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IAPRI-MSU Technical Training: An Introduction to Agricultural Household Models

Part 1

Using Economic Theory to Guide Our Empirical Work: Insights from Basic Producer and Consumer Theory

June 22, 2016

Indaba Agricultural Policy Research Institute

Lusaka, Zambia

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Today's program

- 14:00-14:20 – **Introductions** (name, institution, position, education background, previous exposure to producer theory, consumer theory, and/or agricultural household models)
- 14:20-15:35 – **Objectives**, **review of consumer theory** and **implications for empirical work**
- 15:35-15:45 – **health break**
- 15:45-17:00 – **Review of producer theory** and **implications for empirical work**

- ***Assign time keeper** (for health break & end-of-day)

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Why this technical training?

- Most previous IAPRI-MSU technical trainings have focused on **applied econometrics**
- But **how do you decide which variables** to include in your econometric model?
  - Theory can guide us in this and other ways!
- The difference between a decent paper and really good paper is often the **link between its economic (or other) theory and the empirics**
  - Examples?
- With our empirical work more grounded in a sound conceptual framework, we should be able to produce **better empirical evidence** for policymakers and other stakeholders
- Topics we'll cover = **foundation for future technical trainings**

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Objectives for today's session

1. Refresh your memory on:
   a. **Consumer theory basics** – esp. utility maximization and consumer demand functions (incl. key determinants)
   b. **Producer theory basics** – esp. production functions, profit maximization, and input demand/ output supply functions (including key determinants)
2. Have a basic understanding of how to use insights from microeconomic theory to inform/ improve your empirical model specifications

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Consumer Theory 101

- Based on basic consumer theory:
  - **How does a (pure) consumer choose what to consume given his/her limited income**?
  - And what are the **determinants of his/her consumer demand** for various goods?
- Work through example on white board

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From Sadoulet and de Janvry (1995) reading (p. 3 of Chapter 2)

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Consider an individual consumer whose utility function is $u(q, z)$, where q is the vector of quantities of n commodities on which a consumption decision must be made and z are individual characteristics. The amount of income which can be spent is y, imposing a budget constraint $p'q = y$, where p' is an n-dimensional row vector of prices. The consumer's objective function is to maximize utility with respect to q, subject to the budget constraint $p'q = y$. This can be rewritten as:

$$\underset{q,\lambda}{Max}\, u(q,z) + \lambda(y - p'q),$$

where λ is a Lagrange multiplier (see the Appendix).

The solution to this maximization problem is a set of n demand equations:

$$q_i = q_i(p,y,z), \quad i = 1, \ldots, n.$$

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What does all this mean for empirical work?

- Suppose you want to **estimate the effect of an increase in the breakfast meal price on a Lusaka consumer's demand for breakfast meal**
  - Assume that they are not involved in agriculture
- *Based on consumer theory, what key explanatory variables would be important to include in your econometric model?*

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Application: Empirical estimation of food demand

- *What is the information we need to an **individual's** consumer demand and what does the data we use often really look like?*
- **Individual** consumer demand functions:
  - Quantity demanded (X) – dependent variable
  - Income (Y)
  - Own price (p_x)
  - Prices of complements and substitutes ($\mathbf{p}_{-x}$)
    - Or CPI to capture "all prices"
    - Or put prices & income in real terms to implicitly include CPI
  - Individual characteristics affecting tastes & preferences ($\mathbf{z}_c$)

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Application: Empirical estimation of food demand

- *What would be different if we were estimating an **aggregate** consumer demand function? E.g., demand by a country instead of by an individual person*
- **Aggregate** consumer demand functions:
  - Total quantity demanded (X) – dependent variable
  - Total income (Y) – often GDP or GNI
  - Population (or per capita income instead of total income and population as separate variables)
  - Measure of the distribution of income (e.g., Gini coef.)
  - Prices – same as individual demand curve
  - Population characteristics affecting tastes and preferences (and possibly distributions thereof)

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Many other issues to consider

- Like single equation vs. system-of-equations, functional form, seasonality, dealing with consumer heterogeneity in cross-sectional or panel data, and many other issues
- But this is a good starting point

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Also many other consumer demand basics that would be good for you to review – e.g.:

- **Income slopes and elasticities of demand** (& related concepts of normal vs. inferior goods)
- **Own- and cross-price slopes and elasticities of demand** (& related concepts of complements and substitutes)
- **Engel's Law**
- **Bennett's Law**
- Among others

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Producer Theory 101

- What is a **production function**?
- Based on basic producer theory:
  - **How does a (pure) producer/firm decide how much produce**, and **how much of various inputs to use**?
  - And what are the **determinants of his/her supply of various goods ("output supply") and demand for various inputs ("input demand")**?
- Work through example on white board

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From Sadoulet and de Janvry (1995) reading (p. 2 of Chapter 3)

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Let the production function of a farm be given by:

(1) $h(q, x, z) = 0,$

where q is the vector of output quantities, x is the vector of variable input quantities, and z is a vector of fixed factor quantities. Variable inputs are usually labor, fertilizer, water, pesticides, seeds, hours of rented tractor use, and such, which can be purchased in the desired quantities. Fixed factors are either private factors that cannot be acquired in the time span analyzed (land, equipment), public factors (infrastructure and extension services), or exogenous features (such as weather and distance to market).

If w and p are the prices of inputs and outputs, respectively, the producer's restricted profit is $p'q - w'x$ (the symbol $'$ indicates transposition of a vector, and "restricted" profits means that only variable costs are subtracted from gross revenues). The producer is assumed to choose the combination of variable inputs and outputs that will maximize profit subject to the technology constraint:

(2) $\underset{x,q}{\text{Max}}\ p'q - \mathrm{w}'x, \quad \text{s.t.}\ \ h(q, x, z) = 0.$

The solution to this maximization problem is a set of input demand and output supply functions that can be written as:

(3) $x = x(p, w, z)$ and $q = q(p, w, z).$

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What does all this mean for empirical work?

- Suppose you want to **estimate the effect of an increase in the DAP fertilizer price on a Zambian commercial farm's demand for DAP and their supply (production) of maize**
  - Treat the farm as a pure producer for now (we'll consider the case where farmers consume some of what they produce next time)
- *Based on producer theory, what key explanatory variables would be important to include in your econometric models?*

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Application: a commercial farm's demand for DAP and supply of maize

- Dependent variables: DAP use, maize quantity produced
- Explanatory variables: (*Same or different for DAP demand vs. maize supply?*)
  - Output prices (**p**) for maize and other crops
  - Input prices (**w**) for DAP and other inputs
  - Levels of fixed/quasi-fixed factors ($\mathbf{z}_q$) – e.g., farm equipment, possibly landholding size, agro-ecological conditions, distance to market, etc.

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Many other issues to contend with

- E.g., price expectations, single equation vs. system-of-equations, functional form, risk aversion, price and yield uncertainty, technical change, dynamics and adjustment costs, short-run vs. long-run effects, etc.
- But this is a good starting point

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Also many other producer theory basics that would be good for you to review – e.g.:

- **Diminishing marginal returns, 3 stages of neo-classical production function**
- **Cost functions, cost minimization**
- **Returns to scale**
- **Input and output price slopes and elasticities for input demand and output supply functions**
- Among others

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Tomorrow

- **Please read Singh, Squire, and Strauss (1986), "Introduction", pp. 3-9, before session**
- **How do we think about consumer demand, input demand, and output supply for an agricultural household** that consumes some of what it produces and provides some of its own labor for production on the farm?
  - Combines producer and consumer theory and yields some important insights on how agricultural household behavior is/is not different from the pure producer and pure consumer cases
  - Implications for empirical work

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Reference cited

- Sadoulet E., de Janvry A. 1995. *Quantitative Development Policy Analysis*. Baltimore: Johns Hopkins University Press.

Acknowledgements

This training session was supported by the Innovation Lab for Food Security Policy through funding from the U.S. Agency for International Development.

Development of the training materials was also supported by Michigan State University.