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Agricultural Research Spending in Sub-Saharan Africa: How important are political economy considerations?

Motivation

- Agriculture contributes significantly to GDP and employment in developing countries.
- Historical agricultural output has been increased by:
  - Intense cultivation of existing plots (Ruttan, 2002)
  - Expanding plots under cultivation (Alston and Pardey, 2014)
- The above is no longer feasible due to:
  - The effects of climate change (Beintema and Stads, 2017)
  - Natural bounds of agro-climatic geography (Fuglie, 2015)
  - Population growth
- This leaves agricultural R&D as the primary source of improved agricultural performance.

Motivation, con'd

- Agricultural TFP growth is influenced primarily by knowledge: through innovation (agricultural research spending) and assimilation of knowledge created elsewhere (spill-overs).
- Agricultural Science and Technology Indicators (ASTI) data displays two key patterns
  - Heterogeneity in agricultural R&D spending, with the ratio of spending to GDP considerably low.
  - Agricultural R&D investment lags other input investments.
- An important prerequisite for investing in knowledge is concerted government action. Popularly known as **political commitment**.
- Underinvestment in local agricultural R&D in SSA (Mogues, 2015). Political economy reasons

Conceptual Framework

- Local R&D capacity is important for absorption of knowledge spill-overs.
- Elites' incentives and interests towards agricultural transformation depend on how much they can benefit from such transformation (Mogues, 2015; Benin, McBride and Mogues, 2016.
- The benefits of agricultural research accrue in the long-term (time lag between allocation of resources and realisation of outcomes), making them less popular than more overt agricultural infrastructure investments (Benin et al., 2016).
- Ex ante policy impact. The level of agricultural performance influences the availability of future resources (Birner and Resnick, 2010).

Related Literature

- Descriptive studies on the evolution of R&D spending and intensity (Beintema and Stads, 2014, 2017; Pardey, Alston and Chan-Kang, 2013)
- Studies focusing on the productivity of R&D investments (Block, 2014; Eberhardt and Teal, 2013; Fuglie, 2015,2017; Lusigi and Thirtle, 1997)
- Studies focusing on knowledge spill-overs (Guiterrez and Guiterrez, 2003; Johnson and Evenson, 1999, 2000; Islam and Madsen, 2018)
- Studies focusing on the political economy of agricultural investment (Benin and Binswanger-Mkhize, 2012; Mogues, Fan and Benin, 2015; Mogues, 2015)

Data

- **Annual data on 45 SSA countries, 1960-2016**
- **IFPRI Agricultural Science and Technology Indicators (ASTI) database**
  – Public agricultural R&D expenditure
  – Excludes private R&D investments as they contribute less in SSA countries.
- **FAOSTAT Database**
  – Net agricultural output
  – Labor (economically active population)
  – Tractors in use (agricultural capital stock for sensitivity analyses)
  – Arable and permanent crop land
- **Polity IV, V-Dem Database, WDI**
  – Measures of institutional quality

Methods

- **Standard common factor framework**

$$\ln y_{it} = \beta_i^x x_{it} + u_{it} \qquad u_{it} = \alpha_i + \lambda_i' f_t + \varepsilon_{it} \qquad (1)$$

Where

- y_{it} represents agricultural net output
- x_{it} represents a vector of inputs: capital (K_{it}), labor (L_{it}), arable land (N_{it}) and agricultural R&D stock (R_{it})
- β_i^x is a vector agricultural factor input coefficients that differs across countries
- The equation also includes:
  - Country-specific intercepts, α_i (agricultural TFP levels)
  - A vector of unobserved common factors (f_t) with country-specific factor loadings (λ_i').

Methods, *con'd*

- The common factors can be induced strong or weak shocks
  - Strong shocks: the ongoing coronavirus pandemic, the relatively recent financial crisis, the food price crisis of 2008.
  - Weak shocks: externalities from innovation and production, deliberate international knowledge spillovers.
- Dynamics are important so we prefer and ECM specification

$$\Delta y_{it} = \alpha_i + \rho_i(y_{it-1} - \beta_i^x x_{it-1} - \lambda_i' f_{t-1}) + \gamma_i^x \Delta x_{it} + \gamma_i^F \Delta f_t + \varepsilon_{it} \quad (2)$$

Where

- β_i^x represents the long-run relationship
- the γ_i^j represent the short-run adjustment dynamics
- the ρ_i indicates the speed of convergence of the economy to its long-run equilibrium

Methods, *con'd*

- We employ the dynamic Common Correlated Effects Mean Group (CCEMG) estimator which uses cross-section averages (CSAs) and lags of CSAs of the variables to filter out unobserved common factors:

$$\Delta y_{it} = \pi_{0i} + \pi_i^{EC} y_{it-1} + \pi_i^{x} x_{it-1} + \Phi_i^{x} \Delta x_{it} + \pi_{1i}^{CA} \overline{\Delta y}_t + \pi_{2i}^{CA} \overline{\Delta y}_{t-1} + \pi_{3i}^{CA} \bar{x}_{t-1} + \pi_{4i}^{CA} \overline{\Delta x}_t + \sum_{l=1}^{p} \pi_{5i}^{CA} \overline{\Delta y}_{t-p} + \sum_{l=1}^{p} \pi_{6i}^{CA} \overline{\Delta x}_{t-p} + \varepsilon_{it} \qquad (3)$$

Where

-The terms π^{CA}s and $\sum_{l=1}^{p} \pi^{CA}$s represent the coefficients on CSAs and lags of CSAs, respectively

- Chudik and Pesaran (2015) show that for equation (3), lags of CSAs are chosen based on $p = \sqrt[3]{T}$

Spill-over analysis

- Obtain residuals from the dynamic production function (accounting for unobserved heterogeneity and the presence of global shocks)

$$TFP_{it} = \bar{y}_t - \widehat{\beta'_{CCE,l}}\bar{x}_t - \widehat{\varepsilon_{it}} \quad (4)$$

Where

- $\bar{y}_t$ and $\bar{x}_t$ are cross-section averages of the dependent and independent variables.
- We analyze TFP from equation (4) using spatial econometric techniques. Various channels of knowledge diffusion include:
  - The nature and quality of institutions
  - Agro-climatic zones
  - Agricultural output mix

Robustness Analysis

- Countries are split according to their level of development (LICs vs non-LICs).
- Countries split by geographical region: WAAPP, EAAPP, APPSA and CAAPP.
- Countries split by the level of volatility of agricultural R&D spending.
- Countries split by the primary source of R&D funding (Beintema and Stads, 2017)
- Countries split by their level of political commitment to agricultural R&D investment (Brinkerhoff, 2000, 2010): commitment measured by the agriculture orientation index and average budgetary resources spent on agriculture.

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