Finite Change – Implication for Trade Theory, Policy and Development

Marjit, Sugata and Mandal, Biswajit

Centre for Studies in Social Sciences Calcutta, India, Visva-Bharati University, Santiniketan, India

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*Sugata Marjit**

Centre for Studies in Social Sciences Calcutta, India

Biswajit Mandal

Visva-Bharati University, Santiniketan, India

Address for correspondence:

Sugata Marjit
Centre for Studies in Social Sciences, Calcutta
R-1, Baishnabghata Patuli Township,
Kolkata - 700 094, India
E-mail: marjit@gmail.com

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Abstract

The paper traces the evolution of trade theory beyond the standard 2X2 models and looks for implications of higher dimensional structures and adjustment problems with large shocks. Typically trade theory and policy talk about expansion and contraction of existing activities. In this paper we explore various situations where certain activities vanish altogether. Similarly other activities may come to existence following major changes in the economic environment. Such regime shifts are interpreted as finite changes as opposed to infinitesimal alterations. These changes allow us to think differently about standard policy changes, all of which have direct implications for developing countries. Emigration, wage inequality and distribution, non-equivalence of tariff and quota in competitive models, capital mobility and corruption are some of the applications involving such finite change. At a theoretical level the paper starts by an interesting interpretation of factor price "non-equalization" hypothesis in the basic Heckscher-Ohlin-Samuelson type models without depending on standard text book type argument.

Keywords: General Equilibrium, Trade

JEL Classification: D5, F1

1. Introduction and Preliminaries

Trade should lead to specialization. This is universally accepted as the fundamental lesson derived from pure theory of international trade. The start up model of the discipline, the well known Ricardian theory of comparative advantage talks about the extreme case where trade leads to complete specialization. The intrinsic message is that for a country to reap the benefits from international trade, it is wise to concentrate on production of a few goods and services, export them and in turn enjoy a wide range of consumption items. Thus the process of international trade necessarily eliminates production of certain goods. Inability to sustain competition from the rest of the world leads to closure of certain activities. In a standard two-good Ricardian model competition leads to complete specialization and all workers are absorbed in a single economic activity. Thus the adjustment mechanism does not allow only contraction in output of the import competing sectors, but a total shut down. In mathematical terms such changes cannot be treated in terms of calculas. These are not small changes. We define them as "finite change".

In a standard textbook kind of analysis we do generally find a diagram like the following one (Figure-1). Though we frequently talk about the implications of different equilibrium points, we do not focus particularly on the bearing of such points for "finite" and "infinite" change. Let us briefly explain such phenomenon in a Ricardian structure where we consider a world consisting of two countries producing two goods (X and Y) using a single factor of production labor (L). The world PPF (production possibility frontier) would be kinked one as shown in the diagram. The shape and/or slope of different segments of the kinked PPF depends

on the technology of different countries. Production equilibrium may take place anywhere on the PPF. We are concerned about three equilibrium points: on the vertical axis (A); on the horizontal axis(C); and at the point of kink (B). At A (C) both the countries specialize in Y(X). This indicates complete closure of either X or Y. However, trade is not possible in such cases as countries are left with no other

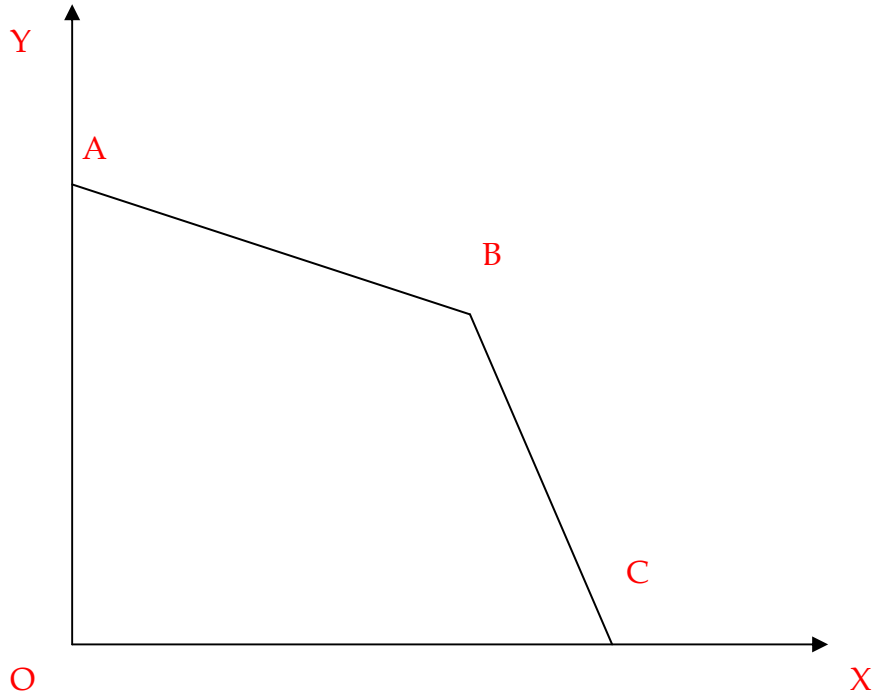

Figure-1

commodities that could be traded. Whereas, equilibrium at B allows for trade inspite of having complete specialization. One produces only X and the other produces Y. This also resembles complete specialization and hence complete shutdown of another activity. This is the issue that we generally refer to as "finite change" in trade theory since trade is not stopped even if some activities are stopped.

Concept of finite change or large shocks is important in understanding the process of growth and development. Aggregate models of economic growth hide a

lot of effects which alter the structure and composition of produced goods and services. Some goods vanish and new goods emerge due to technological and other transformation. In particular external competition may shut down some sectors, reward occupations that were not properly rewarded in a closed economy. As we shall prove eventually, large shocks may raise return to certain factors in particular industry but eventually that industry may vanish yielding place to either a new one or to an existing but more competitive one. The fact that we allow the industry to vanish, the concerned factor continues to enjoy its rising fortune.

While in the standard Ricardian framework finite change is bound to happen, the major workhorse in trade theory, the Heckscher-Ohlin-Samuelson (HOS) framework does not yield complete specialization as a definitive outcome. In fact the emphasis is on incomplete specialization even if trade squeezes the import competing sector[1] .

Jones (1974) is probably the earliest attempt to formalize the idea of finite change in the HOS framework though the model did not particularly emphasize the concept of finite change. A small country having the potential to produce many goods with two factors of production capital (K) and labor (L) will end up producing either one good or two goods. In figure-2, borrowed from Jones (1974) goods 1, 2 and 3 are ranked according to capital intensities. As the endowment ratio k of a country

[1] More recent popular analytical structure developed by Krugman (1979) and Melitz (2003) warrant special mention. In Krugman-Dixit-Stiglitz (KDS) type framework exposure to trade increases number of varieties without eliminating any of the domestic varieties. Thus production reallocation is not an issue. In Melitz variety of models trade may actually lead to the exit of relatively unproductive firms and that itself has a positive productivity impact. But it is essentially an intra-industry outcome. The industry itself is not eliminated in equilibrium. We shall return later to the issue of intra-industry finite changes.

moves from a high to a low value, pattern of specialization changes for this small country. k_1 coincides with the capital intensity of the first good, k_2 lies between the intensities of 1 and 2 and the country produces 1 and 2. If k_1 moves further down to the right to

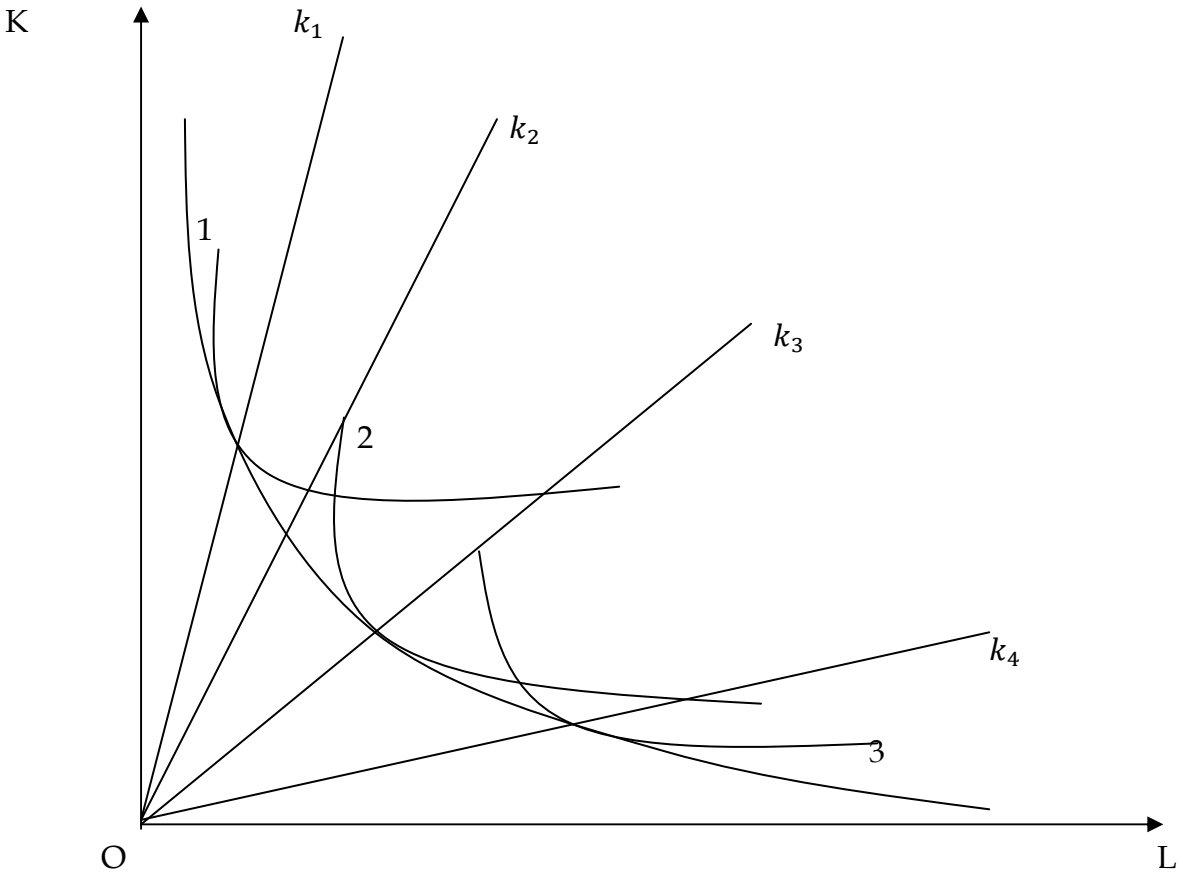

Figure-2

k_3 production of 1 vanishes and with k_4, production of 2 vanishes as well. So if we consider a change in k over time the other way round, moving up from k_4 to k_1, may be through a process of growth, technical progress and accumulation of capital sectors such as 3 and 2 will cease to exist.

Figure-3 describes the very familiar relationship between $\left(\frac{w}{r}\right)$, the factor price ratio and$\left(\frac{K}{L}\right)$. Note that when the country is completely specialized, an increase in $\left(\frac{K}{L}\right)$ must increase$\left(\frac{w}{r}\right)$ because of diminishing marginal productivity (DMP) and constant returns to scale (CRS). With incomplete specialization two goods are produced and

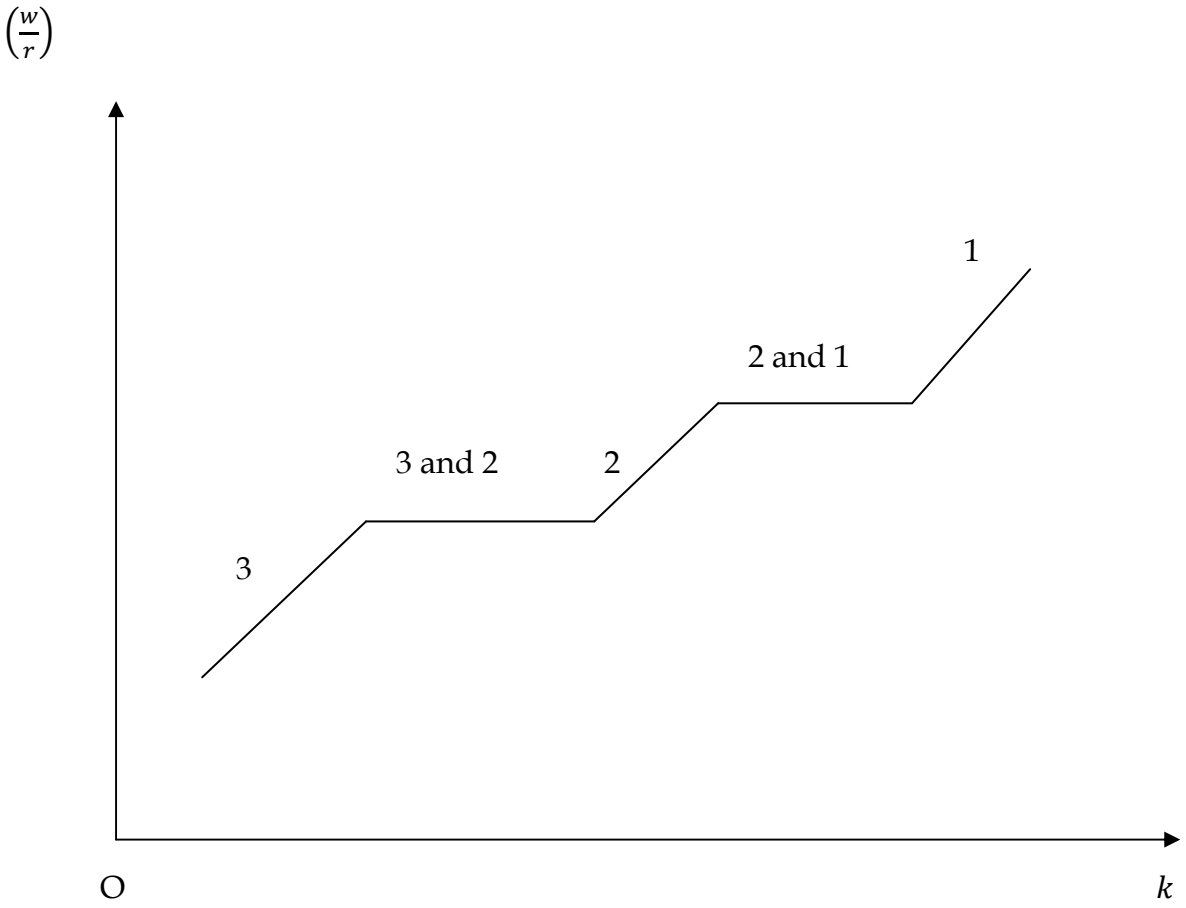

Figure-3

with given commodity prices w and r are uniquely determined[2]. The endowments cannot affect factor prices on the "flat" segment in Figure-3. As the economy moves from a low to high k, sectors vanish and sectors emerge.

So far what we have shown is fairly standard and well known. But there are certain salient features of the specialization pattern worth a mention.

(a) Let us think of capital (K) as skilled labor and therefore $\frac{w}{r}$ acts as a very basic distributional indicator. If the economy concerned is producing 1 and 2, and there is an increase in L, wage distribution will remain invariant for a while. But definitely same is not true if the economy is forced to specialize in 2. Further decline in k will reduce $\frac{w}{r}$, worsening the distributional index. Thus finite change may fundamentally alter the pattern of factor price movement following exogenous shocks.

(b) Movement in relative prices will tend to shift segments of the curve in Figure-3. Though labor-saving technological progress in labor-intensive sector will increase wage contrary to the expectation derived from the usual partial equilibrium framework. Once such a change leads to complete specialization, the result will be reversed. This is eloquently argued in Findlay and Jones (2000). Thus finite change will alter qualitative outcome.

(c) The figure also shows that countries specializing in different sets of goods will not have their factor prices equalized even if they are identical otherwise. Differences in endowments may allow them to specialize in all goods but

[2] It is worth noting that sometimes in the standard HOS model if two countries specialize in different sets of goods factor prices will not be equalized. We do not need the standard assumptions such as factor intensity reversals etc. Complete specialization is not needed also. The only requirement is specialization in different sets of goods. We shall discuss such issues in Section 4.

different sets of goods. Also with changes in endowments factor prices will start diverging. If one studies 2x2 models, it would seem that, complete specialization is necessary for factor prices to diverge. But that is not true in many-commodity models. Even if countries remain incompletely specialized producing a subset of goods, factor price equalization will not hold.

2. Finite Change and Tariff-Quota Non-Equivalence

Following the earlier section and essentially Jones (1974) one could argue that the backstage of a 2X2 HOS system may contain a set of competitively non-viable set of industries such that for (w, r) derived from the competitive price conditions relevant for goods 1 and 2, the set of active production sectors, it may be the case that

$$C_i(w, r) > P_i, \qquad i = 3,4, \ldots\ldots, n \tag{1}$$

Where $C_i(w, r)$ is the minimum average cost of producing ith good, $i = 3,4, \ldots\ldots, n$ and P_i^* is the world price of the ith good.

One interesting exercise is to consider a trade policy that seeks to protect a few of the "closed" industries either through a tariff or a quota. This problem was considered by Choi and Marjit (1998). Without loss of generality, let us assume that sector 3 is the targeted sector for protection with initially $X_3 = 0$. Let the policy instrument be a unit tariff t.

Therefore, for $X_3 > 0$, t must be such that

$C_i(w,r) \leq P_3^* + t \quad ((P_3^* + t)$ is the world price of 3) (2)

If goods 1 and 2 continue to be produced,

$$C_i(w,r) = P_3^* + t \tag{3}$$

Note that given (P_1, P_2), (w,r) are uniquely determined under the usual assumption of neo-classical production theory implying (3) to hold for any amount of X_3.

As X_3 rises from level zero, both labor and capital are drawn from X_1 and X_2. X_1 and X_2 adjusts through the Rybczynski mechanism as long as the resource crunch allows them to lie within the cone of diversification. One cannot rule out the possibility that the entire import-demand for X_3 is wiped out through such a process and t turns out to be highly restrictive.

Now, think of a quota on import of X_3. Given prices, such a quota will uniquely determine the local production of X_3 and the resource extraction from X_1 and X_2 and their levels of production. Note that by construction entire import-demand cannot be eliminated through such protectionary measures. Thus in an otherwise competitive system a tariff and a quota will have asymmetric effects and tariff can turn out to be more restrictive. This is a clear hint towards a non-equivalence result. The idea exploited in this analysis is related to a flat average cost function for all industries which are not viable under free trade. Any price protection to such industries must entail a support for all output levels. Whereas, quantitative protection pins down to a maximum amount that can be produced locally. More generally the proposition points towards the asymmetry between price and quantity related regulation in a competitive environment.

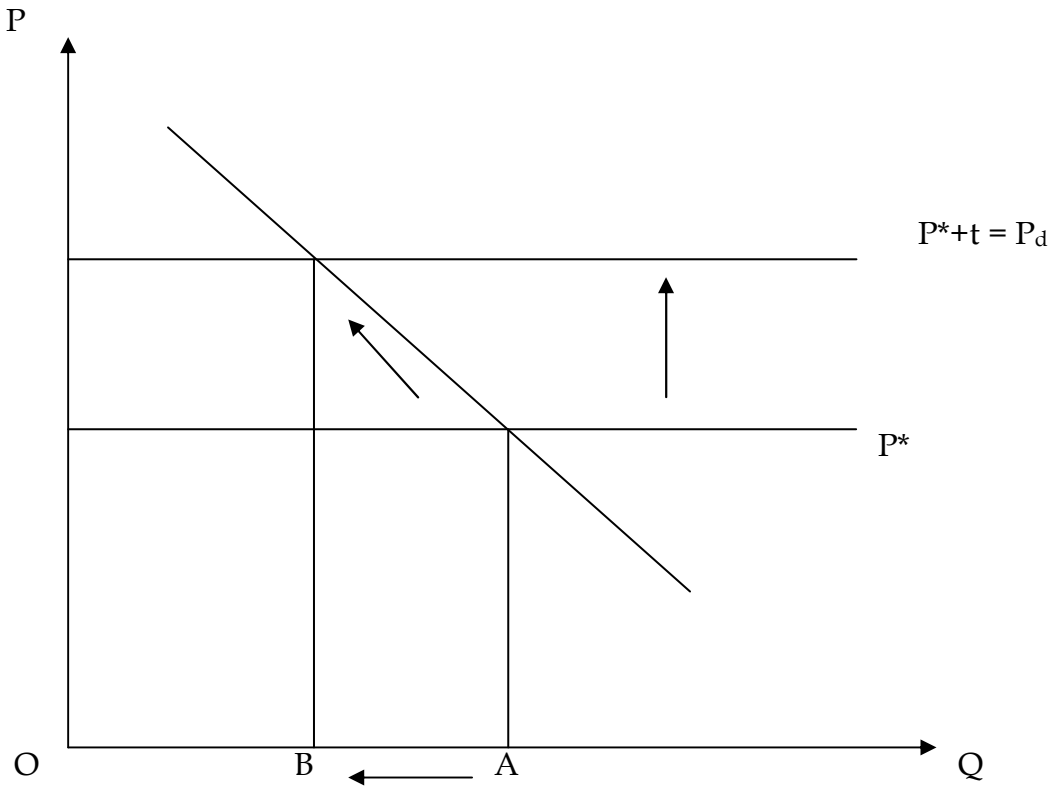

Figure-4

Initially OA was the amount of import with $P_d > P^*$, the world price. As tariff t equates P_d and P^*, the entire demand can be satisfied through domestic source. Hence, OB may reflect zero import or total import restriction. Instead a quota trivially guarantees some import. Thus a tariff is more restrictive than quota.

3. A Complex Production Structure

Consider a scenario, a closed economy environment where there are n industries and within each industry there are m_i varieties $(i = 1, \ldots\ldots, n)$of goods. Thus one may be an electronic goods sector, one may be the textile sector and so on. Within an industry, there are variety of goods produced using labor and a common type of capital K_i. Thus labor is mobile across industries and within an industry

across varieties. Capital is specific to an industry but mobile across varieties within the industry. In a closed economy, positive demands for all goods guarantee positive output for all varieties.

Once we allow for trade and the country finds itself to be small in the global economy with prices pre-determined in the world, drastic alteration in production structure takes place. For each industry only one variety will survive or for one of the industries two varieties will survive and the rest will produce only one variety. The logic behind such "finite" change has been explained in Jones and Marjit (1992). Large shocks to the system will lead to vanishing varieties. For each industry the variety that promises highest return to the specific factor survives. The rest are imported from abroad. In a way the most productive of all varieties survives under competition as measured by the highest return to the specific factor. Note that in the case one of the industries produces two varieties. Wage rate is determined there via the standard HOS mechanism. Thus we shall have either a pure specific factor model or a system where (n-1) sectors will have a specific factor structure and the residual a 2X2 HOS framework. Once factor prices are all determined the non-surviving varieties will have "flat" average cost functions. Several applications of this structure have been attempted in the literature such as Beladi and Marjit (1992), Marjit and Beladi (1996, 1999), Marjit (1991, 2003) etc.

4. International Factor Mobility, Wage Distribution and Finite Change

A question that trade theorists have been busy investigating has to do with the impact of trade in goods and factors on inequality within a country. This became

a topic of intense investigation over the last two decades as rich and poor countries alike started exhibiting a rise in the skill premium. Typically a rise in the exports of countries using mostly unskilled labor intensive items should be accompanied by a decline in the relative wage of skilled workers and the reverse should happen in nations that exports skilled labor intensive goods. That is the usual prediction of HOS framework. Somehow that did not happen and other alternative explanations based on technological change and capital movement have been floated. Feenstra (2004) deals with it extensively.

In this section we provide a few examples where international factor flows have drastically different implications for skilled wage premium within an economy. In the process we reiterate our stand regarding the well known factor price equalization theorem. We shall argue that even with identical technologies, no factor intensity reversals and all other standard assumptions of the Heckscher-Ohlin model factor prices may not be equalized if the countries specialize in non-overlapping sets of goods. Beladi, Kar and Marjit (2013) and Marjit and Kar (2011) develop two cases with emigration and international capital flow and demonstrate how production structure alter due to large shocks. In one case the impact of wage distribution drastically alters and in the other countries are affected asymmetrically to reveal factor price differences.

While Marjit and Kar (2005) argues that emigration of the skilled can improve the wage distribution in favour of the unskilled. Similarly emigration of the unskilled can worsen the distribution against the unskilled contrary to the conventional wisdom as the wage of the emigrating factor must go up after

emigration. Yet the relative wage distribution may move against outflowing workers. It turns out that emigration may lead to other possible production structures different from the one used in Marjit and Kar (2005) starting from a generalized production set up embodying specific factor framework as well as a Heckscher-Ohlin type sector which uses all factors of production. The result as shown by Beladi, Kar and Marjit (2011) reveals that post emigration wage distribution critically depends on which sectors will survive in equilibrium. Thus finite change can alter qualitative outcome. They argue that if skilled labor emigrates, return to capital may not have to fall as in Marjit and Kar (2005). In equilibrium the mixed sector and the pure unskilled sector survive and return to capital goes up wiping out the pure skilled sector and reducing unskilled wage. It is important to realize that mandatory survival of a sector pins down the maximum return to a factor used in that sector. But with large shocks or finite change, that concerned factor may quit that sector altogether and join a new sector or can engage exclusively in another existing sector. Such movement will allow the factor to earn much more than what it would have if it was restricted to operate only in one sector. The possibility of vanishing and emerging sectors can accommodate for wider range of variations in factor prices.

In the companion piece Marjit and Kar (2011) illustrates a case where international capital flow can increase skill premium across countries which is difficult to obtain in a standard Heckscher-Ohlin model. In a world where one country exports skilled labor intensive good and other the unskilled labor intensive good, better prospects of trade will increase skill premium in one and reduces in the

other. With capital flowing from North to South each country may specialize in different subsets of goods and skilled wage relative to unskilled wage or the wage gap can rise everywhere.

We start with a variant of the specific factor and HOS model[3]

$$a_{SX} w_S + a_{KX} r = P_X \quad (4)$$

$$a_{LY} w + a_{KY} r = P_Y \quad (5)$$

$$a_{SZ} w_S + a_{LZ} w + a_{KZ} r = P_Z \quad (6)$$

$$a_{SX} X + a_{SZ} Z = \bar{S} \quad (7)$$

$$a_{LY} Y + a_{LZ} Z = \bar{L} \quad (8)$$

$$a_{KX} X + a_{KY} Y + a_{KZ} Z = \bar{K} \quad (9)$$

A sector or industry like Z is added to the specific factor structure. One can interprete X, a primarily skilled sector, Y, a primarily unskilled sector and Z, a general one where both skilled and unskilled work together. Capital nonetheless is required everywhere. A similar production structure exists in the rest of the world (ROW). Suppose to start with $r > r^*$, the real return to capital in the ROW. As one allows for international capital flow, the new world equilibrium is reached at r_W where $r > r_W > r^*$. As r decreases upto r_W in the home country, there are more goods than factors. (4) – (6) are allowed to determine only two factor prices w_S and w, the wages of skilled and unskilled workers. Thus one of the industries must

[3] We use following symbols to describe the set of equations. Note that here $P_j \Rightarrow$ price of the j[th] commodity (j= X, Y); $w_s \Rightarrow$ skilled wage; $w \Rightarrow$ unskilled wage; $r \Rightarrow$ rate of return to K; $a_{ij} \Rightarrow$ input-output coefficient ($i \neq j$; i = S,L,K and j = X,Y,Z); $\bar{S} \Rightarrow$ total supply of skilled labor; $\bar{K} \Rightarrow$ total supply of capital; and $\bar{L} \Rightarrow$ total supply of unskilled labor; $\theta_{ky} \Longrightarrow$the value shrae of ith cinput in jth commodity; $\wedge \Longrightarrow$ proportional change.

vanish. Here is how it goes. Suppose Z is "labor" intensive. A drop in r will increase both w_S and w and will render Z unsustainable due to competitive pressure with unit cost of producing Z exceeding exogenous world price.

Therefore, from (4) and (5)

$$\hat{w}_S = \frac{-\theta_{KX}\hat{r}}{\theta_{SX}} \tag{10}$$

$$\hat{w} = \frac{-\theta_{KY}\hat{r}}{\theta_{LY}} \tag{11}$$

$$(\hat{w}_s - \hat{w}) > 0 \text{ if } \theta_{kx} > \theta_{ky} \tag{12}$$

Let us now turn to the ROW. There r has gone up. Hence by similar logic i.e. Z is labor intensive, it is unlikely that Z will vanish. In fact Marjit and Kar (2011) demonstrates that with Y and Z being produced production of X may vanish and w_s in fact will rise. Note that with higher r and higher w_s production of X will cease to remain competitive. Also note that in a pure specific factor structure w_s must go down with a rise in r. Thus we shall have an equilibrium where both w_s and r are higher and w is lower. Hence in both countries $\frac{w_s}{w}$ must go up. Such a result is driven by large shocks or finite change whereby the pattern of specialization alters drastically.

Conclusion of Marjit and Kar (2011) demonstrating a rise in local $\frac{w_s}{w}$ following international capital movement has to allow the closure of the pure skilled sector in the North, where only mixed sector survives. Such an outcome is definitely at odds with conventional wisdom and general perception. However, in an extended version of the paper they try to show that with imported intermediates, the South can produce a cheaper intermediate as capital cost comes down and that in turn may

help the pure skilled sector in the North even when skilled wage and return to capital in the North increase.

In another interesting extension of such type of models Mandal and Marjit (2012) shows how corruption as an activity may be squeezed out due to international capital mobility. Mandal and Marjit (2012) used a structure quite akin to Marjit and Kar (2011). Here goods' prices are noramilized to unity and it is assumed that Production of both X and Y are symmetrically affected by corruption related transaction costs denoted by α which is exogenously fixed. This is covered by a part of the value of per unit of outputs. Thus by definition corruption smoothening intermediation requires all factors of production. Further Z defines a sector comprising only corruption related intermediation activity and each unit of production or transaction of both X and Y requires one unit of Z.

In such a scenario an inflow of foreign capital depresses r. In what follows both w_s and w would increase. The rate of rise of w_s and w entirely hinges upon factors' share in X and Y, respectively. Subsequently the value of lost output due to corruption related intermediation must increase as both w_s and w rise and skilled and unskilled workers are used as specific factors in X and Y respectively. Also note that Z will also increase since (X+Y) has to be identical with Z as intermediation is required for per unit of output. If for some reason the cost of intermediation becomes greater than the value of intermediation, Z will not survive. Only X and Y would exist and Z would vanish from the structure. Underlying arguments are as follows. As w_s and w increase, cost of intermediation increases countered by a decline in r. If Z is "labor" intensive implying a low cost share of capital, the cost will exceed α and

Z will vanish. This is trivially true if $\theta_{kz} = 0$. If α is not allowed to go up, workers are better off being employed in X and Y rather than in intermediation. This is ensured if the following condition is satisfied

$$\left(\frac{\theta_{kx}}{\theta_{sx}}\frac{\theta_{sz}}{\theta_{kz}} + \frac{\theta_{ky}}{\theta_{ly}}\frac{\theta_{lz}}{\theta_{kz}}\right) < 1$$

For reverse argument there will be no X and Y, only Z would theoretically exist. But this is not feasible by definition as Z is a by-product of X and Y. Now we are left with the possibility where intermediation cost is exactly equal to the lost value of output. In that case either X or Y may vanish from the system. X would no longer be produced if $\theta_{kx} > \theta_{ky}$ or $\theta_{sx} < \theta_{ly}$. Production of X would be non-viable when unit cost would be higher than unit price which is normalized to unity. We already know that r falls and w_s rises. When w_s rises by a greater extent then only the cost of production may outweigh price. In order to get this outcome the share of capital in X has to be sufficiently high or the share of labor has to be sufficiently low compared to that of in Y. For analogous reasoning Y would be vanished *if* $\theta_{kx} < \theta_{ky}$ and all unskilled workers have to go to the intermediation sector for survival. Thus what we see here is that the possibility of a sector vanishing essentially depends on the factor intensity assumption and more importantly a country may get rid of corruption only by allowing foreign capital to come in. Higher dimensional trade theory and finite change arguments can only provide with satisfactory explanation for such an outcome.

The issue of finite change in association with two-sided wage inequality has been tried in a very recent attempt by Dutta, Kar and Marjit (2013). They used a

variant of Krugman (1981) where both North and South start with production of both homogenous good and slightly differentiated varieties. Producer of each variety is the sole supplier of its variety and hence market becomes monopolistically competitive. In such a set up it has been shown that international mobility of labor and capital between North and South may lead to finite change in the production patterns and eventually South produces only homogeneous product and North produces different varieties. Emigration of skilled labor in this backdrop raises the skilled wage first and then raises the price of some goods as supply falls short of domestic demand. Under some reasonable conditions price may go up less than the increase in cost leading to what we call finite change or closure of the activity. Movement of capital may also have similar kind of alteration effects in production pattern.

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