

Agricultural Production and Technological Change

Course Overview and Objectives

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AREC 705: Lecture 1

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Introductions

About this class:

- Syllabus
- Expectations
- My promises to you
- Questions?

My objectives for you:

- Familiarity with the literature and methods
- Improved ability to develop and solve theoretical models
- Fairly polished research paper
- Ability to write and respond to formal referee reports

Introductions

About me

- Originally from Chicago
- B.S. and M.S. in agricultural economics from UIUC
- Ph.D. in agricultural economics from UC Davis
- Most of my research is on the productivity and labor supply of agricultural workers.

About you:

1. Why are you in this class and what are you hoping to get out of it?
2. What sort of job(s) are you interested in?
3. Are there any software or platforms you are interested in learning?
4. Of the topics on the course outline, which are you most and least interested in?

Course Topics

Advanced Producer Theory and Analysis

Technology and Productivity

Efficiency and Productivity Analysis

Contract Theory

Advanced Market Models

Week One: Course Overview

This week we will be glancing at the literature in each of the topic areas.

At the end of the week you should be able to answer the questions:

- How should I read a research paper and what does this imply for how I should write a research paper?
- What characterizes each topic area/field?
- What models will we be learning that are commonly used in each field?
- What are some gaps in the literature?
- What am I most interested in researching?

At the end of next week (9/4) you will be submitting three research ideas for your term paper.

Keshav, S. How to Read a Paper. Link:

<https://web.stanford.edu/class/ee384m/Handouts/HowtoReadPaper.pdf>

Three-pass approach:

First –

Second –

Third –

The “five C” approach:

Category –

Context –

Correctness –

Contributions –

Clarity –

Reading and Writing Academic Papers

My expectation for every class is that you can answer the following:

Contributions & what question is the paper addressing? –

Category – theoretical? empirical? case study? meta-study? –

Conclusions – what are the results? –

Context – what are related papers? –

Methods – what methods are used to analyze the problem? –

Overview: Adv. Producer Theory and Analysis

What makes agriculture unique?

Why is agricultural production different from the production of widgets?

Overview: Adv. Producer Theory and Analysis

How do we go about modeling and analyzing the behavior of agricultural producers given these complexities?

We can begin with a multi-period production function that accounts sequential stages and temporal allocation:

$$y = f \left(f_1 \left(\mathbf{x}^1, t_1 \right), \dots, f_m \left(\mathbf{x}^m, t_m \right) \right), \quad (1)$$

where y is a single output, \mathbf{x}^i is the variable input vector at time t_i , \mathbf{x}^m are harvest inputs applied at time t_m , and there are m -production stages.

Overview: Adv. Producer Theory and Analysis

How do we go about modeling and analyzing the behavior of agricultural producers given these complexities?

We could alternatively represent this production function problem as a function of intermediary outputs, y_i :

$$\begin{aligned} y &= f_m(\mathbf{x}^m, t_m, (f_{m-1}(\mathbf{x}^{m-1}, t_{m-1}, f_{m-2}(\mathbf{x}_{m-2}, t_m, \dots, f_1(\mathbf{x}_1, t_1, y_0), \dots))) \\ &= f^*(f_1(\mathbf{x}^1, y_0), \dots, f_m(\mathbf{x}^m, y_{m-1})) \end{aligned} \quad (2)$$

where y_0 are initial conditions, y_i is the output at stage i , and the efficient production is such that the producer applies inputs \mathbf{x}^i to maximize y_i at each stage i .

Overview: Adv. Producer Theory and Analysis

How do we go about modeling and analyzing the behavior of agricultural producers given these complexities?

Given commonly available data (annual), we tend to proxy this as:

$$y = f^0(\mathbf{x}) \approx f^0(\mathbf{x}, y_0) \approx \max_{\{x_i\}} \{f^*(.) \mid \sum_{\forall i} x_i = \mathbf{x}\} \quad (3)$$

Why is this representation problematic and what data might be usable to improve the estimation of y ?

Overview: Adv. Producer Theory and Analysis

How do we go about modeling and analyzing the behavior of agricultural producers given these complexities?

Given commonly available data (annual), we tend to proxy this as:

$$y = f^0(\mathbf{x}) \approx f^0(\mathbf{x}, y_0) \approx \max_{\{x_i\}} \{f^*(.) \mid \sum_{\forall i} x_i = \mathbf{x}\} \quad (4)$$

An example in recent literature:

McArthur, J.W. & McCord, G.C. (2017). Fertilizing Growth: Agricultural Inputs and their effects in Economic Development. *Journal of Development Economics*.

$$a_{it} = \beta_0 + \beta_1 f_{it} + \delta' X_{it} + \eta_t^a + \varepsilon_{it}^a$$

$$\varepsilon_{it}^a = \mu_i^a + \nu_{it}^a$$

Overview: Adv. Producer Theory and Analysis

How do we go about modeling and analyzing the behavior of agricultural producers given these complexities?

There are far too many sub-topics within “producer theory” to cover them all. In this course we will go in depth in a few:

1. Theory: Optimal planting of perennials
2. Empirical: Modeling supply
3. Theory and empirical: Producer decision-making under risk

Overview: Technology and Productivity

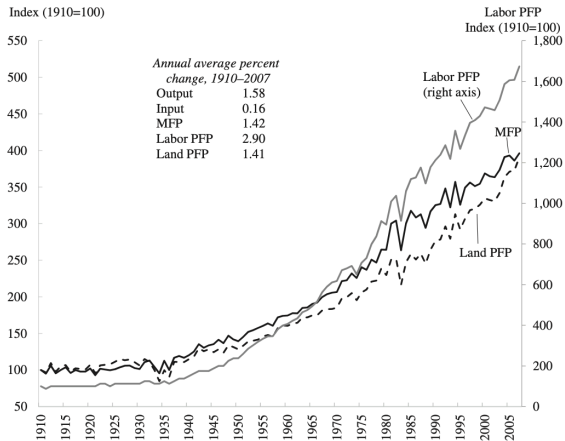


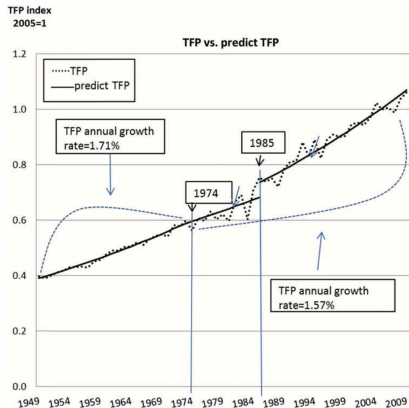
Figure 1. Measures of U.S. agricultural productivity, 1910–2007

Sources: Index numbers calculated by the authors using Version 5 of the InStePP Production Accounts backcast with data taken from USDA ERS (1983; see table 45), USDA ERS (1983; see table 69), USDA ERS (1983; see table 1), and Olmstead and Rhode (2006; series Da-5).

Note: MFP and Land PFP, left axis, Labor PFP, right axis.

Overview: Technology and Productivity

Figure 2. Actual TFP vs. predict TFP



Source: Ball, E.V. et al. (2016). Productivity and Economic Growth in U.S. Agriculture: A New Look. *Applied Economic perspectives and Policy*, 38(1): 30 – 49.

Overview: Technology and Productivity

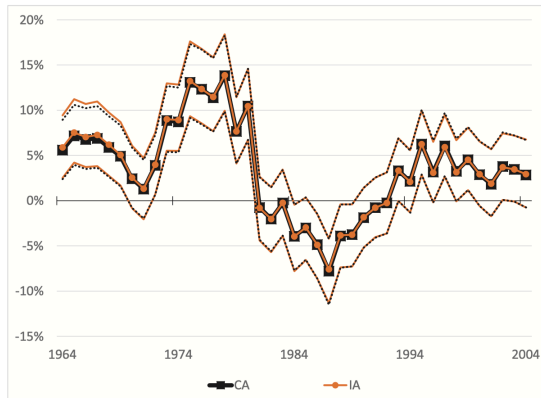


Figure 1. Estimated technical change for California and Iowa (annual median and 95% credible interval), 1964–2004

Source: Plastina, A. & Lence, S.H. (2018). A Parametric Estimation of Total Factor Productivity and Its Components in U.S. Agriculture. *American Journal of Agricultural Economics*, 100(4): 1091 – 1119.

Overview: Technology and Productivity

What we will cover:

1. Theoretical: Technology generation, adoption, and diffusion
2. Theory and Empirical: The role of new technologies in producer decision-making

Overview: Efficiency and Productivity Analysis

How do we study them?

Let's define a set of inputs used by producers as $x = (x_1, \dots, x_N) \in R_+^N$ and a set of outputs produced by those inputs as $y = (y_1, \dots, y_M) \in R_+^M$. Then production technology can be represented by a set of inputs and outputs:

$$T = \{(y, x) : x \text{ can produce } y\}.$$

We can also define technology by input (or level) sets

$$L(y) = \{x : (y, x) \in T\},$$

which for every $y \in R_+^M$ have input isoquants

$$I(y) = \{x : x \in L(y) \text{ and } \lambda x \notin L(y) \text{ if } 0 \leq \lambda < 1\}.$$

Overview: Efficiency and Productivity Analysis

How do we study them?

These input isoquants define the production function. We can then define the input efficient subsets in terms of the level sets:

$$E(y) = \{x : x \in L(y), x' \notin L(y) \text{ for } x' \text{ when } x'_k \leq x_k \forall k \text{ and } x'_k < x_k \text{ for some } k\}.$$

Then we can see that the three sets will satisfy: $E(y) \subseteq I(y) \subseteq L(y)$.

Overview: Efficiency and Productivity Analysis

How do we study them?

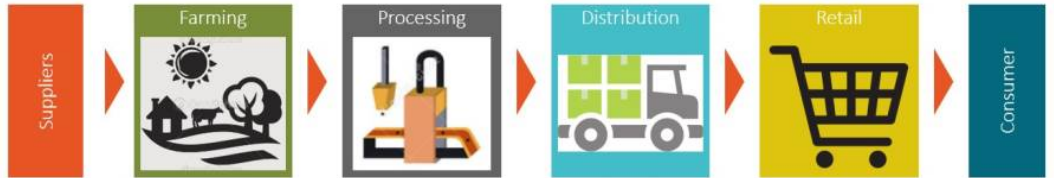
Overview: Efficiency and Productivity Analysis

What methods will we use in this class?

- Theoretical underpinnings
- Data Envelopment Analysis (DEA) – non-parametric production frontiers
- Stochastic Frontier Analysis (SFA) – parametric/ some semi-parametric
- Alternative measures of firm productivity

Overview: Agricultural Contracts

The Agricultural Supply Chain



Overview: Agricultural Contracts

Resource-Providing Contracts

Buyer provides one or more production inputs and participates in management decisions.

Production-Management Contracts

Agreements (typically formal) between a buyer and a grower that specify at least some aspects of the production process as well as compensation.

Marketing Contracts

Formal or informal agreements between a buyer and a grower that set conditions of sale — price determination, quantity, and quality.

Overview: Agricultural Contracts

Two types of theoretical approaches:

Agency Theory

Asymmetric information and risk sharing.

Transaction Cost Economics

Characteristics of transactions defining a production process to explain why specific transactions are organized within a firm or through some method of coordination.

Overview: Agricultural Contracts

Some potential opportunities in contract agriculture...

Hop Contracting:

<https://midwesthopproducers.com/brewer-connection-2/hop-contracting/>

PACA rules, retail refusals, and strategic behavior of retail firms in fresh strawberry production (talk to me if interested!)

Overview: Advanced Market Models

How can we program a CGE model?

- Single country models: GAMS (MPSGE), GEMPACK
- Global models: GTAP (GEMPACK)

- GTAP:

<https://www.gtap.agecon.purdue.edu/products/rungtap/default.asp>

Overview: Advanced Market Models

What parameters do we need to input?

- A CGE model requires parameters, exogenous variables and endogenous variables
- The CGE model database provides the values of all parameters, exogenous variables, and initial values for endogenous variables
 1. Social Accounting Matrix (SAM) describes the circular flow of income and spending in a national economy during a specific time period (currently 2016, I believe). This gives exogenous variables and starting values for endogenous variables
 2. Elasticity parameters for all aspects of the economy
- So, we need to decide:
 1. Changes in endogenous variable(s)
 2. How to aggregate economic activity (for example, you can start with a 3-sector, 3-factor database for the U.S. and an aggregated rest of world)

Overview: Advanced Market Models

What we will cover:

1. Theory and Empirical: Equilibrium Displacement Models
2. Empirical: Systems of Simultaneous Equations
3. Applications in agriculture:
 - Trade
 - Labor and migration
 - GMO foods
4. If time and interest: CGE Modeling