Factor Intensity Versus Factor Substitution in a Specified General Equilibrium Model

Henry Thompson
Auburn University

Abstract

This paper examines the sensitivity of the comparative static elasticities of a general equilibrium model of production to factor intensity and factor substitution. A model of the US economy is specified with three factors and two goods. Changing factor endowments have consistently inelastic effects on factor prices. Prices of goods, however, have elastic effects on factor prices, and factor endowments have elastic effects on outputs. Factor intensity influences the comparative statics more than factor substitution. Under a move toward free trade characterized by a falling price of manufactures relative to services, the wage of unskilled labor falls while the wage of skilled labor and the price of capital rise.

I. Introduction

The interplay between factor intensity and factor substitution determines the direction and magnitude of comparative static adjustment in the general equilibrium economics of production. Quite a bit is known about the qualitative nature of general equilibrium models, but there is little intuition about the quantitative properties of comparative static elasticities.

* Correspondence Address: Department of Economics, Auburn University, AL 36849, U.S.A. (Tel.) 334-844-2910, (Fax) 334-844-9516, e-mail: hthompson@business.auburn.edu
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This paper specifies and examines the comparative statics of a three factor, two good \((3 \times 2)\) model of production and trade. Sensitivity of the comparative static elasticities to translog, Cobb-Douglas, constant elasticity, and complementary technologies is examined. Important insights emerge.

Elasticities of factor prices with respect to changing factor endowments are less than one in absolute value, and typically close to zero. This result is called near factor price equalization (NFPE). Globally, factor prices would be nearly equal across freely trading economies. Stolper-Samuelson and Rybczynski (SSR) elasticities, on the other hand, are typically much larger than one in absolute value. Furthermore, SSR elasticities depend almost entirely on factor intensity and are insensitive to the pattern of factor substitution or complementarity.

Characterizing the trend toward free trade in the US by a falling price of manufactures relative to business services, there will be income redistribution favoring skilled labor and capital over unskilled labor. Also, production patterns can be expected to vary substantially across countries under free trade, driven by international differences in factor endowments.

II. General Equilibrium Model of Production and Trade

The long run competitive model of production, summarized by Jones and Scheinkman [1977] and Chang [1979], assumes constant returns, full employment, nonjoint production, competitive pricing, cost minimization, and perfect factor mobility across sectors. The model is summarized by

\[
\begin{bmatrix}
\sigma & \lambda \\
\theta' & 0
\end{bmatrix}
\begin{bmatrix}
\dot{\tilde{w}} \\
\dot{\tilde{x}}
\end{bmatrix} = \begin{bmatrix}
\dot{\tilde{v}} \\
\dot{\tilde{p}}
\end{bmatrix},
\]

(1)

In the \(3 \times 2\) model, \(\sigma\) represents a \(3 \times 3\) matrix of aggregate price elasticities of factor demand. Factor shares in the \(3 \times 2\) matrix \(\theta\) represent the share of revenue in each sector paid to each factor. The \(3 \times 2\) matrix of industry shares \(\lambda\) represents the share of each factor employed in each sector. The variables are written in vectors: \(\tilde{w}\) represents endogenous factor prices, \(\tilde{x}\) endogenous outputs, \(\tilde{v}\) exogenous factor endowments, and \(\tilde{p}\) exogenous world prices of goods facing the economy. The \(\dot{\cdot}\) represents percentage changes.

The top equation in (1) comes from the full employment of the factors of