Understanding the Impact of Agricultural Productivity on Farm Income: An Equilibrium Displacement Modeling Approach

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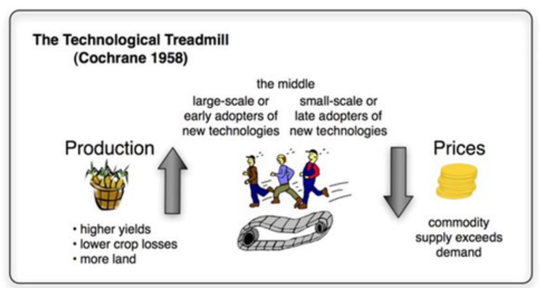
Introduction

- That growth in farm income in developing countries reduces poverty is widely accepted and empirically validated [see e.g., Irz et. al. (2001)].
- The proposition that growth in productivity increases farm income is less well established.
- *"…compelling evidence has not been developed to show whether farmers benefit from technological change in agriculture. This is serious unfinished business." [J. Alston (2017)].*
- The objective of this analysis is to address this *unfinished business*.
- We develop an Equilibrium Displacement Model (EDM) to pursue that objective

Some Economists are doubtful:

Believing that the benefits of productivity for farmers are:

- Fleeting and only for early adopters of new technologies.
- Negative for late and non-adopters.
- Unevenly distributed, with most to large commercial farmers.
- Diminished as reductions in output price offset cost savings.
- Such pessimism began with Cochrane's Treadmill and continues…

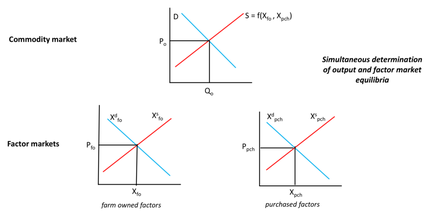


Equilibrium Displacement Model

A system of linked supply and demand equations comprising:

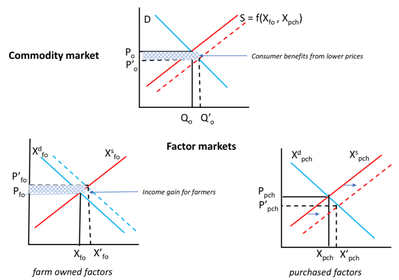
- Commodity supply equation determined by factor demand and supply.
- Factor demand equations derived from FOC's for profit maximization.
- Factor supply equations linking quantities supplied to prices with elasticities.
- Commodity demand equation linking quantity to price with demand elasticity.
- Market-clearing conditions to determine equilibrium prices.

A basic two factor EDM



We define 'productivity improvement' as a cost-saving increase in purchased factor supply.

An increase in purchased factor supply leads to: :

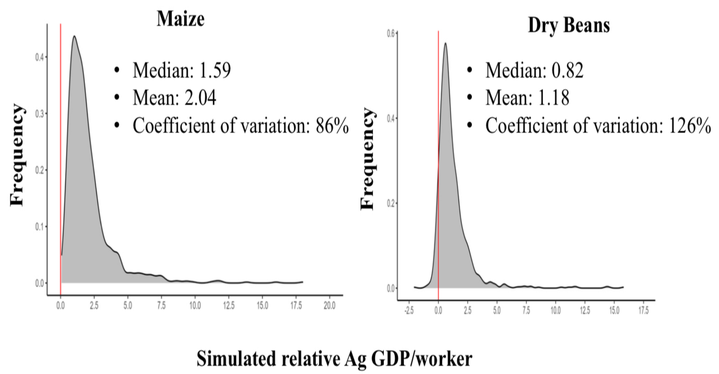


- Rightward shift in purchased factor supply curve ✓
- Increased effective supply, lower cost of purchased factors ✓
- Rightward shift in commodity supply curve ✓
- Increased commodity supply, lower commodity price ✓
- Higher demand price for farm-owned factors or lower demand price?

A prototype empirical EDM developed for illustration and to guide future development

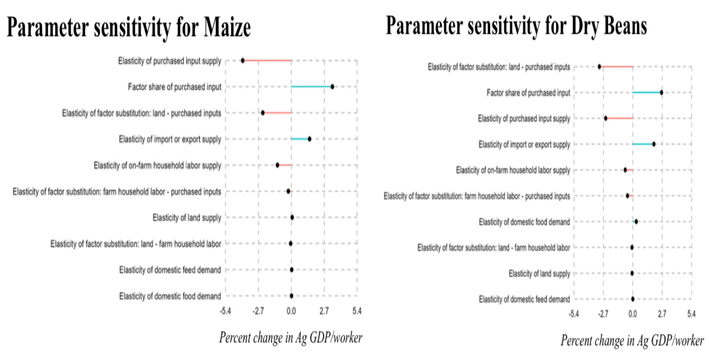
- A three-factor (land, labor, and purchased) (CES) production function.
- Factor demand equations as functions of production function parameters.
- Factor supply equations as functions of own price and elasticities.
- Food and feed demand, each function of domestic price and elasticities.
- Endogenous imports as functions of domestic price and trade elasticities.
- Mexico EDM for Maize and Dry Beans is initialized using historical data as a base.

Farm Income Impacts - Monte Carlo Analysis



- 'Reasonable' parameter ranges guided by results from previous studies
- Repeated simulations of 10% productivity impact on AgGDP/worker (to indicate impact on farm income)
- Each such simulation using a random draw of parameter values (1000 draws) from their respective reasonable ranges
- Assumes draws are from uniform distributions of reasonable ranges of parameter values

Testing Parameter Sensitivity



- Repeated simulations of 10% productivity impact
- Each one uses either the max or min value of just one parameter from the range
- Results rank ordered by magnitude of impact (+ or -)
- Elasticities of substitution, purchased factor supply share rank high.
- Trade elasticities are the fourth most important for maize, the third most important for dry beans.

Conclusion

- Yes, an increase in purchased factor productivity can cause farm income to increase!
- We obtain non-trivial average positive impacts for both Mexican maize and dry beans
- Positive impacts are narrowly distributed using the best-guess parameter ranges
- No non-negative impacts for maize, only a few for dry beans
- Pessimistic views about the productivity impacts on farm income are largely unsupported.