Capital-Intensity Hypothesis and Factor Price Equalization Theorem: Intriguing Relationship?

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ABSTRACT

Predicated upon a 2x2x2 model of general equilibrium, this paper shows conditions under which the so-called factor price equalization theorem may not hold. Consider a developing nation with a strong propensity to save and accumulate capital on one hand and a developed country that can afford specializing in consumption on the other hand. If the consumption good sector is more capital-intensive than the investment sector, then free trade can lower the developing nation's wage rate while increasing the developed nation's wage rate. The assumed conditions are all empirically plausible. And if the outcome sounds surprising, it deserves theoretical scrutiny.

Key Words:
2x2x2 general equilibrium, capital intensity, factor price equalization, trade, capital-rich *versus* -poor countries

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Introduction

The so-called factor price equalization theorem states that real factor incomes such as wage rates tend to equalize among nations after trade, if not before trade. This well-known theorem in trade theory may not hold water if the less well-known hypothesis on certain particular technological conditions holds true. This latter hypo is called in macro growth theory the capital-intensity hypothesis. (E. g., R.M. Solow, 1956; Y Shinkai, 1960.) It assumes two sectors of production, and states that stable economic growth requires, though not necessarily, the consumption good sector to be more capital intensive than the investment good sector. This condition has recently been confirmed empirically by H. Takahashi, *et. al*. (2012) utilizing data from the IO tables of the OECD countries, H. Kawano, *et. al*. (2009, 2012) within the confines of the 2-sector, 2-factor model of applied general equilibrium.

This paper challenges the well-known factor price equalization theorem on the basis of an empirically plausible condition, albeit less known, on capital intensities in consumption and investment sectors. To be shown in particular is that if a rich developed nation endowed with large capital and a poor developing country endowed with small capital trade their products, then their real factor prices may tend to diverge rather than converge.

The crucial conditions required for such a startling outcome other than the capital-intensity hypothesis aforementioned are that the developing nation being capital-poor has a strong taste for investment goods, and the developed capital-rich nation happily specializes in consumption. *The poor stay hungry, and the rich foolish. Isn't it cool and realistic?*

Background

Almost a decade ago a trilateral round of international trade conferences was inaugurated in Tokyo in March 2004, followed by the subsequent ones in Hong Kong and Taipei consecutively. Since then I have kept revisiting my past contributions to this international venture of *trilateral monopoly* in effect. In order to reveal certain moral scientific nature of the well-known Stolper-Samuelson theorem and the related less well-known proposal to 'bribe' for free trade, my initial paper assumed two identical countries, identically endowed with homogeneous labor and capital (two factors) but with internationally different tastes. Pursuant to these basic assumptions I presented a simple account of the Stolper-Samuelson theory in a simple 2x2x2 general equilibrium framework. The next paper presented in Hong Kong in 2005 examined the orthodox

HO model with the H.O. (H. Ohta's, 2005) heretical ideas on taste differentials in addition to HO's ideas on different endowments. The 2005 workshop in Hong Kong in turn inspired Ohta to ponder on Ronald Jones and Roy Ruffin (2005; Ruffin & Jones, 2007) discussing their "technology transfer paradox" along with some other seeming paradoxes in trade theory in a subsequent workshop in Taipei in 2006. Part of it has been further elaborated with Hiro Nakagawa (2008). The more recent H. O. papers (2009, 2011, 2012) are getting increasingly more directly focused on a **bitter maxim** of free trade that the Stolper-Samuelson theorem revealed.

With these prior inquiries in the background the present paper goes beyond the static model of general equilibrium of production and exchange by incorporating in it capital formation and economic growth. It shows conditions under which how factor prices, product prices, and sectoral factor intensities may be related to the stages of capital accumulation or economic development. Given that the bitter maxim of free trade is an inconvenient truth despite the factor price *equalization* theorem, we may have to reluctantly admit that the bitterness intensifies all the more if and when the rosy theorem is reversed.

In what follows Section 1 reviews the basic 2x2 general equilibrium model of two clone nations with no growth, nor trade. The model for a representative clone country is presented using just one CD parameter to represent both technology and taste. Section 2 in turn presents a 2x2x2 by 1 CD parameter model of two contrasting nations with asymmetric national tastes before and after trade to examine what impact free trade may have on factor prices as well as commodity prices. We confirm the orthodox outcomes of free trade and the related factor-price equalization theorem. Section 3 then introduces growth, asymmetric growth in particular, to see what happens to factor prices between the trading nations. The question is if factor price equalization will be achieved. The answer is no, we find. Moreover, we show that factor prices that may be equal before trade will necessarily diverge after trade. Section 4 concludes. Appendix replaces the CD with CES production functions to revisit previous analysis of growth impact on factor prices, with a passing note on the present pension program.

Section 1. The 2x2 GE Model of Clone Economies before Asymmetric Growth and Trade

Consider an autarky economy endowed with fixed amounts of two factors, say, labor and capital. For simplicity we further assume the same numbers of clone workers and capitalists who own identical units of capital individually. Both capital and labor are normalized to be unity. These factors of production are used to produce consumption goods and investment goods under conditions of constant returns to scale. For simplicity, though not needed, the production

functions are assumed to be of Cobb-Douglas type:

The Consumption Good Sector: $C = f(K_C, L_C) = K_C^{\alpha} L_C^{(1-\alpha)}$

The Investment Good Sector: $I = g(K_I, L_I) = K_I^{(1-\alpha)} L_I^{\alpha}$

where I stands for investment, C for consumption, and $f(\ )$, $g(\ )$ are production functions for C and I, which are functions of capital and labor in Sectors C and I respectively. It is important to note that α above represents 'output elasticity' of capital in the C sector and also 'output elasticity' of labor in the sector I. This is a deliberate contrivance for analytical simplicity to differentiate the two sectors' methods of production by a single parameter α, to be more fully explained later.

Pursuant to these assumptions the following optimization problems and equilibrium conditions are to be introduced.

Consumptive Optimum:

$U_1 (I, C)/p = U_2(I, C)$ (1)

where U_1 is one's MU of the first good or investment I, U_2 MU of the second good or consumption, and p is the relative price of investment goods in terms of consumption goods assumed as *numeraire*.

Individual Budget Constraints:

$w = pI_L + C_L$

$r = pI_K + C_K$, (2), (3)

Productive Optimum:

$w/r = f_2/f_1 = g_2/g_1$, (4), (5)

where w is wage rate, r rent on capital, respectively in terms of consumption goods, f_1 (or g_1) is marginal product of capital in the C sector (or I sector), f_2 $(= f(k_I, 1) - k_I f_1(k_I, 1)) = \phi(k_I)$ is marginal product of labor in the I sector, which is a function of capital/labor ratio or capital intensity in the I sector, and g_2 $(= g(k_C, 1) - k_C g_1(k_C, 1)) = \gamma(k_C)$ is marginal product of labor in the C sector, which is a function of capital/labor ratio or capital intensity in the C sector.

Factor Market Equilibrium:

$K_I + K_C = 1$ (6)

$L_I + L_C = 1$ (7)

Product Market Equilibrium:

$I = f(K_I, L_I)$ (8)

$C = g(K_C, L_C)$ (9)

Walras' Law:

$pI + C = w + r$ (10)

The following observations on the properties of the production functions are important.

1) When $\alpha = 1/2$: The two production functions are identical.
2) When $\alpha > 1/2$ ($\alpha < 1/2$): The consumption sector C is capital intensive, and the investment sector I is labor intensive. (The I sector is capital intensive, and the C sector is labor intensive.)
3) The larger the parameter α (exceeding 1/2), the higher the capital intensity of the capital-intensive C sector is, and the higher the labor intensity of the I sector by comparison, and *vice versa*. [*That is*: The lower the α (below 1/2), the higher the labor intensity of the labor-intensive C sector.]

Equi-MRTS (of *L* for *K*) for Optimal Resource Allocation

Focusing on autarky, the following optimization conditions are to be observed along a contract curve, which is concave (when $\alpha > 1/2$) or convex (when $\alpha < 1/2$).

$(-dK_I/dL_I) = ((1-\alpha)/\alpha)(K_I/L_I) = (-dK_C/dL_C) = (\alpha/(1-\alpha))(K_C/L_C)$

This combined with the conditions of a given endowment of L and K, which are assumed both to be unity, yields a unique relation between K_C and L_C (or K_I and L_I).

$$K_C = \frac{1}{(\frac{1}{L_C} - 1)(\frac{1-\alpha}{\alpha})^2 + 1} \qquad (K = L = 1)$$

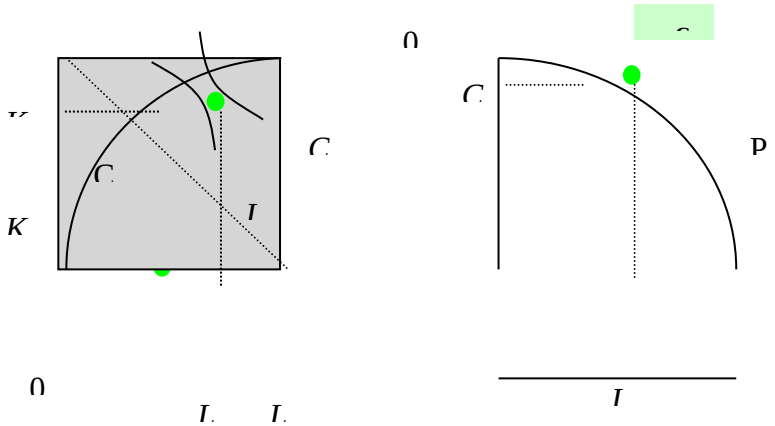

Figure 1. Given α, Arbitrary L_I Determines K_I, Hence

Figure 1 illustrates an autarkic equilibrium, labeled E^{CCA}, for a clone country **CC**, and it is straightforward to plot the counterpart equilibrium for another clone country **CI** to take place on both the conflict curve CC on the left and the production possibilities frontier on the right hand

side of the Figure. Before trade the country **CC** produce and consume more consumption goods than the **CI** do. It goes without saying that the workers in the **CC**, before trade, are poorer than their capitalist neighbors. Not only are the **CC** workers poorer than the **CC** capitalists, but also they are poorer than the workers in the **CI**. The workers in the **CI**, by comparison, are richer than not only their domestic capitalists, but also the **CC** workers abroad.

These observations are made on Figure 2 below by comparing a square point with a triangular point along the concave conflict curve on the left. Note in particular that wage rate given by factor allocation identified at the triangular point must be strictly greater than unity and hence greater that at the square point, which is required to be strictly less than unity. Associated with this particular wage rate of unity is a circular point at which MRTS is required to be unity. Not only wage rate or relative factor is required to be unity at this point, but also so is relative product price identified at a circular point on the production possibility frontier on the right.

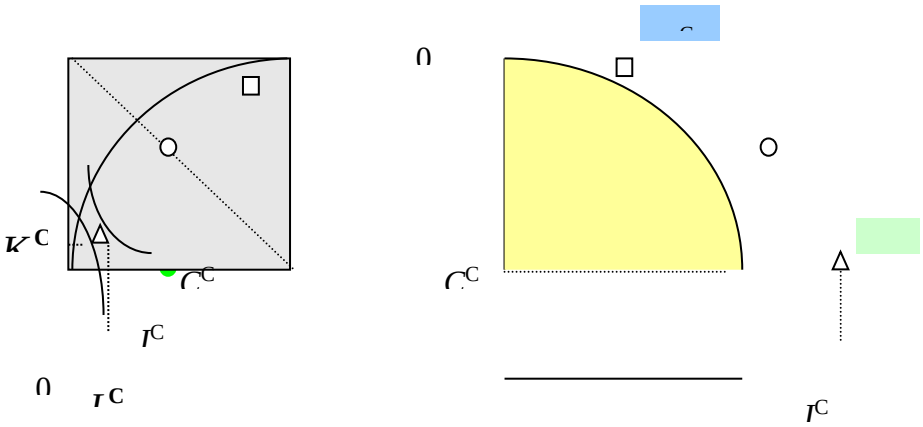

Figure 2. Alternative Resource Allocations and

Underlying the diagram above is a more formal 2-sector, 2-factor, 2-country model of general equilibrium of production, trade, and consumption. A simple 2x2x2 CGE representation of the model is readily available subject to the basic theoretical requirements such as variable proportions and linear homogeneity to be demonstrated below in Section 2 more fully.

Section 2. 2x2x2 GE of Clone Economies with Hetero-National Tastes before/after Trade

Suppose that the two identically endowed countries have two sectors of production to produce consumption goods (or a basket of both nuts and bananas) and investment goods (rather than bananas) using the same technologies assumed above, i.e., α = 2/3. Also assume that the one nation is addicted to consumption having an exclusive taste for consumption and little or no taste for investment. The other nation, by comparison, loves to invest, stay hungry and live on air.

Commodity Prices and Factor Prices Before Trade

With no trade, under conditions of autarky, the **CI** is unable to import the investment goods they need for growth, which is nonexistent abroad. The **CC** produces little or no investment goods for possible export. Each country specializes in production (and consumption) of a single kind they are addicted to. The upshot: the workers in the investment-addicted country **CI** become strictly richer than in the consumption-addicted country **CC**. Figure 3 below illustrates these relations. Compare points $\mathbf{E}^{\mathbf{CIA}}$ and $\mathbf{E}^{\mathbf{CCA}}$, which show (w/r) in **CI** strictly higher than (w/r) in **CC** under autarky.[1] To be more precise the following relations are to be observed: $(w/r)^{\mathbf{CIA}} > 1 > (w/r)^{\mathbf{CIA}}$.

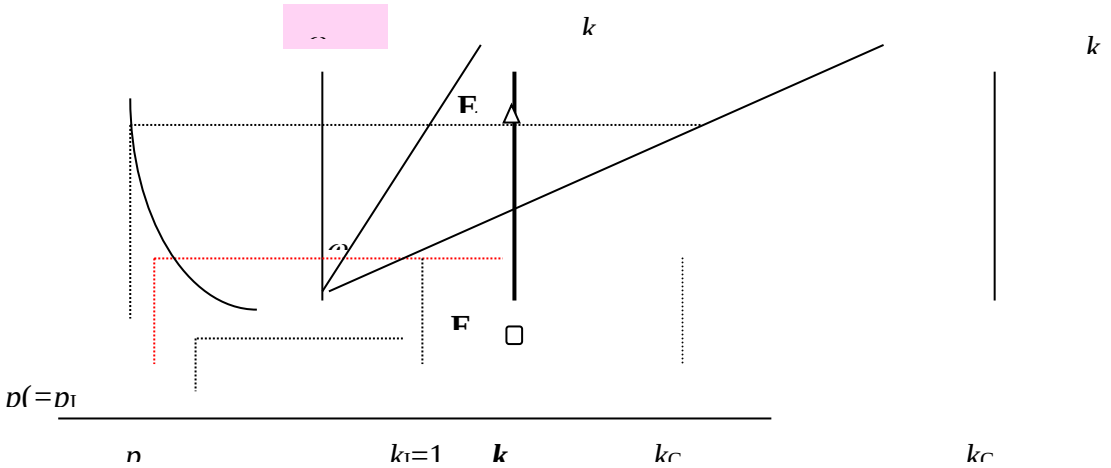

Figure 3. CP, FP, Sectoral Capital

Commodity Prices and Factor Prices after Trade

Figure 4, in turn, illustrates how factor prices equalize with free trade in the short run. The vertical axis of the back-to-back diagram measures the relative factor prices FP = w/r, the horizontal axis is partitioned to represent the relative commodity prices CP = p_I/p_C on the left hand side and the capital intensities, either sectoral k_i or aggregate k, on the right. Pursuant to the assumed extreme differences in national tastes, the 2-country autarky equilibrium points are given as E_{I0} and E_{C0}, respectively, at intersections of a vertical line on $k = 1$ and two lines k_I and k_C, representing sectoral MRTS as a function of sectoral capital intensity k_i (i = I, C). Note that the line k_C is flatter than k_I by assumption A2-5. Some related notes are warranted below.

1) The country **CC** specializing in consumption allocates almost all resources to the production of consumption goods. Hence their k_I approaches $k_I=k=1$. Their autarky equilibrium point is accordingly given at E_{C0}. Related to this is their low commodity prices CPs = p_I/p_C (or

[1] Moreover, the workers of the investment-addicted **CI** are strictly richer than their capitalist citizens while the capitalists of the consumption-addicted **CC** are richer than their workers.

high p_C/p_I) identified on a CPFP curve in the second quadrant, Figure 4.

2) The **CI**, by comparison, specializing in investment with little consumption finds its autarky equilibrium at E_{I0}, pointing to strictly higher FP (= w/r), and related CP (= p_I/p_C).

3) Both countries are endowed with the same identical amount of aggregate capital k = 1. Nevertheless **CI** specializing in investment (labor-intensive sector) while **CC** in consumption (capital-intensive sector), the *weighted average of capital intensities* in **CC** must be strictly higher than that in **CI**. The upshot differences in factor prices are reflected on the first quadrant by $E_{I0} > E_{C0}$, and the second-quadrant commodity prices correspondingly by $(p_I/p_C)_I > (p_I/p_C)_C$.

Note that the obvious differences in CPs in the two countries provide apparent incentives for them to trade. The question then is what happens to prices CPs and FPs. Given k = 1, in the short run, trade will tend to equalize them all, as illustrated by two dotted arrows along which the high prices before trade must fall and the low prices rise after trade.

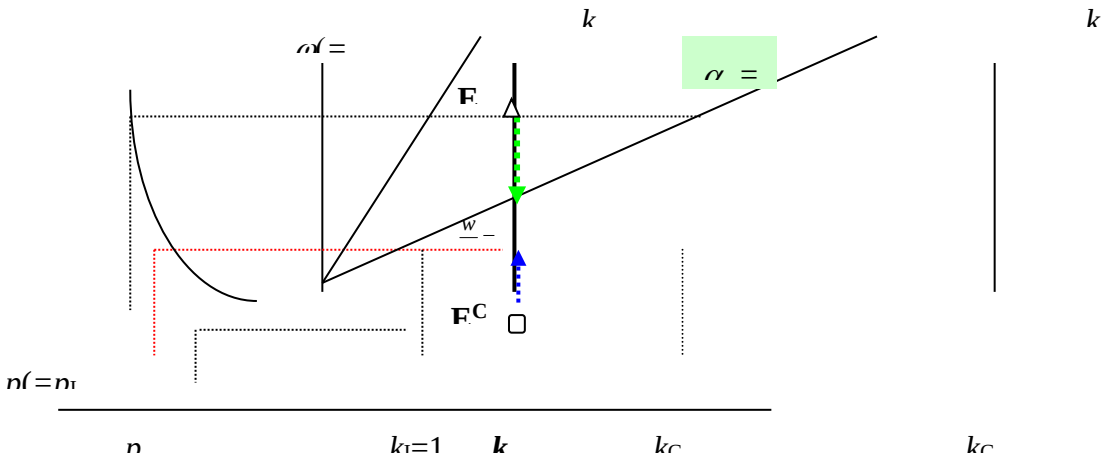

Figure 4. What Factor-Price Equalization after

Note as Figure 4 illustrates how factor prices tend to be equalized, nevertheless the rich workers in the investment-addicted country **CI** become poorer and the poor workers in the consumption-specialized country **CC** richer after trade than before trade. See Ohta (2012). Thus both the bitter part of the Stolper-Samuelson outcome of free trade and the factor price equalization theorem are confirmed, … so far. We are now in position to proceed to the next section to probe dynamic (or comparative static) conditions under which this seemingly robust theorem on factor price equalization may collapse.

Section 3. Impact of Trade under Asymmetric Growth and Tastes upon Factor Prices

Despite the bitter outcomes of trade both nationals each as a nation are richer after trade, and the

CC can consume more consumption goods while the **CI** can invest more than they could before trade. This implies that while the factor endowment in **CC** remains the same regardless of trade the capital endowment in **CI** tends to increase over time, all the more after trade. As the **CI** grows to be a developed economy, it can afford turning itself into a country specializing in consumption. The ex-**CI** is now a developed country **DCC**. The ex-**CC** realizing no growth, by comparison, may learn from the ex-**CI** to turn itself to a new developing country **DCI**.

What then would happen to factor prices if trade took place between these countries? Would they tend to equalize between **DCC** and **DCI**? To answer this particular question we restate formally the following basic assumptions/conditions of our requisite analysis.

A1) Two clone countries exist with divergent national tastes: the one addicted to consumption, called **DCC**, and the other to saving and investment, called **DCI**.

A2) Each country is endowed with two factors of production, capital K and labor L, to produce two kinds of goods, one for consumption and the other for investment: C and I.

A3) In both countries labor is owned by a given number of workers L, and capital owned by a given number of capitalists K, in the same number. So, L=K=1. This, however, is before asymmetric growth. As ex-**CI** grows capital accumulated K^* becomes distinctively higher than in the ex-**CC** so that $K^* > K = 1$ in the long run or asymmetric growth.

A4) Each country has two sectors of production: one for producing consumption goods and the other investment goods. (Though not needed, the sectors of production are characterized by the Cobb-Douglas technologies such that in the one sector, say consumption goods, output elasticity of capital is α, and that of labor $(1-\alpha)$, while in the other sector the counterpart elasticity are $(1-\alpha)$ and α, respectively, so that constant returns to scale prevail in all the sectors.)

A5) The consumption good sector is more capital-intensive than the investment good sector. (This requires $\alpha > 1/2$ in terms of the CD parameter assumed above.)

A6) The developing country is investment-oriented: producing investment goods extensively with little consumption goods, therefore living on thin air. The poor stay hungry.

A7) The developed country, by comparison, having developed, is *more consumption- than investment-oriented*. They specialize in consumption taking advantage of the accumulated capital while producing little investment goods. *The rich can afford staying foolish; they can afford specializing in consumption.*

Further specify, for simplicity, the basic assumptions above **A3)** and **A5)** as follows.

A3)* The ex-**CC**'s capital outstanding remains to be $K_{\mathbf{x\text{-}CC}} = 1$, while the ex-**CI**'s capital outstanding after accumulation is $K^*_{\mathbf{x\text{-}CI}} = 4$.

A5)* Output elasticity of capital in the consumption sector $\alpha = 2/3$.

These additional specifications of the Assumptions above are needed only for the sake of yielding the initial conditions for autarky equilibrium for the two nations' CPs and FPs under consideration before trade as illustrated by Figure 5 below.

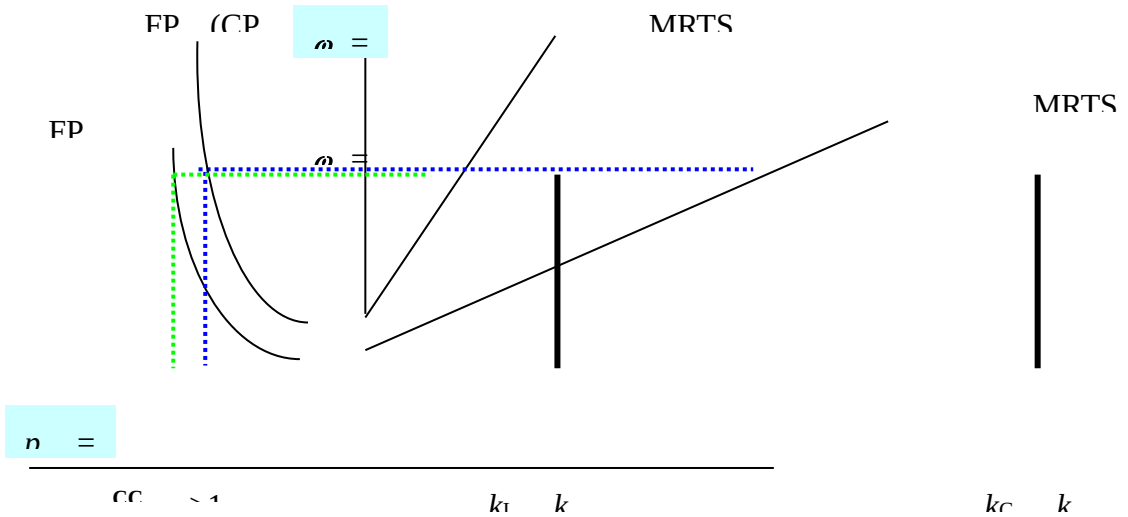

Figure 5. Sectoral Capital Intensities k_i's, and

Note that the differences in CPs in two countries provide apparent incentives for them to trade. The question then is what happens to prices CPs and FPs. However, remember that given $k = 1$ for two clone countries trade tends to equalize them all, as illustrated by two dotted arrows, Figure 4 *supra*, along which the high prices must fall and the low prices rise after trade.

But in the long run they could diverge insofar as capital accumulation proceeds in the **CI** where the workers may tend to resist opening their market in fear of their real wage declines at least in the short run when k is fixed. But *over time* while the stagnant **CC**'s factor endowment remains unchanged the **CI**'s capital tends to increase because they love to invest. Moreover, free trade will accelerate their capital accumulation, thereby increasing their wages over time to such an extent that their real wage will exceed the stagnant **CC**'s when capital accumulation proceeds beyond $k = 4$, Figure 5. The growing **CI**'s real wages will also increase with increasing output of investment goods to be exported by the stagnant **CC** to the growing **CI**, but will peak out when it reaches $\omega (=w/r)$ 2 in the figure. Thus, real wages of a growing economy can surpass those in the stagnant economy, all the more with trade, accelerating capital accumulation.

Further accumulation beyond $k = 4$ keeps price of investment goods increasing as the ex-**CI** can now specialize in consumption on their production possibilities frontier that has kept shifting outward with increasing slopes at the vertical consumption-good axis. They are now on **PPF**$^{\mathbf{DCC}}$ and capable of offering the entire amount of the consumption goods in exchange for the

maximum investment goods the ex-**CC** can produce along their **PPF**^{DCI} that intersects with the horizontal axis. The maximum wage $\omega^{DCI}{}_{max}$ that the **DCI** can earn by producing the investment goods at **E**^{DCIP*} is now strictly lower than the minimum $\omega^{DCC}{}_{min}$ that the **DCC** earn by specializing in consumption now at the left corner of **PPF**^{DCC} with $\boldsymbol{k}^{DCI} > 4$. See Figure 6.

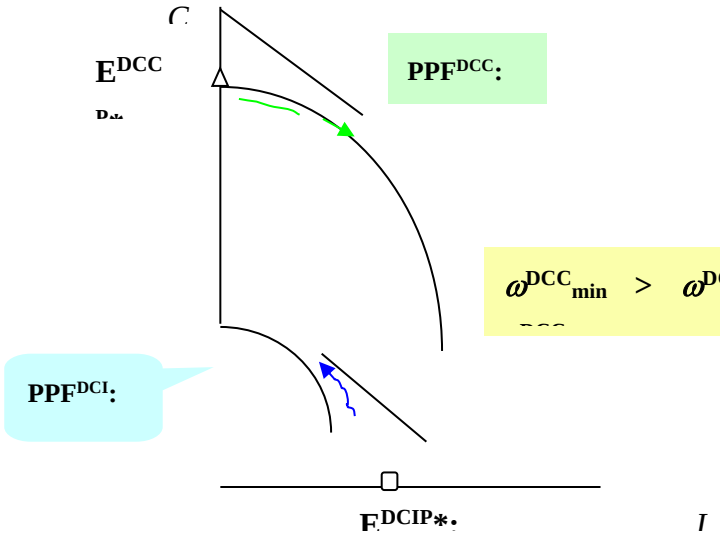

Figure 6-1 Trade Can Cause Factor

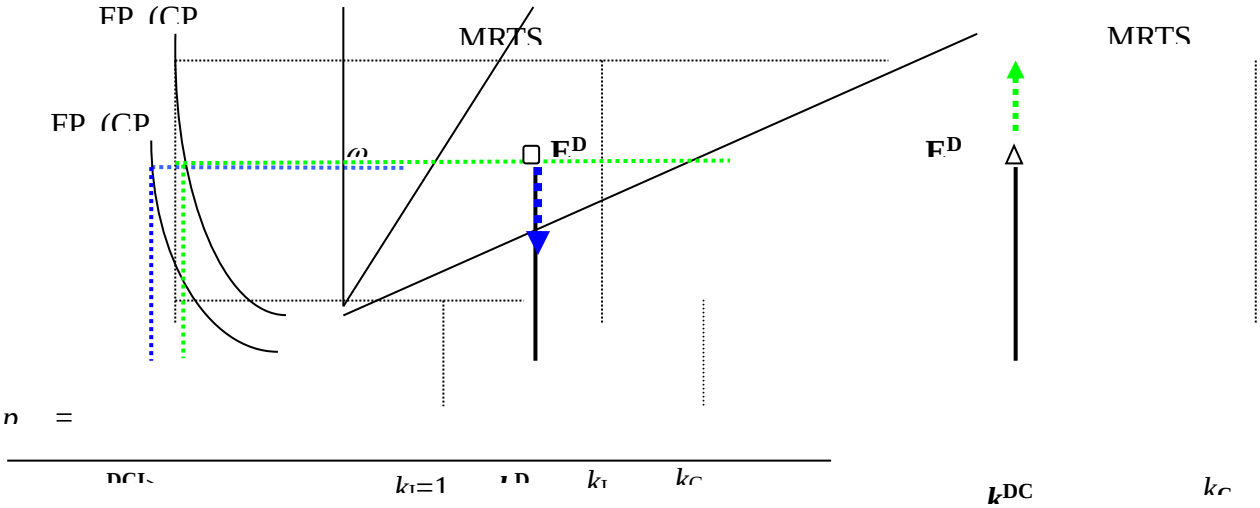

Figure 6-2 Trade Can Cause Factor Price Diversions under

Underlying Figure 6 are assumptions **A1)** through **A7)** including two special-case assumptions **A3)*** and **A5)*** imposed on **A3)** and **A5)**. Figure 6-1, upper panel, depicts two contrasting production possibility frontiers **PPF**^{DCI} and **PPF**^{DCC} of the ex-developing (now developed) country **DCC** and the ex-consumption-addicted (now hungry) country **DCI**, respectively. Note initially that asymmetric autarky equilibria are represented by **E**^{DCIP*} and **E**^{DCCP*} and related

equilibrium commodity prices of $\boldsymbol{p}^{\mathbf{DCC}} > \boldsymbol{p}^{\mathbf{DCI}}$.

Then two arrows show how trade may yield resource reallocations and related changes in the commodity bundles produced and, of particular interest to the present inquiry, the factor prices between the countries under consideration. In particular the rich **DCC** that now prefers consumption to investment nevertheless had better produce less consumption goods and more investment goods for export while the poor **DCI** that now prefers investment to consumption should produce more consumption goods for export. Thus they move along their own **PPC**s until when $\boldsymbol{p}^{\mathbf{DCC}} = \boldsymbol{p}^{\mathbf{DCI}}$ is established. In this process toward equilibrium what happens to factor prices within the trading countries is that they must necessarily diverge as indicated by the dotted arrows in opposite directions.

Note also in this related vein that trade tends to lower the poor nation's real wages and increase, on the contrary, the wages of the rich nationals! An inconvenient truth it may be? Or would it call for the Stolper-Samuelson proposal to 'bribe' for free trade, with no apology?

Section 4. Conclusions

A simple model of general equilibrium with trade by Ohta (2004, 5, 6) has been revisited to probe the Stolper-Samuelson (SS) theorem and the related orthodoxy of the HO factor price equalization theorem. We find that free trade may dis-equilibrate factor prices under certain particular empirically plausible conditions of asymmetric international tastes among nations at the outset of asymmetric growth, followed by non *ad hoc* reversal of national tastes upon asymmetric growth. Taste reversal is likely to occur insofar as an ex-hungry, now rich nation can afford specializing in consumption while a stagnant nation with little prior saving realizes that they need to become hungry to take off for growth/development.

This conclusion, if surprising, can be readily confirmed by the departure point conditions, seemingly *ad hoc* but not in fact, that factor prices, say, real wages, happened to be equal in a poor developing country and a rich developed country under autarky, respectively. Within the confines of our simple 2x2x2 GE model presented in Section 3, related Figures 4, 5, and 6, this requires capital stock of the developed country to be four times that of the developing country. The assumed technological clones are represented by just one CD parameter α, and moreover $\alpha = 2/3$. This last specification reflects our other related basic assumption that requires the consumption sector to be more capital intensive than the investment sector.

This required condition is to be noted as crucial to our present inquiry, crucial for two counts. First, our conclusion above crucially depends upon this seemingly unrealistic assumption. Second, if this seemingly unrealistic assumption were in fact unrealistic, then our surprising

conclusion must collapse. Fortunately, the seemingly unrealistic assumption is empirically supported, and hence crucial and relevant in the second sense. And our conclusion is valid.

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Appendix: What If Sectoral Elasticities of Substitution Are Different?

Following Jensen and Larsen (2004) we show below how different elasticity of substitution parameters σ in different production sectors are related to the convexity/concavity of the contract curve in the factor endowment space, capital intensity k, relative factor price ω (=w/r), and commodity price p(=p_I/p_C). The Edgeworth box diagrams and back-to-back diagrams can do the job. An interesting example case is when one sector's σ is large (>1) and the other small (<1). As capital accumulation proceeds with a rise in capital intensity k, we can show how or why price in the elastic sector tends to rise initially, but followed by a decline eventually. According as either 'σ_C low and σ_I high' or conversely 'σ_C high and σ_I low' ω tends to either rise or decline as relative price changes along the PPF. Figure 7 below shows how.

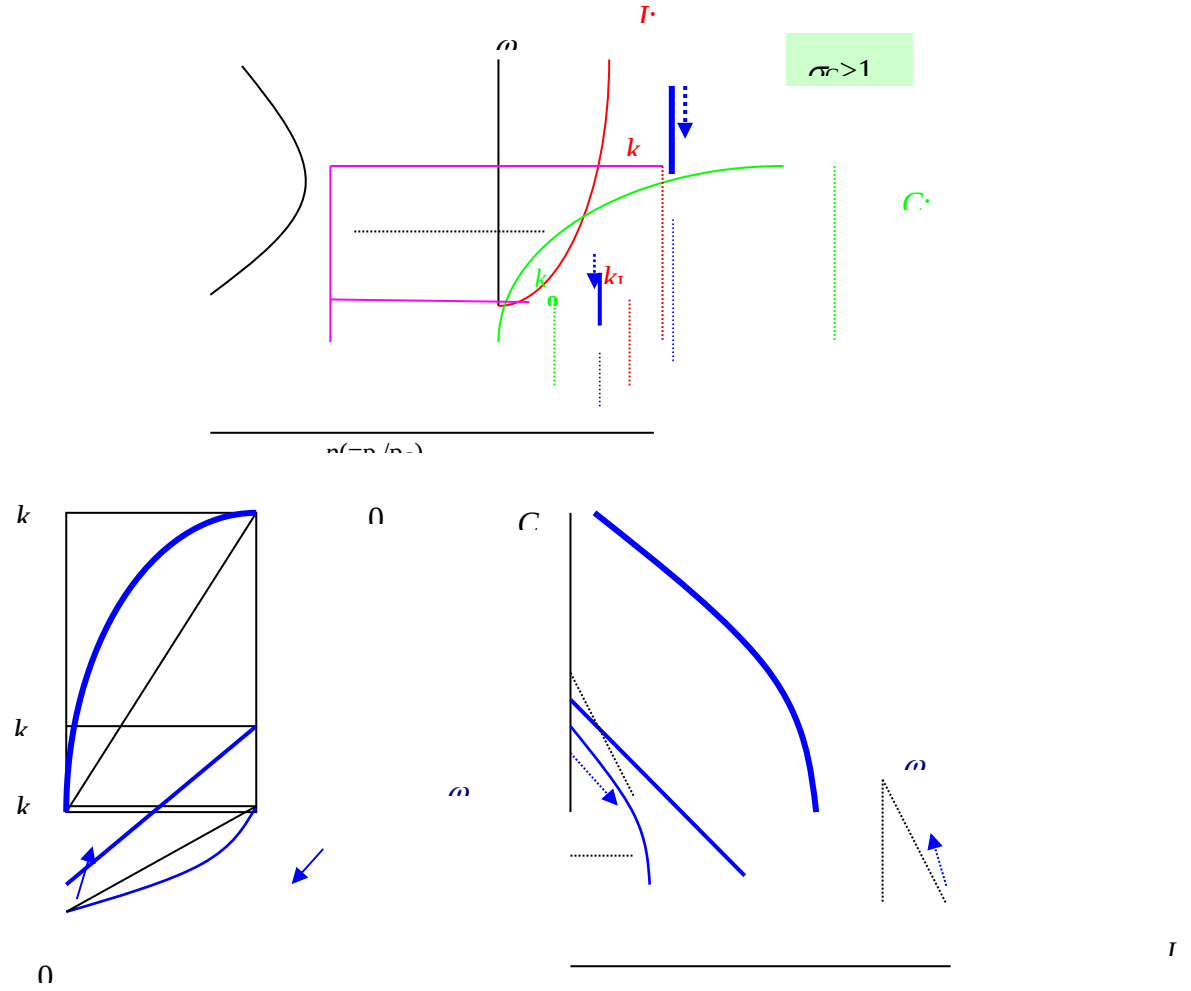

Figure 7. Trade Impact on Capital Accumulation, Contract Curves, PP Sets, FPs, CPs

Figure 7 assumes $\sigma_C > 1$, $\sigma_I < 1$ and shows that under asymmetric capital accumulation factor price equalization is impossible regardless of free trade.

1) Given different elasticities of substitution, $\sigma_C > 1$ and $\sigma_I < 1$, economic growth in terms of increasing capital endowments and related increases in capital intensity (from, say, k_0 to k^* to k_1) must expand the *more* capital-intensive sector *more than* does *the less* capital-intensive sector, be it the capital goods sector I or the consumption goods sector C.
2) Any particular sector, say, capital goods sector, may be capital intensive at an earlier stage of growth. But a continued growth must eventually reverse each sector's factor intensity insofar as the one elasticity of substitution is assumed small and the other large.
3) The relative wage rate ω tends to increase monotonically with the aggregate capital intensity, but the product prices, say, in the consumption sector C, that *may* also increase with ω initially (as does under the present parameter combinations: $\sigma_C > 1$, $\sigma_I < 1$) must peak out eventually while ω keeps increasing.
4) Opposite relations must hold for the other sector's prices. Prices, say, in the capital goods sector must decline initially as ω increases, but the decreasing prices must bottom out eventually and start rising as ω keeps increasing with capital accumulation.
5) Short-Run (Given k) Results: Summary Proposition A

   Wages may either rise or fall if and when any structural changes take place along a given production possibilities frontier according as either the one sector's elasticity is small and the other large or oppositely large and small. Related to this is either a concave or convex contract curve reflecting relevant differences in the method of production in two sectors.
6) Short-Run (Given k) Results: Summary Proposition B

   When k is small enough a rise in real wages can be accompanied by a fall in a given sector's output and price, say, in the capital good sector if it is more capital intensive than the other sector (given $\sigma_C > 1$ and $\sigma_I < 1$).
7) Short-Run (Given k) Results: Summary Proposition C

   When k becomes large enough and the consumption sector becomes more capital-intensive, given $\sigma_C > 1$ and $\sigma_I < 1$, then any further rise in relative wage rates must be accompanied by a rise in output and price in the small elasticity of substitution sector, i.e., investment.
8) Long-Run Results A: Early Stage

   Growth at an early stage requires lower real wages and higher capital good prices relative to consumption goods in order to reallocate resources to promote the capital good sector.
9) Long-Run Results B: Intermediate Stage

   Growth in terms of increasing k tends to raise consumer prices along with wage rates. The prices that may have been decreased in the short run must start to rise as the PPF shifts out with a particular skew, strictly steeper (and linear) than ever.

10) Long-Run Results C: Mature Stage

However, consumer prices will eventually peak out as growth continues with rising wages, consumer prices must start falling thereafter *provided* σ_J *large and* σ_I *small*. Otherwise, if σ_J *small and* σ_I *large*, investment prices must start falling as wages increase, all the more if production of consumption goods increases along the PPF. If preference for consumption is strong enough, as in the Nuts Country in our example above, then capital accumulation could come to a halt. This could be one underlying reason for the so-called capital intensity hypothesis, which states that stable economic growth requires the consumption sector to be more capital intensive.

We have seen above that commodity market equilibrium requires not only the rich national's real wages to decline, but also the poor wages to decline with free trade. This may appear as a resurging stumbling block to free trade, which could have engineered the world-wide sentiment against the so-called *irrational exuberance* starting from stock-market, housing-market, auto-market, and everything else, say, on American over-consumption?

If free trade is to be maintained should the poor workers adversely affected from free trade in both countries be 'bribed' for Pareto improvement? But in this example, it would not equalize international wage gaps.

Note in this connection that we assumed identical workers equally endowed in both countries. If free trade of factors were introduced along with commodities, then factor prices would surely equalize internationally. But they are likely to provoke the rich country's rich workers to cry against free trade of not only commodities but also factors, lest workers from abroad enter their labor market while the poor country's rich capitalists would have incentives for blocking capital inflow from abroad. Genuine factor price equalization for homogeneous factors would then require free trade of both commodities and factors, and without bribing that would keep genuine factor price equalization from being fully achieved. Moreover, given even if asymmetric tastes are assumed, capital accumulation thanks to the thrift country will enable both nations welfare to increase over time. Furthermore welfare must increase with no gap in international factor prices inasmuch as there will be a single international capital/labor ratio that will keep increasing over time.

In a stationary economy the original capitalists may own capital and nothing else. The original workers, by comparison, own labor and nothing else. As the economy starts to grow the original capitalists remain to be capitalists, own capital, and nothing else. The original workers, by comparison, now own both labor and capital insofar as their wages, even if paid in

consumption goods, are saved for investment. If trade causes rent on capital to rise and wage rate to fall, then the original capitalists would have no reason to complain. How about the workers? They become the working capitalists. The capitalists do not work, but the working capitalists do.

So, income distribution becomes little or no stumbling block to free trade if and insofar as individuals were equally gifted with both factors of production. The poor young generation with little or no capital may have his day in the future. However, the poor old generation, even if endowed with a lot of capital, are unable to work.

In a nutshell, free trade may become a stumbling block to the rich developed nation more than it does to the poor developing nation, all the more if their rent on capital declines. Diminishing income should be hard to those unable to work. Here lies, it seems to me, the *raison d'etre* for the present pay-as-you-go pension program, even if it is characterized as the so-called 2x4x8 rule, thus allegedly unfair or imposing unbearable burden to the future generation.