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Joint outputs and real wage rates

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Abstract

The magnification effect in standard international trade theory asserts that if the relative price of the labor-intensive commodity increases, the real wage will also increase, as will the wage/rental ratio. This result depends upon the assumption that both activities are nonjoint—each combining labor and capital to produce a single output, so that if activities are joint instead, the results are in jeopardy. It is shown that if the difference between the share of commodity one produced in the first activity and in the second activity exceeds the difference between the labor distributive shares in the first activity and the second, an increase in commodity 1's relative price raises the wage/rental ratio. The real wage unambiguously rises in this case if and only if the ratio of the commodity output shares in the two activities exceeds the ratio of labor shares.

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One of the standard pillars of the neoclassical theory of international trade is the Stolper and Samuelson (1941) Theorem, first expressed as the unambiguous improvement in the real wage rate of labor should a country that imports labor-intensive products raise a tariff that proves to be protective. It is well known, however, that a basic assumption about technology, namely, that each productive process consists of a pair of inputs but only a single commodity output, is standard in proving the theorem. It is this asymmetry between the number of commodities produced per activity (1) and the number of inputs (2) that supports the *magnification* result (Jones, 1965) that a change in relative commodity prices results in a

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more widespread change in factor returns. Hence, with a tariff on labor-intensive importables the wage rate will rise by more than any commodity price, thus yielding the unambiguous result on the real wage rate.

Will a touch of jointness in production invalidate the Stolper–Samuelson result? No. However, there are limits. In this note I show that a comparison is required between the extent to which factor input intensities differ between activities and the degree to which each activity yields different combinations of commodity outputs.

To obtain a more precise meaning of this comparison, consider the competitive profit equations of change representing equilibrium changes in a competitive setting for each of the two activities. If there were no joint production, cost minimization would ensure that the distributive factor share weighted average of the relative changes in factor prices of labor and capital (denoted by $\hat{w}$ and $\hat{r}$, respectively) would equal the relative change in the commodity price. With joint production, such an average must represent the relative change in the "price" per (arbitrary) standard unit of each activity. Denote these prices by q_i, and distributive factor shares by θ_{Li} and θ_{Ki}. As well, each activity produces outputs of the two commodities (call them 1 and 2). Now suppose there is a change in the prices of produced commodities, p_1 and p_2, perhaps because there is a disturbance to prevailing world prices. If both activities are active, this will change the price of each activity. In particular, suppose the relative price of the first commodity increases. As to intensity rankings, assume that the first activity is labor intensive relative to the second, and, as well, yields a higher proportion of the first commodity per unit of the second commodity than does the second activity. Following standard procedure (e.g., Jones, 1965), applied as well to the outputs produced by each activity,

$$\theta_{L1}\hat{w} + \theta_{K1}\hat{r} = \hat{q}_1 \tag{1}$$

$$\theta_{L2}\hat{w} + \theta_{K2}\hat{r} = \hat{q}_2 \tag{2}$$

And, letting α_{ij} denote the share that commodity i represents of the value of a unit of the jth activity,

$$\alpha_{11}\hat{p}_1 + \alpha_{21}\hat{p}_2 = \hat{q}_1 \tag{3}$$

$$\alpha_{12}\hat{p}_1 + \alpha_{22}\hat{p}_2 = \hat{q}_2 \tag{4}$$

It is standard procedure to subtract Eq. (2) from Eq. (1) to obtain Eq. (5):

$$(\hat{w} - \hat{r}) = \{1/|\theta|\}(\hat{q}_1 - \hat{q}_2), \tag{5}$$

where the determinant of coefficients, $|\theta|$, is equivalent either to $(\theta_{L1} - \theta_{L2})$ or $(\theta_{K2} - \theta_{K1})$. Since the first activity is assumed to be labor intensive, this determinant is a positive fraction. In similar fashion subtract Eq. (4) from Eq. (3) to obtain:

$$(\hat{p}_1 - \hat{p}_2) = \{1/|\alpha|\}(\hat{q}_1 - \hat{q}_2) \tag{6}$$

Once again, the determinant can be more simply expressed as the difference between the share of a commodity in the two activities. Thus, the determinant, $|\alpha|$, equals either $(\alpha_{11} - \alpha_{12})$ or $(\alpha_{22} - \alpha_{21})$, both positive fractions since the first activity is intensive in its output of the first