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South Korea's Shipbuilding Industry: From a Couple of Cathedrals in the Desert to an Innovative Cluster

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Summary

After the publication of the competitive advantage of nations by Porter in 1990, the competitiveness of regional concentrations of industries has been often explained by the cluster concept. There are many definitions of clusters, but they mainly boil down to a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities. The shipbuilding industry in Korea can for sure be regarded as a competitive industry, as the spectacular rise of its world market share from 2% in the early 1970s to the current 38% impressively testifies, but can it be considered a cluster?

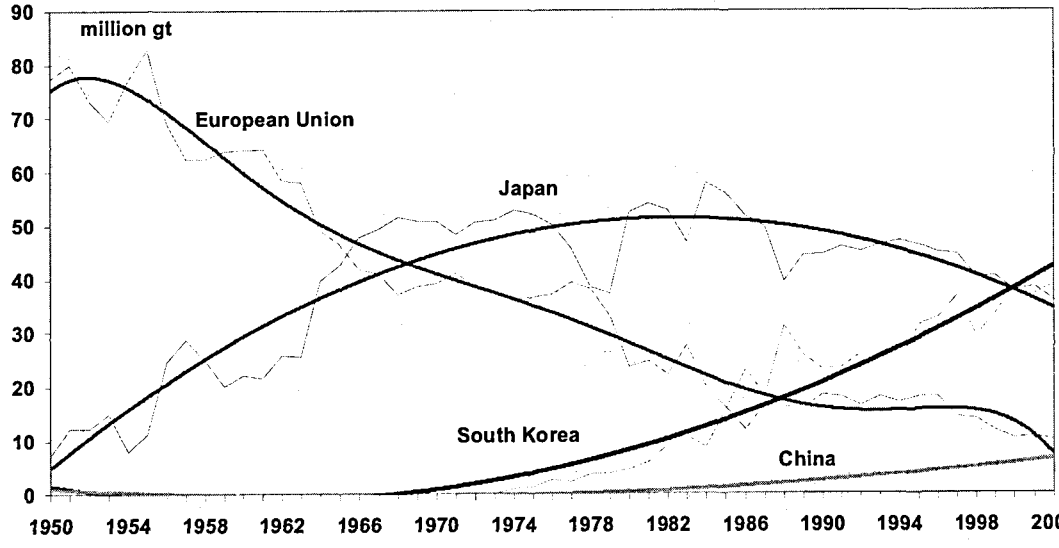
Based on an analytical framework consisting of a typology of clusters and a context-sensitive evolutionary approach, the paper will show that over the last thirty years Korea's shipbuilding developed from a mere number of isolated, large shipyards (cathedrals in the desert) established by large conglomerates (*chaebol*) in close collaboration with the central government into an innovative cluster. The cluster is on the one hand characterised by a strongly developed supply industry and specialised universities and research institutes, but on the other hand by a weak, yet increasing role for local and regional institutions. The specific and context-dependent characteristics of this innovative cluster are more important explanations for its competitiveness than the financial interventions by the central government, which are repeatedly put forward by European policy-makers in their trade war with Korea.

Key words: shipbuilding industry, Korea, innovative cluster, trade war, political lock-in.

1. Introduction

The shipbuilding industry is both a very global industry and an industry with much state

intervention (Cho and Porter, 1986; Stopford, 1997). During the history of the industry, there have been dramatic changes in global leadership (Cho and Porter, 1986; Stopford, 1997; Todd, 1991). At the beginning of the 19th Century, the USA was the world leading shipbuilding nation, at a time when ships were made of timber. From 1850, when the first steel ships were built, until 1945 Great Britain was the world leader in shipbuilding (in 1882 it captured 80% of the world market), whereas shortly after the Second World War Germany and some other European countries took over leadership from Great Britain. In the 1960s Japan became the world leading shipbuilding nation. Since 1973 South Korea has been building up and expanding its shipbuilding industry and since a couple of years Japan and South Korea share world leadership in shipbuilding (Figure 1). Among the emerging shipbuilding countries, Poland and in particular China are the most prominent (Michael, 2004). Whereas new countries successfully entered the world shipbuilding markets others, such as Sweden, had to withdraw from the market (Todd, 1991).



Source: Eich-Born and Hassink (2005).

Figure 1 : Tonnage Completed and Delivered by Major Shipbuilding Regions from 1952 to 2002

The shipbuilding industry has been a global manufacturing industry for a long time, since product needs are quite standardised for certain vessels and transport costs for completed ships are relatively low (Cho and Porter, 1986). At the same time, the industry is geographically highly concentrated, as it is dependent both on large singly manufacturing sites and on coastal locations and as the shipbuilding industry has always been dominated by one or a few countries

world-wide. Paradoxically, although highly globalised when it comes to sales, until recently the industry has at the same time been highly nationalised when it comes to the organisation of production with relatively high levels of state intervention. Furthermore, during the history of the shipbuilding industry there has been a strong link between the fortunes of trading, shipping and shipbuilding (Stopford, 1997).

That has been the case in Britain, Continental Europe and Japan. It has been much less the case, though, in South Korea, where growth in shipbuilding "has been far more heavily dependent upon the export market than was the case for either Britain or Japan, both of which based their initial expansion upon the domestic fleet" (Stopford, 1997). Moreover, every time in history the production has shifted from one country to another country, institutional and political reactions led to protectionism and to trade conflicts (Stopford, 1997). Due to different cost levels between countries there have always been conflicts between new entrants and established shipbuilders (Stopford, 1997). Five hundred years ago it was the Dutch versus the Venetians and later for instance the Japanese versus the Europeans. "The high cost yards have to survive on the orders they can win during booms when the low cost yards have full orderbooks.

As time goes by the most expensive yards give up, making way for the low cost newcomers. Government subsidies often play a part in the process by allowing high cost shipyards to quote at lower prices" (Stopford, 1997). Apart from receiving subsidies, established shipbuilders have been trying to move into higher value-added, niche markets that require sophisticated engineering know-how and high standards of workmanship. European shipbuilders, for instance, moved into the markets of research ships, luxury cruisers and icebreakers (Cho and Porter, 1986).

The most recent battle in this series of battles during the history of the shipbuilding industry is the one between the European and the South Korean shipbuilding industry. During the 1990s South Korea's shipbuilding capacity expanded contrary to market trends. In order to use these capacities, Korean shipbuilders had to made enormous price concessions, so that they have been accused of price-dumping (Heseler, 2000, 2001; Lűken, 2001). Bankrupt yards such as Halla and Daedong continued to produce and to expand their market share. European officials also stated that IMF money, which was transferred to Korea in the framework of the financial crisis of 1998, has been indirectly used via the banks to repay and finance debts of Korean shipbuilders (Heseler, 2000).

The European Commission and the Association of European Shipbuilders and Shiprepairers (AWES) recently presented a couple of reports on the situation in world shipbuilding (CEC, 2000). These reports attack South Korean shipbuilding practices, indicating the likelihood of subsidies and possible misuse of funds received under the IMF rescue package. The European

Commission commissioned consultants to do research on the accounting practices of Korean shipbuilders in order to prove that they offer ships on the world market below cost prices. The Korea Shipbuilders' Association regularly publishes reports on the World Wide Web with counter arguments against the European reproaches. One of these counter-arguments is that both Brussels and EU states have been subsidising European shipyards, not only in the 1970s and 1980s when the European shipbuilding industry was in sharp decline (Str 1986), but also more recently (Lee, 2001). Furthermore, it is stated that the Korean shipbuilding industry is very competitive due to competitive advantages, such its strong supply base, particularly with regard to steel and ship engines. Meanwhile, the EU has brought the case to the WTO.

Although the trade war between the European Union and the Korea has attracted much attention (Eich-Born and Hassink, 2005), little is known about competitive factors related to the cluster concept that contributed to the success of Korea's shipbuilding industry. *Clusters* are groups of firms in one location (co-location) that have a competitive advantage in innovation due to co-operation, collaboration, competition, networking, trade associations and lobbying (Benneworth et al., 2003). This paper therefore aims at analysing the shipbuilding industry from such a cluster perspective. With the help of a typology based on the development stages of clusters, the emergence and development of the Korean shipbuilding will be analysed. The empirical part of this paper is based on secondary literature study and 19 in-depth interviews with managers of shipyards, suppliers, trade unions, industry associations, central government policy-makers and academic experts in South Korea in July 2002.

In order to be able to soundly analyse the development of a regional shipbuilding cluster in South Korea, we first need to build an analytical framework. In Section 2 of this paper the theoretical framework focuses on regional production clusters. Section 3 will describe the joint planning and construction of cathedral in the deserts by *chaebol* and the central government. Section 4 will present empirical material on the current innovative shipbuilding cluster in Gyeongnam in South Korea, whereas Section 5 will give the main conclusions of this paper.

2. Regional Production Clusters

Much literature in economic geography has been written about the positive sides of the geographical clustering of industries, such as in the work on the rise of new high-tech regions, industrial districts and regional production clusters in North America and Western Europe (Clark et al., 2000). Most authors have tried to come up with explanations for the rise of these regions

in order to contribute to regional economic development theories and to learn policy lessons from these success stories for other regions. In the 1980s, for instance, geographers and sociologists launched concepts such as flexible specialisation, industrial districts and the innovative milieu. Furthermore, some well-known economists have been dealing with the question why internationally successful industries tend to concentrate in a few nations or regions (Porter, 1990, 2000; Krugman, 1991).

More recently, authors have tried to bring together economic geography with the evolutionary school of technological change, which, unlike neoclassical theory, takes routines, history and geography seriously by recognizing the importance of place-specific elements and processes to explain broader spatial patterns of technology evolution. This school regards the mutual relations between innovations, firms and the political and socio-institutional forces as conditions for an optimal diffusion process and thus for economic growth. Closely related to the evolutionary school are the regional innovation systems concept (Cooke et al., 2004) and the learning region (Morgan, 1997; Hassink, 2001), concepts stressing the importance of linkages between firms and other organisations in order to promote benefits from geographic clustering. They see regional 범overnance These explanations share with each other the focus on the origin and development of innovation and the significance of industrial organisation and inter-firm linkages for regional competitiveness and regional innovation processes. Most of them belong to the recently coined family of territorial innovation models (Moulaert and Seika, 2003).

Thus, geographical 'clustering' of firms in related industries and its implications for regional development have been debated in economic geography for a long time now (Cumbers and Mackinnon, 2004). There have been intensive discussions about the extent of clustering at a regional level and the potential economic benefits that might be generated by clustering. It is well-known that the spatial co-localisation or 'clustering' of firms and other organisations in related industrial sectors has potential for economic and innovation benefits. These benefits have been labelled variously as 'external economies of agglomeration', which support the co-operative and competitive relationships between firms and enables the effectual developmentand manufacture of products. Storper(1997) argues that traded interdependencies may be based on upstream and downstream linkages between buyer and supplier firms, and untraded interdependencies include, resource base, skills, technologies and governance agencies. Proximity is said to provide the social solidarity and trust, the face-to-face contact and the pool of skills and know-how.

Although many authors assume there are economic and innovation advantages from geographic clusters, there are also arguments that appear to run counter to the 'benefits from localisation' thesis (see Hassinkand Shin, 2005; Enright, 2003). Potential disadvantages lie in labour cost

inflation, inflation of land and housing costs, widening of income disparities, local congestion, environmental pressure, over-specialisation and last but not least lock-ins (Martin and Sunley, 2003). Among the potential lock-ins that might emerge in clusters are the functional lock-ins (hierarchical inter-firm relationships) and cognitive lock-ins(a collective mindset in a cluster that might confuse secular trends with cyclical downturns) and political lock-ins (thick institutional tissues aiming at preserving existing traditional industrial structures and therefore unnecessarily slowing down industrial restructuring and indirectly hampering the development of indigenous potential and creativity) (Hassink and Shin, 2005).

There are other important spatial dimensions, including the national and international arenas, which may influence the extent to which geographic clustering occur. The geographic pattern of local industrial innovation activity should be seen in the context of national and international forces. For example, the role of the 'national system of innovation', in shaping firms' innovation activities and capabilities, has been discussed extensively (Lundvall, 1992). Economic and innovation benefits may arise for firms which belong to the same national system due to short geographical distance, common language and social organisation, andcultural proximity. There may be an important role for national 'governance' institutions such as national state structures and strategies, as well as other organisations such as networks of national research organisations and universities. This, indeed, may support and enhance local innovative activities and capabilities, but as part of the 'national system of innovation' (Bathelt and Depner, 2003; OECD, 2001). In turn, increasing regionalisation tendencies are overlaid by an increasingly intensified global division of labour (Bathelt et al., 2004). Based on 'global' information and communication trends together with new forms of global governance, institutions and strategic alliances, locational proximity may be unnecessary. There are authors who suggest that globalisation may, however, reinforce the presence of geographic clustering, where regional economies represent important areas of specialisation (Storper, 1997).

A closer look at some papers on clustering and clusters, which, of course, can only be a small part of the bookshelves on clusters that have recently been produced, shows that there are many definitions of clusters, such as (collected by and to be found in Martin and Sunley, 2003):

- "A cluster is a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities" (Porter, 1998)
- "The more general concept of 'cluster' suggests something looser: a tendency for firms in similar types of business to locate close together, though without having a particularly

important presence in an area." (Crouch and Farrell, 2001)

- "A cluster is very simply used to represent concentrations of firms that are able to produce synergy because of their geographical proximity andinterdependence, even though their scale of employment may not be pronounced or prominent" (Rosenfeld, 1997)
- "A cluster means a large group of firms in related industries at a particular location" (Swann and Prevezer, 1998)
- "A regional cluster is an industrial cluster in which member firms are in close proximity to each other." (Enright, 1996)

Martin and Sunley (2003) are very critical about the ambiguities and identification problems surrounding the cluster concept. In fact, the concept bears many characteristics of what Markusen (1999) has coined a fuzzy concept, that is a concept characterised by both lacking conceptual clarity, rigour in the presentation of evidence and clear methodology and difficulties to oprationalize. One, in our view useful, solution to solve these problems is to look at different dimensions of clusters and to use a typology of clusters based on development stages. By doing this we put the cluster in an evolutionary perspective.

Different dimensions of clusters include (Enright, 2003): the geographic scope of clusters, the density (dense vs. sparse clusters), breadth of clusters (broad vs. narrow), the depth of clusters (shallow vs. deep clusters), the geographical span of sales (from local to global), the strength of competitive position, the innovative capacity, the ownership structure and last but not least the stage of development. The latter point refers to a life cycle of clusters, going from embryonic to emerging to mature and declining stages (see also Gilsing and Hospers, 2000). Related to this typology of the stages of development, clusters also vary in terms of their level of activity and self-realisation (Enright, 2003). Working clusters are those in which critical masses of local knowledge, personnel and resources createagglomeration economies from which local competitors, suppliers, customers and institutions benefit. Latent clusters have a critical mass of firms in related industries but have not yet developed the level of interaction necessary to benefit from co-location. Potential clusters have some elements, but where these elements must be deepened and broadened. Policy-driven and "wishful thinking" clusters clearly lack critical mass and have a very thin foundation on which a cluster should be built.

Given the fact that one can find some kind of cluster policies in nearly all industrialised countries, there is a large variety in these kind of policy initiatives. These initiatives differ in the type of government intervention from non-existent to catalytic (bringing interest parties together without much support and direction), to supportive (catalytic plus cluster-specific

investments in infrastructure, education and training), to directive (supportive plus more directive targeted programmes), to interventionist (government making the major decisions about the evolution of the cluster rather than the private actors) (Enright, 2003). There are also strong differences in the level of government that is involved, although in most large industrialised economies it is the local and regional governments that are mostly involved in cluster support (Enright, 2003). A potential danger of regional cluster policy is that by supporting specialisation, negative lock-ins might emerge that hinder timely adaptation to changing external circumstances.

So, there are important questions about the extent, sorts, benefits and policies of clustering. In order to contribute to, and help clarify, existing conceptual discussion, this paper focuses on two key questions: whether and why geographic 'clustering' of firms and other organisations occurs in a globally competitive industry, such as shipbuilding; and what is the impact of such clustering, in terms of collaboration and innovation. These questions are explored by providing empirical evidence from a particular industrial and geographic context, namely the shipbuilding industry in South Korea.

3. Planning and Building Cathedrals in the Desert: the *Chaebol* and Central Government in Optimal Co-operation

Before 1970, the shipbuilding industry was virtually non-existent in Korea. From 1945 until 1970 the only shipbuilding activities were carried out by the state-owned enterprise Korea Shipbuilding and Engineering Corporation (KSEC). In the 1970s shipbuilding was selected as a targeted sector by the central government. This selection and the government support the industry received during the 1970s and 1980s should be seen against the background of the socio-economic model of the developmental state. In order to close the industrial and technological gap with the West, South Korea followed the route of this developmental or plan-rational state, rather than market-rational or plan-ideological state, characterised by a strong, authoritarian, central government which deliberately and strategically supported large enterprises and industrial competitiveness (Jun, 1992; Henderson, 1993). Economic policy successfully followed the sequence of import, import-substitution and export orientation. Over the years, the emphasis of economic policy gradually shifted from trade policy, to industry policy and more recently to technology policy in both countries.

Industrial policy was particularly prominent in the 1970s and shipbuilding was one of the archetypical industries supported by this policy. It played an important role in South Korea,

which is regarded as the most interventionist country of all East Asian Newly Industrialising Economies (Amsden, 1989; World Bank 1993). The South Korean government introduced so-called Five Year Plans, in which 'promising strategic industries' were identified as financial and technical support targets. By having large control over the financial sector, the government was able to channel investment funds to these industries. In return for the support priority industries received from the government, they were also heavily controlled by the state. The heavy and chemical industrialisation (HCI) drive, which was launched in the third and fourth Five Year Plan (1971-1981), can be regarded as the most prominent example of supporting promising strategic industries' in Five Year Plans. It was at this time that the state set up the shipbuilding industry. South Korea is not different from other countries in that industrial policy has created many inefficient firms as well. "However what differentiates Korea from other countries is that the Korean state has been willing and able to withdraw from support whenever performance has lagged" (Chang, 1993; Fukuyama, 1995). In fact, the state pushed and pulled firms with threats and promises.

In the 1980s and 1990s the policy shift from industry to technology policy led to a sharp increase in R&D expenditure levels in general and that spent by the private sector in particular (Kim, 1997). With this policy, South Korea followed Japan with a time lag (Economist 1999; Hobday, 1995). Both countries lack natural resources and are consequently strongly committed to education and the development of human resources. The similarities between Japanese and Korean business organisation and government structures can be partly explained by the Japanese colonisation of South Korea from 1910 until 1945 (Jun, 1992; Fukuyama, 1995). According to Castelles (1996) "the Japanese state not only molded Japan, but also Korea ... under its colonial domination". Furthermore, and probably more importantly, institutional innovations and calculated political moves taken by the military regime of Park, Chung-Hee, who ruled from 1961 until 1979 and who was strongly influenced by Japanese varieties of corporatism and communism, laid the foundation for industrial policy in South Korea ('guided capitalism'). Japan's prominent role of government in guiding industry was explicitly imitated (World Bank 1993, p. 80).

Thus shipbuilding started in the early 1970s due to the interventionist central government led by Park, Chung-Hee. The government's extensive control over the financial sector enabled channelling of investment funds to the industry, which has been heavily concentrated organisationally in a few extremely large shipyards (the world's three largest shipyards are located in Korea) and geographically in the province of Gyeongnam (Figure 2). Apart from Halla, which is located in Mokpo (Jeonnam), Korea's seven main shipbuilding companies have their

manufacturing facilities in the region (including Ulsan and Busan): the largest being in Ulsan (Hyundai Heavy Industries) and Geoje (Daewoo and Samsung), other large yards can be found in Ulsan (Hyundai Mipo), Busan (Hanjin) and Jinhae (STX), whereas small, but traditional yards are located in Tongyeong (Shina) and Busan (Daesun) (see Figure 2). The location of yards in Ulsan and other locations in Gyeongam were due to favourable possibilities for the construction of harbours, due to deep water and a lack of sandbanks, but also to military strategic considerations (Ulsan, for instance, was one of the few cities in South Korea that had not been taken by the North Koreans), to agglomeration effects (the proximity to the enterprises of participating business representatives) and to favouritism (Ulsan, for instance, had been the native town of various military leaders, especially of Yi Hu-Rak, who became head of the secret service later on) (Dormels and Hassink, 2004).

Even though shipbuilding is an outstanding industry in Gyeongnam's production structure, it is relatively diversified. Not only auqtther transport equipment

Priority industries, such as shipbuilding, were heavily controlled by the state in return for governmental support. The government's aim to support industries with a certain minimum scale of efficient production led to the intentional creation of *chaebol*. As all *chaebol* diversified in the same kind of industries, they competed fiercely with each other, also to bid for governmental support. Despite their wide diversification, *chaebol* were characterised by a hierarchical, top-down style of management and a high degree of central control. Shipbuilding was set up by the *chaebol* in close co-operation with the central government.

The best documented history of individual shipbuilding companies in Korea is the establishment of the Hyundai shipyard in Ulsan in the early 1970s (Amsden, 1989), nowadays the largest shipbuilding company of the world. Hyundai started building shipyards at a totally newly built shipyard without any experience in shipbuilding and against a gloomy international background of excess capacity and cutthroat price competition. Embedded in the Hyundai chaebol structure it could pursue a forward and vertical integration strategy at the beginning. Propelled by the slogan "our own ships, our own engines, our own designs" it focused on total capabilities. The main reasons behind Hyundai's success were threefold (Amsden, 1989). First, the government's supportive role was important: the government raised overseas credit for Hyundai, provided extensive subsidies for infrastructure and provided extensive financial guarantees to help Hyundai to win its first order. Secondly, Hyundai strongly benefited from foreign technical assistance (dockyard designs from a Scottish naval architecture firm, ship designs from a Scottish shipbuilding firm and production know-how from Japan's Kawasaki Shipbuilding Company). Thirdly, the forward and backward integration in the Hyundai group: it set up the Hyundai Merchant Marine

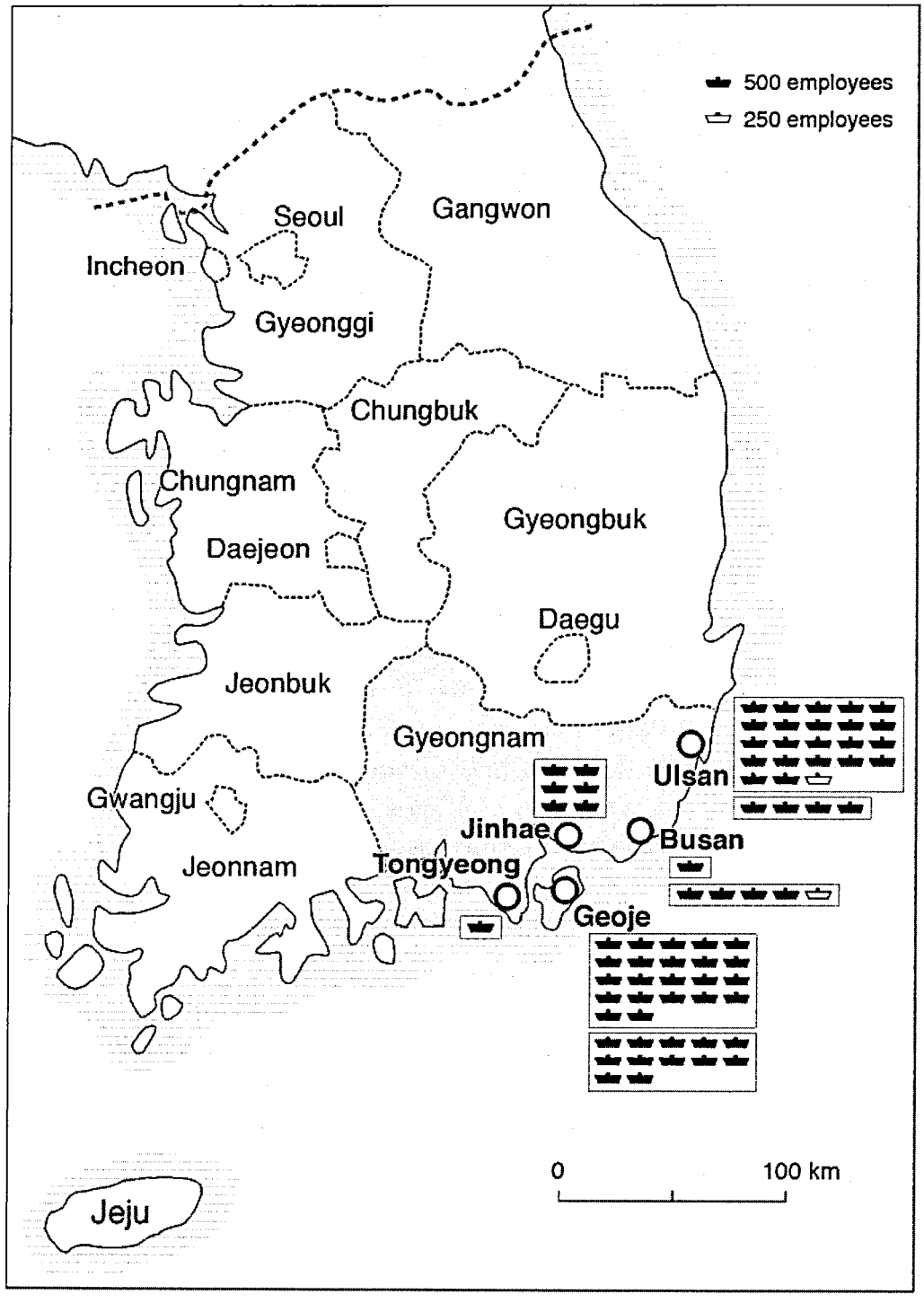


Figure 2 : The Location of the Main Shipyards in South Korea

Company, which bought ships, in order to provide the shipyard with an alternative to expensive Japanese engines, it established the Hyundai Engine and Heavy Machinery Company as a ship engine supplier in 1978 and it benefited from human capital available in related divisions within the group, such as Hyundai Construction Company and Hyundai Motors, when building up the shipyards. The two other large Korean shipbuilders, Samsung and Daewoo, pursued similar strategies (Amsden, 1989) (for the role of foreign technical assistance to Samsung, see Table 1).

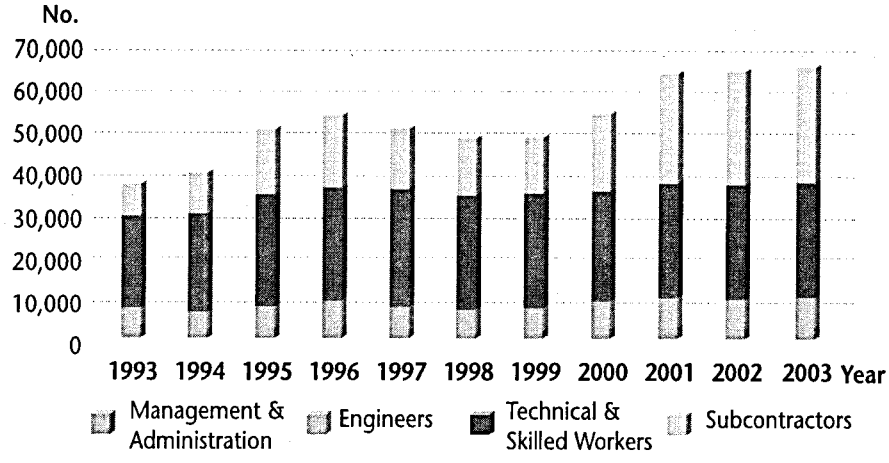
Although South Korea's world market share in shipbuilding has increased dramatically since the 1970s, its workforce did not increase significantly until the mid-1980s. Employment peaked in 1984, when 75,000 people worked in the shipbuilding industry and Daewoo and Hyundai had workforces of about 28,000 and 25,000 workers respectively, and strongly increased at the beginning of the 1990s and in the mid-1990s (Heseler, 1999) (see Figure 3). Since then there have been strong fluctuations with a strong decline around 1986-1988. In South Korea, shipbuilding output has been heavily focused on export: in South Korea 90% were destined for customers in foreign countries. At the end of the 1980s, the South Korean yards exported to other Asian ship owners with a rising share of European customers.

The shipbuilding companies could not rely on the strong supply base at the beginning. Many SMEs lacked functions that went beyond production (boundary spanning functions), such as R&D and marketing, which in turn, negatively affected their level of innovativeness and competitiveness (Hassink, 1999). Moreover South Korea lacked the kind of industrial districts that could be found in Japan. In Japan industrial districts are vastly important to endogenous knowledge creation and learning, whereas in South Korea they are not (Nonaka and Reinmőller,1998). Many of Korea's production clusters could be regarded as satellite industrial districts, districts consisting of both non-local suppliers and customers often noting more than a co-location of branch plants without networking, new firm formation and local embeddedness (Park and Markusen, 1999). In Japan, therefore, large enterprises could have used the regional areas in which they are located much better for the generation of knowledge and competitive advantage than their counterparts in South Korea. Korea's shipyards were therefore clearly strongly dependent on imports for their main suppliers during a long time. The large yards in Gyeongnam from the beginning were focused on export and were relatively isolated from the surrounding economy concerning supply. They could therefore be considered as cathedrals in the desert.

Table 1 : Samsung's Purchased Technology Licenses from Abroad

TechnologyArea	Partner	Period	Details
ManagingShipyards	B&W (Denmark)	Mar. 1978- Dec. 1984	Management
Managing Shipyards	B&W(Denmark)	Mar. 1981-Dec. 1987	Technological Consulting Design Contract
Managing Shipyards	IEC (Japan)	Sept. 1987-Nov. 1990	Management of Production Process
Design & Manufacturing	AUTOKON (Norway)	Oct. 1982-Nov. 1990	Computer Programs for Design
Design & Manufacturing	MARCON (Germany)	Apr. 1983-Aug. 1989	Design Technology
Design & Manufacturing	MONNECKE (Germany)	Apr. 1983-Jan. 1992	Design Technology
Design & Manufacturing	IHI (Japan)	Jun. 1986-Jun. 1989	Consulting Production Technology
Design & Manufacturing	Sanoyath (Japan)	Dec. 1986-Dec. 1996	Technological Training
Design & Manufacturing	MEC (Japan)	Jun. 1994-Jun. 2004	Technology of Building
Design & Manufacturing	Don Shead (England)	Sept. 1994-Sept. 1999	Design Technology for High-speed Yachts
Design & Manufacturing	Mitzbishi (Japan)	Sept. 1994-Sept. 2004	Technology for Open-type VLCC
Design & Manufacturing	MAN-B&W Doesel (Denmark) & New Sulzer Diesel (Switzerland)	Nov. 1994-Nov. 2004	Development of Diesel Engines
Design & Manufacturing	MKK(Japan)	Dec. 1994-Dec. 1996	Designing Technology for Ships
Design & Manufacturing	MARITEC (Japan)	Dec. 1995-Dec. 1996	Technology for Double Hull VLCC
Design & Manufacturing	NKK(Japan)	Dec. 1987-Dec. 1988	Consulting on CAD
Design & Manufacturing	CADAM(US)	Aug. 1989-Dec.1993	Design & Development for CAD

Source: Cited from Woo (2003a), Song (1998); Koshipa (2002).



Source: Korea Shipbuilders' Association.

Figure 3 : Development of Employment in Korea's Shipbuilding Industry

4. Towards an Innovative Cluster

Thus Korea's shipbuilding industry was characterised by co-location and competition, but one could not yet speak of a cluster until the mid-1980s. Two developments changed this situation, however, namely the extensive extension of a supply base and the establishment of an R&D infrastructure both within the shipbuilding companies and at universities and research institutes.

First, a *supply base* was gradually set up, partly supported by the central government, partly due to an increase in sub-contracting and partly due to selling off parts of the business and management buy-outs. Whereas the shipyards were heavily dependent on imports for key components during the 1970s and part of the 1980s, 70-80% of supply is nowadays purchased domestically (Drewry Shipping Consultants Ltd. and Silberston, 2001) and the lion's share of that supply comes from Gyeongnam and close surroundings. Two main ship engine manufacturers, HSD and STX, are both based in Changwon, the capital of Gyeongnam, whereas Hyundai, the largest engine manufacturing in the world, is based in Ulsan. South Korea's ship engine manufacturing industry has recently gone through an intensive restructuring process. Before the financial crisis, there were four main ship engine manufacturers: Hyundai, Doosan, Samsung and Ssangyong. The ship engine division of Ssangyong Heavy Industries became independent under the new name STX in 2000. In that year the company also took over the Daedong shipyard in Jinhae. Doosan, Samsung and DSME (the latter, former Daewoo, only with a financial

participation) jointly set up a new engine manufacturing company called HSD in 2000. Both HSD and STX are based in Changwon.

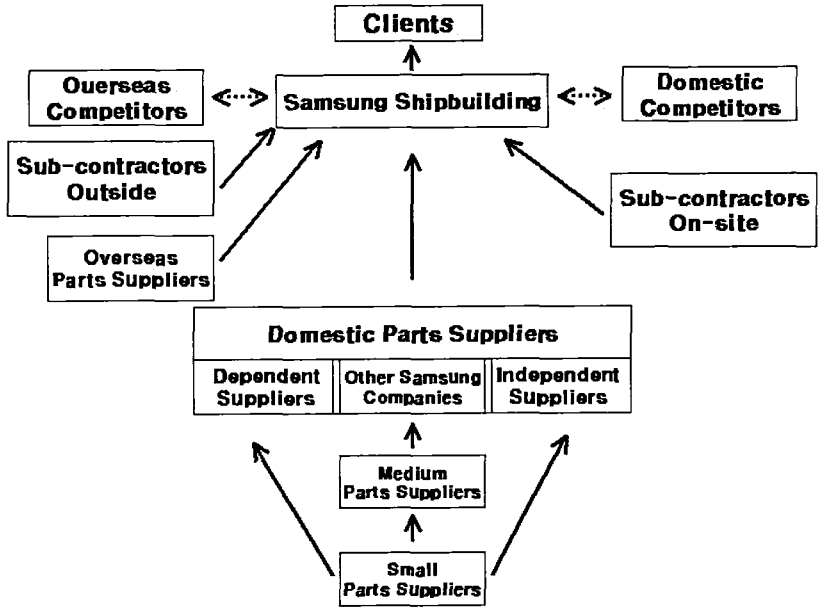
They manufacture engines under the licence of European ship engine manufacturers. In addition to engines, steel is also supplied from within the region. The world's largest steel producer, POSCO, is namely located in Pohang, north of Ulsan. It secures material price advantages over the European shipbuilding industry on the basis of its productive efficiency. In addition, large Korean yards, such as Hyundai, which order 90% of their steel demand at POSCO, secure further price advantages (Eich-Born and Hassink, 2005). Whereas most Korean shipbuilders still have to import ship electronics and navigation systems, Samsung, which has a strong electronics division, can also buy these components within the group. Despite the strengthened supply base, there are still some deficiencies in some specific supply areas. Attempts to move into higher value-added ships such as luxury liners and research ships pose namely a big challenge to Korea's shipbuilders due to the lack of domestic suppliers for special outfitting materials used in these ships.

In addition to the extended supply base, shipyards increasingly sub-contract parts of the production process to sub-contractors, which are often located on or very close to the yard. Traditionally, Korea's car industry used this practice, mainly to reduce union activities and labour costs (by externalising fringe benefits of the workers, for example). However, the practice was expanded to the shipbuilding industry as well, because of the same reasons. Initially, it was only common with regard to low-skilled jobs, but it increasingly spread to even more sophisticated tasks, especially since the financial crisis. In 2003, Samsung had 94 of these sub-contractors assisting directly from the shipyard and another 16 located elsewhere (see Figure 4). These firms together employed 12,268 workers (Sshi, 2004), producing approximately two-thirds of Samsung's total shipbuilding products. To effectively manage these firms, Samsung established one project team of three people in 1977, which has grown to several sections with in total 114 employees.

Gyeongnam's shipbuilding companies actively promote both parts suppliers and sub-contractors by providing technical assistance and physical spaces for production activities. This is one way of allowing the suppliers to reduce costs and time required to transport products, while at the same time to improve the quality of supplied parts. Samsung, for example, has developed an industrial estate of 12 km2 near its shipyards, to help its sub-contractors. It also promotes organisational activities in order to transfer Samsung's guidelines, standards, and work orders to its sub-contractors in an effective and efficient manner. To help sub-contractors, Samsung has also developed two industrial sites: one near the shipyard and the other in the city of Gimhae, about two-hour drive away from the shipyard. The latter (established in 1997) provides approximately

500,000 m2 of industrial land, hosting ten companies, while the former (established in 1992) provides 264,000 m2 of land, hosting another five companies (Sshi, 2004).

All in all, Korea's shipbuilders increasingly rely on regional suppliers and sub-contractors in high as well as low value-added segments. Especially the larger suppliers increasingly penetrate the global market.



Source: Modified from Figure 2 of Woo (2003b).

Figure 4 : Samsung's Linkages with Its Partners

The second main change that led to the shift of a co-location of cathedrals in the desert to an innovative cluster is the growing importance of *R&D and innovations*, both at the large shipbuilding companies, as well as at research institutes and universities related to shipbuilding technology.

After having been dependent on foreign technology during the 1970s and 1980s, the shipyards have become more and more successful in internalising the acquired knowledge of foreign technologies (see Table 1, for the case of Samsung) and in, in a next step, establishing their own R&D centres. Meanwhile the large shipbuilders all heavily invest in R&D. Hyundai, for instance, has a strong R&D centre, Hyundai Maritime Research Institute, whereas also DSME has its Ship and Ocean Institute. Samsung established its Shipbuilding and Ocean Research

Centre in 1985 to cover the technological areas of ship structure, wave, oscillation, and noise. In 1999, the Centre for Telecommunications Technology Research was established in Geoje. The Centre for Production Technology Research was set up in Seoul in 1996 to cover the technology in the areas of automation, robotics, welding, and painting. The three largest shipbuilders, Hyundai, DSME and Samsung all strongly co-operate both with Korean universities specialised in shipbuilding engineering, such as Seoul National University, Busan National University and Inha University and foreign universities and research institutes. DSME's institute, for instance, carries out joint research projects with Det Norske Veritas, the University of Texas and MIT.

Korea also has a strong supply of ship engineering graduates from its universities. In contrast to the situation in Japan, where many shipbuilding engineering departments of universities have been recently closed, at Korea's universities, particularly from Seoul National University, Inha University and Busan National University, still 300~400 shipbuilding engineers graduate annually.

Moreover, the Ministry of Commerce, Industry and Energy initiated the so-called Technical Roadmap for the Shipbuilding Industry. In the framework of this roadmap, Korea's largest shipbuilders, the main shipbuilding engineering departments at universities and public research establishments jointly develop several projects, which have to be financed by industry itself. Based at the Korea Maritime University in Busan, the central government recently set up the Korean Marine Equipment Research Institute (KOMERI), which carries out R&D activities jointly with yard suppliers in Gyeongnam. 60% of the budget is provided by the central and local government, whereas about 40% of the income comes from companies.

Finally the shipyards could boost their innovativeness by intensive co-operation. Although, as such, the shipbuilders heavily compete with each other, they co-operate well in two areas. They do not only team up when it comes to lobbying, as is demonstrated in the active stance of the Korea Shipbuilders against their common overseas competitors, but they also co-operate concerning technological issues (see Table 2, for example). An important tool in exchanging technological information and in solving common problems seems to be the biannual informal meetings between the engineers of Korea's largest (competing) shipyards, as it was mentioned in nearly all the interviews carried out with the yards. These linkages are developed not necessarily within Gyeongnam, as some important research institutions and offices of such associations are located in Seoul and Daejeon, more than 200 km away from Gyeongnam.

Table 2 : Technological Co-operation between Major Shipbuilders in Korea

Technology/ Research Topic	Participants	Period	Million Korean Won
Improvements of Manoeurablity for VLCC	Samsung, Hyundae, Daewoo, Hanjin, Samho, KRISO	Aug. 1994-Jul. 1996	1,200
Designing Technology for Building Small Passenger Ships	Samsung, Hyundae, DaeWoo, Hanjin, KRISO	Sept. 1995-Nov.1997	485
Technology Development for the Next Generation Ships Manufacturing	Samsung, Hyundae, Daewoo, Hanjin. KRISO	Dec. 1995-Oct. 2000	14,548
Measuring Manoeurability of Ships	Samsung, Hyundae, Daewoo, Hanjin. KRISO	Dec. 1997-Dec. 2000	300
Electronic Business in Shipbuilding Industries	Samsung, Hyundae, Daewoo, Hanjin. KRISO	Apr. 2000-Jul. 2000	200
Development of Analytical Program of ISO Speed Trial Standards	Samsung, Hyundae, Daewoo, Hanjin. Samho, Hyundai Mipo, Daedong, KRISO	Jul. 2000-Dec. 2001	151
Shipbuilding Industry	Samsung, Hyundae, Daewoo, Hanjin. KRISO	Dec. 2000-Sept. 2003	3,510
Revision of IMO Standards	Samsung, Hyundae, Daewoo, Hanjin, Samho, Mipo, Daedong, Shinah, SNU, KMU, KRS, KSSRI, KRISO	May 2001-Mar. 2002	109

Source: Korean Cooperative of Shipbuilding Technology Research (http://www.mecabiz.com/ksra/biz.htm).

In the cluster literature the role of local and regional governments to support clusters is often highlighted. Until recently, however, the provincial government of Gyeongnam has been showing, except for the example of KOMERI mentioned above, little interest in its shipbuilding cluster, which became clear when interviewing provincial officials on the topic in 2002. There were some vague future plans for supporting the cluster, but up to now no activities have been developed. The main reason for this limited involvement is that the shipyards belong or used to belong to the *chaebol* and were planned and managed jointly by the *chaebol* headquarters management and central government officials in Seoul. Local and regional authorities did not see it as their job to promote such exogenously implemented clusters. Recently, however, some changes in this attitude can be observed.The provincial government of Gyeongnam has selected the shipbuilding industry as one of the ten strategic industries to advance technology with more R&D activities and improved infrastructure, such as testing facilities. It has planned to invest 1.6 million US $ between 2004 and 2008. In addition, the small municipality of Geoje, hosting Daewoo and Samsung shipyards, has become more active. Traditionally it maintained little control on the

shipyards and simply had to co-operate with the central government, reluctantly or not. Recently, however, it changed its course and initiated strategic actions to help the cluster with a team of four officials. The team is expected to assist spin-offs and sub-contractors, as well as parts suppliers by providing production space, administrative and management services, and even technology support (see Woo, 2003a).

Although the main players in the shipbuilding cluster (see Figure 5 for its main structure), that is the shipyards, are concentrated in Gyeongnam, other parts of the cluster, that is research centres, business and professional associations, parts and services suppliers, steel makers and universities are more scattered over several regions within the country. While most parts and services suppliers are concentrated on the costal areas of Gyeongnam, activities of R&D, business and professional associations, and training and education can also be found in Daejeon and the Capital Region. Samsung, for instance, as well as other shipbuilders of the cluster, uses outside R&D services, provided by governmental research institutions located in Daejeon and by universities in the Seoul and Busan areas. Moreover, it uses some electronic parts manufactured mainly by Samsung Electronics located in Gyeonggi Province, more than four hours.

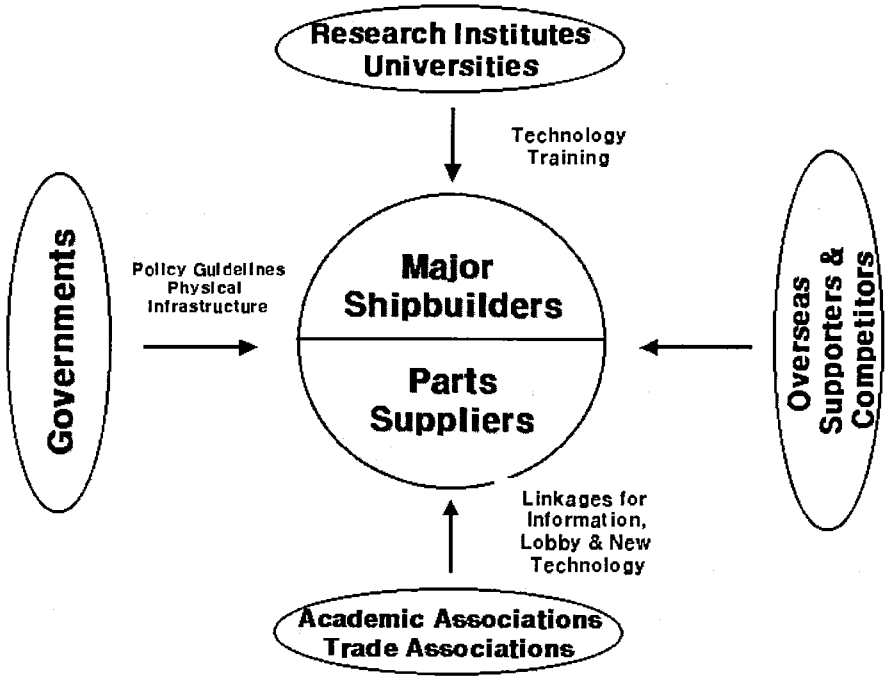


Figure 5 : Linkages among Major Shipbuilders and Their Partners

5. Conclusions

Korea has become a world market leader in shipbuilding within just a time period of about thirty years. The industry has been virtually built up from scratch, as Korea's world market share in the early 1970s was about 2%, compared to the current 38%. Both academics and the popular press in Europe are very much focused on the role of the central government in subsidising Korea's shipbuilding industry, as an explanation for its success. In our paper we have made clear that the industry has developed from a couple of cathedrals in the desert, highly dependent on import for its main supply, towards an innovation cluster with much interaction between the large yards and their suppliers, as well as with universities and research institutes. The production complex developed from simple co-location enforced by the central government and favoured by the natural physical conditions in the area, as well as favouritism by political leaders of the central government, to a full fledged cluster, with strong competition, collaboration and policy support at the central level.

In Enright's (2003) terminology the Korea's shipbuilding complex can be regarded as a working regional cluster (given its strong concentration in Gyeongnam), a dense cluster, a deep cluster, a highly competitive cluster, as well as a mature cluster. The government's role has clearly been interventionist in the early stages of development, but can be currently regarded as supportive. Until recently, local and regional governments played an unimportant role in supporting the cluster.

In the present situation, therefore, the shipbuilding cluster, which mastered the financial crisis in 1998 remarkably well, is enabled for regional growth. However, the growth enabling nature of the cluster in Gyeongnam might turn into a constraining one in the future, if external conditions negatively affect the cluster and at the same time lock-ins hinder the cluster to react to the changing conditions. Among these changing conditions are the conflicts with the European Union on unfair competition, the expected cyclical downturn in the industry due to over-capacity combined with the increasing competitiveness of low-cost shipbuilder China, which might increasingly make shipbuilding in South Korea a vulnerable industry and which might turn the cluster from a mature into a declining one (Korea Herald 1999). Potential lock-ins might occur due to the common worldview shared by the main actors in the industry that China is not yet a threat (cognitive lock-in) and due to the high dependencies between suppliers and large yards in the close-knit cluster which is still completely in Korean hands (functional lock-in). If, therefore, competition from China strongly increases in a future scenario (Brooke, 2005), a constraining political lock-in may occur. This constraining political lock-in might, however, be much more

the product of national interests than interests of a regional coalition of enterprises and policy-makers.

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