International trade and internal organization

Urjit R. Patel\textsuperscript{a,b,*}

\textsuperscript{a} Infrastructure Development Finance Company Ltd., Mumbai, India
\textsuperscript{b} Department of Economic Affairs, Ministry of Finance, Government of India, New Delhi, India

Received 16 June 1997; received in revised form 9 March 2000; accepted 4 April 2000

Abstract

Informal discussions on international trade attribute much importance to organizational differences. Nevertheless, economic theories of international trade have not been extended to incorporate this important element. This paper integrates theories of internal organization with a model of international trade by adding another dimension — how decisions regarding which ideas or projects to accept are made — to the standard trade framework. It is shown that asymmetry in the organization of economies per se can be a source of comparative advantage and two-way trade. Implications for the pattern of trade are derived. © 2000 Elsevier Science B.V. All rights reserved.

\textit{JEL classification:} F10; F11

\textit{Keywords:} Internal organization; Polyarchy; Hierarchy; Comparative advantage

1. Introduction

Observed economic performance varies greatly across countries, particularly in the case of international trade. In many informal discussions, a significant part of these differences is often attributed to differences in organizational decision making. Nevertheless, theories of international trade have not yet incorporated this important element. In this paper, we embed the decision-making framework of Sah and Stiglitz (1986) into the standard $2 \times 2 \times 2$ Heckscher–Ohlin–Samuelson (HOS) model of international trade and show that it can be a source of comparative advantage.

2. A model of international trade with organization

2.1. Organization

In an economy where there is considerable decentralization in information processing and limited communication, it is probably impossible and definitely very costly to share
completely all relevant information and for the entire collectivity to reprocess all the information to reach an optimal decision. The crucial aspect of internal organization that we concentrate on is, therefore, the distribution of decision-making authority, i.e., how different parts of the system communicate with each other.

The organization or architecture of a system determines how decisions regarding ideas, projects and policies are made. An example of different types of organizations accomplishing the same activity are the widely documented distinctions between US and Japanese methods of running their corporations, not so much due to different technologies, but because of differently structured decision making. Aoki (1990) provides detailed examples of how horizontal decision-making (J-mode) in Japanese firms may have resulted in greater flexibility regarding adapting to new information, in contrast to the hierarchical structure (H-mode) followed by US firms. Conversely, the H-mode is superior to J-mode in responding to certain other types of changes in business.

In this paper, we consider two specific decision making organizations, polyarchies and hierarchies. A polyarchy consists of several decision-makers, who can undertake projects independently of one another. In contrast, the decision-making authority is more concentrated in a hierarchy since the final decision of whether or not to undertake a project is in relatively fewer hands. Errors in judgement ensure that some projects are rejected that should have been accepted (type-I error), and some projects are accepted that should have been rejected (type-II error). Without perfect screening, the way decision-makers are arranged affect the relative importance of the two types of errors that are made, and ipso facto affect output. The decision-making framework that is used is simple and does not pretend to completely capture the complex nature of real world decision making. However, we feel that the stylized framework does contribute to highlighting some aspects of the issues discussed above. We do not claim that asymmetry in decision making is the only determinant of comparative advantage or even the most important one, only that it can plausibly influence it.

In the model, projects or ideas are generated randomly from a common pool. In these organization systems, decision-makers act as screens that decide whether to accept or reject a project. In a polyarchy these screens are placed in series, whereas they are placed in parallel in a hierarchy, i.e., projects are screened independently in the latter system. It is also useful to define a system where all projects are accepted, which reflects the outcome that would occur in the absence of such organizations. Given the random generation of projects this is equivalent to a system that randomly picks out projects from the common pool. We call this the ‘mean’ outcome.

It is assumed that there are two screens in each system. Each screen accepts a project with probability equal to ‘\( p \)’. In a polyarchy, a project gets two chances, once with the first screen and again with the second screen, who ignores the rejection of the first screen. In a

---

1 For the sake of brevity, we shall use the term ‘project’ to mean any new information or ideas that managers have to make a decision on whether to accept or ignore. It should not be confused with an industrial project with specific outputs. Thus, the effect of such ‘projects’ can be both positive and negative. In heuristic terms, the negative effect of such projects can be considered as production decisions that divert resources from productive activities and thus reduce the total output of the sector.

2 For a discussion of efficiency of hierarchical coordination, see Williamson (1985, Chapter 9) and Aoki (1988, Chapter 2.2); see Itoh (1987) on non-hierarchical systems. Also see Johnson (1982) and Krauss and Pierre (1993).
hierarchy, however, both screens must accept the project in order for it to be accepted by the system. The probability of acceptance in the three organizational systems is given below.

Polyarchy: \[ P^p_D = p + (1 - p)p = p(2 - p) \]  
Hierarchy: \[ P^H_D = p^2 \]  
Mean: \[ P^M_D = 1 \]  

2.2. Production

It is assumed that there are two factors of production, capital \((K)\) and labor \((L)\). Producers can produce either commodity \(z\) or \(y\). The number of projects in each sector is \(N^{(i)*}\), where \(i = z, y\) and superscript \(*\) denotes variables and parameters that pertain exclusively to the foreign economy. Initially, it is assumed that \(N_z\) and \(N_y\) are normalized to one.\(^3\) It is also assumed that the set of projects to be reviewed consists of only two types of projects, good or bad. If the project that has been chosen is good, then its effect on the output of \(z\) is given by

\[ z_1 = s^g_z F(K, L), \text{ where } s^g_z > 0 \]  

(4a)

On the other hand, if the project that is chosen is bad, then its effect on the output is given by

\[ z_2 = s^b_z F(K, L), \text{ where } s^b_z < 0 \]  

(4b)

\(F(K,L)\) is a homogeneous production function. The parameters, \(s^g_z\) and \(s^b_z\) represent measures, respectively, of the positive and negative effects on output of good and bad projects, ideas, decisions, etc. Recall that bad projects can be considered as production decisions that divert resources from productive activities and thus reduce the total output of the sector. This is represented by assuming \(s^b_z\) is negative. Correspondingly, for the other good \(y\)

\[ y_1 = s^g_y G(K, L), \text{ where } s^g_y > 0 \]  

(5a)

\[ y_2 = s^b_y G(K, L), \text{ where } s^b_y < 0 \]  

(5b)

\(G(K,L)\) is also homogeneous of degree 1. As in the HOS model, the production technology is the same in both countries. That is, the same \(F(K,L)\) and \(G(K,L)\) functions apply to both countries.

**Definition.** The environment is said to be symmetric when \(s^g_i = |s^b_i|, i = y, z\).

Both countries face the same pool of projects, where in sector \(z\), the fraction of good projects is \(\alpha\), and \(\delta\) is the fraction of good projects in sector \(y\). Thus, \(s^g_z, s^b_z, s^g_y\) and \(s^b_y\) are also the same for both countries. Furthermore, while each sector has a distinct screening function, the same screening functions apply to both countries. Consequently, the same

---

\(^3\) This assumption can be easily relaxed, without affecting any of the results, as shown later in Section 4.
screening function probabilities apply to both countries. This implies that there are no differences in ‘knowledge’ across the two countries, but only in the manner in which that knowledge is processed. This assumption is made to emphasize the point that differences in organizational arrangement alone are enough to influence trade between two countries.

The screening function for the sector producing $z$ is characterized by the probability that a good project gets accepted, denoted by $\pi_z(s^g_z) \equiv \epsilon_1$, and the probability that a bad project is accepted, denoted by $\pi_z(s^b_z) \equiv \epsilon_2$. For sector $y$, the analogous functions are characterized by $\pi_y(s^g_y) \equiv \mu_1$ and by $\pi_y(s^b_y) \equiv \mu_2$.

**Monotonicity.** An environment is monotonic when $\epsilon_1 > \epsilon_2$ and $\mu_1 > \mu_2$.

Thus, under monotonicity — which is assumed throughout the paper, projects that have a higher impact on output have a higher probability of being accepted. The total output is a consequence of the combined effect of the bad and good projects adopted. Under polyarchy, for instance, the $\alpha$ proportion of good projects that are considered have an $\epsilon_1$ probability of being accepted, while the $(1-\alpha)$ proportion of bad projects that are considered have an $\epsilon_2$ probability of being accepted. Using (1), (4a) and (4b), output under polyarchy is therefore as below, where $\Omega^P$, $\Omega^H$, and $\Omega^M$ are implicitly defined as

$$ Z^P = \alpha z_1 \epsilon_1 (2 - \epsilon_1) + (1 - \alpha) z_2 \epsilon_2 (2 - \epsilon_2) \equiv \Omega^P F(K, L) \quad (6a) $$

Analogously, under hierarchy, using (2), (4a) and (4b):

$$ Z^H = \alpha z_1 \epsilon_1^2 + (1 - \alpha) z_2 \epsilon_2^2 \equiv \Omega^H F(K, L) \quad (6b) $$

The ‘mean’ output, using (3), (4a) and (4b) is:

$$ Z^M = \alpha z_1 + (1 - \alpha) z_2 \equiv \Omega^M F(K, L) \quad (6c) $$

Similar expressions would prevail for sector $y$, where $G(K, L)$ would replace $F(K, L)$, $\delta$ would replace $\alpha$ and $\mu$ would replace $\epsilon$. It is, of course, essential to ensure that the total sector output, as a consummation of the positive and negative effects of the projects is ultimately positive.

**Claim 1.** The ‘mean’ output for sector $z$ is positive when $\alpha > \frac{|s^b_z|/(s^g_z + |s^b_z|)}$. 

**Proof.** See Appendix A.

**Corollary.** In a symmetric environment, ‘mean’ output for sector $z$ is positive when $\alpha > \frac{1}{2}$.

Exactly analogous conditions hold for sector $y$. This has a simple intuition. If the relative effect of bad projects on total output is greater than the proportion of good projects in the pool then the total output cannot be positive, as the effect of the bad projects will weaken the effect of the good projects. We can further establish the following.

**Result 1.** If ‘mean’ output is positive, then output under both hierarchy and polyarchy is also positive.
Proof. See Appendix A.

Let us now define the following parameters:

\[
\Lambda(\epsilon) \equiv \frac{1 - \epsilon_2^2}{2 - \epsilon_1^2 - \epsilon_2^2} \tag{7}
\]

\[
\Gamma(\epsilon) \equiv \frac{(1 - \epsilon_2)^2}{(1 - \epsilon_1)^2 + (1 - \epsilon_2)^2} \tag{8}
\]

\[
\Psi(\epsilon) \equiv \frac{\epsilon_2 - \epsilon_2^2}{\epsilon_1 + \epsilon_2 - (\epsilon_1^2 + \epsilon_2^2)} \tag{9}
\]

**Result 2.** In a symmetric environment \(\Omega_z^M > \Omega_z^H\) when \(\alpha > \Lambda(\epsilon)\), \(\Omega_z^M > \Omega_z^P\) when \(\alpha > \Gamma(\epsilon)\), and \(\Omega_z^P > \Omega_z^H\) when \(\alpha > \Psi(\epsilon)\). Furthermore, \(\Gamma(\epsilon) > \Lambda(\epsilon) > \Psi(\epsilon)\).

Proof. See Appendix A.

Analogous claims can be established for sector \(y\), where \(\delta\) would replace \(\alpha\) and \(\mu\) would replace \(\epsilon\). The intuition for this result is straightforward. As \(\alpha\) and \(\delta\) increase, the proportion of good projects rise. Since hierarchies give only one consideration to a specific project, they tend to erroneously reject a number of good projects. Thus, in a more favorable environment, i.e., where the proportion of good projects is higher, a polyarchy, which provides a project two independent considerations before rejecting it, will tend to dominate a hierarchy. Since the ‘mean’ system accepts all projects, it will tend to erroneously accept a number of bad projects. However, as the environment becomes increasingly favorable, the effect of this handicap of the ‘mean’ system diminishes and it first dominates a hierarchy (for \(\alpha > \Lambda(\mu)\) and \(\delta > \Lambda(\mu)\)) and then a polyarchy (for \(\alpha > \Gamma(\epsilon)\) and \(\delta > \Gamma(\mu)\)). Fig. 1 shows the environments, i.e., parameter regions, where different organization systems produce greater output. The shaded areas indicate parameter regions where one organization form is better than the others in both sector \(y\) and sector \(z\). For example, in the parameter region defined by \(\alpha > \Gamma(\epsilon)\) and \(\delta > \Gamma(\mu)\), the ‘mean’ system dominates polyarchy and hierarchy in both sectors. This indicates that certain organizations produce greater output in certain environments,\(^4\) while others do better in other environments as defined by the parameter configurations above. They will prove useful later in establishing sufficient conditions for the nature of international trade.

\(^4\) It may be questioned why countries choose to stick with certain institutions. One explanation, given above is that the institutions are suited to the environment of the country. However, at another level, there are significant lock-in effects in a number of models proposed for institutional development and the adoption of ideas (see, e.g. Schotter, 1981; Arthur, 1989). This imparts considerable inertia to existing structures. The focus of this paper is to examine whether differences in such institutional structures, whatever be the manner by which they have come into being, can in themselves provide a rationale for trade.
2.3. Consumption

We assume that consumption patterns are identical across the two countries, and that there are no multiple pre-trade equilibria. A sufficient demand restriction that does not permit multiple self-sufficiency equilibria is that there are identical, homothetic indifference curves characterized by interminability of consumption of either good (Bhagwati and Srinivasan, 1983).

3. Comparative advantage

There are two distinct determinants of output in both domestic and foreign economies: the usual inputs, capital and labor, and the quality of decision making (polyarchy, hierarchy and
randomization). We initially assume that the home country is characterized by polyarchical decision making and the foreign country by hierarchical decision making. To relate the above structure with traditional trade models it is assumed that the domestic country is the capital rich country compared to the foreign country which has relatively more labor, and good $z$ uses more capital intensive technology compared to good $y$. We assume that $F(K,L)$ and $G(K,L)$ are production functions with properties that ensure that factor-intensity reversals do not occur. A We allow for perfect factor mobility between the two sectors, so that the wage rate ($w$) and the rental ($r$) are equalized between the two sectors. Each producer minimizes his cost of production. That is, he chooses his capital–labor ratios, i.e.,

$$k_z = \frac{(w - r_k)}{f(k_1)}, \quad i = y, z$$

(12)

Since constant returns to scale is assumed for both $z$ and $y$, $f(k_z) \equiv L_z^{-1} F(K_z, L_z)$ and the function $g$ is defined as $g(k_y) \equiv L_y^{-1} G(K_y, L_y)$. The optimal $k_z$ and $k_y$ thus depend only on $\omega \equiv w/r$, the factor–price ratio. Optimality requires that the marginal rate of substitution (MRS) between capital and labor in the two sectors to be equal to this wage–rental ratio, $\omega$. Since the expressions representing internal organization factors, $\Omega^P_z$ and $\Omega^P_y$, influence input choice symmetrically, they do not affect the MRS between capital and labor, as is evident below (see (13)). Note that $f_1$ and $g_1$ denote the partial derivatives with respect to the relevant capital–labor ratio.

$$f - k_z f_1 = \omega \equiv \frac{g - k_y g_1}{g_1}$$

(13)

The marginal rate of transformation is, however, affected by the relative impact of the particular internal organization (polyarchy in the domestic economy) on the two sectors between the two commodities, in addition to the usual trade-off between the two commodities arising from the different capital–labor ratios in the two sectors as $\omega$ varies. It is given by the following expression:

$$\frac{-dZ}{dY} = \frac{-dZ^P_i/\omega}{dY^P / \omega} = \frac{-\Omega^P_y (l_z f_1 ((dk_z/d\omega) + f (dl_z/d\omega)))}{\Omega^P_y ((1 - l_z) g_1 (dk_y/d\omega) - g((dl_z/d\omega)))}$$

(14)

5 As is well known, if there are two activities, then if their elasticities of substitution are unequal there must be factor-intensity reversals. However, if both goods have Cobb–Douglas production functions and therefore the elasticities of substitution are equal, factor-intensity reversals are impossible.

6 The $\Omega$s are similar to neutral efficiency parameters posited by Minhas (1962) in a different context.
and are, respectively, the total output of sectors and under polyarchy as given by (6a) and its analog, and is the proportion of labor force employed in the production of good .

In the standard model, the _Ω_ s, of course, do not appear since there is no assumption regarding decision-making. Since the condition for optimality, the production set and the rate of transformation for the foreign country are exactly analogous to that for the domestic economy, they are omitted. The important difference is that the production set and the rate of transformation are influenced by expressions that represent hierarchical decision-making (Ω^H_ and _Ω^H_y) in place of polyarchical ones.

For establishing comparative advantage, it is important to observe that the cost functions for the two commodities in both economies are influenced by the particular internal organization structure incorporated in the two countries. In the traditional model if, prior to trade, the home economy is defined as the capital-abundant country because \( \omega^+ > \omega^- \), then \( q^+ > q^- \), the pre-trade price ratios of \( y \) with respect to \( z \) at home and abroad, respectively, are such that \( q^+ > q^- \) since \( k_z > k_y \). This follows because \( C(\omega)^+ > C(\omega)^- \), where \( C(\omega)^+ = c_y^z / c_z^z \) and \( C(\omega)^- = c_y^y / c_z^y \). Recalling that in the traditional model unit costs are given by (12). But in this model with organization, unlike the standard model, the link between the wage–rental ratios and unit costs may not hold, since the relative impact of the particular decision making system on the two sectors is also important (see Eqs. (10) and (11)).

We could conceivably have a situation where the capital-intensive good (commodity \( z \)) in the domestic economy (capital-rich country) is, relative to commodity \( y \), more expensive than in the foreign country. Trade in this model occurs when the organization-adjusted relative costs differ across the two countries. It is useful to state this, since it would be used frequently in later discussion.

**Result 3.** Trade occurs when \( C(\omega)^+ \neq C(\omega)^- \).

**Proposition 1.** The pattern of comparative advantage is reversed from the traditional model when the following conditions hold.

\[
\frac{C(\omega)^+}{C(\omega)^-} < 1 \quad \text{and} \quad \frac{\Omega^P_z \Omega^H_z}{\Omega^H_y} \quad \frac{C^*(\omega^+)^+}{C^*(\omega^+)^-} > \frac{C^*(\omega^-)^+}{C^*(\omega^-)^-}
\]

\[
\frac{C(\omega)^+}{C(\omega)^-} > 1 \quad \text{and} \quad \frac{\Omega^P_z \Omega^H_z}{\Omega^H_y} \quad \frac{C^*(\omega^+)^+}{C^*(\omega^+)^-} < \frac{C^*(\omega^-)^+}{C^*(\omega^-)^-}
\]

**Proof.** See Appendix A.

---

7 See, e.g., Bhagwati and Srinivasan (1983).

8 If the impact is the same, i.e., if \( \Omega^H_z = \Omega^H_y \) and \( \Omega^H_z = \Omega^H_y \), then \( \omega \) and \( \omega^- \) completely determine relative unit costs in the two countries.

9 Formally, the condition for establishing comparative advantage in the model of Section 3 has Ricardian features (Patel, 1994). However, as noted in Section 1, the motivation for trade is distinct from existing well known formulations, e.g., differences in factor endowments (Ohlin, 1933; Samuelson, 1948), a desire for variety by consumers (Ethier, 1979; Krugman, 1979; Helpman, 1981), and variable returns to scale (Panagariya, 1980; Ethier, 1982).
The result follows directly from a comparison of the relative unit costs of the traditional model with those derived for this model, where internal organization is explicitly modeled. The larger the $\Omega$, the lower the cost of production. Ordinarily, since the domestic country is capital rich, it will be able to produce the capital-intensive good, $z$, relatively more cheaply. However, when the relative efficiency of the domestic organization structure, viz., a polyarchy, is sufficiently strong, given by the condition in Proposition 1, in sector $y$, the reduction in unit costs due to organizational efficiency will be so large that the domestic country will end up producing the labor-intensive good, $y$, more cheaply, i.e., the pattern of comparative advantage will be reversed. In other words, the ‘organization effect’, i.e., $\Omega^P_z = \Omega^H_z / \Omega^H_y$, must be sufficiently strong in order to overcome the ‘cost effect’.

**Definition.** An identical environment is said to exist when $c_i^e = c_i^f, i=y, z$.

**Corollary 1.** In an identical environment, an asymmetry in the relative efficiency of a polyarchy and a hierarchy in producing $z$ and $y$ is sufficient for trade to occur.

**Proof.** See Appendix A.

When the relative efficiencies of the organization systems differ across countries, they affect the unit costs in the two sectors in an unequal manner. This creates a difference between the costs of producing goods in the two countries, which furnishes the basis for trade. It is thus possible for comparative advantage to obtain even when two economies have identical endowments of factors of production (capital and labor in our case), production technology and consumption pattern for the two commodities, but have distinct forms of internal organization.

**Proposition 2.** If two economies have distinct decision making organizational structures, then factor prices are unlikely to be the same in both countries even if both countries produce the two commodities in the trading equilibrium, i.e., factor-price equalization does not hold.

**Proof.** See Appendix A.

This is another consequence of the break in linkage between wage rental ratios and unit costs. With identical technologies and a common set of prices due to trade, the univalent mapping between factor prices and commodity prices guarantees factor-price equalization. However, in this case, while there is one univalent mapping in each country, it is not the same as in the other country, because of the effect of organization related parameters. Only in the unlikely case where the value of the parameters is identical or the effect of the $\Omega$s is the same, i.e., they balance each other appropriately, would factor-price equalization occur.

The effect of commodity price changes on factor rewards can also be analyzed. As noted above, even in this model with organization, there continues to be a monotone relationship between factor-prices and commodity prices within a country. Hence, the following analog of the Stolper–Samuelson proposition can be stated and proved.
Proposition 3. The competitive reward to the factor used intensively in the production of the good whose relative price rises also increases, even when returns to factors are influenced by the particular internal organization (hierarchy or polyarchy) in that country.

Proof. See Appendix A.

4. Patterns of trade and extensions to the basic model

4.1. Patterns of trade

To further explore the circumstances under which trade obtains, we establish sufficient conditions for the pattern of trade between countries with different organizational structures. In order to simplify notation we present these conditions for an identical and symmetric environment. Analogous and slightly more messy conditions would characterize trade patterns in a more general environment. Based on Result 3, it is easy to show the following.10

Result 4. Trade occurs when \( \Omega_y / \Omega_z \neq \Omega_y^* / \Omega_z^* \).

There are two sufficient, but not necessary, conditions under which the above will hold.

\[
\Omega_y \leq \Omega_y^* \quad \text{and} \quad \Omega_z \geq \Omega_z^*
\]  
(15)

We consider three cases. First, where the home country is hierarchical and the foreign country is organization-free, i.e., ‘mean’; second, where the home country is polyarchical and the foreign country is organization-free; and third, where the home country is polyarchical and the foreign country is hierarchical. The following sufficient conditions on the parameters can then be established based on Result 2.

Case 1. In this case the domestic country will export good \( z \) and import \( y \) from the foreign country if (this is a sufficient condition), \( \delta > \Lambda(\mu) \) and \( \alpha < \Lambda(\epsilon) \), and will import good \( z \) and export \( y \) if \( \delta < \Lambda(\mu) \) and \( \alpha > \Lambda(\epsilon) \). See Fig. 2a.

Case 2. In this case the domestic country will export good \( z \) and import \( y \) from the foreign country if \( \delta > \Gamma(\mu) \) and \( \alpha < \Gamma(\epsilon) \), and will import good \( z \) and export \( y \) if \( \delta < \Gamma(\mu) \) and \( \alpha > \Gamma(\epsilon) \). See Fig. 2b.

Case 3. In this case the domestic country will export good \( y \) and import \( z \) from the foreign country if \( \delta > \Psi(\mu) \) and \( \alpha < \Psi(\epsilon) \), and will import good \( y \) and export \( z \) if \( \delta < \Psi(\mu) \) and \( \alpha > \Psi(\epsilon) \). See Fig. 2c.

As seen in Fig. 2a–c, sufficient characterization of trade is possible when the organization systems in the two countries are relatively more suited for the production of different goods.

10 Since the algebra is entirely analogous to the proof of Result 5, in Appendix A (with \( N_z, N_z^*, N_y, \) and \( N_y^* \) set to 1), it is omitted for brevity.
Fig. 2. (a) Case 1: domestic country will export good z and import y from the foreign country in Region II and will import good z and export y in Region IV (domestic country is hierarchical and foreign country is organization-free). (b) Case 2: domestic country will export good z and import y from the foreign country in Region II and will import good z and export y in Region IV (domestic country is polyarchical and foreign country is organization-free). (c) Case 3: domestic country will export good y and import z from the foreign country in Region II and will import good y and export z in Region IV (domestic country is polyarchical and foreign country is hierarchical).
From Fig. 1, when \( \alpha \) and \( \delta \) are both high or low, one organization system dominates in both goods, and the pattern of trade depends on the specific project environment, i.e., the exact values of \( \alpha \) and \( \delta \). However, if there is sufficient difference between the population of projects in the two sectors, i.e., \( \alpha \) and \( \delta \) are sufficiently different, each country (or organization system) is more suited for the production of one good relative to the other, which provides a sufficient reason for trade between the two countries.

4.2. Asymmetry in number of projects

The normalization that \( N_z = N_x^* = N_y = N_y^* = 1 \) was imposed to derive a rationale for trade to take place that was not based on differences in the number of projects between the two countries. For the case where the number of projects are different between the two countries, i.e., \( N_z \neq N_x^* \), and \( N_y \neq N_y^* \), the following analogous result exists.

**Result 5.** In an identical environment, when the domestic country is characterized by polyarchical decision making and the foreign economy is characterized by hierarchical decision making, trade occurs when

\[
\frac{N_y \Omega_y^p}{N_z \Omega_z^h} \neq \frac{N_y^* \Omega_y^h}{N_z^* \Omega_z^h}.
\]

**Proof.** See Appendix A.
4.3. Many commodities

The two-good model, where the two economies have identical endowments, can be extended to a multi-commodity case with the proviso that goods that are produced in the home and foreign countries can be conveniently arranged in order of diminishing home country comparative advantage. This essentially entails an \( n \)-good generalization of the conditions, as below.

\[
\frac{\Omega_i^P}{\Omega_i^H} > \cdots > \frac{\Omega_i^P}{\Omega_i^H} > \cdots > \frac{\Omega_n^P}{\Omega_n^H}. \tag{16}
\]

If there are a continuum of goods on an interval, say \([0,1]\), then a commodity \( v \) is associated with each point on the interval.\(^{11}\) We can then define the following relative economic system performance function.

\[
S(v) \equiv \frac{\Omega_i^P(v)}{\Omega_i^H(v)}, \quad S'(v) < 0. \tag{17}
\]

For the function to be well defined, the chain cannot be crisscrossed, i.e., each exported good must have a relative organizational advantage over each imported good. The home country will export those commodities for which it has an organizational comparative advantage, the cut-off in the above chain being defined by the point \( S(v) = 1 \), and the converse is true for the foreign country. To ensure that all commodities are consumed after trade takes place, we have to impose a strong uniform homothetic demand structure on the demand functions of the two countries, such as Cobb–Douglas, which associates a constant expenditure share with each of the \( n \) commodities.

5. Conclusion

The paper has attempted to integrate theories of internal organization with traditional models of international trade by adding the extra dimension of organizational structure to the traditional organization-neutral HOS model. An important conclusion is that in addition to relative factor endowments, asymmetry in how two economies are organized is also a determinant of comparative advantage. Indeed, in the absence of differences in relative factor endowments, differences in the organizational structure can alone be a determinant of comparative advantage, i.e., given an otherwise similar environment, trade could very well be motivated by differences in the way decisions are made. The model showed that there was no a priori reason for one structure to be superior to another; depending on the parameter configuration, one system can outperform the other and vice versa. Further, factor-price equalization need not emerge once trade takes place. This model was generalized to allow for different number of projects in the two countries, and to allow for multiple goods. Although, we have used the traditional model to highlight the role of decision-making organizations in determining comparative advantage, the framework is flexible enough to

\(^{11}\) This analysis is similar to Dornbusch et al. (1977) for a model with multiple goods.
be used in any international trade framework; in fact, in any model where decision making could conceivably play a role irrespective of market structure.

Finally, there are at least two lines of further research that lend themselves to exploration. First, embedding other market structures commonly used in international trade, e.g., monopolistic competition in an organizational framework. Second, exploring the impact of different modes of decision making on the likelihood of particular protectionist trade policy proposals getting accepted in a political economy context.  

Acknowledgements

The paper has benefited immensely from the comments of two anonymous referees. I would like to thank T.N. Srinivasan and Pradeep Srivastava for helpful comments on an earlier draft and Sunaina Kilachand and Aditi Jagtiani for assistance. I am especially grateful to Partha Mukhopadhyay for his help in completing the paper. The views expressed here are the author’s and are not necessarily those of the organizations to which he is affiliated.

Appendix A

Proof of Claim 1.

\[
\alpha > \frac{|s^b_1|}{s^b_3 + |s^b_3|} \tag{A.1}
\]

\[
\Rightarrow \alpha (s^b_3 + |s^b_3|) > |s^b_3| \tag{A.2}
\]

\[
\Rightarrow \alpha s^b_3 > (1 - \alpha)|s^b_3| \tag{A.3}
\]

Now, \(z_1 \equiv s^b_3 F(K, L), s^b_3 > 0\) and \(z_2 \equiv s^b_3 F(K, L), s^b_3 < 0\)

\[
\Rightarrow \alpha z_1 > (1 - \alpha)|z_2| \tag{A.4}
\]

\[
\Rightarrow \alpha z_1 - (1 - \alpha)|z_2| > 0 \tag{A.5}
\]

Since \(s^b_3 < 0, z_2 < 0\). Therefore,

\[
\alpha z_1 + (1 - \alpha)z_2 > 0 \tag{A.6}
\]

\[
\Rightarrow Z^M > 0 \quad \square \tag{A.7}
\]

Proof of Result 1. Manipulation of the definition of \(Z^H\) and \(Z^P\) would show that \(Z^H > 0\) iff \(\alpha > |s^b_3|/(\epsilon_1^2 s^b_3 + |s^b_3|)\) and \(Z^P > 0\) iff \(\alpha > |s^b_3|/((\epsilon_1 (2 - \epsilon_1))/\epsilon_2 (2 - \epsilon_2))s^b_3 + |s^b_3|)\).

\footnote{In particular, this can be attempted in a model of the type put forward by Grossman and Helpman (1994). Also, see Patel (1997) for further discussion on this issue.}
From Result 1, we know that if \( Z^M > 0 \Rightarrow \alpha > |s^b_Z|/\left(s^g_Z + |s^b_Z|\right) \). It is therefore sufficient to show that \( |s^b_Z|/\left(s^g_Z + |s^b_Z|\right) > |s^b_Z|/\left((\epsilon_1^2/\epsilon_2^2) s^g_Z + |s^b_Z|\right) \) to ensure that output under hierarchy is positive if ‘mean’ output is positive. Now, since monotonicity has been assumed, i.e., \( \epsilon_1 > \epsilon_2 \),

\[
\frac{\epsilon_1^2}{\epsilon_2^2} > 1 \tag{A.8}
\]

\[
\Rightarrow \left(\frac{\epsilon_1^2}{\epsilon_2^2}\right) s^g_Z > s^g_Z \tag{A.9}
\]

\[
\Rightarrow \left(\frac{\epsilon_1^2}{\epsilon_2^2}\right) s^g_Z + |s^b_Z| > (s^g_Z + |s^b_Z|) \tag{A.10}
\]

\[
\Rightarrow \frac{1}{(s^g_Z + |s^b_Z|)} > \frac{1}{\left(\epsilon_1^2/\epsilon_2^2\right) s^g_Z + |s^b_Z|} \tag{A.11}
\]

\[
\Rightarrow \frac{|s^b_Z|}{(s^g_Z + |s^b_Z|)} > \frac{|s^b_Z|}{\left(\epsilon_1^2/\epsilon_2^2\right) s^g_Z + |s^b_Z|} \tag{A.12}
\]

Similarly, if it is shown that \( |s^b_Z|/\left(s^g_Z + |s^b_Z|\right) > |s^b_Z|/\left(((\epsilon_1(2-\epsilon_1))/\epsilon_2(2-\epsilon_2)) s^g_Z + |s^b_Z|\right) \), then output under polyarchy is positive if ‘mean’ output is positive. From the deduction above, this will be the case if \( (\epsilon_1(2-\epsilon_1))/\epsilon_2(2-\epsilon_2)) > 1 \). Now, since \( \epsilon_i < 1 \), \( i=1, 2 \) we can state that

\[
\Rightarrow \epsilon_1 + \epsilon_2 < 2 \tag{A.13}
\]

\[
\Rightarrow (\epsilon_1 + \epsilon_2)(\epsilon_1 - \epsilon_2) < 2(\epsilon_1 - \epsilon_2) \tag{A.14}
\]

\[
\Rightarrow (\epsilon_1^2 - \epsilon_2^2) < 2(\epsilon_1 - \epsilon_2) \tag{A.15}
\]

\[
\Rightarrow 2\epsilon_2 - \epsilon_2^2 < 2\epsilon_1 - \epsilon_1^2 \tag{A.16}
\]

\[
\Rightarrow \epsilon_2(2-\epsilon_2) < \epsilon_1(2-\epsilon_1) \tag{A.17}
\]

\[
\Rightarrow \frac{\epsilon_1(2-\epsilon_1)}{\epsilon_2(2-\epsilon_2)} > 1 \tag{A.18}
\]

**Proof of Result 2.** To prove the first claim, we shall show that \( \alpha > \Lambda(\epsilon) \Rightarrow \Omega^M_Z > \Omega^H_Z \).

\[
\alpha > \Lambda(\epsilon) \equiv \frac{(1-\epsilon_1^2)}{2-\epsilon_1^2-\epsilon_2^2} \tag{A.19}
\]

\[
\Rightarrow \frac{(1-\epsilon_1^2) + (1-\epsilon_2^2)}{1-\epsilon_2^2} > \frac{1}{\alpha} \tag{A.20}
\]

\[
\Rightarrow 1 + \frac{1-\epsilon_1^2}{1-\epsilon_2^2} > \frac{1}{\alpha} \tag{A.21}
\]
\[ \frac{1 - \epsilon_1^2}{1 - \epsilon_2^2} > \frac{1 - \alpha}{\alpha} \]  \hspace{1cm} (A.22)

\[ \frac{\alpha}{1 - \alpha} (1 - \epsilon_1^2) > (1 - \epsilon_2^2) \]  \hspace{1cm} (A.23)

\[ \Omega_z^M > \Omega_z^H. \]  \hspace{1cm} (A.24)

Now consider the second claim,

\[ \alpha > \Gamma(\epsilon) \equiv \frac{1 - \epsilon_2^2}{(1 - \epsilon_1)^2 + (1 - \epsilon_2)^2} \]  \hspace{1cm} (A.25)

\[ \frac{(1 - \epsilon_1)^2 + (1 - \epsilon_2)^2}{(1 - \epsilon_2)^2} > \frac{1}{\alpha} \]  \hspace{1cm} (A.26)

\[ \frac{(1 - \epsilon_1)^2}{(1 - \epsilon_2)^2} > \frac{1 - \alpha}{\alpha} \]  \hspace{1cm} (A.27)

\[ \frac{\alpha}{1 - \alpha} (1 - \epsilon_1)^2 > (1 - \epsilon_2)^2 \]  \hspace{1cm} (A.28)

\[ \Omega_z^M > \Omega_z^P. \]  \hspace{1cm} (A.29)

Now the third claim,

\[ \alpha > \Psi(\epsilon) \equiv \frac{\epsilon_2 - \epsilon_2^2}{\epsilon_1 + \epsilon_2 - (\epsilon_1^2 + \epsilon_2^2)} \]  \hspace{1cm} (A.30)

\[ \frac{\epsilon_1 - \epsilon_1^2 + \epsilon_2 - \epsilon_2^2}{\epsilon_2 - \epsilon_2^2} > \frac{1}{\alpha} \]  \hspace{1cm} (A.31)

\[ \frac{\epsilon_1 (1 - \epsilon_1)}{\epsilon_2 (1 - \epsilon_2)} > \frac{1 - \alpha}{\alpha} \]  \hspace{1cm} (A.32)

\[ \frac{\alpha}{1 - \alpha} (\epsilon_1 (1 - \epsilon_1)) > (\epsilon_2 (1 - \epsilon_2)) \]  \hspace{1cm} (A.33)

\[ \Omega_z^P > \Omega_z^H. \]  \hspace{1cm} (A.34)

Now we show that \( \Lambda(\epsilon) < \Gamma(\epsilon) \):

\[ (\epsilon_1 - \epsilon_2) (1 - \epsilon_1) > 0 \]  \hspace{1cm} (A.35)

\[ \epsilon_1 (1 - \epsilon_1) - \epsilon_2 (1 - \epsilon_1) > 0 \]  \hspace{1cm} (A.36)

\[ \epsilon_1 (1 - \epsilon_1) + \epsilon_2 (1 - \epsilon_1) > 0 \]  \hspace{1cm} (A.37)

\[ \epsilon_1 - \epsilon_1^2 + \epsilon_1 \epsilon_2 - \epsilon_2 > 0 \]  \hspace{1cm} (A.38)

\[ \epsilon_1^2 + \epsilon_2^2 + \epsilon_2 - \epsilon_1^2 - \epsilon_1 \epsilon_2 < 0 \]  \hspace{1cm} (A.39)
\[ 2(\varepsilon_1^2 + \varepsilon_2^2) + 2\varepsilon_2(1 - \varepsilon_2) - 2\varepsilon_1(1 + \varepsilon_2) < 0 \]  
(A.40)

\[ ((1 + \varepsilon_2) + (1 - \varepsilon_2))(\varepsilon_1^2 + \varepsilon_2^2) + (1 + \varepsilon_2 - 1) 
(2(1 - \varepsilon_2)) - (1 + \varepsilon_2)2\varepsilon_1 < 0 \]  
(A.41)

\[ (1 + \varepsilon_2)(\varepsilon_1^2 + \varepsilon_2^2) + (1 + \varepsilon_2) 
(2(1 - \varepsilon_2)) - (1 + \varepsilon_2)2\varepsilon_1 < 2(1 - \varepsilon_2) - (1 - \varepsilon_2)(\varepsilon_1^2 + \varepsilon_2^2) \]  
(A.42)

\[ (1 + \varepsilon_2)(\varepsilon_1^2 + \varepsilon_2^2 + 2(1 - \varepsilon_2) - 2\varepsilon_1) < (1 - \varepsilon_2)(2 - (\varepsilon_1^2 + \varepsilon_2^2)) \]  
(A.43)

\[ \frac{(1 + \varepsilon_2)(1 - \varepsilon_2)}{2 - \varepsilon_1^2 - \varepsilon_2^2} < \frac{(1 - \varepsilon_2)^2}{(1 - \varepsilon_1)^2 + (1 - \varepsilon_2)^2} = \frac{(1 - \varepsilon_2)^2}{1 + \varepsilon_1 - 2\varepsilon_1 + 1 + \varepsilon_2^2 - 2\varepsilon_2} \]  
(A.44)

\[ \frac{1 - \varepsilon_2^2}{2 - \varepsilon_1^2 - \varepsilon_2^2} < \frac{(1 - \varepsilon_2)^2}{(1 - \varepsilon_1)^2 + (1 - \varepsilon_2)^2} \]  
(A.45)

\[ \Rightarrow \Lambda(\varepsilon) < \Gamma(\varepsilon) \]  
(A.46)

Now consider \( \Lambda(\varepsilon) > \Psi(\varepsilon) \)

By monotonicity, \( \varepsilon_1 > \varepsilon_2 \)  
(A.47)

\[ \Rightarrow \varepsilon_1(1 - \varepsilon_1) - \varepsilon_2(1 - \varepsilon_1) > 0 \]  
(A.48)

\[ \Rightarrow \varepsilon_1 - \varepsilon_1^2 - \varepsilon_2 + \varepsilon_1\varepsilon_2 + \varepsilon_1^2\varepsilon_2 - \varepsilon_1^2\varepsilon_2 + \varepsilon_2^2 - \varepsilon_2^3 > 0 \]  
(A.49)

\[ \Rightarrow \varepsilon_1 - 2\varepsilon_2 + \varepsilon_2 + \varepsilon_1\varepsilon_2 + \varepsilon_1^2\varepsilon_2 + \varepsilon_2^2 - \varepsilon_1^2\varepsilon_2 - \varepsilon_2^2 - \varepsilon_2^3 + \varepsilon_2^3 > 0 \]  
(A.50)

\[ \Rightarrow \varepsilon_1 + \varepsilon_2 + \varepsilon_1\varepsilon_2 + \varepsilon_2^2 - (1 + \varepsilon_2)(\varepsilon_1^2 + \varepsilon_2^2) - 2\varepsilon_2 + \varepsilon_1^2\varepsilon_2 + \varepsilon_2^3 > 0 \]  
(A.51)

\[ \Rightarrow (1 + \varepsilon_2)(\varepsilon_1 + \varepsilon_2 - (\varepsilon_1^2 + \varepsilon_2^2)) > \varepsilon_2(2 - \varepsilon_1^2 - \varepsilon_2^2) \]  
(A.52)

\[ \Rightarrow \frac{1 + \varepsilon_2}{2 - \varepsilon_1^2 - \varepsilon_2^2} > \frac{\varepsilon_2}{\varepsilon_1 + \varepsilon_2 - (\varepsilon_1^2 + \varepsilon_2^2)} \]  
(A.53)

Multiplying both sides by \((1 - \varepsilon_2)\)

\[ \Rightarrow \frac{1 - \varepsilon_2^2}{2 - \varepsilon_1^2 - \varepsilon_2^2} > \frac{\varepsilon_2 - \varepsilon_2^2}{\varepsilon_1 + \varepsilon_2 - (\varepsilon_1^2 + \varepsilon_2^2)} \]  
(A.54)

\[ \Rightarrow \Lambda(\varepsilon) > \Psi(\varepsilon) \]

(A.55)

**Proof of Proposition 1.** Assume that, in the traditional model, the pattern of comparative advantage is given by \( C(\omega)/C'(\omega') > 1 \). In this model, the pattern depends on whether
$C(\omega)/C^\ast(\omega^\ast)$ is greater than or less than one. Thus, the pattern of comparative advantage would be reversed when $C(\omega)/C^\ast(\omega^\ast)<1$. Now,

$$C(\omega) \equiv \frac{c_y}{c_z} = \frac{\Omega^P_z \cdot c'_y}{\Omega^P_y \cdot c'_z} = \left(\frac{\Omega^P_z}{\Omega^P_y}\right) C(\omega)' \quad (A.56)$$

$$\frac{C(\omega)}{C^\ast(\omega^\ast)} = \left(\frac{\Omega^P_z/\Omega^P_y}{\Omega^H_z/\Omega^H_y}\right) \left(\frac{C(\omega)'}{C^\ast(\omega^\ast)'}\right) \quad (A.57)$$

$$\frac{C(\omega)}{C^\ast(\omega^\ast)} < 1 \Rightarrow \left(\frac{\Omega^P_z/\Omega^P_y}{\Omega^H_z/\Omega^H_y}\right) \left(\frac{C(\omega)'}{C^\ast(\omega^\ast)'}\right) < 1 \quad (A.58)$$

$$\Rightarrow \frac{\Omega^H_z/\Omega^H_y}{\Omega^P_z/\Omega^P_y} < \frac{C^\ast(\omega^\ast)'}{C(\omega)'} \quad (A.59)$$

**Proof of Corollary 1.** Asymmetry in the relative efficiency of a polyarchy and a hierarchy implies:

$$\frac{\Omega^P_z}{\Omega^P_y} \neq \frac{\Omega^H_z}{\Omega^H_y} \Rightarrow \frac{\Omega^P_z/\Omega^P_y}{\Omega^H_z/\Omega^H_y} \neq 1$$

In an identical environment, $(c'_z/c'_y) = (c'^*_z/c'^*_y)$, i.e., $(C(\omega)'/C^\ast(\omega^\ast)')=1$

$$\Rightarrow \left(\frac{\Omega^P_z/\Omega^P_y}{\Omega^H_z/\Omega^H_y}\right) \left(\frac{C(\omega)'}{C^\ast(\omega^\ast)'}\right) \neq 1$$

$$\frac{C(\omega)}{C^\ast(\omega^\ast)} \neq 1$$

Hence, by virtue of Result 3, trade will occur. \qed

**Proof of Proposition 2.** Consider an equilibrium in the world economy where there is no sector specialization. Once trade is opened up, goods market equilibrium for the domestic economy is given by:

$$q_i = c_i(\omega, \Omega^P_i), \quad i = y, z$$

where $q_i$ and $q_x$ are the world market clearing prices of, respectively, $z$ and $y$. Since the conditions for the foreign economy are exactly analogous, we omit them for brevity. Given commodity prices, the above relationships determine the country’s factor prices. In the absence of factor intensity reversal, there is a univalent mapping between factor prices and commodity prices. However, this is so for given $\Omega^P_z$ and $\Omega^P_y$ in the domestic economy, and for given $\Omega^H_z$ and $\Omega^H_y$ in the foreign country. The two countries, of course, will have the same factor prices after trade if $\Omega^P_z = \Omega^H_z$ and $\Omega^P_y = \Omega^H_y$. If this does not hold, i.e., if
Proof of Proposition 3. Since the proposition applies symmetrically to both economies, for brevity we will show the proposition to hold for the domestic economy only. In equilibrium \( q = C(\omega) \), where \( q = q_z/q_y \), and \( C(\omega) = c_z/c_y \), the ratio of unit cost of \( y \) to \( z \). Now, the equilibrium wage (rental) in the sectors is defined as the marginal product of labor (capital) in producing that commodity. Therefore,

\[
\frac{dw_z}{dq} = \Omega_z^P \left( \frac{f_z^2}{f} \right) k_z \left( \frac{d\omega}{dq} \right)
\]

(A.61)

\[
\frac{dr_z}{dq} = -\Omega_z^P \left( \frac{f_z^2}{f} \right) \left( \frac{d\omega}{dq} \right).
\]

(A.62)

\[
\frac{dw_y}{dq} = \Omega_y^P \left( \frac{g_y^2}{g} \right) k_y \left( \frac{d\omega}{dq} \right)
\]

(A.63)

\[
\frac{dr_y}{dq} = -\Omega_y^P \left( \frac{g_y^2}{g} \right) \left( \frac{d\omega}{dq} \right).
\]

(A.64)

Hence,

\[
\frac{dw}{dq} = \left( \omega + k_z(\omega) \right) + \left( \omega + k_y(\omega) \right)
\]

(A.65)

Thus, \( dw_z/dq \) and \( dw_y/dq > 0 \) and \( dr_z/dq \) and \( dr_y/dq < 0 \) since \( k_z(\omega) > k_y(\omega) \). □

Proof of Result 5. When \( N_z \neq N_z^* \neq N_y \neq N_y^* \neq 1 \), then the total output relationships in the home and foreign country, based on (6a) and (6b), and given that the domestic country is organized as a polyarchy and the foreign country as a hierarchy, are as below:

13 The following example makes this clear. Consider, for the domestic economy, the case where the average cost functions (assuming Cobb–Douglas technology) for \( z \) and \( y \), respectively, are \( (\theta_1, r^u w^{1-\sigma})/\Omega_z^P \) and \( (\theta_1, r^u w^{1-\sigma})/\Omega_y^P \), where \( \theta_1 = \sigma^{-\sigma} (1-\sigma)^{1-\sigma} \), and \( \theta_1 = \beta^{-\beta} (1-\beta)^{1-\beta} \). This implies that factor returns post trade are \( r = \{(q_z/\theta_1)\Omega_z^P\}^{1-\beta}/(\sigma-\beta) \) and \( w = \{(q_z/\theta_1)\Omega_z^P\}^{1-\beta}/(\sigma-\beta) \). Similarly, for the foreign country after trade factor returns are \( r^* = \{(q_y/\theta_1)\Omega_y^P\}^{1-\beta}/(\sigma-\beta) \) and \( w^* = \{(q_y/\theta_1)\Omega_y^P\}^{1-\beta}/(\sigma-\beta) \). Obvioulsy, \( w = w^* \) and \( r = r^* \) when \( \Omega_z^P = \Omega_y^P \).

14 We use the relationship \( k_z'(\omega) = \frac{-f_z^2}{f z_{11}} \) and \( k_y'(\omega) = \frac{-g_y^2}{g y_{11}} \), which are the derivatives of, \( k_z \) and \( k_y \) respectively, with respect to the wage–rental ratio, where \( f_{11} \) and \( g_{11} \) denote the second-partial derivative with respect to the capital–labor ratio, and \( f_z^2 \) and \( g_y^2 \) is the square of the first-partial derivative with respect to the capital–labor ratio of \( f \) and \( g \), respectively.

15 This can also be easily checked for the example given in Footnote 13, where \( \sigma > \beta \) since commodity \( z \) is more capital intensive compared to \( y \).
\[ Z^P = N_z \alpha z_1 \epsilon_1 (2 - \epsilon_1) + N_z (1 - \alpha) z_2 \epsilon_2 (2 - \epsilon_2) \equiv N_z \Omega_z^P F(K, L) \quad (A.66) \]

\[ Z^{H^*} = N_z^* \alpha z_1 \epsilon_1^2 + N_z^* (1 - \alpha) z_2 \epsilon_2^2 \equiv N_z^* \Omega_z^{H^*} F(K, L) \quad (A.67) \]

Using (10) and (11), we can state that

\[ C(\omega) \equiv \frac{c_y}{c_z} = \frac{N_z \Omega_z^P c_y}{N_y \Omega_y^P c_z} \quad (A.68) \]

\[ C^*(\omega^*) \equiv \frac{c_y^*}{c_z^*} = \frac{N_z^* \Omega_z^{H^*} c_y^*}{N_y^* \Omega_y^{H^*} c_z^*} \quad (A.69) \]

Based on Result 3, trade will occur when \( C(\omega) \neq C^*(\omega^*) \), i.e.,

\[ \frac{N_z \Omega_z^P c_y}{N_y \Omega_y^P c_z} \neq \frac{N_z^* \Omega_z^{H^*} c_y^*}{N_y^* \Omega_y^{H^*} c_z^*} \quad (A.70) \]

In an identical environment \( c_y' = c_y^* \) and \( c_z' = c_z^* \). Hence, \( C(\omega) \neq C^*(\omega^*) \) implies that

\[ \frac{N_z \Omega_z^P}{N_y \Omega_y^P} \neq \frac{N_z^* \Omega_z^{H^*}}{N_y^* \Omega_y^{H^*}} \quad (A.71) \]

Generally,

\[ \frac{N_z \Omega_z^P}{N_y \Omega_y^P} \neq \frac{N_z^* \Omega_z^{H^*}}{N_y^* \Omega_y^{H^*}}. \quad \square \quad (A.72) \]

References


