Demystifying the Smiling Curve in a buyer-driven global supply chain—an O-Ring theory perspective

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Abstract: This paper explores a theoretical framework about mechanism of divisions of the gains in the global supply chain by incorporating the O-Ring theory model developed by Kremer (1993) into the sequential production framework. By introducing the vertical constraint so called quantity forcing, the double marginalization problem would be eliminated under a joint-profit maximizing contract among firms in the supply chain. Motivating by the recently widely discussed concept called “smiling curve” in the management and international business literature, this paper found that the variation of average profitability along firms producing at different production stages in the supply chain illustrates the U-shaped curve depends on the nature of supply chains. (buyer driven or producer intensive). For the U-shaped curve to hold in the producer-driven supply chains, it must be the case that the firms specializing at higher value-added stages have higher market power than firms at low value-added stages. For the U-shaped curve to hold in the buyer driven supply chains, the market power of firms spanning the chain does not necessarily matter. The only thing matters is to ensure firms specializing at higher value-added stages have higher labour productivity.

Keywords: divisions of the gains; global supply chain; O-Ring theory; smiling curve; average profitability

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1. Introduction

The development of globalization led to fragmentation of manufacturing production across national borders. Hence, intra-product specialization (Arndt 1997, 1998; Lu, 2004) generated a new pattern of global division of labour with each country specializing in particular stages
of a good’s production sequence (Costinot, et al., 2013). Consequently, trade in intermediate products has dominated the flows of world trade as evidenced by the increasing percentage share of intermediate products in world trade flows, which accounted for more than 50% of nonfuel world exports in the decade of 2000–2010. Therefore, the global supply chain (GSC) has become one of the most popular topics in international economics and cross-border management of the multinational corporations (MNCs).

However, the theoretical model regarding the divisions of the gains in the global supply chain at the firm level has been rarely discussed due to the difficulties in modelling the pricing behaviour adopted by different firms producing at different positions in the chains. For instance, the market concentration of some of production stages such as Assembly could be much lower than the ones as Marketing and R&D caused by different levels of entry barriers. The consequent determination of prices for firms in the chain must vary across different stages. One of the most recent works by Bernard and Dhandra (2015) assumes that there exists the monopolistic competition structure in vertical production network and market power between importers and exporters holds the key for understanding the profit-sharing in the global trade. Likewise, another work by Shen, Liu and Deng (2016) assumes there exists the one-to-one injective mapping between each firm and each stage, which forms the bilateral monopoly market structure along the chain.

There emerges a puzzle regarding the assumption of market structure at each stage in the chain, as varying number of firms producing at any particular stage of the chain would give us different theoretical predictions regarding how the profitability is shared along the global supply chain. In order to resolve this problem, we incorporate O-Ring theory framework in which the prices setting is both relevant with the market structure of each production stage and the technological choice determined by the upstreamness and downstreamness of the chain. In O-ring theory framework developed by Kremer (1993) as well as the later hierarchy assignment model by Garicano and Rossi-Hansberg (2004) and Wu (2015), since the prices

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1 There are some other forms of terminology describing such change of international trade pattern including “outsourcing or offshore outsourcing” (Arndt, 1997; Grossman & Helpman, 2004, 2005; Feenstra & Hanson, 1997), “fragmentation of production” (Jones & Keirzkowski, 1990; Deardorff, 2001; Jones & Kerizkowski, 2001), “vertical specialization” (Hummels, Rapoport & Yi, 1998) and “slicing up the value chain” (Krugman, 1994). Irrespective of the terminologies adopted, there are basically two production organizational forms that could be implemented under the context of this new international trade pattern: vertical integration and vertical disintegration. In accordance with the research done by Grossman & Helpman (2004, 2005), the former refers to “FDI” and the later refers to “outsourcing”. Also, in some management literature, some scholars use “global value chain”, “global supply chain”, “global commodity chain”, “global production network”, “inter-firm network to elucidate the same meaning that is equivalent to the one of this new international trade pattern” (Porter, 1990; Gereffi, 1999; etc). In this paper, it only puts its focus on the governing mechanism of vertical disintegration and vertical integration is beyond the scope of this piece of research.

2 Similarly, Ju & Su (2013) developed a model of global supply chain to study how the profits are distributed between intermediate input suppliers and final good producers. They argue that differences in market structure between upstream and downstream stages are the driving forces in determining the difference of profitability along the global supply chain. Using the framework of heterogeneous firms by Melitz & Ottaviano (2008), they assume firms in the downstream market as the monopolistic competition whereas the upstream market as oligopolistic (Cournot) competition. Ju and Su (2013) also found that the increases in the entry cost in the upstream market and segmentations in the final good market increases (decreases) the market power of intermediate input producers, which in turn increase(decrease) the profitability of intermediate input (final good) producers. Furthermore, the prices determined by the increases in the demand of the final good would also have the effects on the profit sharing system along the global supply chain.
are endogenously given by the complexity of tasks as well as the spans of control within the organization, we could thus model the prices level of firms as a function of different stages spanning the chain in which a global supply chain could be understood as a particular sort of hierarchy organization structure.

The another aspect which makes this paper different from the previous work is that we also consider the role of endogenous sunk cost in determining the divisions of the gains in global supply chain. In this paper, firms locating at continuum of sequential of stages with distinct types (different productivity measured by different firms’ different cost capacity) will have different measure of desirable physical characteristics of the goods achieved through different level of enhanced R&D outlay or advertising expenditure (Sutton, 1991). This means some firms producing more knowledge-intensive goods such as those involved in the Marketing or R&D sector would expends more money to R&D outlay or advertising, whereas those producing less knowledge-intensive goods such as firms locating in the assembly sector would spend less money on R&D outlay or advertising. This is to say, a continuum of the sequenced stages involved in the chain characterizing by distinct level of knowledge of goods being provided would have different level of sunk cost for firms choose to invest to maintain their viability in the chain.

2. Empirical Motivation

The empirical work of the divisions of the gains in the global supply chains at the firm level is normally seen in the current management and international business literature. For instance, the value-added of the GSCs in each stage is characterized by an U-shaped —smiling curve, which has become one of the most well-known concepts in management literature (Mudambi, 2008; Shih, 1996; Ye, Meng & Wei, 2015) \(^3\) The basic idea of the smiling curve is to use a U-shaped curve of value-added to describe a firm’s position in the supply chain in three stages of production and distribution. Take the semi-conductor industry as an example, the upstream market mainly contains the innovation and knowledge-intensive R&D such as integrated circuit (IC) design, the middle stage concentrates on the wafer production, precision testing and assembly whereas the downstream stage specializing in marketing and follow-up services. This means both upstream and upstream markets have higher value added than that in the middle stage of wafer fabrication which is usually under manufacture subcontracts.

While the hypothesis that firms specializing at higher value-added stages on both ends of the smiling curve are also those that gain the highest shares of profits is fairly accurate, there is no theoretical analysis on the relationship between profitability and production stages through the GVCs. Some recent papers attempt to empirically test the hypothesis of the U-shaped smiling curve. Ye, Meng & Wei(2015) used the time-series data from the WIOD with explicit

\(^3\) The concept of “smiling curve” was firstly coined Taiwanese entrepreneur who is the founder of ACER in the 1990s
consideration on both the benefits to, and the position of, participating countries and industries in global supply chain to examine the hypothesis of “smiling curve”. They showed that the length of value added propagation can be measured by using either Lentief’s forward industrial linkage or Leontief’s backward industrial linkage where the former could measure the position (upstreamness or downstreamness) of industries in value chains, while the latter can be used to identify the level of complexity in the production processes of final products. Although this paper is the first paper in the field that use the rigorous econometric tools to empirically test the hypothesis of smiling curve, while they did not prove this concept theoretically either.

Among others, Shin, Kraemer & Dedrick (2012) found that leading firms and component suppliers at the upper stage earn much higher gross and net profit margins compared to manufactured contractors in the middle stage of production. The key finding of their paper is that the smiling curve is right if and only if value added is defined in terms of gross margins. They came up with the conclusion that the cost of sustaining a position on either end of the curve is too high to make the returns on investment different across the curve because of the long gestation of investment in high-tech industries. Nevertheless, it is arguable whether firms specializing at two ends of the curve are more profitable than those in the middle of the curve. It could be argued that their conclusions empirically verify the importance of the core argument of this paper in which it states that it is actually ambiguous whether firms specializing at two ends of the curve are more profitable than those in the middle of the curve. The weakness of this empirical paper is that they did not mention what is the role of cost of sustaining the position in the chain in terms of shaping the distributions of the gains in the chain. By introducing the concept of endogenous sunk cost, this paper fills in this gap and looks at how profitability differs with sequential of stages through the channel of the dynamic change in the size of endogenous sunk cost at sequential of stages. By examining the dynamic change of profitability with respect to sequential of stages involved in the chain, this paper could demonstrate whether the hypothesis of “smiling curve” is verifiable or not.

The purpose of this paper is to investigate to what extent the smiling curve would move in the same direction after examining the profit margins in the model. The following graph illustrates how smiling curve works:

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4 Shin, Kraemer and Dedrick (2012) in another paper focusing on the study of global electronics industry also came up with the similar conclusions that it could be insignificant that firms specializing at marketing and R&D earns higher profitability compared with the firms specializing at assembly.
The rest of the paper is organized as the follows. The third part will be the model-solving. The fourth part will be several case studies focusing on some selected global industry chains to provide the empirical evidences. The final part is the concluding remark.

3. Model

3.1. Basic Environment

To produce the final good, the whole supply chain is consisted of $n$ production stages. We denote the set of production stages as $S = (s_1, s_2, ..., s_i, ..., s_n)$. A particular stage is indexed by $s_i$ where $1 \leq i \leq n$. If this supply chain is more labour intensive, then it means that the more downstream stages the firms specialize at, the higher capital employed by these downstream firms. Then, high $i$ implies the production stages with higher value-added. Vice versa for production stages lower value of $i$. Vice Versa for more capital intensive supply chain.

One modification here is made compared with the O-Ring framework. We do not assume labours are homogenous across stages. Hence, $L_i \neq L_{i-1}$. In line with the Costinot, et al. (2013), It is assumed in this paper that $L_{i-1} > L_i$. This implies firms specializing at more downstream stages are less labour intensive. In addition, $(w(L_i) > wL_{i-1})$ implying that wages of workers at more downstream stages (higher value added) receive higher wages.

There exists the upper bound of the AP of labour in low value-added stages, which we denote it as $k$; the upper bound of the AP of labour in high value-added stages is unbounded $^5$.

The labour supply function at stage $i$ is represented by $(w(L_i))$. This leads to the second assumption for this model:

$^5$ The $k$ here serves the role of threshold value above which firms specializing at low value-added stages are no longer viable.
Assumption 1: \( w(L_i)l_i = w(L_{i-1})l_{i-1} \)

The assumption 1 illustrates the fact that in the high value-added stages, the wage rate is high and the quantity of labour is low, while in the low value-added stages, the wage rate is low and the quantity of labour is high and hence it is approximately assumed that the multiple of the wage rate and the quantity of labour is the same across through all stages.

Definition 1: In a buyer driven supply chain. The downstream stage is more capital-intensive than upstream stages, thus generating higher value-added. Hence, \( \frac{K(s_{i+1}, q)}{L(s_{i+1}, q)} > \frac{K(s_{i-1}, q)}{L(s_{i-1}, q)} \). Hence, I assume more downstream stages are high value-added stages whereas all more upstream stages are low value-added stages.

3.2. Contracting choices (quantity forcing)

It is assumed in this paper that the production level at each stage are equal in which the vertical restraint so called “quantity forcing” is imposed upon all the firms in the chain. This restriction sales of each stage corresponds to the optimal level of quantity set by a vertically integrated firm in the chain. The reason of introducing such vertical restraint is to eliminate the incentives for firms in the supply chain to vertically integrate due to firms’ potential incentives for the double marginalization. This then leads to the second assumption of our paper:

Assumption 2: \( q_{i-1} = q_i = q^* \) where \( 1 \leq i \leq n \)

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6 The derivation of \( \frac{\alpha(s_i)}{\beta(s_i)} = \frac{w(s_i)}{r(s_i)} \) is as follows: Consider the profit maximization problem under the established setting in this paper. The \( j \)th firm in the \( i \)th stage in the chain seeks to maximize the following profit function: \( \pi_j = \frac{\alpha(s_j)}{\beta(s_j)} + \frac{K(s_j, q)}{L(s_j, q)} - \frac{rK(s_j, q)^\beta(s_j)}{\alpha(s_j)} - w(s_j)L(s_j, q) \) Take the derivative with respect to the \( L \) and \( K \) respectively, then I could obtain the following:

\[
\begin{align*}
\frac{\partial \pi_j}{\partial L} & = \alpha(s_j)K(s_j, q)^\beta(s_j) - rK(s_j, q)^\beta(s_j) - w(s_j)L(s_j, q) = 0 \\
\frac{\partial \pi_j}{\partial K} & = \alpha(s_j)K(s_j, q)^\beta(s_j) - rK(s_j, q)^\beta(s_j) - w(s_j)L(s_j, q) = 0
\end{align*}
\]

(1)

For the first order condition with respect to \( L \) in (1), multiply \( L(t_{i-1}, q) \) by both sides. Meanwhile for the first order condition with respect to \( K \) in (1), multiply \( K(t_{i-1}, q) \) by both sides:

\[
\begin{align*}
\frac{\partial \pi_j}{\partial L} & = \alpha(s_j)L(s_j, q)K(s_j, q)^\beta(s_i) - rK(s_j, q)^\beta(s_j) - w(s_j)L(s_j, q) = 0 \\
\frac{\partial \pi_j}{\partial K} & = \alpha(s_j)L(s_j, q)K(s_j, q)^\beta(s_j) - rK(s_j, q)^\beta(s_j) - w(s_j)L(s_j, q) = 0
\end{align*}
\]

(2)

Hence, (2) reduces to the following pairs of equations:

\[
\begin{align*}
\frac{\partial \pi_j}{\partial L} & = \alpha(s_j)L(s_j, q)K(s_j, q)^\beta(s_j) - rK(s_j, q)^\beta(s_j) - w(s_j)L(s_j, q) = 0 \\
\frac{\partial \pi_j}{\partial K} & = \alpha(s_j)L(s_j, q)K(s_j, q)^\beta(s_j) - rK(s_j, q)^\beta(s_j) - w(s_j)L(s_j, q) = 0
\end{align*}
\]

(3)

Divide the first part of (3) by the second part of (2), I could obtain \( \frac{\alpha(s_j)}{\beta(s_j)} = \frac{w(s_j)}{rK(s_j)}L(s_j, q) \)

7 The fixed proportion of output at each stage implies we do not consider the mistake rate as the Costinot, et al. (2013) did in which the more downstream firms are subject to the fewer mistake rates, thus ending with higher productivity. This assumption is also inspired by Stigler (1951)’s work in which he also assumes the fixed proportion of output at each stage to study the evolution of industry cycles.
3.3. Endogenous sunk cost

Moreover, in this paper, firms locating at sequential of stages with distinct types (different productivity measured by different firms’ cost capacity) will have different measure of desirable physical characteristics of goods (such as quality). Such distinct characteristics are achieved through different level of enhanced advertising expenditure (Sutton, 1991).

The term $F(s_i)$ represents the endogenous sunk cost for the firm to be viable at stage $i$. This paper argues that more downstream firms tend to spend more money on advertising, thus generating higher level of endogenous sunk cost whereas firms specializing at more upstream stages such as Assembly stage would spend much less money on the advertising which leads to the lower level of endogenous sunk cost. Hence, it leads to our final assumption of this paper:

**Assumption 3**: (Endogenous sunk cost assumption) $F(s_i) > F(s_{i-1})$.

4. Solution

In free trade equilibrium, we assume that there exists the monopolistic competition at each stage of the chain. Thus, firm $j$ at a particular stage $s_i$ maximizes their own profits as the following:

$$\pi_j(s_i, q) = p(s_i, q)q - w(s_i)L(s_i) - rK(s_i, q) - F(s_i)$$

Where $\pi$ is the profit function, $L$ indicates the labour which is the function of output and different production stages, $K$ indicates the capital which is the function of output and different production stages. $Q$ is the output. $p$ is the price for each unit of output at the $i$th stage. $w$ is the wage rate, $r$ is the interest rate.

In order to maximize the profit at each stage, take the derivative of $q$ by both sides,

$$\frac{\partial \pi_j(s_i, q)}{\partial q} = p(s_i, q) + \frac{\partial p(s_i, q)}{\partial q} q - w(s_i) \frac{\partial L(s_i, q)}{\partial q} - r \frac{\partial K(s_i, q)}{\partial q} = 0$$

Then,

$$p(s_i, q) = \left\{ w(s_i) \frac{\partial L(s_i, q)}{\partial q} + r \frac{\partial K(s_i, q)}{\partial q} \right\} \left[ \frac{\epsilon_{ij}}{\epsilon_{ij} - 1} \right]$$

where $\epsilon_{ij}$ is the market power of firm $j$ at stage $i$.

We assume that the labour demand function could be denoted as the following: $L(s_i, q) = q^{\lambda}l(s_i)$ where $\lambda$ is a positive parameter which remains to be constant at all stages and $l(s_i)$ is the number of units of labour per unit of output.

Plugging this labour demand function into the production function $q = K^\alpha L^\beta$, the demand function for the capital employed by this firm at stage $s_i$ could be obtained:
Plug (4) into (3), the price with respect to the change of production stages as well as quantity could be obtained as follows:

\[
p(s_l, q) = \left\{ \lambda q^{1-\lambda} w(s_l) l(s_l) + \frac{r(1-\beta \lambda)}{\alpha} q^{\frac{\beta(1-\lambda)}{\alpha}} l^{-\frac{\beta}{\alpha}}(s_l) \right\} \left[ \frac{\epsilon_{ij}}{\epsilon_{ij-1}} \right]
\] ...............................(5)

According to the assumption 4, output is independent from production stages, hence in (5), the output which maximizes the profit is independent from \( s_l \), let \( q = q^* \), plugging this forcing quantity into (5), then:

\[
p(s_l) = \left\{ \lambda q^{1-\lambda} w(s_l) l(s_l) + \frac{r(1-\beta \lambda)}{\alpha} q^{\frac{\beta(1-\lambda)}{\alpha}} l^{-\frac{\beta}{\alpha}}(s_l) \right\} \left[ \frac{\epsilon_{ij}}{\epsilon_{ij-1}} \right]
\] ...............................(6)

Formula (6) indicates the price set by monopolist incumbents under the assumptions of perfect contestability of the market structure of all production stages involved in the chain.

**Definition 2:** A free trade equilibrium corresponds to output levels \( Q = (q_1, q_2, q_3 \ldots q_n) \) where \( q_i \in Q \) and \( q_i \) is the output of \( i \)th production stage where \( q_{i-1} = q_i = q^* \), \( 1 \leq i \leq n \), Capital \( K(s_l) \in \mathbb{R}^+ \), Labour \( L(s_l) \in \mathbb{R}^+ \) for all \( s_l \in S \) and intermediate good prices \( p(.) \):

\( S \rightarrow \mathbb{R}^+ \) such that Conditions (4), (5) and (6) hold.

Now dividing (1) with \( q \) by both sides, the expression of average profit could be obtained:

\[
\frac{\pi_j(s_l, q)}{q} = p(s_l) - \frac{w(s_l)L(s_l, q)}{q} - \frac{rK(s_l, q)}{q} - \frac{F(s_l)}{q}
\] ...............................(7)

Plugging (6) into (7), then:

\[
\frac{\pi_j(s_l, q^*)}{q^*} = \frac{r\beta(1-\lambda)}{\alpha} l^{-\frac{\beta}{\alpha}}(s_l) q^{\frac{\beta(1-\lambda)}{\alpha}} - \left( 1 - \frac{\epsilon_{ij}}{\epsilon_{ij-1}} \right) \frac{w(s_l)L(s_l, q^*)}{q^*} - \frac{F(s_l)}{q}
\] ...............................(8)

From assumption (1), \( w(s_l)L(s_l, q^*) \) remains the same at each production stage, hence we could denote

\[
\left( 1 - \frac{\epsilon_{ij}}{\epsilon_{ij-1}} \right) \frac{w(s_l)L(s_l, q^*)}{q^*} = C, \text{ then}
\]

\[
\frac{\pi_j(s_l, q^*)}{q^*} = \frac{r\beta(1-\lambda)}{\alpha} \left[ q^{1-\lambda} l^{-\frac{\beta}{\alpha}}(s_l) \right] - C - \frac{F(s_l)}{q}
\] ...............................(9)

Thus, we could obtain the general expression for the average profit function for firm \( j \) at stage \( i \).
The first term of this average profitability function is the labour productivity effect whereas the last two terms are the cost effect of this firm.

**Proposition 1:** Under a buyer driven supply chain, the average profit at high value-added stages is larger than the one at low value-added stages if and only if the following two conditions hold:

\[
\frac{q^*}{L(s_i,q^*)} \geq \max \left\{ \frac{\beta(s_{i-1})}{\alpha(s_{i-1})} \left(1 - \frac{\epsilon_{i-1,j}}{\epsilon_{i-1,j-1}}\right) \frac{\alpha(s_i)}{\beta(s_i)} \frac{q^*}{L(s_{i-1},q^*)}, k \right\}
\]

\[\epsilon_{i,j} > \epsilon_{i-1,j} \text{ or } \epsilon_{i,j} < \epsilon_{i-1,j}\]

**Proof of proposition 1:** \(\frac{q^*}{L(s_i,q^*)}\) is the AP of labour. At high value-added stages, \(\frac{q^*}{L(s_i,q^*)} > k\), and value-added is higher and the AP of labour is bigger; At low value-added stages, \(\frac{q^*}{L(s_i,q^*)} < k\), and value-added is lower and the AP of labour is smaller. Let the high value-added stage be \(s_i\), and its labour and capital elasticity of output are \(\alpha(s_i), \beta(s_i)\); Let the low value-added stage be \(s_{i-1}\), its labour and capital elasticity of output are \(\alpha(s_{i-1}), \beta(s_{i-1})\), Also that \(\frac{\beta(s_{i-1})}{\alpha(s_{i-1})} < \frac{\beta(s_i)}{\alpha(s_i)}\). When \(\frac{q^*}{L(s_i,q^*)} \geq k\), it could be derived that \(\left[\frac{q^*}{L(s_{i-1},q^*)}\right] \frac{\beta(s_{i-1})}{\alpha(s_{i-1})} \leq \left[\frac{q^*}{L(s_i,q^*)}\right] \frac{\beta(s_i)}{\alpha(s_i)}\).

We are now going to identify under what condition the average profit at high value-added stages is higher than the one at low value-added stage.

\[
\frac{\pi(s_{i-1},q^*)}{q^*} < \frac{\pi(s_i,q^*)}{q^*} \..................................................(11)
\]

Plugging (10) into (11),

\[
\frac{r \beta(s_{i-1})}{\alpha(s_{i-1})} \left(1 - \frac{\epsilon_{i-1,j}}{\epsilon_{i-1,j-1}}\right) \frac{\beta(s_{i-1})}{\alpha(s_{i-1})} \frac{q^*}{L(s_{i-1},q^*)} - F(s_{i-1}) < \frac{r \beta(s_i)}{\alpha(s_i)} \left(1 - \frac{\epsilon_{i,j}}{\epsilon_{i,j-1}}\right) \frac{q^*}{L(s_i,q^*)} - F(s_i) \..................................(12)
\]

Rearrange (12), it could be obtained that

\[
\frac{r \beta(s_{i-1})}{\alpha(s_{i-1})} \left(1 - \frac{\epsilon_{i-1,j}}{\epsilon_{i-1,j-1}}\right) \frac{q^*}{L(s_{i-1},q^*)} < \frac{r \beta(s_i)}{\alpha(s_i)} \left(1 - \frac{\epsilon_{i,j}}{\epsilon_{i,j-1}}\right) \frac{q^*}{L(s_i,q^*)} \..................................(12)
\]

Since \(\left[\frac{q^*}{L(s_{i-1},q^*)}\right] \frac{\beta(s_{i-1})}{\alpha(s_{i-1})} \leq \left[\frac{q^*}{L(s_i,q^*)}\right] \frac{\beta(s_i)}{\alpha(s_i)}\)
Then we know that there will be two cases emerging:

\[
\frac{r\beta(s_{i-1})\left(1 - \frac{\epsilon_{i-1j}}{\epsilon_{i-1j} - 1}\right)}{\alpha(s_{i-1})} < \frac{r\beta(s_i)\left(1 - \frac{\epsilon_{ij}}{\epsilon_{ij} - 1}\right)}{\alpha(s_i)}
\]

\[
\frac{r\beta(s_{i-1})\left(1 - \frac{\epsilon_{i-1j}}{\epsilon_{i-1j} - 1}\right)}{\alpha(s_{i-1})} > \frac{r\beta(s_i)\left(1 - \frac{\epsilon_{ij}}{\epsilon_{ij} - 1}\right)}{\alpha(s_i)}
\]

.............................................................................................................. (13)

Since \(\frac{\beta(s_{i-1})}{\alpha(s_{i-1})} < \frac{\beta(s_i)}{\alpha(s_i)}\), from the first part of (13), it could be deduced that \(1 - \frac{\epsilon_{i-1j}}{\epsilon_{i-1j} - 1}\) < \(1 - \frac{\epsilon_{ij}}{\epsilon_{ij} - 1}\)

Then we could obtain that \(\epsilon_{ij} > \epsilon_{i-1j}\)

Similarly, for the case 2, we could derive that \(\epsilon_{ij} < \epsilon_{i-1j}\)

**Lemma 1:** In order to ensure the average profit that being obtained is a maximum value, not a minimum value, it has to satisfy that \(w(s_i) < \frac{r\beta(1 - \frac{\epsilon_{ij}}{\epsilon_{ij} - 1})}{\alpha\lambda} \frac{q^*}{L(s_i, q^*)^\lambda} \frac{1}{\lambda}
\)

**Proof of Lemma 1:** We let the second derivate of average profit function smaller than 0 and plug the forcing quantity into it, then we could get:

\(w(s_i) < \frac{r\beta(1 - \frac{\epsilon_{ij}}{\epsilon_{ij} - 1})}{\alpha\lambda} \frac{q^*}{L(s_i, q^*)^\lambda} \frac{1}{\lambda}
\) .............................................................................................................. (14)

5. Conclusions and Policy Implications

In a buyer driven supply chain, the mechanism which reflects upon the divisions of the gains in global supply is complex. Firms specializing at high value-added stages are more profitable than those specializing at low value-added stages if and only if the formers have higher average labour productivity that the later counterparts. However, so far this is only the production side gains stories. Regarding the consumption side gains, the stories become more staggering. In this paper, we surprisingly found that the market power of firms specializing at either high value-added stages or low value-added ones does not shape the divisions of the gains in global supply chains. This implies that the production side gains such as higher labour productivity plays a more important role in terms of determining who actually gains more in global supply chains.

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