Appendix

**Table A1: Armed Conflict Incidents in Kaduna and Ogun States by group, 1997-2018**

|  |  |  |
| --- | --- | --- |
| **Group Name** | **Kaduna****State** | **Ogun****State** |
| Fulani Ethnic Militia (Nigeria) | 74 | 9 |
| Boko Haram | 28 | 0 |
| Military Forces and Police | 61 | 12 |
| Unidentified Armed Group (Nigeria) | 95 | 35 |
| Protesters (Nigeria) | 109 | 75 |
| Rioters (Nigeria) | 64 | 42 |
| Christian Militia (Nigeria) | 13 | 0 |
| Muslim Militia (Nigeria) | 8 | 0 |
| Others | 30 | 15 |
| TOTAL | 482 | 188 |

**Table A2: Armed Conflict Incidents in Kaduna and Ogun States by Type of Violence, 1997-2018**

|  |  |  |
| --- | --- | --- |
| **Type of Violence** | **Kaduna State** | **Ogun State** |
| Number | Percent | Number | Percent |
| Battles | 94 | 15.1 | 40 | 9.6 |
| Explosions/Remote violence | 29 | 5.8 | 2 | 1.1 |
| Protests | 123 | 23.0 | 82 | 41.5 |
| Riots | 71 | 13.1 | 47 | 22.3 |
| Strategic developments | 22 | 3.7 | 4 | 2.1 |
| Violence against civilians | 208 | 39.2 | 61 | 23.4 |
| TOTAL | 547 | 100% | 236 | 100% |

**Table A3: Armed Conflicts in Kaduna and Ogun States by Subtype of Violence, 1997-2018**

|  |  |  |
| --- | --- | --- |
| **Type of Violence** | **Kaduna****State** | **Ogun****State**  |
| Abduction/forced disappearance | 12 | 3 |
| Agreement | 1 | 0 |
| Air/drone strike | 0 | 0 |
| Armed clash | 93 | 40 |
| Arrests | 7 | 0 |
| Attack | 196 | 58 |
| Change to group/activity | 6 | 0 |
| Disrupted weapons use | 3 | 0 |
| Excessive force against protesters | 5 | 4 |
| Government regains territory | 1 | 0 |
| Headquarters or base established | 1 | 0 |
| Looting/property destruction | 3 | 4 |
| Mob violence | 25 | 22 |
| Other | 1 | 0 |
| Peaceful protest | 110 | 77 |
| Protest with intervention | 8 | 1 |
| Remote explosive/landmine/IED | 16 | 2 |
| Shelling/artillery/missile attack | 1 | 0 |
| Suicide bomb | 12 | 0 |
| Violent demonstration | 46 | 25 |

Mathematical Model

To further explore how a conflict-related shock may impact on the interest in stepping-up, consider the case of a farm household with a planning horizon of *t* = 0, 1, …, T. Note that T is the perceived terminal period. Our conceptual model follows Adelaja and George (2019b), who used a utility maximization problem to represent the households’ input demand functions. However, we modified it to address the issue of scaling-up.

Based on Adelaja and George (2019b), we represent the household’s utility function as:

 $U\left(z\_{t},b\_{t}\right)=\sum\_{t=1}^{t=T}γu\left(z\_{t}\right)+γ^{T+1 }α\left(b\_{t+1}\right). $ (1)

In equation 1, $z\_{t}$ is goods consumed by the household, $γ$ is a discount factor, $b$ is household assets (including savings), and $α$ is the rate of return from such assets. Assume the following farm household production function that is continuous, concave and increasing in input arguments:

 $Q\_{t}=Q(L\_{t},A\_{t}, ϵ\_{t})$, (2)

where $Q\_{t}$, $L\_{t}$ and $A\_{t}$ are output produced, labor used and land actively farmed in time period *t*, respectively. Further assume that $ϵ\_{t} $is an independently and identically distributed vector of random variables representing conflict- and climate-related shocks. Denote the full income of the farmer as $I\_{t}$. We express the household’s income constraint as the sum of farm profits and returns from assets owned or operated. That is,

 $I\_{t}=w\overbar{L}+a\overbar{A}+PQ\left(L\_{t},A\_{t}, ϵ\_{t}\right)-a\_{t}A\_{t}-w\_{t}L\_{t}+\left(1+r\right)b\_{t}$, (3)

where, respectively$,\overbar{L}$ is the labor endowment, $\overbar{A}$ is the land endowment, $P$ is the output price, *r* represents the return rate on assets, and$ a\_{t}$ and $w\_{t}$ are the rental rate for land and the wage rate. Equation 3 can be expressed as:

 $I\_{t}=π\_{t}+\left(1+r\right)b\_{t}.$ (4)

where $π\_{t}$ is the farm profit.

We assume that asset holdings,$ b$, changes over time as a function of income ($I\_{t}$) and consumption ($C\_{t}$) as follows:

 $b\_{t+1}=I\_{t}-C\_{t}$ (5)

From equations (4) and (5),

 $b\_{t+1 }=π\_{t}+\left(1+r\right)b\_{t}-C\_{t}$ (6).

Based on equations 1 to 6, $V^{t}\left(Q\_{t},b\_{t},ϵ\_{t}\right) $is a value function for the household’s problem for the *t*th period $V^{t}\left(.\right)$ is the maximum expected present value of the utility derived from periods *t* to T. The latter is a dynamic equivalent of the household’s indirect utility function. The optimal choice of $z\_{t},A\_{t}$ and $L\_{t}$ is obtained by applying the implicit function theorem to the following problem:

 $\max\_{z\_{t}, A\_{t}, L\_{t}}λ\_{t}=u\left(z\_{t}\right)+γE(V^{t+1}\left(Q\_{t+1},b\_{t+1},ϵ\_{t}\right)) $ (7)

subject to

 $Q\_{t+1}=f\left(L\_{t},A\_{t},ϵ\_{t}\right)$ (8)

and

 $b\_{t+1}=\left(1+r\right)b\_{t}+PQ-wL\_{t}-aA\_{t}-Pz\_{t}. $ (9)

Note that *E* (.) denotes expected value.

From the first order conditions for optimal land input choice, the input demand function is:

 $A\_{t}=L(a,w,p,ϵ)$ (10)

From equation 10, the actual land in production,$ A\_{t}$, is a function of the rental rate for land, the wage rate, product prices and conflict/climate-related shocks. However, actual land in production can be lower than total land owned/operated because the farmer can choose to idle some of the land. Furthermore, the farm household may have access to free land or land abandoned by neighbors and relatives. Therefore,

 $A\_{t}=\overbar{A}-A\_{It}$ (11)

where $\overbar{A}$ is the family’s ownership of land and $A\_{It}$ is the amount of land that is idled. Note that in equation (11), we assume that no land is rented in or out and no land is acquired or given away for free. However, equation 11 is easily adjusted to account for these possibilities.

Since $\overbar{A}$ is purely fixed in the short term, $A\_{It}$ can be represented as:

 $A\_{It}=A\left(a,w,p,ϵ\right)$ (12)

In the above, conflict-related shocks directly affect production, but input prices can also be affected. Conflict affects the demand for farmland mainly through the effects on the price of land and directly through $ϵ$. Taking the derivative of $A\_{t}$ with respect to conflict shocks, one obtains

 $\frac{∂A\_{t}}{∂ϵ}=\frac{∂f}{∂a}.\frac{∂a}{∂ϵ}+\frac{∂f}{∂ϵ}$ (13)

The first term on the right side of equation (13) is the change in land demand from lower land prices. As land values drop due to farm abandonment, land availability may increase for remaining households due to temporary management arrangements, caretaking opportunities and free transfers. The second term is the production shock from a conflict shock through various inputs. The overall effect on farmland demand depends on the signs and relative magnitudes of both terms.

 Now we extend the Adelaja and George (2019) model to accommodate scaling-up. Consider the fact that the decision of a SHF to scale-up to a larger scale is dependent on the nature of his/her current land holdings ($\overbar{A}$), vis-à-vis demand ($A\_{t}$). Equation 12 and 13 above relate to $A\_{t}$, not $\overbar{A}$. Recall that the current landholding of the farmers ($\overbar{A}$) is related to land demand as follows:$ A\_{t}=\overbar{A}-A\_{It}$. For a SHF, scale-up or transition to larger land size implies that $A\_{t}>\overbar{A} which requires that A\_{It}<0$. In essence, excess demand for land $(A\_{Et})=(-A\_{It})$ Since in equation 12, $A\_{It}=A\left(a,w,p,ϵ\right)$, the same expression is valid for demand for $A\_{Et}, except that the expected signs will be the opposites. $That is,

 $A\_{Et}=A'\left(a,w,p,ϵ\right)$ (14)

where $A\_{Et}=-A\_{It} where $ $A\_{It}<0. $Therefore, equation 13 can be modified as follows:

 $\frac{∂A\_{Et}}{∂ϵ}=-[\frac{∂f}{∂a}.\frac{∂a}{∂ϵ}+\frac{∂f}{∂ϵ}]$ (15).

The anticipated sign of the effect of conflict on idled land is the opposite of the sign of the effect on excess demand for land, keeping land holdings constant. Actual scale-up is, however, also a function of affordability, profitability and other factors.