Specific Factors and Heckscher-Ohlin: An Intertemporal Blend

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Two of the standard "workhorse" models used in discussing competitive equilibrium in the pure theory of international trade are the Heckscher-Ohlin model and the Specific Factors Model. These models differ in the characteristic of capital, with the Heckscher-Ohlin model typically allowing capital to be mobile from sector to sector while the Specific Factors Model highlights the notion that the type of capital used in one sector is different from that used in others. Much of the literature concerning these models focuses on the low-dimensional examples: the simple *2x2* version for Heckscher-Ohlin (two mobile factors and two commodities) and the *3x2* version for the Specific Factor model (two sector-specific kinds of capital and a mobile labor force).[1] Whereas the specific factor view of production allows easy generalization to any number of productive activities, each using a specific form of capital as well as mobile labor (indeed the *(n+1)* x *n* model is basically no more difficult than the *3x2* version), generalizing the Heckscher-Ohlin model to the *nxn* version allows few comparative static results unless a great degree of structure is imposed. By contrast, the move in a Heckscher-Ohlin setting to a many-commodity case with only two factors is easy to make. Such a restriction has an enormous advantage in addition to ease of manipulation, because generally a country need not produce more commodities than it has factors. In the two-factor case this means a trading open economy will produce either a pair of commodities or a single best

[1] For a comparison of these core models see Jones (1971).

commodity (as in a Ricardian setting). This implies that if the number of commodities is large, an important question can be raised and answered: *which* commodities does a country produce in a competitive equilibrium.

A model in which a country only produces either a single commodity or a pair of commodities seems rather limited in allowing so little variety in production, whereas a specific factors model allows for a wider variety of productive activity. The purpose of this note is to suggest a *blend* of the two model settings that allows both the great degree of concentration that trade enforces when there is a limited number of factors as well as a wider degree of production reflecting past choices of productive activity. An intertemporal setting in which both specific factor and Heckscher-Ohlin models are blended has indeed become a staple in competitive trade theory, with the classic paper of J. Peter Neary (1978) showing how with the passage of time an initial free-trade equilibrium in a specific-factors setting can converge to a simple *2x2* longer run Heckscher-Ohlin equilibrium as time allows capital to lose some of its specificity (e.g. with depreciation and replacement to a common form of capital).[2] In a sense what I intend to do in this note is to proceed in the opposite direction – from Heckscher-Ohlin to specific factors instead of the other way around. The basic ideas relate back to those of the "putty-clay" literature (e.g. Leif Johansen, 1959 or Robert Solow, 1962).

Start by considering the situation of a small open economy facing given world prices for commodities traded on world markets, utilizing its own technology (not necessarily

[2] The middle-products setting in Sanyal and Jones (1982) allows specific types of capital to be exchanged for other forms via international trade instead of requiring the passage of time to accomplish the transformation.

the same as that of other trading countries). The country possesses a homogeneous labor force that is mobile among sectors. To simplify I assume first that a given quantity of labor is set aside each period to produce a putty-like quantity of capital (that can then be applied to whatever traded sector is desired). The remaining quantity of labor (fixed in amount unless attention is focused on changing the amount of "investment" over time) can be employed in a combination of (i) producing the best single commodity or pair of commodities at this period's world prices, converting the currently available putty-like capital to a "clay-like" form specific to the relevant sector(s), and (ii) producing a number of other commodities that each have available sector-specific capital that was in a previous period the best selection given world prices in that period.

These basic ideas are captured in Figures 1 and 2. Figure 1 illustrates, for a case of four commodities, the concept of a Hicksian composite unit-value isoquant, making use of isoquants that show for each commodity the quantities of capital and labor (the "H" subscripts refer to Hicks) that can produce a single dollar's worth of that commodity given world prices and the country's own technology. The convex Hicksian locus suggests minimal amounts of capital and labor required to earn a dollar, and in the three (shaded) "cones of diversification" shown, this minimum must entail producing a mixture of two commodities, in which case the wage/rental ratio is determined (in this *2x2* setting) by the slope of the chord tangent to the pair of isoquants. (This is the standard result in *2x2* models in which commodity prices uniquely determine factor returns). The model specifies arbitrarily the quantity of (putty-like) capital that can be used with labor to produce the traded commodity (or pair of commodities) that are the best this

period. What has yet to be determined is the quantity of labor assigned to producing these commodities.

Figure 2 focuses on the demand for labor in the "Hicksian" sector as well as the demand for labor from other sectors of the economy in which sector-specific capital stocks are available from past periods (denoted by the L_S-curve relative to the O_S-origin). The total supply of labor available to produce this period's best choice of traded good(s) as well as labor available to produce other commodities in sectors that have specific capital is shown by the horizontal distance between the two origins, O_H and O_S.[3] In Figure 2 an equilibrium wage rate, w*, is determined in which a pair of commodities in the H-sector is produced, say commodities *k* and *(k+1)*, representing the best use of putty-like capital.[4] Indeed, part of this capital is fashioned into the kind appropriate for sector *k* and part for the kind appropriate for sector *(k+1)*. In addition, some labor (illustrated by the distance between O_S and point *A*) is devoted to the sector or sectors that have sector-specific capital stocks obtained in previous periods in which they represented the optimal use for which putty-like capital was transformed into clay-like sector-specific capital. The L_S-curve is smoothly downward-sloping; given world prices for commodities produced with these capitals, in each sector an announced wage rate dictates a unique demand for labor, and the L_S-curve adds these up. The return to sector-specific capital in each such sector will be lower than that obtainable for the best use of the current period's supply of putty-like capital. In contrast, the demand curve, L_H, is a

[3] Figure 2's horizontal axis shows the economy's total labor supply net of that required to produce the current period's putty-like capital.
[4] Alternatively, the L_S curve might have intersected the L_H demand curve at a point in which only one new commodity is produced.

step-function, with flats corresponding to regions in which it is optimal to produce a pair of commodities. Once the quantity of labor devoted to the "H" sector is determined, in Figure 2, the capital/labor ratio devoted to this sector is shown by the appropriate ray from the origin in Figure 1.

What emerges as an equilibrium in the current period reflects this blend of Heckscher-Ohlin properties for the *2xn* case and the Specific-Factors properties for commodities that can still be produced as long as returns to sector-specific capital are positive, although these returns may well be less than were originally obtained when world commodity prices were different. The Heckscher-Ohlin component reveals the strong tendency of international trade to encourage a convergence of newly produced capital into the commodity (or pair of commodities) in which the country has the greatest revealed comparative advantage, and the Specific-Factors component allows production of previous period winners in sectors that have specific capitals that still earn a positive return given this period's world prices for commodities and the endogenously-determined local wage rate. Of course if such returns become low enough or negative in certain sectors, production will cease and such capital scrapped.

The analogy of this setting with the earlier models of vintage capital is close but not exact. There it was technical progress that introduced variety in the kinds of capital that would be utilized in producing a particular commodity, with older capital eventually being scrapped as its return ceases to be positive. In the present setting capitals differ from each other not because of technical progress but because the kind of capital used to

produce one commodity differs from that used to produce another. In each period new capital is made available by production, but its form is appropriate to that sector (or pair of sectors) that at that period's world prices would yield the highest return to capital. (Of course the commodity or commodities that attract newly produced capital might also have been selected in the past, so that if technical progress is taking place, more than one vintage of capital could be working with labor to produce these commodities). As world prices change, so does the economy's optimal choice.[5] If capital were mobile between sectors, production of commodities that are no longer optimal would cease. By blending in aspects of the specific-factors model, a greater array of current production is allowed, reflecting echoes of past periods.

If world relative commodity prices change randomly from period to period, some of the capital/labor ratios utilized in sectors no longer representing the optimum would be greater than the current best use, while other capital/labor ratios would be lower. By contrast, suppose the amount of putty-like capital available each period grows, or that such capital becomes steadily more productive in all uses. In such a case the "echo" represented by those sectors that are no longer optimal would tend to reflect capital/labor ratios lower than those used currently in the best sector or sectors. Thus the total array of a trading economy's production not only reflects the current state of comparative advantage but also reveals some aspects of the setting in previous periods by the comparison between returns to capital and capital/labor ratios used earlier.

[5] Technical progress of the kind reflected in improvements in the productivity of (putty-like) capital can easily be introduced. This best-vintage capital would only be found in production of the good(s) currently produced.

More formal extensions of this hybrid model can be developed, especially if, say, savings behavior (both locally and in the form of foreign investment) dictates a growth of current supply of capital that can be put into the best form given world prices. The object of the present paper, however, is to suggest a blend of the simple two-factor, many commodity Heckscher-Ohlin model for determining best use of currently available capital and the standard Specific Factors model in the many-commodity case for determining labor demand in sectors still viable but not yielding returns to capital as great as to capital currently produced. Such a blend allows the forces of trade greatly to concentrate the use of new capital to a small number of commodities while allowing the country's labor force as well to maintain production of commodities that would not represent best allocation of capital and labor at current period commodity prices.

References:

Johansen, Leif (1959): "Substitution versus Fixed Production Coefficients in the Theory of Economic Growth: A Synthesis," *Econometrica*, 27, pp. 157-76.

Jones, Ronald W. (1971): "A Three Factor Model in Theory, Trade and History," ch. 1 in J. Bhagwati, R. Jones, R. Mundell and J. Vanek (eds.): *Trade, Balance of Payments and Growth,* (Amsterdam, North-Holland).

Neary, J. Peter (1978): "Short-run Capital Specificity and the Pure Theory of International Trade," *Economic Journal* v. 88, pp. 488-510.

Sanyal, Kalyan and Ronald W. Jones (1982): "The Theory of Trade in Middle Products," *American Economic Review*, v. 72, pp. 16-31.

Solow, Robert M. (1962): "Substitution and Fixed Proportions in the Theory of Capital," *Review of Economic Studies*, v. 29, pp. 207-18.

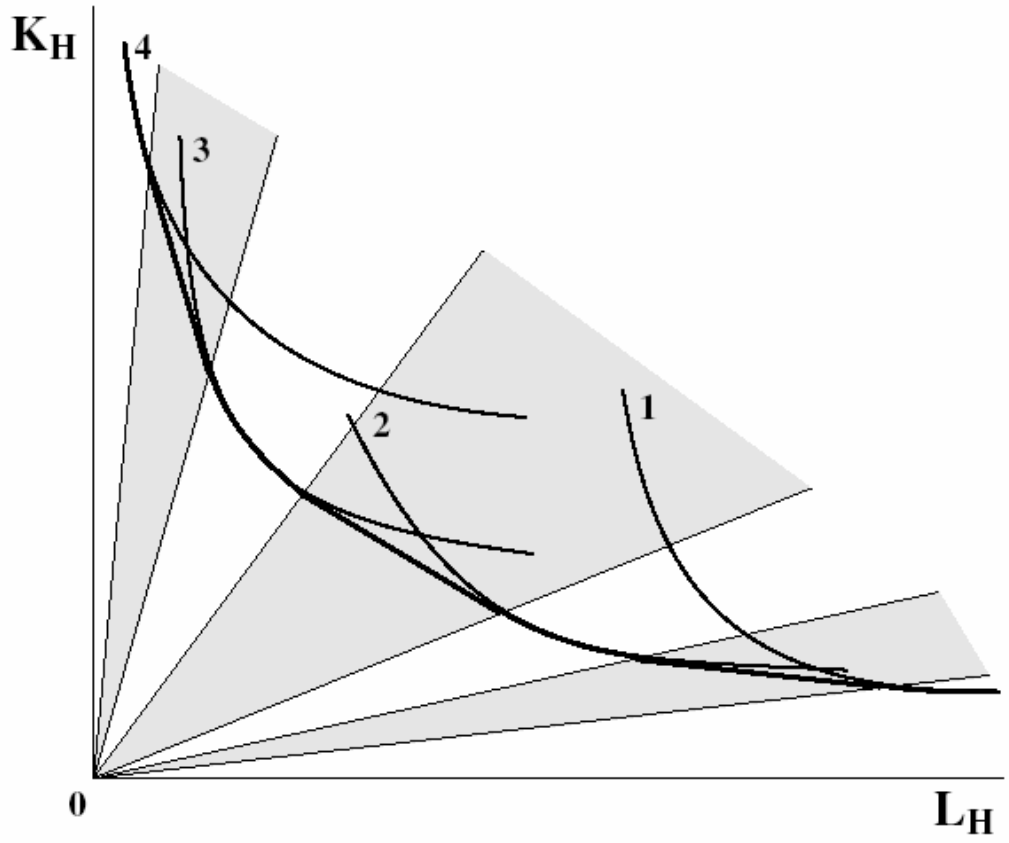

Figure 1: Hicksian Cones of Diversification

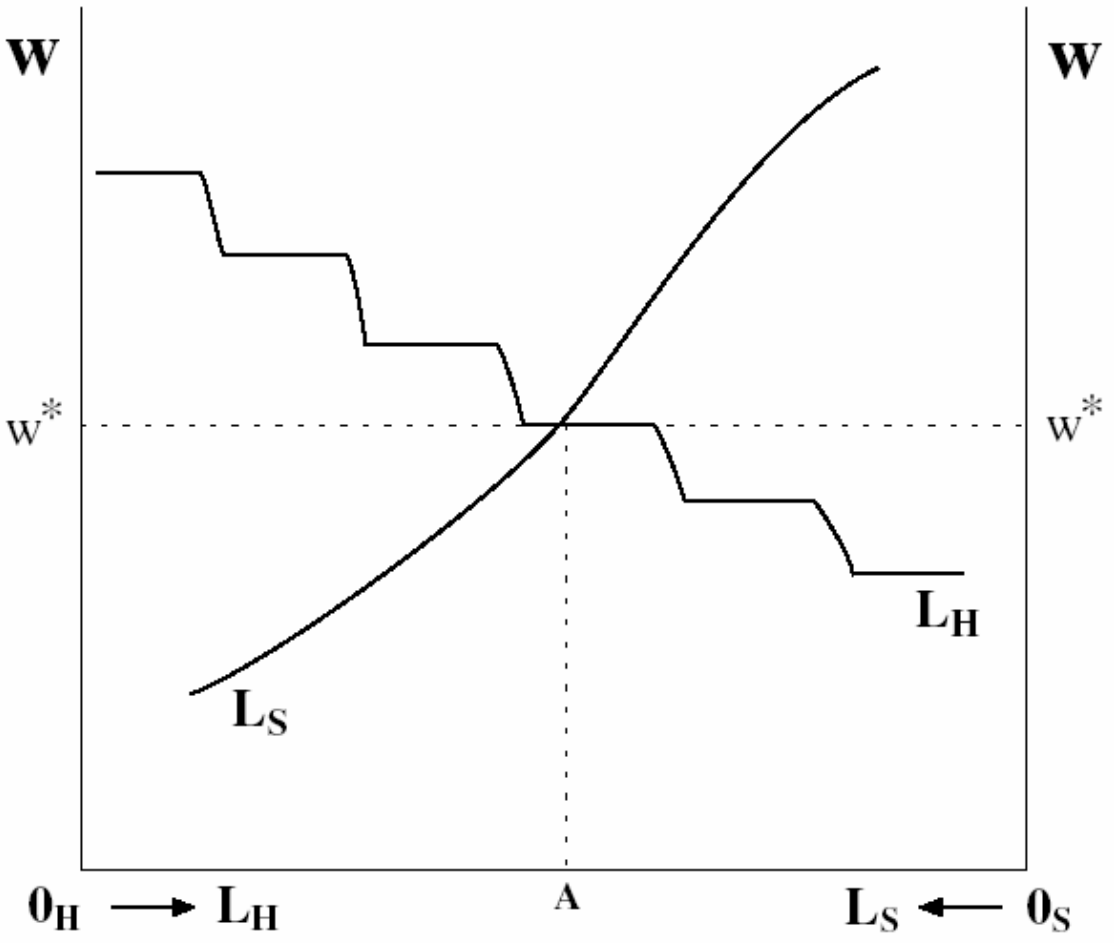

Figure 2: Equilibrium Wage Rate