBLIC EXPENDITURES ON AGRICULTURE IN NIGERIA AND THE GLOBAL OIL PRICE

The close relationship between Nigerian federal government revenues and the global oil price were estimated and discussed by Hatzenbuehler and Mavrotas (2017) in the context of the implications this relationship has on the pass-through of federal funding to state governments. We now analyze

the dual aspect of whether total federal government revenues and expenditures by FMARD also move closely with the global oil price. While Fielding (1997) found evidence of a broad tendency of high correlation between African government revenues and expenditures, those findings may not apply to the specific case of Nigeria over the past decade.

The ability to break the linkage between revenues and expenditures is related to the ability of the government to save and borrow. Consistently saving tax revenues for future use means that expenditure levels may move independently from revenues. Analogously, borrowing to fund current period expenditures that are higher than current revenues can also cause expenditures to move independently from revenues. The federal government is generally better able than are state governments in Nigeria to issue debt on foreign or domestic markets, although there is some limited evidence of Nigerian states also issuing debt (SPARC 2011; Nnoroma 2017).

Table 2.1 compares the average annual global oil price with recurrent, capital, and total expenditures for FMARD and the aggregate federal government expenditures between 2011 and 2017. Recurrent expenditures, such as staff salaries and overhead costs, have tended to vary much less than capital expenditures, which are for project implementation and infrastructure investments, and total expenditures. The capital and total expenditures of the federal government have varied substantially less than those for FMARD over this period. Capital expenditures for FMARD have been particularly volatile relative to the other expenditure categories. This implies that there is intertemporal divergence in the degree to which the federal government has chosen to fund agricultural programs. In addition to the volatile nature of agricultural expenditures, the levels of expenditures by FMARD relative to total expenditures have been only around 2 percent, although a rise is seen in 2017 relative to previous years, primarily due to increased FMARD capital expenditures.

Table 2.1. Global oil price with recurrent, capital, and total expenditures for the Federal Ministry of Agriculture and Rural Development and the federal government, 2011 to 2017, billions of Naira except where noted

Year	Average global oil price (USD)	FMARD recurrent expenditures	FMARD capital expenditures	FMARD total expenditures	Federal govt. recurrent expenditures	Federal govt. capital expenditures	Federal govt. total expenditures	FMARD expenditures as share of federal expenditures (%)
2011	104.01	34.46	31.40	65.87	2,425	1,147	3,572	1.84
2012	105.01	33.97	45.01	78.98	2,471	1,320	3,792	2.08
2013	104.08	32.40	50.81	83.20	2,386	1,621	4,007	2.08
2014	96.24	31.49	35.55	67.04	2,455	1,120	3,575	1.88
2015	50.75	31.87	8.75	40.62	2,607	701	3,309	1.23
2016	42.81	29.75	47.00	76.75	2,648	1,846	4,494	1.71
2017	50.68	31.79	91.65	123.44	2,979	2,059	5,038	2.45
SD	29.26	32.22	25.16	24.98	205	468	606	...
Mean	79.08	1.58	44.31	76.56	2,568	1,402	3,969	...
CV	0.37	0.05	0.57	0.33	0.08	0.33	0.15	...

Sources: World Bank and the Budget Office of the Federation of the Federal Government of Nigeria.

To sustain funding for agricultural programs in the context of federal government revenues being tightly aligned with the global oil price, a key issue to consider is whether expenditures have also behaved in a comparable manner. Table 2.2 shows the estimated correlation between the global oil price and the expenditure categories listed in Table 2.1. The correlation coefficient for FMARD recurrent expenditures and the global oil price is 0.74, which implies a close correspondence between these variables. This means that there have been cuts and expansions in staff and other

overhead costs as the federal government revenues¹ have fallen and risen, respectively. However, FMARD capital and total expenditures have moved rather independently of federal government revenues. The negative and somewhat high correlation coefficient estimates between the global oil price and the federal government expenditure categories implies that federal government spending has been somewhat countercyclical to the global oil price in recent years, especially for recurrent expenditure. This means that the federal government has tended to expand and cut salaries and overhead as the global oil price has fallen and risen, respectively. Federal capital expenditures have been more independent of the global oil price. These statistics are indicative of the federal government saving or borrowing on global or domestic markets to fund public initiatives, some of which are agriculture-related capital projects.

Table 2.2. Correlation coefficients for annual average global oil price with annual recurrent, capital, and total expenditures for the Federal Ministry of Agriculture and Rural Development and the federal government, 2011 to 2017

	FMARD recurrent expenditures	FMARD capital expenditures	FMARD total expenditures	Federal govt. recurrent expenditures	Federal govt. capital expenditures	Federal govt. total expenditures
Correlation coefficient for expenditure type with global oil price	0.74	-0.16	-0.12	-0.78	-0.28	-0.48

Sources: Authors' calculations from World Bank and the Budget Office of the Federation of the Federal Government of Nigeria data.

We next examine aggregate state level expenditures in a comparable manner to determine whether the patterns of expenditures at the state level have moved in line with those at the federal level. Table 2.3 shows aggregate state government recurrent, capital, and total expenditures, these same types of expenditures on agriculture, and the global oil price. It is observed that agricultural expenditures have generally been more variable than total expenditures, which is like what was observed with the FMARD and total federal expenditures in Table 2.1. However, unlike with the FMARD expenditures, the state level agricultural expenditures have risen from a very low base to a higher level with some intermittent fluctuations, which has led to a high variance relative to the other variables. The agriculture shares of total expenditures are generally higher than those that were observed for the federal government, but rarely exceed 4 percent.

¹ We use Nigerian federal government revenues as synonymous with the global oil price due to the estimated correlation of 0.93 in Hatzenbuehler and Mavrotas (2017).

Table 2.3. Global oil price with total recurrent, capital, and total expenditures by state governments of Nigeria on agriculture and aggregate for all operations, 2002 to 2015, billions of Naira except where noted

Year	Average global oil price (USD)	Agriculture recurrent expenditures	Agriculture capital expenditures	Agriculture total expenditures	State govt. recurrent expenditures	State govt. capital expenditures	State govt. total expenditures	Agriculture expenditures as share of state govt. total expenditures (%)
2002	24.93	13.66	6.68	20.34	724.54	283.47	1,008.01	2.02
2003	28.90	18.11	9.58	27.69	921.16	324.02	1,248.18	2.22
2004	37.73	17.08	20.86	37.95	1,125.06	412.93	1,537.98	2.47
2005	53.39	24.20	26.02	50.22	1,478.59	514.73	1,993.31	2.52
2006	64.29	30.22	34.89	65.11	1,587.75	584.98	2,172.72	3.00
2007	71.12	35.35	37.28	72.63	1,217.40	854.80	2,072.20	3.50
2008	96.99	44.30	46.70	91.00	1,591.80	1,455.70	3,047.50	2.99
2009	61.76	59.30	52.20	111.50	1,426.10	1,284.20	2,710.30	4.11
2010	79.04	52.80	53.50	106.30	1,648.40	1,522.40	3,170.80	3.35
2011	104.01	71.20	45.10	116.30	2,055.80	1,375.30	3,431.10	3.39
2012	105.01	75.90	84.90	160.80	1,664.40	1,965.30	3,629.70	4.43
2013	104.08	52.10	67.00	119.10	1,948.40	1,890.40	3,838.80	3.10
2014	96.24	115.30	78.60	193.90	2,120.50	1,862.50	3,983.00	4.87
2015	50.75	45.00	41.80	86.80	2,267.30	1,201.80	3,469.10	2.50
SD	28.49	27.85	23.41	49.64	453.07	606.85	990.72	...
Mean	69.87	46.75	43.22	89.98	1,555.51	1,109.47	2,664.98	...
CV	0.41	0.60	0.54	0.55	0.29	0.55	0.37	...

Sources: Central Bank of Nigeria Annual Reports.

With these historical expenditure patterns as context, we next determine the degree to which the aggregate state level total expenditures, as well as those on agriculture, have moved in line with the global oil price. The correlation coefficient estimates between the global oil price and the expenditure types listed in Table 2.3 are shown in Table 2.4. All correlation coefficients are positive and near or above 0.70. This implies that state level expenditures on agriculture and total public expenditures have tended to move closely with the global oil price, and hence, federal government revenues. These correlation coefficients are starkly different to those for the federal government expenditures (Table 2.2), suggesting that the federal government has much more autonomy and discretion about saving revenues for future use and issuing debt to fund current period expenditures than do state governments. The federal government and FMARD have greater control over their expenditures than do state Ministries of Agriculture, and thus, are plausibly in a better position to sustain funding for key programs during periods of negative fiscal shocks.

Table 2.4. Correlation coefficients for annual average global oil price with annual recurrent, capital, and total expenditures by state governments of Nigeria on agriculture and aggregate for all operations, 2002 to 2015

	Agriculture recurrent expenditures	Agriculture capital expenditures	Agriculture total expenditures	State govt. recurrent expenditures	State govt. capital expenditures	State govt. total expenditures
Correlation coefficient for expenditure type with global oil price	0.76	0.86	0.83	0.69	0.89	0.86

Sources: Authors' calculations from World Bank and Central Bank of Nigeria Annual Report data.

The generally low shares of total federal and total aggregate state expenditures on agriculture imply that Nigeria’s total public expenditures on agriculture are unlikely to be near the 10 percent pledge of total expenditures toward agriculture that Nigeria agreed to as a signatory of the CAADP, a finding consistent with data reported by Benin and Yu (2013) for earlier years. The data in Table 2.5 are ratios of the sums of the federal and state level expenditures on agriculture and sums of the total federal and aggregate state government expenditures. These ratios, shown in column 4, mean that total public agricultural expenditures between 2011 and 2015 were generally about 3 percent of total public expenditures. This suggests that increases of public expenditures of over 7 percent are needed for Nigeria to meet its CAADP obligations. While this is not in line with expenditure trends in recent years, the substantial increase in appropriations to FMARD for capital expenditures between 2016 and 2017 suggests that the federal government may now be taking substantive steps toward closing this gap. More recent data are presently unavailable to discern whether this is also the case at the state level.

Table 2.5. Agriculture expenditures as share of total expenditures for federal government of Nigeria, state governments, and combined, 2011 to 2015

Year	FMARD expenditures as share of total federal government expenditures	State government agriculture expenditures as share of state government total expenditures	Federal and state agriculture expenditures as share of federal and state total expenditures combined	Increase in combined expenditure shares needed to meet CAADP target of agricultural expenditures being 10 percent of total budget
2011	1.84	3.39	2.60	7.40
2012	2.08	4.43	3.23	6.77
2013	2.08	3.10	2.58	7.42
2014	1.88	4.87	3.45	6.55
2015	1.23	2.50	1.88	8.12

Sources: Budget Office of the Federation of the Federal Government of Nigeria, various Central Bank of Nigeria Annual Reports, and Benin and Yu (2013).

This review of total public expenditures and public expenditures on agriculture have implications for the interactions between state and federal government institutions. The apparently very high pass-through of adjustments in global oil prices to state government expenditures implies that state governments have relatively little autonomy regarding adjusting their expenditures during periods of negative fiscal shocks. Federal government expenditures, however, show some degree of independence from fluctuations in the global oil price, which is likely due to the better ability of the federal government to save revenues for future use and to issue debt on domestic and foreign markets. Hence, the federal government is in a better position to sustain funding for key agricultural programs than are state governments during fiscal downturns. Consequently, enhanced coordination between FMARD and state Ministries of Agriculture can plausibly prevent the discontinuance of successful agricultural programs due to unexpected negative fiscal conditions.

3. ECONOMIC MODEL: KEY FEATURES

We formalize these linkages between levels of government and institutions within an intertemporal economic model to show how large the potential transfers from FMARD to state Ministries of Agriculture may need to be in some periods and whether such transfers are feasible based on the size of the FMARD budget. Our model also builds on the fiscal response literature, which is germane to the present case of agricultural program implementation in Nigeria, since a commodity price shock effect on federal government revenues influences the availability of public funds to allocate to

state governments.² This is the same exercise as was done for Kaduna in Hatzenbuehler and Mavrotas (2017). We now do this for Cross River state, a state located in the South-South geopolitical zone of Nigeria that has different geophysical and socioeconomic characteristics and presumably different government funding preferences for agriculture than Kaduna. These contrasts provide an opportunity for comparison and analysis of the feasibility of enhanced budgetary coordination between FMARD and state Ministries of Agriculture.

A thorough description of the economic model used is presented in Hatzenbuehler and Mavrotas (2017), so only the major features and logic of the model are described here. The model is principally designed to describe the linkages between institutions at the federal and state government levels to show that factors that influence the fiscal conditions of the federal government can filter down to have a substantial impact on the budget of lower levels of government. The model links the federal government, state governments, state Ministries of Agriculture, and households. Three types of households are demarcated: small farm, big farm, and non-farm. For Cross River, big farms were defined as farms that had positive farm sales, while small farms did not report any farm sales.

The federal government budget is a function of the global oil price. The state government budget is influenced partly by the federal allocation. The state Ministry of Agriculture budget is a function of the state government allocation, as well as funding from donors. Households are linked to the state Ministry of Agriculture because the ministry purchases inputs for small farmers, which influences their production functions and budget constraints.

The objective function for the model is to maximize the joint utility of all household types. Clearly this does not accurately reflect the preferences of a government that chooses to favor one segment of the population over the other. However, we chose to keep this simplified framework since it is not our goal for this paper to fully capture actual government preferences, which, in any case, appear to fluctuate over time as shown in the fiscal data. The inclusion of government purchased inputs into the small farmer production function already implies some preference toward allocating resources toward small farmers, which allows us to show an example of how a government may act if it is working to increase funding in the agricultural sector. This could also have been achieved through the development of a more complex objective function, but we chose not to do this in this paper to make clearer the linkages between agents and institutions.

The model has two periods: the first period reflects base conditions, while the second period represents circumstances after an influential macroeconomic factor adjusts. Hypothetically there could be many periods, but the simplified two-period model is sufficient to make observations regarding the pass-through between levels of government and across institutions and households. Descriptions of the variables and parameters in the economic model and an outline for the full economic model are in Appendices A and B, respectively.

² The fiscal response literature, pioneered by Heller (1975), has been reignited in recent years in consideration of the persistent challenges faced by governments that are dependent on natural resources for government revenue (see, for example, Agénor (2016) for a very recent application). Following Heller's seminal paper (1975), the fiscal response literature has seen various applications, with extensive use in many aid effectiveness studies examining the overall nexus between aid inflows and fiscal conditions in aid recipient countries. In this context, early fiscal response studies include Gang and Khan (1990), Khan and Hoshino (1992), and Otim (1996), as well as more recent studies by Mavrotas (2002, 2005), Gupta et al. (2004), Mavrotas and Ouattara (2006a, b), Ouattara (2006a, b), and Mavrotas and Ouattara (2007). Mavrotas (2010, 2015) provide further discussion.

4. DATA AND MODEL SIMULATION VALUES

Federal and Cross River fiscal and household level data are the primary data types used to calibrate the empirical simulation model. These data provide insights into the preferences of policymakers regarding funding agricultural programs relative to others and the preferences of farm and non-farm households in Cross River.

The federal fiscal data used in the model were from International Monetary Fund (IMF) Article IV Consultation Staff Reports for Nigeria for 2000 to 2016 (IMF-Nigeria). Tables and description of these data are discussed further in Hatzenbuehler and Mavrotas (2017). Table 2.2 showed that proposed federal expenditures are often countercyclical, while the aggregate state government expenditures are more cyclical, as shown in Table 2.4. The implication of this is that adjustments in global oil prices are passed-through to a greater degree to the state level than they are at the federal level. Thus, the model design, in which funds flow from the federal to the state level and not vice versa, appears to be broadly consistent with the federal and aggregated state expenditure data. We next examine the historical fiscal conditions of the Cross River government to determine the degree to which the aggregate conditions apply in Cross River.

Cross River State Fiscal Data

The Cross River state government has several ministries that implement public programs. These are funded by the federal allocation, internally generated revenue (e.g., VAT taxes), and domestic and foreign donors. Most of the data on overall Cross River government revenues and expenditures were gathered from annual reports for 2009 to 2016 published by the Cross River State Office of the Auditor General on the Accounts. Additional data on historical budgets were obtained from the Cross River Agricultural Development Programme, but these were only available for 2010 to 2013.

Cross River government historical budget conditions

Table 4.1 shows the fiscal conditions for Cross River state for the period 2009 to 2016, the degree to which the Cross River government has relied on the federal allocation to fund its operations, an estimate of the strength of the relationship between the Cross River state government revenue and the global oil price, total expenditures, allocations to the Cross River state Ministry of Agriculture and Natural Resources (CRMANR), and the share of the CRMANR allocation in total state government expenditures.

Table 4.1. Cross River government fiscal conditions, correlation of Cross River government revenues with global oil price, and allocations to the CRMANR, 2009 to 2016

Year	Cross River state total revenue, billions Naira	Federal allocation to Cross River, billions Naira	Federal allocation as share of total revenue	World oil price, (USD/barrel), annual avg. 2009 to 2016	Correlation of total revenue with world oil price, 2009 to 2016	Total state govt. expenditures, billions Naira	CRMANR allocation, billions Naira	CRMANR share of total state expenditures, percent
2009	53.38	24.19	0.45	61.76	0.79	61.16	...	...
2010	54.86	27.60	0.50	79.04		54.07	...	...
2011	86.21	49.57	0.58	104.01		91.17	...	...
2012	90.88	45.23	0.50	105.01		98.45	0.82	0.84
2013	113.78	44.25	0.39	104.08		110.73	0.80	0.72
2014	89.27	41.79	0.47	96.24		103.43	0.83	0.80
2015	61.11	36.07	0.59	50.75		61.11	0.72	1.18
2016	64.01	41.79	0.65	42.81		67.10	0.71	1.06

Sources: Cross River State Office of the Auditor General on the Accounts and the World Bank. CRMANR = Cross River state Ministry of Agriculture and Natural Resources.

Cross River state is shown to be highly reliant on the federal allocation to fund its government operations. Over this period, the federal allocation comprised an average of 52 percent of total revenue. Additionally, the estimated correlation between the Cross River government total revenue and the world oil price was 0.79, which implies that Cross River government revenue and the world oil price rise and fall together, but not to as strong a degree as does federal government revenue. Therefore, the Cross River government has a bit of discretion regarding the use of state government funds obtained from non-federal government sources. However, in recent years Cross River state government has not allocated much funding to the CRMANR. Indeed, the CRMANR share of Cross River government expenditures from 2012 to 2016 was only around 1 percent, which is lower than the FMARD share of federal government expenditures, and below the share of expenditures on agriculture in aggregated state government expenditures across Nigeria. Thus, public funding for agriculture in Cross River is generally lower than for most states, as well as for the federal government.

Breakdown of the budget of the CRMANR

While the CRMANR allocation to agriculture appears to be below average in recent years, data obtained from the Cross River Agricultural Development Programme (CRADP) shows that donors have started to increase their funding of agricultural projects in Cross River since 2012 (Table 4.2). Indeed, the share of CRMANR funds provided by donors was around 46 percent in 2012 and 2013. These donor-provided funds were mainly used for implementation of projects rather than for personnel salaries or overhead. This implies that, under the assumption that current donor funding levels are near their levels in 2013, any losses in donor funds would mean that there would essentially be no funding for implementation of agricultural projects by the CRADP unless there was an adjustment in allocation choices made by the Cross River government to direct more funds towards agriculture.

Table 4.2. Cross River State Ministry of Agriculture and Natural Resources and Cross River Agricultural Development Programme budgets, 2010 to 2013, billions of Naira

Year	Combined budget for CRMANR	Cross River state government		Share donor funded, percent	CRADP Expenditures		
		allocation	Donor funds		Projects	Personnel	Overhead
2010	...	...	0.34	...	0.03	...	0.02
2011	...	...	0.35	...	0.10	...	0.04
2012	1.80	0.95	0.85	0.47	0.68	0.22	0.02
2013	1.78	0.97	0.81	0.46	0.94	0.27	0.03

Source: Cross River State Office of the Auditor General on the Accounts and the Cross River State Agricultural Development Programme (CRADP). CRMANR = Cross River State Ministry of Agriculture and Natural Resources.

Household Data

The household survey dataset is drawn from the Nigeria General Household Survey Panel for 2015-16 (Wave 3), which was jointly administered by the National Bureau of Statistics and the World Bank (NBS-World Bank 2016). Survey data were consulted to obtain information on socioeconomic conditions such as household expenditures, income sources, and farm level information, such as input usage and productivity among households in Cross River state. These NBS-World Bank (2016) data also shed light on general economy-wide economic conditions such as the average cost of borrowing for households in urban and rural areas in the state.

Household Characteristics

Within the dataset there were 35 small farm households, 32 big farm households, and 30 non-farm households from Cross River state, thus, a total sample of 97 households. Data on average annual expenditures on several types of goods, such as food, education, food away from home, and any other household items (generally referred to here as durable goods), calculated in terms of annual averages for each of the household types, were assessed to determine whether there are differences across household types regarding expenditure levels or preferences for distinct types of goods. These annual average expenditure levels across good and household types are shown in Table 4.3. On average, non-farm households have substantially higher total expenditures than both small and farm households. However, the share of expenditures spent on food consumed at home does not vary by much across household types. This implies that preferences for food and non-food goods are generally similar across the households included in the survey.

Table 4.3. Annual expenditures by households in Cross River state on food and other categories of goods by household type, thousands of Naira

Household type	Durable goods	Education	Food at home	Food away from home	Total	Food at home, share of total expenditures
Non-farm	259.08	34.48	266.84	57.83	618.24	0.53
Big farm	168.81	14.13	176.83	35.02	394.79	0.54
Small farm	114.95	36.14	153.55	37.55	342.19	0.56

Source: Authors' calculations from NBS-World Bank (2016) data.

Data on average annual household income are shown in Table 4.4. Although these data do not align well with the expenditure data in terms of overall levels across households, they provide insights into income sources across household types. The non-farm households that were surveyed only obtained income from employment. Big farm households obtained income from employment, crop sales, and off-farm enterprises such as informal trading. Small farm households earned most income from employment and off-farm enterprises. Few of the households that were surveyed obtained income from remittances, and this was not a major source of reported income for those that did.

Table 4.4. Annual income for households in Cross River state by source, by household type, thousands of Naira

Household type	Employment	Farm crop sales	Off-farm enterprises	Remittances	Total
Non-farm	346.96	...	...	...	346.96
Big farm	92.60	36.97	567.78	...	697.36
Small farm	243.79	...	151.97	0.26	395.76

Source: Authors' calculations from NBS-World Bank (2016) data.

While small farms do not have any reported farm sales by definition, they do produce crops on the farm for consumption or other uses. Table 4.5 presents information on the relative productivity of big and small farms in terms of the total quantity of vegetation produced per hectare, as well as information on the variety of crops produced. Both big and small farms are not large in total area, with the average farm size below one-half a hectare for both types of farms. Big farms produce more overall and have higher yields than small farms. The implied yield for big farms is nearly 40 percent higher than that of small farms. Big farms also produce a greater diversity of crops on average than do small farms.

Table 4.5. Average farm production by farm type

Farm type	Annual quantity produced, kg	Area farmed, ha	Yield, kg/ha	Number of crops grown, average
Big farm	4,901	0.43	11,505	2.8
Small farm	2,121	0.26	8,332	2.1

Source: Authors' calculations from NBS-World Bank (2016) data.

Table 4.6 shows that part of the reason for why big farms are more productive than small farms is that they expend more on and plausibly use more farm inputs. Big farms on average expend more than twice as much on all inputs except labor than small farms, and expend 60 percent more than small farms on labor. Labor is the only input for which both small and big farm households expend a somewhat sizable amount. Neither household type expends a large amount on fertilizer, pesticides, or animals, and none of the surveyed farm households had any expenditures on agricultural machinery.

Table 4.6. Annual farm input and labor expenditures by farm type, thousands of Naira

Farm type	Non-subsidized fertilizer	Subsidized fertilizer	Seed	Pesticide and herbicide	Hired labor	Animals	Machinery	Total
Big farm	8.88	...	13.11	3.43	84.10	0.13	...	109.64
Small farm	3.83	...	5.38	1.05	51.10	0.01	...	61.36

Source: Authors' calculations from NBS-World Bank (2016) data.

These data on labor expenditures are supplemented with information on the household size in Table 4.7 to make inferences on labor productivity differences between farm types. While the labor share of total input expenditures is similar between farm types, household size is slightly larger for big farms. The larger household size for big farm households and similar share of total inputs spent on labor, despite having over 60 percent larger farms, means that the expenditures on other inputs, management practices, or general farm characteristics, such as soil quality, likely better explain productivity differences between big and small farms than does labor productivity.

Table 4.7. Labor endowments and labor share of total farm input expenditures, by farm type

Farm type	Household size	Expenditures on hired labor per year, thousands of Naira	Labor share of total input expenditures
Big farm	9.0	84.10	0.77
Small farm	7.7	51.10	0.83

Source: Authors' calculations from NBS-World Bank (2016) data.

The general characterization of the Cross River economy that emerges from these household data is one in which non-farm households generally expend more and, thus, likely have higher incomes than the small and big farm households. If the NBS-World Bank (2016) sample for Cross River state are at least somewhat representative of the distribution of household types in the state, then this implies that there are more farm households than non-farm households in the state. The average farm size is generally quite small, and more than half of the surveyed farm households did not report any farm sales. For those that did report farm sales, the share of income earned from farm sales was small relative to other income sources, such as general employment. Thus, while there may be many farm households in Cross River, agriculture is not a sector that presently provides a substantial amount of income in the state relative to other sectors.

Economy-wide Variables

To obtain economy-wide variables, such as the total durable goods expenditures that are subject to the VAT tax for Cross River state, these average annual values for each household type were multiplied by the inferred number of households of each type under the assumption of a somewhat reasonably representative household sample in the NBS-World Bank (2016) dataset. To obtain the inferred number of households, the shares of each household type were multiplied by the Cross River population as reported in NBS (2012). The inferred total population by household type was then divided by the average household size to obtain the estimated number of households by type. The result from this calculation is that there are about 160,600 non-farm households, 127,700 big farm households, and 167,500 small farm households.

The information on the number of households by type was then multiplied by the averages of the variables reported in Tables 4.3 to 4.7 to obtain economy-wide values for variable estimates. For example, the total expenditures on durable goods, which includes all non-food at home items, was calculated by multiplying average expenditures on these goods by household type by the number of households for that type. The inferred VAT tax levels can then be calculated by multiplying this total durable goods expenditure value by the standard VAT tax level of 5 percent as reported in the Value-Added Tax Act of 1993. The results from this exercise are included in Table 4.8. The inferred value of VAT tax for 2015 was 5.755 billion Naira, which is quite a bit lower than the actual VAT revenue value of 8.103 billion Naira obtained in 2014. However, as shown in Table 2.1, 2014 and 2015 were years with notably different macroeconomic conditions. The oil price in 2015 was dramatically lower than that in 2014, and federal government total expenditures were as well. The figures in Table 4.8 at least show that the aggregation strategy to obtain economy-wide variable values yields estimates that are within a reasonable range of actual values.

Table 4.8. Cross River state total expenditures on durable goods, VAT tax rates, and loan interest rates

Total expenditure on durable goods, millions of Naira	VAT rate, percent	Implied VAT tax revenue for 2015, millions of Naira	Actual VAT tax revenue for 2014, millions of Naira
115,100	5	5,755	8,103
Borrowing interest rates, percent, on a loan of...			
	10,000 Naira	50,000 Naira	100,000 Naira
Urban	14.0	14.0	14.0
Rural	26.8	27.7	29.5

Source: Authors' calculations from NBS-World Bank (2016) data and FIRS (1993), and data from Cross River State Office of the Auditor General.

Table 4.8 also includes information on the borrowing interest rates for loans of various amounts. These figures provide insights into the ability for individuals and businesses to access financing for purchase of goods and services on credit. The urban interest rates are substantially lower than the rural interest rates, which implies that households and businesses in urban areas can facilitate purchases on credit more cheaply than those in rural areas. However, the rural interest rates are more consistent with the general rates for commercial loans from Nigerian banks, and so the urban interest rates possibly reflect the existence of unofficial financial markets.

Model Simulation Values

The federal and state fiscal and household data and associated summary statistics were used to obtain parameter estimates and initial variable values such that they are representative of general

economic conditions in Cross River state for 2015. These parameter estimates and initial variable values are presented in Appendix C.

The base parameter and initial variable values for the federal and state fiscal variables were obtained from a variety of sources. For the portion of federal revenue that is derived from income from oil sector rents and fees, data on estimates of daily barrels of oil produced were obtained from the U.S. Energy Information Administration (EIA 2015) and converted to an annual equivalent value for 2015. This estimated annual oil production volume was then multiplied by the average global oil price from the World Bank to obtain the total value of oil. Since the World Bank oil price is in U.S. dollars, the annual average for the Nigerian Naira to U.S. dollar exchange rate for 2015 was obtained from the IMF International Financial Statistics (IMF-IFS) to estimate the value of the oil in Nigerian Naira terms. This was then converted to the share of the total value obtained by the government by relating the average historical shares to the value for 2015. The income tax rate was set to the base value as described in a Kaduna Board of Internal Revenue descriptive report on the elements within the “Personal Income Tax (Amendment) Act, 2011” passed by the Federal Assembly, which states that there is a progressive tax that starts at 7 percent, but rises at higher income rates after accounting for several exemptions (KDBIR 2011). It was assumed that some households would be fully exempt from tax, and some would pay higher rates, so the base level was used as the average income tax rate. In several cases, some initial parameter values were set based on assumptions, such as zero initial savings.

5. SIMULATION SCENARIOS AND RESULTS

There were four scenarios implemented within the simulation model to assess the degree to which federal and state fiscal and household variables can adjust when there are changes in macroeconomic variables. These scenarios are as follows:

- Decrease in the global oil price from the 2015 level;
- Increase in the global oil price from the 2015 level;
- Reduction or full loss of donor funds from the 2015 level; and,
- Reduction in the borrowing rate for small farmers.

The first two scenarios are implemented due to the close correspondence between total federal government revenue, FMARD recurrent expenditures shown in Table 2.2, total state government agriculture and total state government expenditures calculated in Table 2.4, and Cross River state government revenue calculated in Table 4.1. These correspondences imply that revenues and expenditures at all levels of government in the Nigerian federal system move closely with changes in the global oil price. Implementation of the first two scenarios allows for focus on the magnitudes of the effects of oil price changes on state government fiscal conditions and welfare of households within Cross River.

The third scenario is designed to assess the relative importance of donor funding for agricultural programs compared to state government allocations, and how reductions or withdrawal of donor funds can influence Cross River fiscal conditions and household welfare. The data in Table 4.2 show that donor funding has comprised nearly half of agricultural expenditures in some recent years, so it is expected that reductions or withdrawals of these funds would have large effects on the fiscal management of Cross River state government and the CRMANR. Implementation of the simulation allows for measurement of the potential sizes of the effects of these changes, which can be compared to the adjustments due to changes in the variables in the other scenarios.

The final scenario is designed to examine the potential effects of the recently outlined Central Bank of Nigeria managed Anchor Borrowers' Programme, which is designed to provide farmers enhanced access to finance at lower interest rates than are commonly charged by commercial banks (CBN 2016). The data shown in Table 4.8 imply that there is a large disparity in interest rates available to households in urban and rural areas such that farm households may be charged double the rates of urban households. Since the economic model is designed such that the interest rate is related to household time preference, presumably reductions in interest rates for small farmers would have potentially sizable impacts on savings and consumption decisions, resulting in their preferring to consume more in the first period and carry over less savings for consumption in the second period than in the base scenario of high interest rates on borrowing. Implementation of the fourth scenario provides insights into the size of the effects of various interest rate reductions.

Table 5.1 shows simulation results that reflect changes in various Cross River government fiscal and household variables that result from decreases in the global oil price from the 2015 level by 10 to 50 percent in intervals of 10 percent. Decreases in the global oil price are seen to have pronounced effects on the fiscal conditions of the Cross River government and CRMANR. The effects are particularly dramatic for the CRMANR budget – its two-period allocation from the state government declines by more than half after a 20 percent global oil price decline from the 2015 value and is near zero after a 40 percent decline. Cross River state government income declines substantially as well, such that a 30 percent decline in the global oil price from the 2015 level translates into a close to 10 percent decline in period 2 income. These reductions in income for the Cross River state government and CRMANR imply there are less funds available for purchasing inputs to provide to small farmers. Input purchases are estimated to be reduced by more than 10 percent after a decline in the oil price from its 2015 price by 10 percent, and these fall toward zero as the decline in the oil price reaches 50 percent. Small farmer income is lower in both periods because of reductions in CRMANR provided inputs in each period.

Table 5.1. Change in variable values for Cross River state due to decreases in the global oil price

	Base, billions of Naira	Change from base due to oil price decrease from 2015 level by...				
		10%	20%	30%	40%	50%
Federal government period 2 income	7,438.29	-355.33	-710.66	-1,065.99	-1,412.32	-1,776.65
State government savings after period 1	0.19	+1.16	+2.19	+2.93	+2.16	+2.16
State government period 1 income	58.21	-0.02	+0.00	-0.07	+0.03	+0.03
State government period 2 income	58.59	-1.75	-3.53	-5.12	-7.08	-8.79
State government period 1 allocation to CRMANR	4.11	-0.96	-2.48	-3.65	-3.79	-3.79
State government period 2 allocation to CRMANR	0.70	-0.06	+0.06	-0.15	-0.61	-0.61
CRMANR savings after period 1	1.51	-0.07	-1.41	-1.70	-0.62	-0.62
CRMANR period 1 inputs expenditures	2.41	-0.30	-0.09	-0.96	-2.18	-2.18
CRMANR period 2 inputs expenditures	2.01	-0.27	-1.08	-0.88	-2.01	-2.01
Small farmer savings after period 1	1.26	-0.04	-0.42	+0.35	-0.12	-0.12
Small farmer period 1 income	69.11	-0.09	-0.02	-0.33	-0.92	-0.92
Small farmer period 2 income	68.98	-0.09	-0.48	-0.36	-0.72	-0.72

Source: Model simulation results by authors.

We next assess the analogous scenario of an increase in the global oil price from the 2015 level, and the results from the simulation in terms of changes in fiscal and household variables are in Table 5.2. Increases in the global oil price lead to sizable increases in state government income in the

second period, which is partly allocated to the CRMANR. The percentage increases in allocations by the state government are seen to increase as the level of the global oil price increases, such that a 10 percent increase in the global oil price translates into a less than 10 percent increase in state government allocations to the CRMANR, but a 50 percent increase in the global oil price leads to a more than 75 percent increase in the allocation to the CRMANR. Only part of the increase in allocations to the CRMANR is used for input purchases, with the remainder being absorbed for administrative purposes. Following a 20 percent increase in the global oil price from the 2015 level, there are increases in purchases of inputs for small farmers. Thus, small farmer income increases in all simulations following an increase in the global oil price from the 2015 level by 20 percent or more.

Table 5.2. Change in variable values for Cross River state due to increases in the global oil price

	Base, billions of Naira	Change from base due to oil price increase from 2015 level by...				
		10%	20%	30%	40%	50%
Federal government period 2 income	7,438.29	+355.33	+710.66	+1,065.99	+1,421.32	+1,776.65
State government savings after period 1	0.19	-1.33	-2.68	-3.94	-5.31	-6.65
State government period 1 income	58.21	-0.01	+0.01	-0.03	-0.02	+0.00
State government period 2 income	58.59	+1.71	+3.41	+5.13	+6.84	+8.55
State government period 1 allocation to CRMANR	4.11	+0.32	+0.87	+1.57	+2.35	+3.16
State government period 2 allocation to CRMANR	0.70	+0.00	+0.00	+0.00	+0.00	+0.00
CRMANR savings after period 1	1.51	+0.15	+0.39	+0.75	+1.07	+1.41
CRMANR period 1 inputs expenditures	2.41	-0.04	+0.06	+0.17	+0.41	+0.64
CRMANR period 2 inputs expenditures	2.01	-0.02	+0.08	+0.12	+0.35	+0.56
Small farmer savings after period 1	1.26	+0.05	-0.07	+0.48	+0.31	+0.21
Small farmer period 1 income	69.11	-0.01	+0.02	+0.05	+0.11	+0.16
Small farmer period 2 income	68.98	-0.01	+0.03	+0.04	+0.11	+0.17

Source: Model simulation results by authors.

Results for the implementation of the simulation of reductions and eventual loss in donor funding on select fiscal and household variables are presented in Table 5.3. The reduction in donor funds does not affect federal government revenues due to the design of the model to only capture federal to state allocations. However, at every level of donor funds reductions, there are lower input purchases for small farmers, and hence, lower small farmer income. These lower small farmer income levels in both periods lead to reductions in VAT and income tax revenue, and thus, lower state government incomes under all donor funds reduction levels. While expenditures on inputs for small farmers decline at every level of reduction of donor funds, the model design leads to an outcome in which there are not very sizable declines in overall allocations to the CRMANR. These results imply that the state government can provide a fiscal “buffer” through reallocation of resources from other ministries to the CRMANR to make up for some of the losses in donor funds. Some of these reallocated resources are used on administration, so there remain some reductions in input purchases for small farmers. This inherent buffer mechanism is not part of the federal and state level institutional relationship – in the model, the federal government does not reallocate funds to the state government during negative fiscal shock periods such as when the global oil price declines. However, the buffer mechanism that arises within the model provides insights into potential mechanisms at the federal level that could play a similar role in reallocating resources to state governments to sustain spending on key agricultural programs during fiscal downturns.

Table 5.3. Change in variable values for Cross River state due to decreases in donor funds

	Base, billions of Naira	Change from base due to donor fund declines from 2015 level by...				
		20%	40%	60%	80%	100%
Federal government period 2 income	7,438.29	0.00	0.00	0.00	0.00	0.00
State government savings after period 1	0.19	+0.05	-0.01	-0.27	-0.12	-0.01
State government period 1 income	58.21	-0.01	-0.02	-0.02	-0.01	-0.02
State government period 2 income	58.59	-0.02	-0.03	-0.03	-0.00	-0.04
State government period 1 allocation to CRMNR	4.11	-0.16	-0.11	-0.50	+0.01	-0.02
State government period 2 allocation to CRMNR	0.70	0.00	-0.05	-0.05	+0.00	-0.00
CRMNR savings after period 1	1.51	+0.08	+0.28	+0.13	+0.33	+0.48
CRMNR period 1 inputs expenditures	2.41	-0.16	-0.22	-0.22	-0.13	-0.26
CRMNR period 2 inputs expenditures	2.01	-0.13	-0.20	-0.23	-0.14	-0.24
Small farmer savings after period 1	1.26	-0.02	-0.03	+0.17	+0.15	-0.02
Small farmer period 1 income	69.11	-0.05	-0.07	-0.06	-0.04	-0.08
Small farmer period 2 income	68.98	-0.04	-0.07	-0.08	-0.05	-0.08

Source: Model simulation results by authors.

Table 5.4. Change in variable values for Cross River state due to reductions in the loan interest rate for small farmers

	Base	Change from base due to small farmer interest rate reduction by...				
		4%	8%	12%	16%	20%
State government period 1 income	58.21	+0.00	+0.00	+0.01	+0.02	+0.02
State government period 2 income	58.59	-0.01	-0.01	-0.02	-0.03	-0.03
Total period 1 durables expenditures	101.46	+0.06	+0.09	+0.20	+0.24	+0.03
Total period 2 durables expenditures	103.32	-0.13	-0.32	-0.39	-0.53	-0.67
State government period 1 allocation to CRMNR	4.11	+0.03	+0.06	+0.08	+0.09	+0.11
State government period 2 allocation to CRMNR	0.70	0.00	0.00	0.00	0.00	0.00
CRMNR savings after period 1	1.51	+0.03	+0.07	+0.10	+0.13	+0.17
CRMNR period 1 inputs expenditures	2.41	-0.01	-0.02	-0.02	-0.04	-0.05
CRMNR period 2 inputs expenditures	2.01	+0.03	+0.05	+0.09	+0.10	+0.13
Small farmer savings after period 1	1.26	-0.07	-0.16	-0.23	-0.29	-0.38
Small farmer period 1 income	69.11	-0.00	-0.01	-0.01	-0.01	-0.02
Small farmer period 2 income	68.98	+0.01	+0.02	+0.03	+0.03	+0.04
Small farmer period 1 agricultural good consumption	50.00	0.00	0.00	0.00	0.00	0.00
Small farmer period 2 agricultural good consumption	50.74	+0.02	+0.05	+0.07	+0.09	+0.12
Small farmer period 1 durable good consumption	8.50	+0.03	+0.07	+0.10	+0.13	+0.18
Small farmer period 2 durable good consumption	9.81	-0.06	-0.13	-0.18	-0.23	-0.30
Small farmer period 1 input purchases	0.00	0.00	0.00	0.00	0.00	0.00
Small farmer period 2 input purchases	0.00	0.00	0.00	0.00	0.00	0.00

Source: Model simulation results by authors.

The results for the final simulation exercise that assesses the impacts of reductions in interest borrowing rates for small farmers are presented in Table 5.4. Since the interest rate on borrowing primarily influences small farmer savings and consumption decisions and the relative contribution of income taxes to the state government revenues are relatively negligible compared to the federal allocation, the effects of reductions in the small farmer interest rate do not have large economywide effects. However, small farmer income across the two periods does increase, in part due to the state government increasing its allocation to the CRMNR in period 1, and the CRMNR

savings that increase to fund purchases of inputs for small farmers in period 2. These purchases slightly outweigh the increases in state government revenue obtained from higher VAT and income tax revenue that result from increases in small farmer period 1 durable purchases and higher incomes. Thus, the state government revenue effects of interest rate reductions are related to household preferences for durable versus agricultural goods, and the efficiency with which income and VAT taxes are gathered by the state government.

6. CONCLUSIONS AND POLICY IMPLICATIONS

One key observation that emerges from examinations of the relationships between both federal and aggregate state total expenditures and expenditures on agriculture in Nigeria is that federal government expenditures, including, but to a lesser degree, those by FMARD, are somewhat countercyclical, while aggregate state expenditures, including those on agriculture, move closely with the global oil price. This observation implies that in an average year, the federal government, including FMARD, is better able to sustain expenditures on public programs than are state governments. The ability for the federal government to issue debt domestically or on foreign markets and to save revenue to fund expenditures during downward movements in the global oil price is essential for explaining why the federal government expenditures are more decoupled from the variation in the global oil price despite most of federal government revenue still being obtained from oil sector rents and fees.

These fiscal patterns have important implications for sustaining funding for essential agricultural programs in Nigeria over time, and the empirical model in this paper shows that institutional cooperation between levels of government is essential. While the Cross River state government has been highly reliant on donor funds to implement agricultural programs, the results from the empirical model show that adjustments in state government allocations across ministries during periods of negative fiscal conditions can allow programs previously funded by donors to continue after funds are withdrawn. Historical Cross River revenues, however, move very closely with changes in the global oil price, but potentially somewhat less so than is the case in other states.

Therefore, improved cooperation between FMARD and CRMANR could provide for opportunities to fund successful agricultural programs during periods in which the Cross River government revenues are at historical lows or when donor funds for agricultural programs are withdrawn. Such cooperation would be best facilitated with stronger commitments to make overall FMARD funding levels higher – more in line with CAADP obligations – as well as less tied to movements in federal government revenues. Since the recent CRMANR budget for project implementation is a relatively small fraction of total FMARD capital expenditures (e.g., less than 2 percent in 2013), FMARD apparently can facilitate fund transfers to CRMANR in particularly poor funding conditions periods without a large strain on its budget, especially if only essential agricultural programs are funded.

Such inter-institutional cooperation is particularly important for states such as Cross River, which, in recent years, has allocated public funds for agriculture below the federal allocation share to FMARD and did not have much of a budget to implement agricultural programs prior to increases in funding levels provided by donors. This implies that, compared to other sectors, agriculture is presently not an urgent priority for public funding for the Cross River government, and, thus, increased cooperation between FMARD and CRMANR can help bridge the funding gap to bring the state more in line with other states with higher agricultural program expenditures. This type of cooperation would generally provide for a more efficient allocation of public resources to fund

agricultural programs due to the lower frequency of incurring initiation costs for already implemented and successful programs that are in line with the policy goals of FMARD as outlined within the Agriculture Promotion Policy of FMARD (2016) and its successor policy frameworks.

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APPENDICES

Appendix A: List of variables and parameters in the model

Variable	Parameters
<p><i>Households</i> (types: small farmer (<i>s</i>), big farmer (<i>b</i>), non-farmer (<i>n</i>)) c_j^a: consumption of agricultural good by $j=s,b,n$ c_j^d: consumption of the durable good by $j=s,b,n$ i_l: farm input purchases by $l=s,b$ i_g: farm input purchases by government q_l^a: quantity of agricultural good produced by $l=s,b$ E_j: total household expenditure by $j=s,b,n$ Y_j: total income for $j=s,b,n$ Π_j: household savings by $j=s,b,n$</p> <p><i>Government</i> y: total taxable household income k: total value of household durable good consumption Γ: total federal government revenues o: world oil price Φ: federal government allocation to state government N: state government revenues Y: income tax revenue Λ: VAT tax revenue g_a: state government appropriation to Ministry of Agriculture g_x: state government appropriation to non-agriculture ministries and administration G: total state government expenditures Π_g: state government savings M: total Ministry of Agriculture revenue Δ: donor funds to Ministry of Agriculture Σ: total Ministry of Agriculture expenditures I: Ministry of Agriculture expenditure on farm inputs A: Ministry of Agriculture expenditure on administration Π_m: state Ministry of Agriculture savings</p>	<p><i>Households</i> (types: small farmer (<i>s</i>), big farmer (<i>b</i>), non-farmer (<i>n</i>)) μ_j: consumption share parameter by $j=s,b,n$ λ_j: consumption substitution parameter $j=s,b,n$ σ_j: elasticity of substitution for $j=s,b,n$ β_j: rate of time preference for $j=s,b,n$ r_j: interest rate for $j=s,b,n$ p_a: price of the agricultural good p_d: price of the durable good p_l: price of the farm input a_l: production technology for farmer $l=s,b$ l_l: labor endowment for farmer $l=s,b$ α_l: labor share of agricultural production for farmer $l=s,b$ θ_l: farm input share for farmer $l=s,b$ Z_j: exogenous income for $j=s,b,n$</p> <p><i>Government</i> v: VAT tax on durable good τ: income tax rate r_g: interest rate for state government r_m: interest rate for state Ministry of Agriculture e: dollar to Naira exchange rate Ω: quantity of oil produced ω: share of federal government revenue from petroleum ξ: conversion factor of oil production nominal value to government revenue ϕ: federal government revenue from non-petroleum δ: state share of total federal government revenues</p>

Appendix B: Outline of the full economic model

Small farmer problem

$$\max_{c_{s,t}^a, c_{s,t}^d, i_{s,t}} u(c_{s,1}^a, c_{s,2}^a, c_{s,1}^d, c_{s,2}^d) = [\mu_s (c_{s,1}^a)^{-\lambda_s} + (1 - \mu_s)(c_{s,1}^d)^{-\lambda_s}]^{-\frac{1}{\lambda_s}} + \beta_s \left\{ [\mu_s (c_{s,1}^a)^{-\lambda_s} + (1 - \mu_s)(c_{s,1}^d)^{-\lambda_s}]^{-\frac{1}{\lambda_s}} \right\}$$

s.t.

$$E_{s,1} + \frac{E_{s,2}}{(1+r_s)} - Y_{s,1} - \frac{Y_{s,2}}{(1+r_s)} = 0,$$

$$\lambda_s = \frac{(1-\sigma_s)}{\sigma_s},$$

$$E_{s,1} = p_d(1+v)c_{s,1}^d + p_i i_{s,1} + p_a c_{s,1}^a,$$

$$E_{s,2} = p_d(1+v)c_{s,2}^d + p_i i_{s,2} + p_a c_{s,2}^a,$$

$$Y_{s,1} = [p_a q_{s,1}^a + Z_{s,1}](1-\tau),$$

$$Y_{s,2} = [p_a q_{s,2}^a + Z_{s,2}](1-\tau),$$

$$\Pi_s = Y_{s,1} - E_{s,1},$$

$$q_{s,1}^a = a_s l_s^{\alpha_s} (i_{s,1} + i_{g,1})^{\theta_s}, \text{ and}$$

$$q_{s,2}^a = a_s l_s^{\alpha_s} (i_{s,2} + i_{g,2})^{\theta_s}.$$

Non-farmer problem

$$\max_{c_{n,t}^a, c_{n,t}^d} u(c_{n,1}^a, c_{n,2}^a, c_{n,1}^d, c_{n,2}^d) = [\mu_n (c_{n,1}^a)^{-\lambda_n} + (1 - \mu_n)(c_{n,1}^d)^{-\lambda_n}]^{-\frac{1}{\lambda_n}} + \beta_n \left\{ [\mu_n (c_{n,1}^a)^{-\lambda_n} + (1 - \mu_n)(c_{n,1}^d)^{-\lambda_n}]^{-\frac{1}{\lambda_n}} \right\}$$

s.t.

$$E_{n,1} + \frac{E_{n,2}}{(1+r_n)} - Y_{n,1} - \frac{Y_{n,2}}{(1+r_n)} = 0,$$

$$\lambda_n = \frac{(1-\sigma_n)}{\sigma_n},$$

$$E_{n,1} = p_d(1+v)c_{n,1}^d + p_a c_{n,1}^a,$$

$$E_{n,2} = p_d(1+v)c_{n,2}^d + p_a c_{n,2}^a,$$

$$Y_{n,1} = Z_{n,1}(1-\tau),$$

$$Y_{n,2} = Z_{n,2}(1-\tau), \text{ and}$$

$$\Pi_n = Y_{n,1} - E_{n,1}.$$

Federal government

$$\Gamma_1 = \phi + \omega^\xi ((o_1 * e) * \Omega)$$

$$\Gamma_2 = \phi + \omega^\xi ((o_2 * e) * \Omega)$$

Big farmer problem

$$\max_{c_{b,t}^a, c_{b,t}^d, i_{b,t}} u(c_{b,1}^a, c_{b,2}^a, c_{b,1}^d, c_{b,2}^d) = [\mu_b (c_{b,1}^a)^{-\lambda_b} + (1 - \mu_b)(c_{b,1}^d)^{-\lambda_b}]^{-\frac{1}{\lambda_b}} + \beta_b \left\{ [\mu_b (c_{b,1}^a)^{-\lambda_b} + (1 - \mu_b)(c_{b,1}^d)^{-\lambda_b}]^{-\frac{1}{\lambda_b}} \right\}$$

s.t.

$$E_{b,1} + \frac{E_{b,2}}{(1+r_b)} - Y_{b,1} - \frac{Y_{b,2}}{(1+r_b)} = 0,$$

$$\lambda_b = \frac{(1-\sigma_b)}{\sigma_b},$$

$$E_{b,1} = p_d(1+v)c_{b,1}^d + p_i i_{b,1} + p_a c_{b,1}^a,$$

$$E_{b,2} = p_d(1+v)c_{b,2}^d + p_i i_{b,2} + p_a c_{b,2}^a,$$

$$Y_{b,1} = [p_a q_{b,1}^a + Z_{b,1}](1-\tau),$$

$$Y_{b,2} = [p_a q_{b,2}^a + Z_{b,2}](1-\tau),$$

$$\Pi_b = Y_{b,1} - E_{b,1},$$

$$q_{b,1}^a = a_b l_b^{\alpha_b} (i_{b,1})^{\theta_b}, \text{ and}$$

$$q_{b,2}^a = a_b l_b^{\alpha_b} (i_{b,2})^{\theta_b}.$$

State government

$$N_1 = Y_1 + vK_1 + \delta\Gamma_1$$

$$N_2 = Y_2 + vK_2 + \delta\Gamma_2 \quad G_1 = g_{a,1} + g_{x,1}$$

$$G_2 = g_{a,2} + g_{x,2},$$

s.t.

$$N_1 + \frac{N_2}{(1+r_g)} - G_1 - \frac{G_2}{(1+r_g)} = 0,$$

$$\Pi_g = N_1 - G_1,$$

$$Y_1 = Y_{s,1}\tau + Y_{b,1}\tau + Y_{n,1}\tau,$$

$$Y_2 = Y_{s,2}\tau + Y_{b,2}\tau + Y_{n,2}\tau,$$

$$K_1 = c_{s,1}^d + c_{b,1}^d + c_{n,1}^d,$$

$$K_2 = c_{s,2}^d + c_{b,2}^d + c_{n,2}^d,$$

State Ministry of Agriculture

$$M_1 = g_{a,1} + \Delta_1,$$

$$M_2 = g_{a,2} + \Delta_2,$$

$$\Sigma_1 = I_1 + A_1,$$

$$\Sigma_2 = I_2 + A_2,$$

s.t.

$$M_1 + \frac{M_2}{(1+r_m)} - \Sigma_1 - \frac{\Sigma_2}{1+r_m} = 0,$$

$$\Pi_m = M_1 - \Sigma_1,$$

$$I_1 = p_i i_{g,1}, \text{ and}$$

$$I_2 = p_i i_{g,2}.$$

Note: Non-negativity is imposed on all household choice variables.

Appendix C: Parameter and exogenous variable initial values

Parameter values based on gathered data

Parameters	Parameter values	Calculation method
Households (types: small farmer (s), big farmer (b), non-farmer (n))		
μ_j : consumption share parameter by $j=s,b,n$	μ_s : 0.56 μ_b : 0.54 μ_n : 0.53	Share of total expenditure devoted to food at home
β_j : rate of time preference for $j=s,b,n$	r_s : 0.28	Average interest rates: rural for farm households and urban for non-farm
r_j : interest rate for $j=s,b,n$	r_b : 0.28 r_n : 0.14	
α_l : production technology for farmer $l=s,b$	α_s : 1 α_b : 1.38	Ratio of implied yield (in kg/ha) from production (kg) and avg. farm size (ha.)
l_j : labor endowment for farmer $l=s,b$	l_s : 8.35 l_b : 10.74	Expenditure on labor per household multiplied by number of households
α_l : labor share of agricultural production for farmer $l=s,b$	α_s : 0.83 α_b : 0.77	Ratio of labor expenditures to total expenditures
θ_l : farm input share for farmer $l=s,b$	θ_s : 0.17 θ_b : 0.23	Ratio of fertilizer to total input expenditures
Z_j : exogenous income for $j=s,b,n$	Z_s : 70 Z_b : 60 Z_n : 110	Total expenditure minus crop sales (for farm households) plus implied income tax
Government		
v : VAT tax rate on durable good	v : 0.05	Source: FIRS
τ_j : income tax rate for $j=s,b,n$	τ_s : 0.07 τ_b : 0.07 τ_n : 0.07	Source: Kaduna state Board of Internal Revenue
r_g : interest rate for state government	r_g : 0.14	Assumed equivalence with average urban rate
r_m : interest rate for state Ministry of Agriculture	r_m : 0.14	Assumed equivalence with average urban rate
Ω : quantity of oil produced	Ω : 832,701 bbl per year	Annual equivalent of EIA daily estimate
e : dollar to Naira exchange rate	e : 197 N/\$	IMF IFS exchange rate for 2015
ω : share of federal government revenue from petroleum	ω : 0.48	Ratio of petroleum-based revenue to total
ξ : conversion factor of oil production nominal value to government revenue	ξ : 1.16	Used values above to solve for parameter
ϕ : federal government revenue from non-petroleum	ϕ : 3,885 bil. Naira	IMF Article IV data for 2015
ρ : share of state government funds allocated to non-agriculture ministries and administration	ρ : 0.988	Use ratio for 2016, and assume same for 2015
δ : state share of total federal government revenues	δ : 0.0048	Ratio of federal allocation to total federal revenue

Other parameter values to input based on assumptions and gathered data

Parameters	Parameter values	Calculation method
Households (types: small farmer (s), big farmer (b), non-farmer (n))		
λ_j : consumption substitution parameter $j=s,b,n$	λ_j : -0.333	$\sigma_j = 1$ implies a Cobb-Douglas form, $\sigma_j = 0$ implies perfect complements, and $\sigma_j = \infty$ implies perfect substitutes. Assume imperfect substitutability based on expenditure share data.
σ_j : elasticity of substitution for $j=s,b,n$	σ_j : 1.5	
p_a : price of agricultural good	p_a : 1	Agricultural good is numeraire
p_d : price of durable good	p_d : 2	Used expenditure share of non-food to food expenditure relative to total expenditure to infer price
p_i : price of farm input	p_i : 14.2	Used expenditure share of farm input expenditure relative to total expenditure to infer price

Initial values of exogenous household variables based on gathered data

Variables	Initial variable values, in billions of Naira	Calculation method and assumptions
Households (types: small farmer (s), big farmer (b), non-farmer (n))		
c_j^a : consumption of agricultural good by $j=s,b,n$	c_s^a : 50 c_b^a : 22 c_n^a : 43	Total expenditure on food multiplied by number of households by type and rounded
c_j^d : consumption of the durable good by $j=s,b,n$	c_s^d : 13 c_b^d : 13 c_n^d : 26	Total expenditures on non-food and non-farm inputs multiplied by number of households by type, divided by the price and rounded
i_l : farm input purchases by $l=s,b$	i_s : 0.6 i_b : 1.1	Total expenditures on inputs by farm households multiplied by number of households by type and divided by the price
i_g : farm input purchases by government	i_g : 0.035	Assume at least half of project funds devoted to inputs

Initial values of exogenous government variables based on gathered data

Variables	Initial variable values, in billions of Naira, unless noted otherwise	Calculation method and assumptions
Government		
o : world oil price (in USD/bbl.)	o : 50.75 \$/bbl.	Annual average World Bank price for 2016
g_a : state government appropriation to Ministry of Agriculture	g_a : 0.7	Assume ratio from 2016 applies for 2015 and multiplied ratio by 2015 total expenditures
g_x : state government appropriation to non-agriculture ministries and administration	g_x : 58	Residual value from total revenue based on other initial values to make initial state government savings equal to zero
Π_g : state government savings	Π_g : 0	Assume initially zero savings
Δ : donor funds to Ministry of Agriculture	Δ : 0.8	Assume 2013 value applies for 2015
I : Ministry of Agriculture expenditure on farm inputs	I : 0.5	Assume most of donor funds go to input purchases
A : Ministry of Agriculture expenditure on administration	A : 1	Residual value to make initial savings equal to zero
Π_m : State Ministry of Agriculture savings	Π_m : 0	Assume initially zero savings

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