LEARNING TO BE LEAN IN AN EMERGING ECONOMY: THE CASE OF SOUTH KOREA[1]

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First Draft---comments are highly welcome

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1. Introduction

Balance of payments considerations have driven the automobile industry strategies of many late-industrializing countries such as Thailand, Mexico, and Malaysia. These countries do not intend to become leading suppliers in the world automobile industry but rather, have designed (if only by default) their assembly and parts operations with a view towards protecting their balance of payments. Because an automobile is a high-value import, and because demand for automobiles rises steeply as per capita income rises, free importation of automobiles often hurts a young economy's balance of payments. Therefore, virtually all late-industrializing countries have some intention of developing a production capability in autos in order to protect the supply of and demand for foreign exchange.

Other countries intend to become full-fledged automobile industries in the future, with world-renowned companies which are capable of serving a large proportion of domestic demand and of exporting as well. These countries include Korea, China, India, and possibly Brazil. They should be thought of not simply as "emerging markets"---growing markets for the automobile output of existing suppliers from North America, Europe and Japan---but "emerging economies"---economies that are growing fast with ambitions to develop their own automobile industries.

The Korean automobile industry dates to the early 1960s and has progressed from the stage of CKD manufacturer, to

mass producer of a single model (the Pony), to exporter of a wide range of models from three big companies---HM (Hyundai Motors), KM (Kia Motors), and DM (Daewoo Motors). The accomplishments of the industry are many, given the stiffening of international competition since the first energy crisis in 1973. Nevertheless, the Korean automobile industry would be the first to admit that it has a long way to go to become equal in technological capabilities with the world's leading automobile producers. It lags especially in the area of new product development, which is the focus of this paper. It also still suffers to varying degrees (depending on the company) from too low volume, and product development and volume are intimately linked.

Volume considerations continue to drive the Korean automobile industry's development strategy.[2] As Womack, et. al. observed:

> Companies with higher production volumes for all their products combined still have a competitive advantage. As long as corporate management can deal with the complexity, being big still means being better.[3]

To increase volume, exports are necessary. To increase exports, Korean companies require better products. If such products are not of their own brand and design, Korean

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[2]To low volume lay at the origins of the Toyota system; to overcome too low volume initially Toyota concentrated on reducing set-up times for stamping.

[3]James P. Womack, Daniel T. Jones and Daniel Roos, The Machine That Change the World: The Story of Lean Production (Harper, 1990).

companies argue their profit margins are squeezed by the companies that badge their cars. The focus of the Korean automobile industry in the 1990s has been on developing a full-line of their own cars for the domestic and foreign markets.

2. "Learning"

All good companies learn from other companies, but when we say Korea's "Big 3" automobile companies are still "learners" we use this term in a specific sense: (a) they are low volume; (b) they are experiencing a fast rate of introduction of new model types (and not just replacement or up scaling of existing models); (c) as a consequence of new model-type introduction they are also investing a lot in new capacity; and (c) for all these reasons their process is unstable---not necessarily in the sense of being out of specification or control but of changing very fast.

Low volume Evidence of Korea's low volume by international standards is presented in Table 1. This table compares the passenger vehicle (only) production volume of Korea's "Big 3" as well as SM (SSangyong Motors) with each of their respective tie-ins---Mitsubishi Motors in the case of Hyundai Motors, Ford and Mazda in the case of KIA Motors, HM and Honda in the case of Daewoo Motors, and Mercedes Benz in the case of SSangyong Motors. Only in the case of HM is volume anywhere close to that of its tie-in: over the period 1991-1993, HM's production of passenger cars was 76% as great

as that of MM's. At the other extreme DM's production of passenger cars was only around 20% that of Honda's (ignoring GM's volume altogether!).

Korea's emphasis on volume has been based on estimates of economies of scale related to assembly. In 1986 consultants estimated that a minimum efficient scale was 0.3 million cars per model.[4]

To achieve volume automobile assemblers have been steadily adding new model types. As Table 2 indicates, the model types which were new for each of four companies totaled 11 in 1975-80, 7 in 1981-85, 12 in 1986-90, and 15 in 1991-1995. This is a very rapid rate of new product introduction.

Interrelatedly both domestic and export sales rose at a very fast rate (see Table 3). Between 1975 and 1990 total passenger car exports from Korea grew at an average annual rate of approximately 46.8% (from a small base, of course). By 1993 Korea was exporting as much as 38% of its passenger cars, with HM leading the way with an export ratio (ratio of exports to production) of 38% (see Table 3A). Domestic sales of Korean-made cars rose annually by 26.8%. Growth slowed in the 1990-1993 period but as Table 3 shows, it was still break-neck: 18.2% annually in the case of exports and 15.3% annually in the case of the domestic market.

The Korean automobile industry clearly remains a "learner" as we've defined it---low volume, high rate of new

[4]Yoon Dae Euh, The Korean Automobile Industry, Korea University, mimeo, 1986.

model-type introduction, and high rate of expansion. Consequently, we would argue that it is not appropriate **at this time** for Korea to adopt a lean production system.

3. Learning and Leanness

Korean auto makers today argue that large volume is critical in order to introduce a lean production system: lean needs diversified products, small runs and big aggregate volume in order to use common parts. We would add that lean production is an important goal but not a practical proposition in the early stages of the catch-up process. To improve productivity and quality the Korean automobile industry has devised its own set of practices, which we discuss below. Nevertheless, catch-up strategy in terms of technology development is not uniform. It differs among the "Big 3".

A lean production system is not appropriate during the early catch-up process for the following reasons:[5]

(1) Just-in-time inventory management When volume is very low, this system makes no sense---if trucks arrive at an assembler every hour, they may carry half a part! Moreover, when the assembly process is unstable and the quality of parts suppliers is poor, JIT is simply too risky.

[5]This section benefited especially from discussions with Dr. Daechang Lee of the KIA Economic Research Institute.

(2) Multiple skills When new production capacity is being added very frequently, a company may not have to time to train its workers sufficiently to master multiple skills.

(3) Repair on the line It is too costly and time consuming to do repairs on the line when defects have multiple causes---poor materials, poor workmanship of both assemblers and parts suppliers, low worker morale, etc. Under these circumstances and in the absence of a highly-experienced labor force, workers on the line ask not the "Five whys" but the "Fifty-five whys".

(4) Stopping the assembly line Allowing any worker to stop the assembly line is in conflict with a learner's strategy: to build volume as quickly as possible. In Korea the object of automobile makers is to produce as much as possible for a captive domestic market. Given this strategy, empowering workers to stop the assembly line is counter-productive.

Instead of getting into a "lean" production mode as soon as possible, the "Big 3" in Korea have tried to upscale step-by-step, adopting some but not all practices from advanced automobile makers, and keeping an open mind about how to improve. We turn now to the new product development efforts of assemblers.

4. Assemblers' Product Development

By their own reckoning Korea's "Big 3" have made significant strides in developing their own product models. Table 4 tries to provide some evidence of this progress. It

shows to what extent elements of product development that were once purchased from outside technology suppliers have been sequentially brought in-house. The elements or activities in question are:

styling;
engine design;
prototyping;
final drawing;
production preparing; and
pilot production.

In the case of HM, for its earliest models in 1976-1984 (Pony, Excel I, and Stellar)it bought outside (wholly or partially) almost all elements of product development capability, ranging from styling to pilot production. In a second phase (1985-1990) and for more advanced models it made the greatest progress in prototyping, production preparing, and pilot production. HM reports that since 1991 it can do new product development entirely "alone", without outside assistance.

Specifically this means that HM is advanced enough to adapt the best design components from a multitude of different foreign sources and then combine them into its own car. HM does not seem capable yet of moving ahead of the world frontier by, for instance, innovating an entirely new brake or transmission system.

Both KM and DM started much later than HM and may have benefited from HM's experience, although technology transfer

among Korea's "Big 3" appears less than between the "Big 3" and its various tie-ins. The most intense intra-Korean technology transfer appears to be between the "Big 3" and SSangyong Motors, which is making a late start into auto production with a technical tie-in with Mercedes Benz. Ssangyong Motors has also been hiring experienced engineers from HM, KM, and DM. Such head-hunting is also likely to characterize the formation of Samsung Motors, which is planning to enter automobile production with a technical tie-in from Japan.

Product development capability has been slowest in DM, which started producing cars about the same time as HM but as part of a joint venture with GM. Product development was under GM's jurisdiction and models were mostly imported from GM Opel; there was little opportunity for DM to acquire its own product development capabilities. As late as 1995 DM could not do its own engine design.

Whether or not Korean assemblers overstate their capabilities to execute new products it is clear that they have in the past and continue at present to invest heavily in further learning. What is worth noting from Table 5 is how modes of technology acquisition have changed over time.

Technical tie-ins At the early stages of the Korean automobile industry technical tie-ins were the chief means of acquiring technology. For the "Big 3" over time the number of such tie-ins has increased although at a decreasing rate: from 34 in 1980-84, to 64 from 1985-89, to 70 in 1990-93. At

the company level a declining trend is noticeable for HM, the most advanced of the Korean auto makers in terms of volume and technological capability.

In terms of country of origin for tie-ins (for both assemblers and parts makers in 1992), a total of 458 or 57.5% were with Japan. The United States was next in importance with 130 or 16.3% of the total.[6]

In terms of the production process, all the "Big 3," especially HM and KM, are heavily influenced by Japan. But in terms of "technology", or the way engineers understand the engineering of automobile manufacture, American influence is claimed to be predominant.

Korean trainees abroad The number of Korean trainees abroad has also increased over time. Such trainees study overseas in formal educational settings or work in various capacities in different companies.

Foreign engineers in Korea In the early days of Korean industrialization it was too expensive for most companies to employ foreign engineers in Korea. This has changed, and in the case of the automobile industry, in 1990-94 a total of 704 foreign engineers had consulted in Korea for various lengths of time.

Foreign acquisitions Finally, the most advanced form of acquiring technology overseas has recently become the foreign acquisition (not shown in Table 5): the purchase

[6]Korean Automobile Manufacturers Association, Korean Automobile Industry, 1994 (Seoul).

overseas of a small, often financially-strapped high-tech company to supply state-of-the art know-how.

In-house capabilities Parallel with investments by Korean auto makers in foreign technology transfer have been their investments in in-house capabilities. As Table 6 indicates, HM and KM have greatly expanded the number of people working in R&D. Between 1989 and 1993 both the number of researchers with Ph.Ds and Masters Degrees increased sharply.

Typically the R&D centers of the auto makers are headed by Korean-Americans with extensive experience working in the United States. Such people were lured back to Korea with good salaries and challenging opportunities. Reverse brain-drain is an important source of Korea's recent technology build-up.

5. Company Strategies

Given differences in company size, volume of production, group affiliation, experience and history (including history of foreign affiliation), strategies to acquire technological capabilities have varied among the "Big 3." To simplify, HM's strategy is to *grow its own* technology, DM's strategy is to *buy it outside*, and KM's strategy is *somewhere in between*.

Being the biggest and oldest Korean auto maker, as well as the best serviced by its group affiliates, HM is the most inward-oriented in terms of learning.

The extensive group support which HM receives is noteworthy: 14 sister companies within the Hyundai group supply HM with parts, 4 companies supply it with machinery, 2 companies supply it with software or information, and 5 companies supply it with finance (see Table 7). Such support is more extensive than what DM receives from its parent group, although the Daewoo group is Korea's fourth largest chaebol (conglomerate).

Affiliation to one of Korea's giant chaebol provides HM and DM with supply linkages as well as finance. Deep pockets at the group level have been an important part of HM's and DM's technological growth. The absence of such deep pockets in the case of KIA, as well as this company's professional as opposed to family management, are considered by KIA's top managers to be competitive handicaps. (Outside as opposed to family corporate control makes it difficult for KIA to discipline its workforce).

Being a laggard among the "Big 3" to acquire technological capabilities in product development, DM's strategy is to buy such capabilities from outside. As Table 6 indicates, DM's investments in its own R&D are relatively insignificant. Instead, DM has bought a British design firm, Hawtal Whiting, to accelerate its learning.

While the "Big 3" have followed different methods to acquire technological capability in product development, one thread is common: none of them has compromised its independence in terms of equity ownership in order to catch

up (in contrast with the Brazilian automobile industry and Daewoo Motors before the 1990s). Whether this is also the strategy which China and India will follow remains to be seen.

6. Parts Suppliers

Roughly 70% of a Korean-made car comprises parts and components supplied by vendors. Therefore, the ability of assemblers to design their own models depends critically on the capabilities of parts suppliers.

These capabilities have been increasing over time because vendors themselves have invested heavily in learning.

Table 8 gives a general picture of Korea's automobile parts industry. It suggests that sales have risen far faster than inflation, and number of employees and number of companies have also grown over time. Most important, sales per employee have increased steeply. We can infer from this that on average, vendors have become more capital-intensive and probably specialized.

The rising capabilities of vendors are indicated by several metrics. Assemblers divide their vendors into three categories based on a mixture of qualities. As Table 9 indicates, A and B vendors, or those with the highest qualifications, have increased as a share of the total for every assembler.

Moreover, all assemblers report a decline in the average defect ratio of vendors (ppm or parts per million). In all cases the decline has been steep.

Finally, as vendors have gained experience with sequentially new models, the share of vendors which is able to design its own proprietary parts has grown. Table 9 also shows, however, that the design independence of suppliers varies somewhat inversely with the design capabilities of assemblers: more "black box" vendors (as a share of the total), or vendors capable of executing their own designs, exist for KM and DM than for HM. This, however, may merely reflect a discrepancy in how the capabilities of parts suppliers are defined by different assemblers.

Vendors have built up their capabilities through various means: sending "guest engineers" to assemblers, investing more in tie-ins with foreign vendors, and forming joint ventures with foreign vendors (see Table 10). All of these modes of technology transfer have grown in importance over time.

Still, in the opinion of every assembler the product development capabilities of vendors lag far behind the world frontier. This slows and raises the costs of new product development.

7. Government's Role

The automobile industries of emerging markets are far more marked by government intervention than the automobile

industries of established markets (although in the case of the United States and the European Community, VERs or some equivalent have become important while in Japan, "structural impediments" inhibit imports). Government's role in the Korean automobile industry has been extremely critical both in the past and at present, although the nature of that role has changed. The government's emphasis now is on helping the automobile industry invest internationally and improve its science and technology infrastructure.

Over the course of several Automobile Industry Promotion Acts the Korean government has provided auto makers with trade protection, subsidized credit, and export incentives. Now imports of foreign automobiles are being liberalized except in the one case that seriously matters for Korea: imports of cars from Japan or from Japanese-owned factories in third countries (if local content is less than 60%). Japanese cars are banned on the ground that Korea runs a huge overall trade deficit with Japan and needs to diversify its import source.

For a long period neither were foreign cars to be seen on Korean roads nor were Korean cars to be seen on foreign roads. The Korean automobile industry was also highly oligopolistic. This is a recipe for inefficiency and stagnation yet the Korean automobile industry has managed to thrive. It has done so in part as a result of the government's subsidy allocation principle. Whereas governments in many late-industrializing countries have

allocated subsidies according to the principle of "giveaway," the Korean government has allocated subsidies according to the principle of "reciprocity": nothing has been given away to business for free, and companies have been disciplined as they have been supported.[7]

A major form of discipline in the case of the Korean automobile industry has been export targets and price controls. Although for years Korean auto makers have enjoyed high sales in the fast-growing domestic market, they have also been pressured to export. As Table 3A indicates, exports of passenger vehicles now account for as much as 38% of total output.

As for price controls, they have been administered by the Ministry of Finance as part of its fight against inflation. In general, auto makers have been allowed to set prices for new models above world prices. But then prices for the same model have been discouraged from rising. This has helped companies recoup initial investment costs and has pressured them to reduce costs over time in order to make profits. Table 11 presents average prices (measured in 1985 real US. dollars) for small and medium/large cars for 1974-1991. As can be seen, in real terms the average price of both categories of cars has fallen over time.

8. Conclusion

[7]For a general discussion see Alice H. Amsden, Asia's Next Giant: South Korea and Late Industrialization (Oxford University Press, 1989).

The Korean automobile industry has made enormous strides in acquiring technological capabilities but it is still a "learner" as we've defined that term: it produces in relatively small volumes and operates with an "unstable" process due to rapid introduction of new model types and production capacity.

A lean production system is a goal of Korean auto makers but it has not proved a practical method for upscaling and catching up. Korean automobile firms are learning through selective benchmarking, with a heavy emphasis on acquiring know-how from Japan.

To raise volume auto makers have emphasized exports, and to export more they have stressed acquiring capabilities to develop a full product line of their own. The focus of our paper, therefore, has been on learning related to new product development. Our short conclusions about product development are as follows:

(1) Over time the "Big 3" auto makers (Hyundai Motors--HM, KIA Motors---KM, and Daewoo Motors---DM) have all acquired in-house capabilities related to an increasing number of product development sub-activities, although in varying degrees. None, however, has yet pioneered an innovative and entirely new product or sub-product.

(2) Catch-up strategy varies among companies. HM stresses developing capabilities in-house, DM stresses buying capabilities outside, and KM falls somewhere in between.

(3) Despite this variation, none of the companies now appears willing to trade equity ownership and control for foreign technical assistance. All Korea's "Big 3" aim to remain substantially independent.

(4) The government's role in the automobile industry has been and remains greater in Korea than in most highly advanced economies. The government has extensively supported business (both assemblers and key parts makers) but it has distinguished itself from governments in many other late-industrializing countries by also disciplining business. In the case of the automobile industry discipline has mainly taken the form of export targets and price controls.

If Korea is any guide and harbinger of things to come in China and India, it is a misnomer to call it an "emerging market." In terms of its automobile industry Korea is better described as an "emerging economy" or an "emerging "manufacturer" because it has every intention of developing its automobile sector into a global industry with world class players. It is open to liaisons with foreign firms to acquire know-how but it would be naive to think that any of Korea's "Big 3" producers is willing to join a foreign automobile company as a family member.

Whether or not Korea's automobile companies succeed in becoming world class players is another matter, but given their heavy investments in learning, the "deep pockets" of those assemblers which are members of huge business groups (Hyundai Motors, Daewoo Motors and soon Samsung Motors), as

well as their discipline at the hands of a competent state, they have a fighting chance.