Parts Localization Lifecycle in the Auto Industry

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1. Introduction

In this paper, we introduce the concept of parts localization lifecycle. We do this to compare the evolution of the auto industry in different countries. Our analysis explains the cost competition between developing and developed countries in terms of the stage of development of the auto industry in each country. More specifically, automobile production has grown not just in the developed countries, but also in developing countries. Unlike the situation in the electronics industry, the auto industry in developed countries continues to enjoy a cost competitiveness advantage. The value of the vehicles exported from the developing countries to the developed countries does not constitute a large fraction of the total export value. Vehicles are produced in developing countries because the automakers there are compelled to make them locally. The high import duties levied by governments in developing countries on importers restricts imports from developed countries.

How have the vehicles produced in developing countries enhanced their cost competitiveness in the auto industry? In addition, how do the vehicles produced in developed countries maintain an edge in cost competitiveness? Although we cannot give a complete answer to these questions, we try to suggest a new way of thinking about these questions by introducing the concept of parts localization lifecycle.

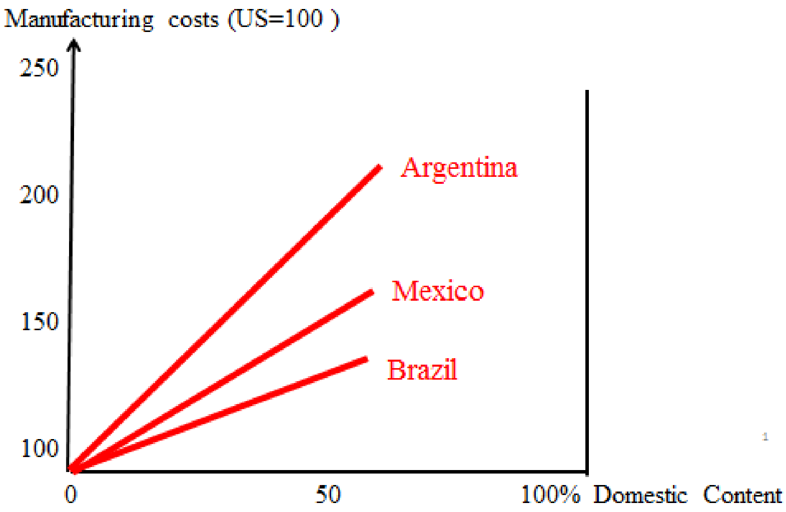
2. Past Research on the Cost Penalty effect

(1) Cost Penalty effect and the Cost Penalty curve

We define cost penalty as the phenomenon where the increase in the parts localization ratio leads to an increase in the manufacturing cost of the complete vehicle. Consider a vehicle whose manufacturing cost is $30,000, when the parts localization ratio is 10%. If the parts localization ratio increases to 30%, the manufacturing cost of the vehicle would increase to $40,000. As a result, the price of a vehicle assembled domestically in developing countries, with a high local parts ratio, would become higher than that of an imported vehicle. This implies a loss of domestic economic welfare.

How did the earlier researchers discuss the cost penalty issue? Baranson (1969) made the pioneering contribution. Baranson derived the cost penalty curve (Figure1) to depict the rise in manufacturing cost with increasing localization in countries such as Mexico, Brazil, and Argentina, by using field surveys and statistical estimation. He explained in quantitative terms the fact that the manufacturing cost of a complete vehicle tended to rise with an increase in the parts localization ratio. He found that if the vehicle manufacturing cost is 100 at a parts localization ratio of 0%, the vehicle cost would be 135 in Brazil, 155 in Mexico and 205 in Argentina at a parts localization ratio of 60%. This different cost in the three countries is due to the different stage of development of the auto parts industry in each country. In other words, the less developed the auto parts industry of a country is, the more its manufacturing cost would increase due to an increase in the parts localization ratio. This implies that countries trying to raise their parts localization ratio despite having a weak parts industry would experience a rise in the vehicle manufacturing cost and, as a result, a loss of domestic economic welfare. In addition, we learn the lesson that it is important for automakers to preferentially foster their own auto parts industry before the government makes it mandatory to meet a parts localization ratio.

Figure1 Cost penalty curve (Baranson curve)



Source: Based on Baranson (1969) and simplified from the original figure.

Ono (1977), Ono (1978), Adachi (1979), Adachi, Ono, and Odaka (1980), Adachi (1987), and Adachi (1993) were the researchers in Japan who built on Baranson's work. These contributions focused on the cost penalty effect, which was a feature of the parts localization in the ASEAN region countries such as Thailand, Philippines, Malaysia, and Indonesia, where Japanese automakers had set up production facilities. Their research was very useful for Japanese automakers because they gave an elaborate presentation of the strategic tasks and practical issues involved.

(2) New analytical model

It is clear that research on auto parts localization has been successful in putting forward cost penalty as the key concept. However, after analyzing closely the dynamic development of auto industries in developing countries since the 1990s, we offer a new analytical approach that introduces a concept previously overlooked by Baranson and the Japanese researchers.

We have a simple observation that the Baranson cost penalty curve alone cannot explain. Analyzing auto industries in developing countries over the last 30-40 years, an undeniable fact emerges. Along with the increase in the localized parts ratio in many developing countries, there has also been a decrease in the complete vehicle costs unless the government forced the industry to increase the localized parts ratio.

However, the Baranson cost penalty curve cannot consistently explain this fact because it is based on the conditions prevalent in South America in the 1960s, when it had a weak parts industry. This historical limitation makes it difficult for it to explain the reduction in total cost.

In this paper, in addition to the Baranson curve, firstly we first introduce the cost reduction effect, where complete vehicle costs decrease in inverse proportion to the increase in parts localization ratio.

This effect is captured by a cost reduction curve. The cost reduction effect precedes the cost penalty effect, in which, as discussed earlier, the complete vehicle cost increases in proportion to the increase in the parts localization ratio. We term the point at which cost curve switches from cost reduction to cost penalty as the penalty switching point or, simply, the switching point.

Previous researchers, including the above mentioned Japanese authors, did not argue for the cost reduction effect in an explicit and logical manner.

For example, Ono (1977) hinted at the cost reduction effect but treated it as an exception. To quote Ono, “After examining each part carefully, it was found that some of the local parts are cheaper than the imported parts because of the low wage effect. In other words, the cost penalty is negative and the part should not be imported. However, most of the local parts are more expensive i.e. there is a cost penalty.” (p. 22). Ono did not expressly recognize that the cost reduction effect had come into play in many developing countries, as their auto parts industries developed. In this paper, we revise the findings by Ono and try to make the cost reduction effect an integral part of the new explanatory model we have proposed.

Second, we discuss how the switching point, which marks the shift from the cost reduction curve to the cost penalty curve, is not fixed and tends to shift toward the increase of parts localization ratio if the developing country’s auto industry is more developed.

Third, the switching point is the point at which the total cost of the parts is the lowest. As it represents a balance between the ratio of local and imported parts leading to the maximum economy, we call it the Most Economical Balance Point (MEBP) for the country. We will explain the upward or downward shift of the MEBP in greater detail in Section 5 of this paper.

Fourth, we explain that the cost penalty curve phenomenon is also observed in developed countries. After a gradual shifting of the switching point towards the increase of parts localization ratio in the developing countries and leading ultimately to a complete localization of parts in developed countries, it is found that in most of them, the parts localization ratio begins to decrease. The cost penalty curve may re-appear in the case of developed countries because some of the developing countries have a competitive parts industry and can export their auto parts to developed countries. We are able to explain consistently the exact position, at any given time, of the cost curves for both developing and developed countries.

We conclude by defining the parts localization lifecycle and offer a new analytical model that explains the development of auto industries in both developing and developed countries.

(3) Explanation of Keywords

To facilitate the understanding of the theoretical description in the next sections, we explain the keywords. First, we define local parts as those parts that are produced in the country of final assembly. Next local parts ratio means the ratio of local parts in the total cost of parts (cost of local parts + cost of imported parts) used in vehicle assembly. We consider the in-house parts produced by automakers as local parts.

The value of a local part is found by calculating the value-added activity in the home country. For example, Denso Japan exports material with a unit value of $200 to Denso Thailand. Denso Thailand does a value-add of $300 to the imported material and assembles the final part, which now has a total value of $500, and delivers it to Toyota Motor Thailand. The cost structure of this part valued at $500 consists of imported material with value $200 and local operations and local materials with a value of $300. Thus, it is seen that the parts localization ratio discussed in this paper differs from the local procurement ratio. As explained in the example above, even if an automaker procures a part from local suppliers, by examining the value composition of the component, we can distinguish between the value of the imported part and the value added locally. In most cases, our parts localization ratio is lower than the local procurement ratio.

3. Cost Reduction effect

(1) How does the cost of local parts became lower than that of imported parts?

Initially, automakers in developing countries had to import all the parts from developed countries because they did not have a local parts industry. The parts localization ratio was initially zero but as the parts industry developed, automakers gradually increased the parts localization ratio by substituting the imported parts with local parts

Comparing the cost of imported parts with the cost of local parts will yield two results – either the cost of the imported part will be higher or, else, that of the local part. Does the result depend on the level of development of the parts industry in the country studied? Considering the development of parts localization in the 1970s and the 1980s in ASEAN countries, it is clear that they incurred cost penalty because the government forced them to meet a minimum parts localization ratio. This is what Baranson also found in the 1960s in South America.

However, there is another strategy whereby automakers carefully increase the parts localization ratio after ascertaining the level of development of the parts industry and considering the optimal mix of local and imported parts which will ensure lowest total cost. In other words, the procurement strategy where auto makers increase the parts localization ratio only when the total cost of parts decreases by substituting the imported parts with the local parts, was a reasonable and effective response. In such a case, where the required parts localization ratio is kept at a low level initially, the vehicle manufacturing cost is, theoretically, supposed to decrease and did actually decrease in Asian countries. For example, in Thailand, it has been decreasing since the 1980s due to the development of production technology, the growth of the auto market, the expansion of production volumes, and the accompanying decrease in the cost of local parts. For example, Toyota Motors Thailand adopted a strategy of steadily raising the parts localization ratio, beginning in the 1980s.

So, how did this strategy succeed? In other words, how did the cost of local parts became lower than that of imported parts? The answer is that some parts are labor-intensive and the proportion of labor cost in the total cost structure may be very high in developed countries. When the labor cost in a developing country is one-tenth of that in Japan, the cost of the labor-intensive parts made there tends to be lower than that in Japan. For example, consider the cost structure of a part made in Japan, where the labor cost usually accounts for 80% of the cost and the capital investment accounts for the remaining 20% (if we exclude material cost). If the labor cost in a developing country is one-tenth of that in Japan, the cost of that part in the developing country will be lower than that in Japan, even if the capital investment cost in the developing country is twice that in Japan

Automakers have been using a strategy of manufacturing labor-intensive parts in developing countries. They have also attempted to raise gradually the parts localization ratio by substituting the imported parts with local parts.

On the other hand, the parts that have retained their cost competitiveness in the developed countries for a relatively long time are capital and technology-intensive parts. For these parts, cheaper labor does not work in favor of developing countries as the proportion of the labor cost in the total cost of the part is low. The total cost of these parts in developing countries tends to be higher than that in developed countries because not only are the capital-intensive machine tools needed to produce them expensive, but also there are many large associated costs such as the transportation cost from Japan and the set-up cost. The total cost in developing countries is twice that in Japan. As a result, in the case of capital and technology-intensive parts, the cost competitiveness of imported parts persists for a long time.

(2) Theoretical classification of parts into L and H Parts

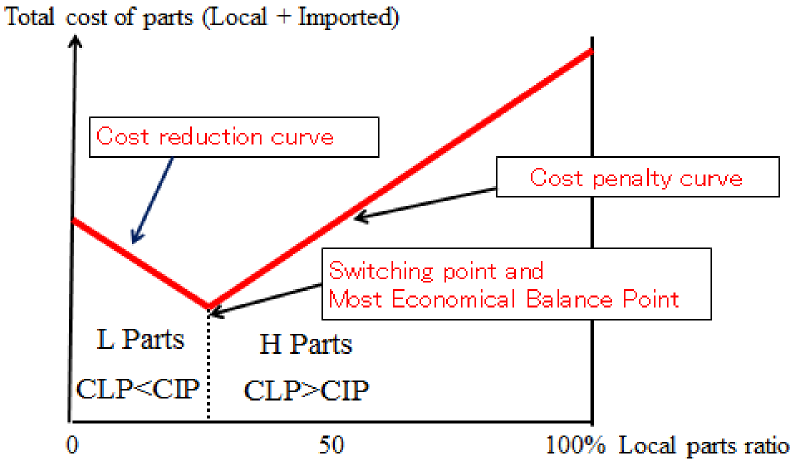
Based on the earlier observation, we can classify the parts into two groups. The first group has parts whose local production cost is lower than their imported parts cost. We refer to such parts as L Parts, where ‘L’ signifies ‘Lower cost’. These L Parts have certain characteristics. In the case of L Parts, we can utilize the cost competitive advantage of ‘cheap labor’ in developing countries because many L Parts are labor-intensive parts. Other L Parts are bulky and incur a large transportation cost when imported from Japan. So, local parts tend to be cheaper than the imported parts, if we factor in the transportation cost. Moreover, L Parts require simple technology to produce and part makers in developing countries can produce them easily.

The parts, whose local cost of production is higher than the cost of imported parts, are called H Parts. The ‘H’ signifies ‘Higher cost’. The main characteristic of these parts is that they are difficult to produce in developing countries because producing them requires an advanced level of technology. The makers of parts in developing countries also cannot capitalize on the cost advantage afforded by their ‘cheaper labor’ because many H Parts are both capital and technology-intensive, that is, their manufacture requires the introduction of expensive capital equipment.

(3) Cost Reduction and Cost Penalty effect

Figure2 describes the relationship between the local parts ratio and total cost of parts. We represent the local parts ratio on the horizontal axis. By subtracting the local parts ratio at a certain point (say, 30%) on the horizontal axis from 100%, we can get the corresponding imported parts ratio (in this case, 70%) at that point. The vertical axis represents the total cost of parts, that is, the sum of the cost of local parts, as well as the cost of imported parts. The cost curve shown in Figure1 describes how the total cost varies with an increase in the local parts ratio.

Figure2 Changes in total cost of parts in local parts ratio



Source: For this and subsequent figures, source are based on the facts and figures obtained in the interviews conducted in ten countries of Southeast countries, Korea, China, Argentine, Brazil, and Mexico.

Note: CLP: Cost of Local Parts CIP: Cost of Imported Parts

First, at the point where local parts ratio is 0%, we get the total cost of parts when all the parts are imported parts. On the other hand, at the point where local parts ratio is 100%, we get the total cost of parts when all the parts are locally produced.

a. Cost of local parts is lower than the cost of imported parts － Cost Reduction effect

Starting from a parts localization ratio of 0% and moving to the right along the axis, the total cost of parts begins to decrease. Automakers identify the parts (L Parts) for which the cost of sourcing locally is lower than the cost of imported parts; subsequently, they replace the imported parts with local parts. We define this as cost reduction effect. How far to the right can the cost reduction effect continue? In other words, the number of L Parts made in a country depends on the level of development of the parts industry in that country. The kind of parts that are localized on a priority basis depends on the country or the automaker. For example, part A is localized before part B in country X but may be localized after it in country Y.

With greater parts localization, the decrease of total cost of parts continues until the switching point (also called the penalty switching point) is reached. As explained earlier, the switching point also corresponds to the MEBP (the Most Economical Balance Point), where the total cost of parts is lowest.

Usually, if there is no mandatory regulation by the government, the actual localization ratio should ideally be near the switching point. However, various governmental policies such as mandatory localization, employment targets, and imposition of customs duties often affect the actual parts localization ratio. In this paper, we discuss the parts localization issue mainly by considering production and transportation costs, while ignoring the governmental policies as far as possible[1].

b. Cost of local parts is more than the cost of imported parts － Cost Penalty effect

Beyond the switching point, L Parts become H Parts. As a result, the total cost of parts begins to rise. We define this increase in cost with greater parts localization as the cost penalty effect. As shown in Figure2, the total cost of parts at a local parts ratio of 100% is higher than the cost at a local parts ratio of 0% in most countries where the switching point is reached at a relatively low local parts ratio.

c. Categorization into L and H Parts is contingent

Here, we would like to explain that the L and H Parts categorization is not fixed but varies according to the stage of a country's development. For example, an alternator may be an H Part in Russia, but could be an L Part when made in Thailand. In the same country, H Parts might become L Parts over time. In Thailand, the engine was an H Part in the 1980s but became an L Part in the next decade.

4. Parts Localization Lifecycle in developing countries

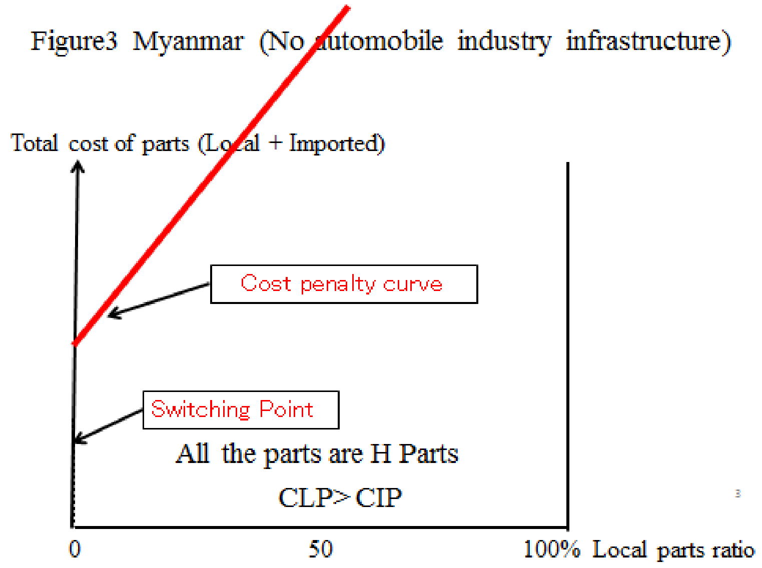
As explained earlier, the switching point for countries can vary because the switch from cost reduction curve to cost penalty depends on the degree of development of the parts industry in each country. In general, the more developed the auto industry, the more the switching points shifts towards the right. In other words, the greater level of development facilitates the increase in the parts localization ratio.

(1) Shifting of switching point to the right

a. A country with no automobile industry infrastructure

First, we consider the switching point in a country where there is no automobile industry infrastructure, an absence of L Parts, and, therefore, no cost reduction curve. As shown in Figure3, in such a country the total cost of parts begins to rise drastically as we shift to the right of the origin (0% localization). In other words, the total cost of parts is lowest when the local parts ratio is 0% (or, in other words, the imported parts ratio is 100%) and is the highest when the local parts ratio is 100% (and the imported parts ratio is 0%). The cost penalty curve is the only cost curve applicable to such a country and is identical to the Baranson curve.

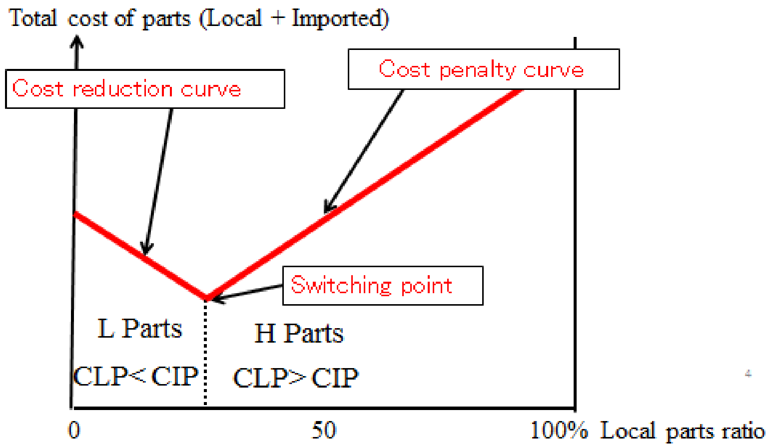
Figure3 Myanmar (No automobile industry infrastructure)



b. Country where automobile industry infrastructure is at an early stage of development — Thailand in the 1980s

Figure4 depicts the situation of Thailand in the 1980s, when its automobile industry infrastructure was not well developed. The total cost of parts begins to decrease with the shift to the right and reaches the switching point at a local parts ratio of around 30%. This is the MEBP, where the total cost of parts is lowest, and the remaining 70% parts have to be imported. Any attempt to increase the local parts ratio leads to a cost penalty. The Thai government attempted to force automakers to achieve the mandatory local content ratio and, as a result, the total cost of parts as well as the complete vehicle cost increased. There was no way to escape the cost penalty without the automakers playing a leading role in developing the nascent parts industry.

Figure4 Thailand (1980s)

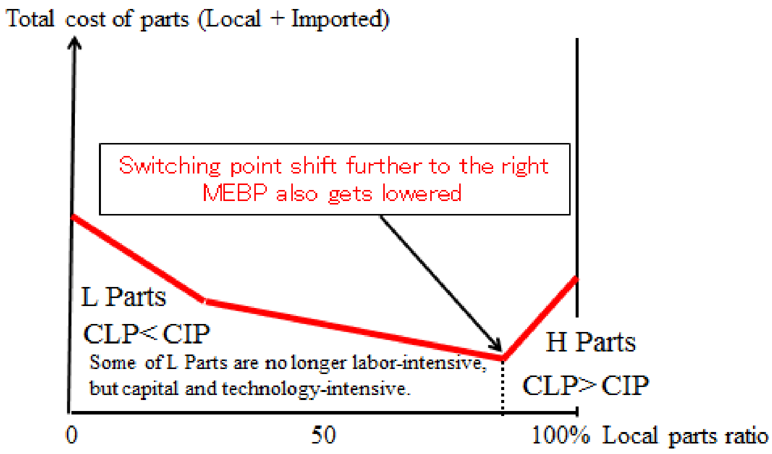


c. Established automobile industry infrastructure — Korea in the 1990s

By the 1990s, Korea was able to establish its own auto industry. As shown in Figure5, the switching point shifted to a parts localization ratio of 90%. The remaining 10% parts that were imported were the technically complex H Parts; for instance, the core parts of differential gears. As compared with Thailand, the switching point shifted further to the right. In addition, the MEBP also fell more than it did in Thailand.

The factors responsible for the Korean automobile industry's success included the growth of the Korean auto market, the scaling up of production and the ability of the Korean parts industry to develop production technology by collaborating with foreign part makers. In addition, many big foreign part makers entered Korea and supplied the local automakers, such as the Hyundai Motor Group.

Figure5 Korea (1990s)

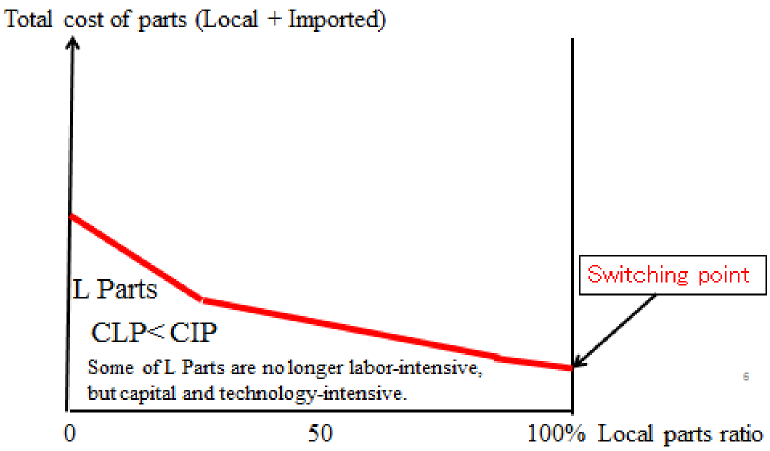


As a result, the Korean auto industry could enhance its cost competitiveness and export complete vehicles, albeit to a small number of developing countries.

d. Achieving a local parts ratio of 100% — Japan in the 1980s

By the 1960s, Japan had basically attained 100% localization of auto parts. By 1980, almost all the parts were local parts, with very few imported parts. Thus, all the parts were L Parts, there being no H Parts. The switching point reached a local parts ratio of 100%, as shown in Figure6, and cost penalty did not operate at all. The MEBP moved to a lower level than in Korea. With enhanced export competitiveness, six million of the total production of eleven million vehicles were exported. Japan's export volume was the highest in the world.

Figure 6 Japan (1960s-1980s)

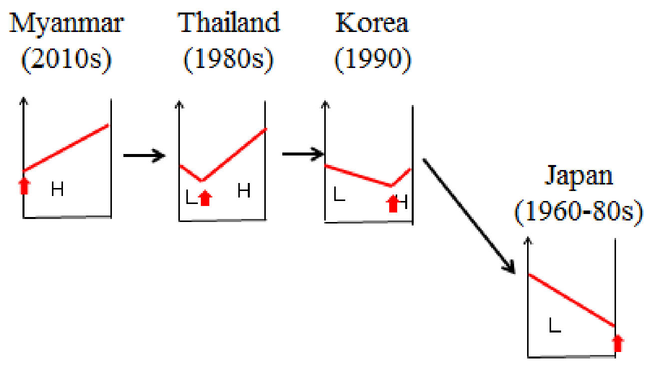


(2) Parts Localization Lifecycle in Developing Countries

As described in the previous section, when there was no automobile industry infrastructure, the switching point was at the local parts ratio of 0% and then began shifting to the right, as the local parts industry developed, finally reaching a local parts ratio of 100%. At the same time, the MEBP shifts downward, as the local parts ratio increases. Figure6 indicates this transition.

In the next section, we will consider how this dynamic reverses when a local parts ratio of 100% is reached in the case of developed countries. In addition, one observes a rise in the cost of the parts that were earlier L Parts.

Figure7 Switching point shifts towards the right



MEBP shifts downwards, indicating a drop in cost

5. Parts Localization Lifecycles in developed countries

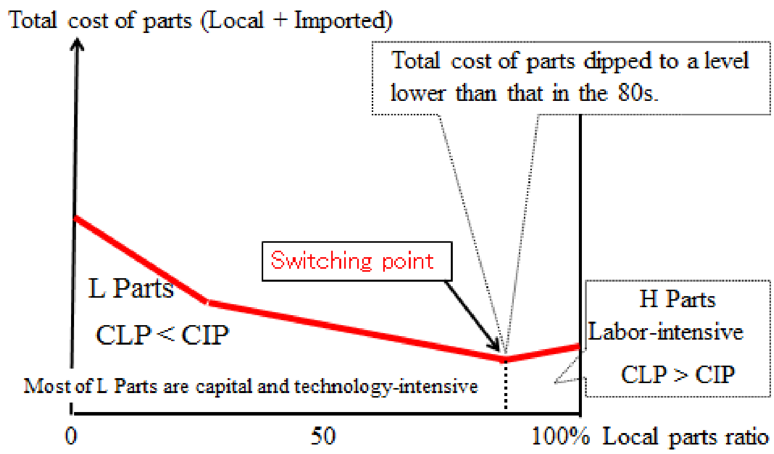
(1) Shift of the Switching point towards the left

The 1990s saw the parts industry growing in the developing countries but some parts makers in the developed countries lost their competitiveness due to the increase in wages and other costs. As a result, some parts that were earlier L Parts in the developed countries now became H Parts. This led to automakers in developed countries substituting these local parts with the cheaper parts produced in developing countries.

a. Japan in the 2000s — Beginning of a shift to the left

As shown in Figure8, the switching point began to shift irreversibly towards the left in Japan during the 2000s. Part makers in developing countries were able to produce some labor-intensive parts at a much lower cost than that in Japan. Japanese automakers began importing these parts to minimize the total cost of parts.

Figure8 Japan (2000s)



The point that we want to make here about the L and H Parts is that although their definition remains the same, their characteristics get interchanged.

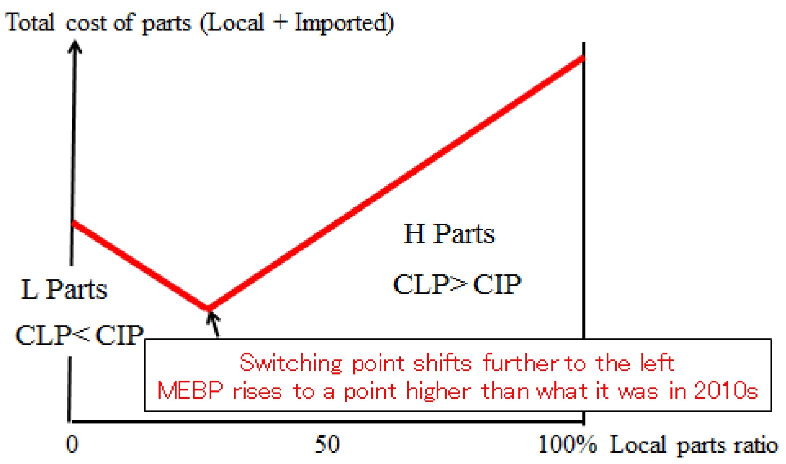
As for the definition, the local cost of L Parts is lower than their imported parts cost whereas the local cost of H Parts is higher than the import cost, in both developing and developed countries.

As for the characteristics, during the shift of the switching point towards the right in developing countries, the L Parts were labor-intensive while the H Parts were capital or technology-intensive. However, when the switching point shifts to the left in the case of developed countries, the L Parts are those that are capital or technology-intensive and the H Parts are the labor-intensive parts. The reason is that the developing countries have a competitive edge over the developed countries in labor-intensive parts whereas the developed countries have a cost or technology advantage, mainly in the capital or technology-intensive parts.

b. Possible Future Development －A further shift to the left

As the trend described earlier intensifies, not only the labor-intensive parts but also some capital or technology-intensive parts will change from being L Parts to H Parts. There is a possibility that the switching point shifts further to the left, as shown in Figure9.

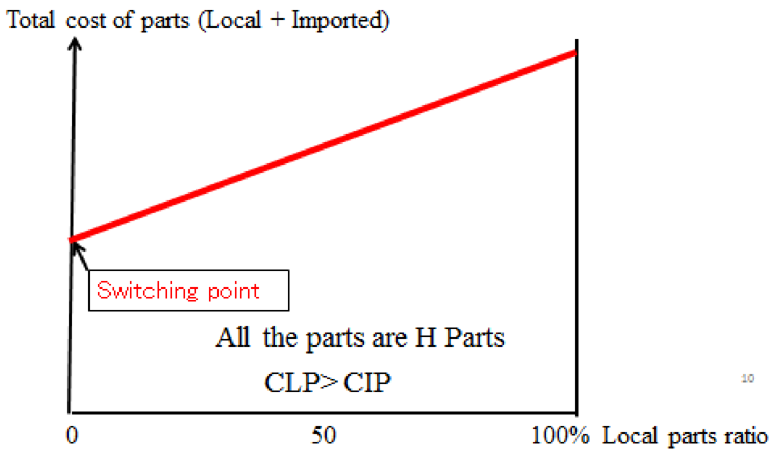
Figure 9 USA (2020s, Forecast)



c. Shift towards a local parts ratio of 0%

If the trend discussed earlier continues, we get the situation depicted in Figure10. Here, the switching point has reached a local parts ratio of 0%.

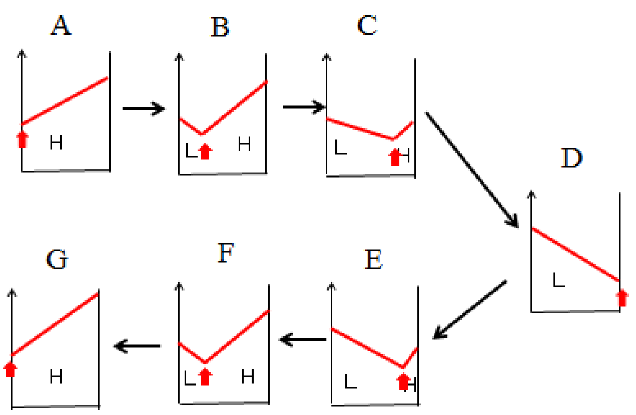
Figure10 Country X (20YY)



(2) Parts Localization Lifecycle in both developing and developed countries

By combining (ⅰ) the shift of the switching point to the right in developing countries and (ⅱ) its shift to the left in developed countries, we get the parts localization lifecycle shown in Figure11. The switching point is at a local parts ratio of 0% in A but progressively shifts to the right (B and C), finally reaching a local parts ratio of 100% in D. The shifts correspond to the gradual development of the parts industries in the developing countries. A gradual lowering of the MEBP accompanies these shifts.

Figure11 Parts Localization Lifecycle



In the 1990s, however, as explained earlier, auto makers in developed countries began substituting these local parts with the cheaper parts produced in developing countries. Subsequently, the switching point starts shifting to the left, as shown in E.

As this trend intensifies, not only the labor-intensive parts but also some capital or technology-intensive parts will change from being L Parts to H Parts, as shown in F. There is also the possibility that the switching point shifts further to the left. If this trend continues, the switching point will finally be at a local parts ratio of 0%, as shown in H. On the other hand the MEBP gets lowered in E. However, it rises again in F and G.

We call this gradual, stepwise shift the parts localization lifecycle. We created this model by not only developing the cost penalty model but also applying the flying geese paradigm[2] to the automobile industry.

6. Summary

We conclude by summarizing our research findings. The cost penalty model proposed by Baranson applied only to the early stage of auto industries in developing countries. Baranson and the Japanese researchers before us overlooked the fact that the cost reduction effect relating to the use of L Parts operates before the cost penalty effect kicks in due to the historical restrictions and the primitive auto industry infrastructure in the developing countries.

In this paper, we first introduce a cost reduction curve, in which the complete vehicle cost decreases in inverse proportion to the increase in parts localization. The cost reduction phase precedes the cost penalty phase, in which the complete vehicle cost increases in proportion to the increase in parts localization. We refer to the point at which the switch from the cost reduction phase to cost penalty phase occurs as the penalty switching point or the switching point.

Second, we show that the shift of the switching point from the cost reduction phase to the cost penalty phase follows the development of the auto industry. We first describe the shift of the switching point towards greater parts localization in the developing countries; subsequently, in the case of the developed countries, we show how the shift is in the opposite direction, that is, towards decreasing parts localization.

In addition the MEBP gets lowered from A to E, however, it rises again in F and G as shown in Figure11.

Third, we show that the cost penalty curve also applies to developed countries. After a complete localization of parts has been achieved, it is found that in most developed countries the parts localization ratio begins to decrease and the cost penalty curve re-appears. This happens because some developing countries have developed a competitive parts industry and can export auto parts to developed countries at a lower cost. Developed countries who do not import will experience a penalty in terms of higher costs. By using both the cost curves, we can explain consistently the actual situation in both developing and developed countries.

Finally, we define the parts localization lifecycle in order to offer a new paradigm for understanding the development of auto industries in both developing and developed countries.

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1. We also ignore the fluctuations in the exchange rate.
2. The Flying Geese Paradigm (FGP) is a model built by Japanese scholars to analyze the industrial development in Asian countries, as they tried to catch up with the West. It was first developed in the 1930s by K. Akamatu and K. Kojima built on it in the 1960s by publishing several papers and books. Being related to the Product Lifecycle theory proposed by R. Vernon, the Flying Geese Paradigm was widely discussed and has been gaining popularity since the 1970s.

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