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MICRO CONVERGENCE AND MACRO CONVERGENCE: FACTOR PRICE EQUALIZATION AND PER CAPITA INCOME

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Abstract. Factor price equalization implies the equality of prices of the same productive factors across countries owing to free trade. The present paper examines the relationship between factor price equalization and the equality of per capita (per worker) incomes in the contexts of the static Heckscher–Ohlin trade model and the dynamic two-sector neoclassical growth model. Factor price equalization is shown to be neither necessary nor sufficient for equality of per capita incomes across trading countries.

1. INTRODUCTION

A substantial literature has emerged showing a correlation between convergence of per capita income (macro convergence) and international trade. A separate literature shows a correlation between convergence of factor prices (micro convergence) and international trade. The relationship between the two types of convergence, however, is rarely noted in the literature. This paper explores the relationship.

The factor price equalization (FPE) theorem provides the foundation for micro convergence while the neoclassical growth model predicts macro convergence. Suppose that trade between two countries becomes free and the FPE mechanism equalizes wages. Whether per capita (per worker) incomes also equalize depends on relative per capita resource endowments. In a two-sector growth model which leads to factor price equalization, per capita incomes across trading partners might well diverge with free trade.

2. MACRO CONVERGENCE

Elmslie (1994, 1995) traces the debate over trade and macro convergence to the writings of David Hume and Adam Smith. Hume believed in a tendency towards international convergence owing to a transfer of technology from more

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advanced to less advanced economies. Smith argued that trade between a rich and a poor country, although mutually beneficial, tends to widen the gap in per capita incomes.

In Smith's model, the rich country exports manufactured goods and imports agricultural goods. If productivity in manufacturing rises faster than in agriculture, the rich country increases its lead. Smith contended that improvements in manufacturing productivity spill over to increase productivity in agriculture. He also believed that trade with a developed country (DC) might eliminate the manufacturing sector in a less developed country (LDC) and remove a potential source to improve productivity in agriculture. International trade could perpetuate and even widen the gap between an LDC and a DC, even though the LDC benefits from trade.

A number of development economists have echoed Smith's contention regarding the role of international trade in development. Myrdal (1956, p. 386) argued that international trade can lead to greater income inequality between the rich and poor countries. If trade results in specialization in primary products, wages would remain low because of an almost unlimited supply of unskilled labor. Myrdal believed trade could have "backsetting effects" which result in stagnation and greater international inequalities in per capita incomes. Growth theorists have recently built models in which international trade keeps poor countries poor forever. For example, Stokey (1991) presents a model in which LDCs produce low-quality goods to exchange for high-quality goods from DCs. In such a setting, although both countries benefit from free trade, the LDCs can never catch up because importing high-quality goods deprives them of the advantage of learning by doing.

Young (1991) builds a model in which a large enough initial technical gap between the DCs and LDCs prohibits the LDCs from ever catching up with the DCs. Young assumes that spillovers of learning by doing increase productivity symmetrically across the economy. Rates of technical progress in the LDCs will then never exceed those in the DCs, and the disparity persists. Young's model retains the static gains from trade, but maintains that free trade reduces the growth rate of LDCs because the benefits of learning by doing spill over across goods, but not across countries.

Empirical studies have found that international trade has contributed to macro convergence among developed countries in the postwar era. Ben-David (1993) studies the contribution of trade to macro convergence in the European Union, and Rassekh (1992) in the OECD countries. Dollar and Wolff (1993) document the convergence of aggregate capital–labor ratios among advanced countries, suggesting a waning role of differences in their capital and labor endowments in international trade. Dollar and Wolff also find substantial micro convergence among these countries.

The debate over international convergence has been intensified since Abramovitz (1986) echoed Hume's contention regarding technology transfer and revived Gerschenkron's (1952) "advantage of backwardness." There has been a substantial amount of writing on the theoretical, empirical, and historical aspects of convergence. A consensus has emerged that if a lagging

country can use the technology of a leading country, backwardness carries the potential for faster growth and convergence. Sachs and Warner (1995) show that policies aimed at reducing trade barriers and protecting property rights significantly contribute to observed macro convergence. The question remains how this literature relates to the micro foundation of trade and factor price equalization.

3. MICRO CONVERGENCE

Heckscher (1919) examined how international trade influences factor prices. In the context of a model with more than a single factor, Heckscher argued that free trade leads to the equality of factor prices across countries. Ohlin (1933) elaborated on this theory and argued there would be only partial equalization. Samuelson (1948) and Lerner (1952) developed the competitive two-factor, two-good model of production for a small open economy in which international trade leads to factor price equalization, the complete equality of the same factor prices across countries.

In the static model with two factors and two goods, the two trading countries are assumed to differ only in factor endowments. With identical preferences and production functions, each country exports the good using its abundant factor intensively. International trade increases each country's demand for its relatively abundant and cheap factor, and decreases demand for its relatively scarce and expensive factor. Trade shifts factor demands, completely eliminating disparity in the return to the same factor across countries. The FPE theorem is demonstrated with two traded goods and two internationally immobile factors, and follows in economies with many factors and many goods when the number of productive factors equals the number of exogenous prices or international markets. The literature examines how various assumptions and market structures affect FPE.

Whether international trade can be expected to equalize factor prices in practice has long been debated. The view is emerging that we might not expect complete *equality* of factor prices, but a *convergence* as trade barriers fall. Dollar and Wolff (1993) present a thorough empirical analysis of micro convergence. For a survey of the theoretical and empirical works on factor price equalization and convergence, see Rassekh and Thompson (1993).

4. THE STATIC LINK BETWEEN MICRO CONVERGENCE AND MACRO CONVERGENCE

Consider the following identity of national income (Y) as the sum of the products of n factor endowments (V_i) and their prices (w_i):

$$Y \equiv \sum_i w_i V_i, \quad i = 1, 2, \ldots, n. \tag{1}$$

Suppose the labor force (L) equals the population. Divide both sides of (1) by

L to obtain per capita income (y) as a function of per capita endowments (v_i):

$$y = \sum_i w_i v_i. \tag{2}$$

Let * denote the foreign country. Under FPE, $w_i = w_i^* = w_i^e$, where w_i^e is the equalized factor price across countries. For ease of presentation, rescale each factor so $w_i^e = 1$. The difference between y and y^* under FPE depends only on per capita factor endowments:

$$y - y^* = \sum_i (v_i - v_i^*). \tag{3}$$

Per capita incomes will be equal if and only if $\Sigma_i(v_i - v_i^*) = 0$. In the two-factor model with capital (K) and labor (L) inputs, $y = w + rk$, where w is the wage, r is capital rent, and k is the endowment of capital relative to labor. In the two-factor model $y = y^*$ if and only if $k = k^*$. The two trading countries will have equal per capita incomes if and only if their ratios of capital to labor are identical.

Suppose that endowments of the two countries remain within the cone of diversification defined by the capital-to-labor ratios in each sector. Free trade equalizes prices of both factors across countries, but would lead to equal per capita incomes only if the endowment ratios of the two countries happened to be identical. Proportional endowments would imply proportional outputs, and only differences in preferences could cause trade. In the standard factor proportions model, free trade does not lead to equal per capita income because factor endowments are assumed to be different between the trading countries.

Consider a third factor of production, natural resources N, with price n. Let η be the ratio of natural resources to labor, N/L. From (3), given FPE, $y - y^* = (\eta - \eta^*) + (k - k^*)$. If $\eta > \eta^*$, then y can equal y^* only if $k^* > k$. If one country is poor in natural resources, equality of per capita incomes cannot occur with free trade unless this country is rich in capital. Per capita incomes will only equalize under FPE if $\Sigma(v_i - v_i^*) = 0$. To catch up with a rich country, a poor country would have to accumulate at least one non-labor factor per worker to exceed the rich country. Free trade alone will not be enough.

As a corollary, begin in autarky with two countries that have unequal factor prices but equal per capita income. International trade then leads to FPE and macro *divergence*. Free trade remains the optimal policy as gauged by the expansion in real income. Public policy could redistribute the gains from trade among the factors of production.

The possibility that one country may possess more of every productive factor per capita is consistent with the FPE result that maintains that differences in relative factor endowments drive international trade. In the model with three factors, three goods, and FPE, suppose the ratio of capital to natural resources γ is smaller in the home country, $\gamma < \gamma^*$. The foreign country is then "capital rich" (relative to natural resources) and may export goods that are "capital intensive" (relative to natural resources). The home country may, however,

have more capital on a per capita basis than the foreign country, $k > k^*$. Various trade patterns in the three goods can arise between the two countries. With as few as three factors, adjustment in factor prices to the changing output prices with trade has various potential sign patterns. The price of a given factor across countries may polarize, depending on conditions of factor intensity and substitution as pointed out by Thompson (1987). The point of this section is that equality of per capita income would require a relative abundance of some factor on a per capita basis, a property that could have important policy implications.

5. FPE AND THE TWO-SECTOR NEOCLASSICAL GROWTH MODEL

The two-sector neoclassical growth model provides the dynamic framework to examine micro convergence and macro convergence. Each economy approaches its own steady state level of income per worker determined by its savings rate, depreciation rate, and population growth rate. Two countries will have equal incomes in the steady-state if they share the same determinants of steady-state income. Technology is assumed to be the same across the two countries. For a clear presentation, see Barro and Sala-i-Martin (1995).

Convergence of incomes could occur in autarky. If the capital–labor ratio of one country begins relatively low with the implied relatively high marginal productivity of capital, it would grow faster than another. The lower initial level of capital implies faster capital accumulation and faster income growth. International mobility of capital and labor would expedite convergence, moving resources from the abundant to the scarce country. Several empirical studies strongly support this convergence hypothesis, including Mankiw *et al.* (1992).

The neoclassical growth model can be directly integrated with the FPE model when two inputs, capital and labor, are used to produce two goods, consumer goods and investment goods. The following presentation is based on the model of growth and trade in a two-factor, two-good, two-country world developed by Oniki and Uzawa (1965). Other contributions include Takayama (1963), Vanek (1971), Stiglitz (1970), Deardorff (1973), and Grossman and Helpman (1991).

Suppose that capital (K) and labor (L) are used to produce a consumption good (C) and an investment good (I), so $Y_j = F_j(K_j, L_j)$, $j = \mathrm{I}, \mathrm{C}$. Assume neoclassical production functions, competitive markets, and full employment. Let δ denote the depreciation rate. With dots ($\cdot$) representing derivatives with respect to time, the evolution of K in the home country is described as $\dot{K} = Y_\mathrm{I} - \delta K$. The exogenous growth rate of labor is $\dot{L}/L = n$. The phase line of such an economy is

$$\dot{k} = (L\dot{K} - K\dot{L})/L^2 = \dot{K}/L - kn = (Y_\mathrm{I} - \delta K)/L - kn = y_\mathrm{I} - (\delta + n)k \qquad (4)$$

where y_I is per capita output of the investment good. In autarky, saving equals investment, $sY/p = Y_\mathrm{I}$, where s is the savings rate and p is the relative price of the investment good $P_\mathrm{I}/P_\mathrm{C}$. Output in terms of the consumer good is $Y_\mathrm{C} = Y + pY_\mathrm{I}$.

Let y represent total output per worker. Saving equals investment in autarky, $sy/p = y_1$. From (4):

$$\dot{k} = sy/p - (\delta + n)k. \tag{5}$$

In the autarky steady state $\dot{k} = 0$, which implies $k = sy/p(\delta + n)$ or

$$p = sy/k(\delta + n). \tag{6}$$

From (2), $dy = dw + kdr + rdk$. The envelope result for maximized national income implies $Ldw + Kdr = 0$, or $dw + kdr = 0$. It follows that $dy = rdk$, a higher k implying a higher y.

Cost-minimizing behavior and free factor mobility across sectors lead to the first-order condition in each sector, $\omega \equiv w/r = F_{jL}/F_{jK}$, where F_{ji} represents the marginal product of factor i in sector j. Owing to the homogeneity of the production functions, the output in sector j can be written $y_j = L_j f_j(k_j)$, and $\omega = (f_j - k_j f_j')/f_j'$. An increase in ω raises k_j in each sector, given positive and decreasing marginal productivity, as shown in the top of figure 1. The

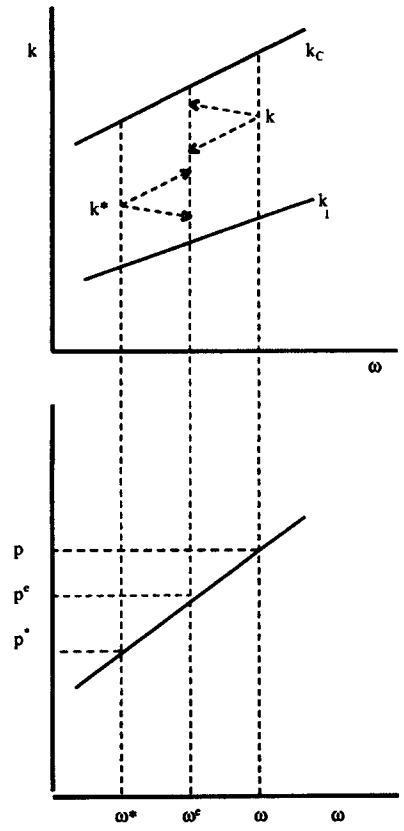

Figure 1