More on Production

Short Course on CGE Modeling, United Nations ESCAP

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Introduction

- We have assumed that the only inputs into production are primary factors.
- In real economies, a significant amount of demand for goods comes from other industries, i.e., intermediate input use.
- We can handle this with some modifications to the production structure.
- It is also common (but not universal) to assume that firm's engage in joint production, producing differentiated goods for domestic and foreign markets. This is very much like Armington.

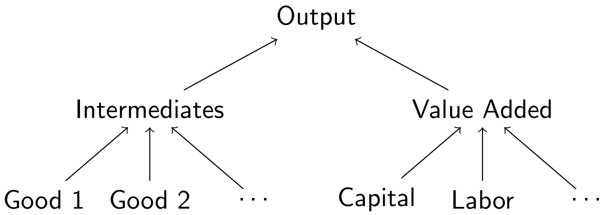
Intermediates

- To introduce intermediates to model, we need to make three basic adjustments.
- First, we need to allow for intermediate use in the production functions.
- Next, we need to solve the GDP maximization problem to generate factor and intermediate demands.
- Finally, we need to incorporate intermediate input use in the market clearing conditions.

Functional Forms

- The main issue in implementing intermediate goods in numerical models of production and trade relates not to the basic economics of the problem, but rather to the choice of functional form for the production function.
- We could use CES, but in most CGE models this approach is not adopted. The reason lies in the relatively restrictive assumptions of the CES form, of which Cobb-Douglas is a special case. In particular, this functional form assumes a common elasticity of substitution across inputs, implying that capital and labor are as substitutable with each other as, say, labor is with steel. This seems unlikely to be the case in practice.
- As a result it is common to use a 'nested' functional form.

Nested Functions



Fixed Proportions

- Fixed proportions (Leontief) technology is often used for intermediate goods.
- The min function is not differentiable. Hence, we can approximate it with a differentiable function (see next slide).
- Or, we can recognize that with Leontieff technology inputs will be used in fixed proportions to value-added (hence the name) and proceed accordingly.

Fixed Proportions

The production function will take the form:

$$q_i = \frac{\gamma_i}{1 - \sum_{\forall h \in \mathbf{I}} a_{hi}} \left[\sum_{\forall j \in \mathbf{J}} \delta_{ji} F_{ji}^{\rho_i} \right]^{\frac{1}{\rho_i}} \qquad \forall i \in \mathbf{I}$$

The net price equation is:

$$p_i^N = p_i - \sum_{\forall h \in \mathbf{I}} p_h a_{hi} \qquad \forall i \in \mathbf{I}$$

and the factor demand equations are:

$$r_j = p_i^N q_i \left[\sum_{\forall k \in \mathbf{J}} \delta_{ki} F_{ki}^{\rho_i} \right]^{-1} \delta_{ji} F_{ji}^{\rho_i - 1} \qquad \forall j \in \mathbf{J}, \forall i \in \mathbf{I}$$

Variable Proportions

- If we want variable proportions in intermediate use, we can specify three different CES functions, one for output, one for value-added, and one for intermediate use.
- Factor and intermediate demands can then be derived as usual.
- This is not as messy as it might seem. Remember, in GAMS there is no particular advantage to compressing the expressions.
- We can differentiate each function and apply the chain rule.
- Calibration of each CES function is the same as previous examples.
- By varying the elasticities, we can approximate the fixed proportions