Assessing the cost competitiveness of China's Shipbuilding Industry

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September 2011

Editor: Urs Steiner Brandt

Department of Environmental and Business Economics
IME WORKING PAPER 111/11

ISSN 1399-3224

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Abstract

Cost has a significant impact on competitiveness within the shipbuilding industry. In China, low costs have created favourable conditions for domestic shipyards competing in the international market. However, China's shipbuilders have been facing rising cost pressures in recent years, which may affect their industrial competitiveness. In this article, we assess China's shipbuilding cost and its impact on the competitiveness of China's shipbuilding industry. We make comparisons with China's major competitors, South Korea and Japan, over the period from 2000 to 2009. First, we analyse principal factors that affect shipbuilding cost. Second, we examine the changes in China's shipbuilding cost over the time period. Finally, we use shipbuilding cost and market share as the basis for analysing the competitiveness of the shipbuilding industry. The results reveal the sources and limiting factors of China's cost advantage, as well as changes in its shipbuilding cost and competitiveness.

Keywords: shipbuilding cost; industry competitiveness; China's shipbuilding industry

1. Introduction

In times of economic globalisation, countries increasingly examine their industrial competitiveness on the international markets. Industries that are not able to keep up with the dynamic developments of national and international markets lose their competitiveness and, in the long run, have to leave the market (Mitschke, 2008). The competitiveness of every national industry is characterised by certain crucial factors that interact with one another. In the shipbuilding industry, competitiveness involves dimensions such as cost, delivery time, quality, after-sales services and financing conditions (Bertram, 2003; ECORYS, 2009; Goldan, 1995; Rashwan and Naguib, 2006). Despite a wide coverage of all these dimensions, cost is the leading factor in shipbuilding competitiveness. For this reason, we have seen the shipbuilding industry gradually draw in low-cost shipbuilders in Asia and drive out less cost-efficient ones in Europe.

China whas been regarded as the cost leader in the shipbuilding industry for the past decade. The cost advantage has allowed the country to become more competitive in the international market, particularly when building standard and less value-added ships. As a low-cost shipbuilder, the cost advantage is crucial for China to sustain its competitiveness. However, in recent years, China has experienced intense competition from emerging shipbuilding industries in countries with lower costs. At the same time, China's shipbuilders are struggling with the rising cost of labour and raw materials as well as yuan appreciation against the US dollar. These changes may affect China's ability to keep costs low and challenge its competitive position in the international shipbuilding market. Therefore, it is necessary for China's shipbuilders to assess their shipbuilding costs, benchmark their competitive position and take action to strengthen their competitiveness.

Estimating shipbuilding costs is an active area of research in shipbuilding. Previous studies concentrate on comparisons of labour costs (Chou and Chang, 2004; Hengst and Koppies, 1996; Hopeman and Nielnuis, 2009; Rashwan and Naguib, 2006; Wergeland, 1999). It has been claimed that labour costs are critical, because other cost components are available as products in the international market, while labour costs differ greatly between countries (Hopeman and Nielnuis, 2009). However, this assumption is not reasonable. First, considerable cost differences exist for other cost components. For example, Japan's ship equipment is much more expensive than China's or South Korea's, because of the strong protectionism in Japan's ship equipment industry. Second, the proportion of labour cost to total shipbuilding cost has declined, while the proportions of materials and ship equipment costs have increased (Chou and Chang, 2004; Ennis *et al*, 1997; Hengst and Koppies, 1996). Shipyards have increasingly concentrated on core production by purchasing larger amounts of equipment and materials from suppliers and subcontractors (Bertram, 2003; ECORYS, 2009; Hengst and Koppies, 1996). As a result, materials and equipment have become two increasingly important components of cost control for a shipyard. Existing models do not fully reflect these shipbuilding costs and require additional parameters.

The purpose of this article is to analyse the principal factors that affect China's shipbuilding cost and to examine how China's changing cost parameters affect its shipbuilding competitiveness. Since competitiveness is a comparative concept, this study selects South Korea and Japan as China's major competitors. European shipyards, which mainly concentrate on special types of vessels, will not be considered. Our findings will examine the sources and limiting factors of China's cost advantage and serve as a reference for policymakers when determining the proper competitive strategy for the shipbuilding industry.

The remaining sections are organised as follows: Section 2 presents the components of shipbuilding cost; Section 3 compares the changes in cost over time and then illustrates the competitive stage for each of the three countries; Section 4 provides the conclusion.

2. Measurement of shipbuilding cost

In this paper, three components are used to evaluate shipbuilding cost: labour, steel and ship equipment. These components account for 90% of the total variable costs of shipbuilding. It is within these components that the largest cost differences are found (Wijnolst and Wergeland, 1997). Cost estimation for shipbuilding can be expressed as follows:

$$C = w_1 \times ULC + w_2 \times S + w_3 \times E \; (\sum_{i=1}^{3} wi = 1) \qquad (1)$$

where C is the shipbuilding cost, ULC the unit labour cost, S the cost of steel, E the cost of ship equipment, and w_i $(\sum_{i=1}^{3} wi = 1)$ the proportion of each respective cost component. Each cost component is expressed in US dollars per CGT over the period from 2000 to 2009, and more details are discussed in the following sections.

3. Unit labour cost

Variation in labour costs between shipbuilders can make a great difference in their shipbuilding costs. China has relatively low labour costs compared with other major shipbuilding nations. The average wage of China's workers in 2001 was 1/20 that in South Korea and 1/25 that in Japan in terms of US dollars per man hour. Over the past decade, China's wage has increased 15 per cent, while Korea's increased 7 percent, and Japan's increased 4 percent. Despite its rapid growth, China's average wage in 2009 was still less than 1/10 that of South Korea and Japan.

It is worth noting that wage alone does not decide the labour costs: it is vital to also consider labour productivity. In other words, wage has to be adjusted by the labour productivity for each country. We use Compensated Gross Tonnage (CGT) per man hour (MH) as a metric of shipbuilding productivity. CGT reflects the volume of tonnage created by a given amount of inputs, such as workers, capacity, management and technical levels (Pires and Lamb, 2008). It is based on ship type and size and is internationally consistent (Bertram, 2003).

However, data collection for productivity is a difficult task. One major problem is that very limited information is available in the public domain. The published data is quoted from different sources and mostly refers to the value of a particular year. Thus, it is difficult to obtain a long series of reliable data. Furthermore, shipbuilding productivity varies from yard to yard within a country. There may be a vast gap in productivity between major and small shipyards, especially in China. Therefore, analysing productivity at the national level creates additional problems with data accuracy. In this paper, we produce a rough estimate of productivity on the basis of very limited information. Productivity data is sourced from previous studies (Chou and Chang, 2004; First Maritime International, 2005; Lamb, 2002a; Lamb, 2002b; Lamb, 2007; Pires and Lamb, 2008). The average value has been adopted for each country. Missing values are assumed to have the same growth rate as the available data.

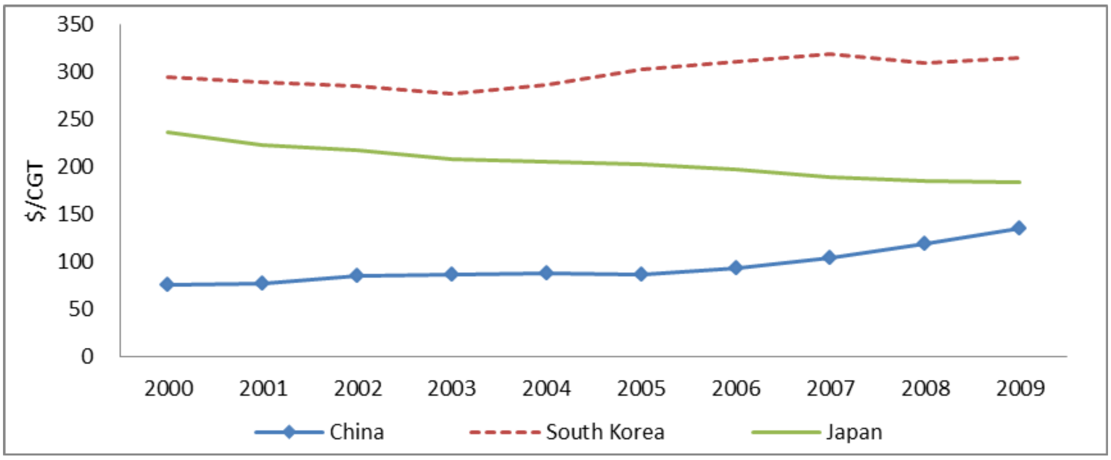
The figures show that productivity has consistently improved across the three countries (Appendix 1.1). The highest productivity worldwide over the past ten years was achieved by Japan, and its current level is about 0.12 CGT per man hour. South Korea's productivity is currently around 0.07 CGT per man hour. The current level of productivity in China varies considerably, ranging from 0.009 to 0.02 CGT per man hour. China lags far behind Japan and South Korea in shipbuilding productivity, and even the most productive yard in China faces considerable disparities.

Unit labour cost is defined as the average industrial wage (US dollars per man hour) divided by shipbuilding productivity (CGT per man hour). An international comparison of unit labour cost is shown in Figure 1. From 2000 to 2009, South Korea had the highest unit labour cost, followed by Japan and China. Unit labour costs in both China and South Korea rose during this period. The annual growth rate was 7 percent in China and 1 percent in South Korea. Japan experienced a gradual decline in unit labour cost over the same period, partly due to increasing productivity. In 2009, China's unit labour cost was roughly 1/3 that of Korea, a much smaller gap than exists between the two national wages. Thus, China's wage advantage is partly offset by its low labour productivity.

$$\text{ULC} = \frac{\text{Average industrial wage}}{\text{Shipbuilding productivity}} \qquad (2)$$

Labour cost normally occurs in local currency and its value in US dollars fluctuates with the exchange rate (Bertram, 2003). It is generally assumed that exchange rate depreciation reduces the local-currency cost in dollars and vice versa. For example, in China, the yuan has appreciated against the US dollar since July 2005. Over the period from 2005 to 2009, wages in yuan grew 12 percent a year on average, but wages in US dollars grew even faster, at 16 percent. The strengthening of the yuan resulted in upwards pressure on China's shipbuilding cost. Furthermore, when exchange rate developments in one shipbuilding country are set against exchange rate developments in another, the effect of exchange rate is even more obvious. Won and yen traditionally moved together against the US dollar, but started to move in opposite directions in 2005. Korea's wage in dollars has increased five times faster than in local currency because of won appreciation against the US dollar; on the contrary, the devaluation of the yen has helped Japan slow down wage increases.

Figure 1: Comparison of unit labour costs



Source of Wage: OECD, Chinese National Bureau of Statistics and the Chinese Ministry of Labour and Social Security

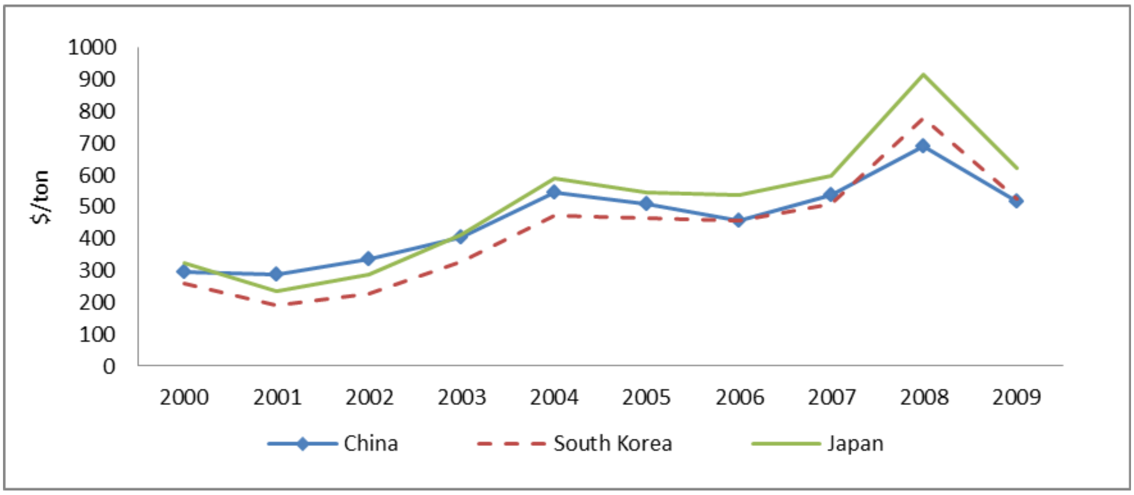
Source of Productivity: Chou and Chang, 2004; First Maritime International, 2005; Lamb, 2002a; Lamb, 2002b; Lamb, 2007; Pires and Lamb, 2008

4. Cost of steel

Large shipyards generally prefer building alliances with domestic steel mills to secure their supply of steel through a fixed-price agreement. As the majority of steel can be domestically supplied in the three countries studied, domestic steel prices will be used. As discussed before, converting domestic steel prices into US dollars also involves the effect of the exchange rate. Medium and heavy steel plate is widely used for shipbuilding, but we lacked price data for Japan and South Korea. Instead, the price of hot rolled plate is used in this study.

Prices of hot rolled plate in US dollars per ton have increased significantly since 2000, especially between 2006 and 2008 (Figure 2). This increase can be attributed to rising prices of iron ore and a tightening supply-demand balance, fuelled by rapid growth in demand—particularly in China—and supply bottlenecks throughout the steel supply chain (ECORYS, 2009). The prices then dropped with the arrival of the recent financial crisis. Throughout the period studied, China's prices fluctuated around those of Japan and South Korea. China has a limited cost advantage with respect to steel prices.

Figure 2: Price comparison of hot rolled plate



Source: Steel Business Briefing (SBB)

For the sake of unit consistency, we transformed the steel price from US dollars per ton to US dollars per CGT. However, the conversion brings a dimension of uncertainty, as the measure of CGT depends on the ship type and size. Steel price in US dollars per ton may correspond to different values of US dollars per CGT for different vessel types. A more advanced ship has lower steel prices in US dollars per CGT because more man hours are involved in ship construction. To solve the problem, shares of delivery by ship type are used to calculate the weighted conversion factors from ton to CGT (see detailed calculations in Appendix 2).

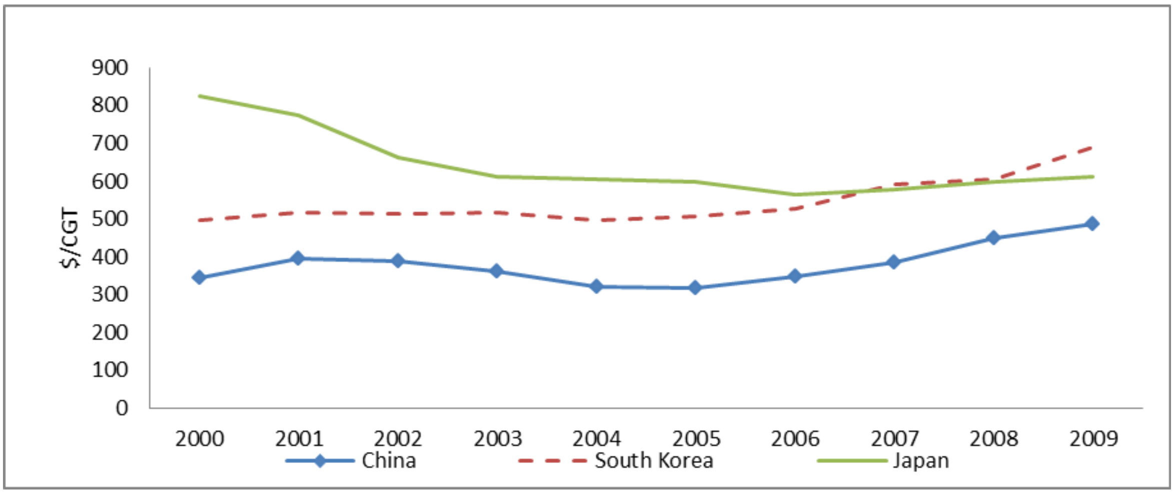
5. Cost of ship equipment

With the shift of the shipbuilding centres to the East, traditional powers in ship equipment manufacturing in Europe now aim to be located near Asian shipyards. They authorise Asian enterprises to use licenses and manufacture locally. Because of different production capacities, Asian shipbuilders have different dependencies on domestic (both licensees and native enterprises) and imported equipment. Japan's ship equipment has been almost 100 percent self-supplied since late 1980s, and Korea also has an 85 percent domestic loading rate. In contrast, China heavily depends on imported ship equipment, which account for 60-70 percent of ship equipment purchased. The cost of ship equipment is measured as follows:

$$E = \frac{\text{Expense on ship equipment}}{\text{Shipbuilding delivery}} = \frac{\text{Production Turnover} - \text{Export} + \text{Import}}{\text{Shipbuilding delivery}} \quad (3)$$

The numerator represents the national expense of ship equipment in US dollars, which is calculated as annual production turnover minus export value plus import value. The denominator represents national shipbuilding delivery in CGT. As there is a time lag between the delivery of ships and ship equipment, the equipment cost is calculated as the three-year cumulative average. Again, exchange rates have an influence on the cost of ship equipment. The appreciation of a country's currency against the US dollar leads to higher production turnover and export value, as well as a lower import cost in dollars. A higher import rate also increases the influence of exchange rates on costs.

Figure 3: Comparison of ship equipment costs



Source: China Customs, Japanese Ship Machinery Export Association, and Korea Marine Equipment Association

There is no available data for equipment costs by ship type. Given the relatively stable product mix (see share of delivery by ship type in Appendix 2.3), we calculate the ship equipment costs on the average level. The equipment data for Japan and South Korea are quite good, but the calculation for China lacks accuracy. According to Figure 3, China has the lowest cost of equipment. However, equipment price in China should be between the Japanese and Korean prices. Normally, Japan has the highest prices because of protectionism in their equipment industry. Additionally, most Japanese yards specialise in one or two ship designs. They deal with the same equipment suppliers, and price competition among suppliers is very limited. In China, ship owners have a strong position in selecting their ship equipment. This position attracts more equipment suppliers and the competition lowers prices. However, the domestic ship equipment manufacturing industry is a recent development in China. With a smaller scale of production and weaker production capacity, more than 60 percent of ship equipment purchased in China depends heavily on import. The tariff imposed on the imported equipment (mostly from Japan, South Korea and Europe) increases equipment costs in China. South Korea has a longer period of development in this field, with moderate competition, strong production capacity and industrial economies of scale. Korean prices for ship equipment should be the lowest of the three. For the above reasons, scenario analyses will be conducted in a later section to test the impact of the data.

6. Cost structure

This paper focuses on the general types of vessel, and we assume that cost structure varies between countries. Previous studies have generally used a specific ship type and size to represent the world cost structure (Hengst and Koppies, 1996; Stopford, 2009; Wijnolst and Wergeland, 1997). Most of the extant research was conducted before 2000, and these data cannot reasonably represent the current status. Built on the theoretical bases of previous studies, Table 1 provides the cost structure that is utilised in this paper. The assumption for the share of labour cost is based on a recent study (ECORYS, 2009). Steel and ship equipment account for the rest of the share, with a ratio about 1:3 to 1: 2 (Hengst and Koppies, 1996; Stopford, 2009; Wijnolst and Wergeland, 1997).

After checking this ratio with an experienced shipbuilding engineer, the ratio was set to 1:2 for this study. The cost structure is regarded as unchanged over the time period and insensitive to changes in production processes, facilities and advanced construction techniques (Ennis *et al*, 1997).

Table 1: Cost structures of three shipbuilding countries (%)

	China	**South Korea**	**Japan**
Labour	10	19	22
Steel	30	27	26
Equipment	60	54	52
Total	100	100	100

Source: Authors' estimation according to references (ECORYS, 2009; Hengst and Koppies, 1996; Stopford, 2009; Wijnolst and Wergeland, 1997)

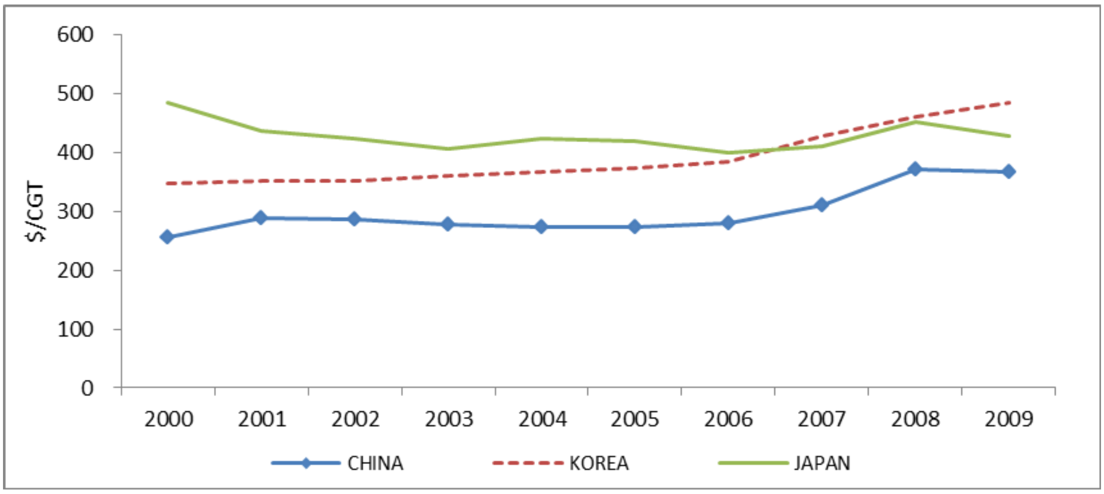
7. Results

To assess the competitiveness of China's shipbuilding industry, two steps were taken. First, we compare the development of shipbuilding costs in China, South Korea and Japan. Second, we evaluate the competitiveness of the three countries on the basis of shipbuilding cost and market share.

8. Shipbuilding cost

On the basis of the above information, Figure 4 shows the development of shipbuilding costs in China, South Korea and Japan from 2000 to 2009.

Figure 4: Comparison of shipbuilding costs



Source: Authors' calculation based on equations, Table 1 and data presented in Figure 1-3

The following points can be observed. First, China has maintained a cost-leading position throughout the period, and South Korea surpassed Japan to become the most expensive shipbuilder in 2006. Second, both China and South Korea have experienced cost increases in recent years whereas Japan has seen a slow decline in costs. In addition, the cost gap between China and the highest cost shipbuilder narrowed. The gap fell from 224.2 $/CGT in 2000 to 112.44 $/CGT in 2009, with an annual decline of 5.6 percent on average. This result means that China's shipbuilding cost increased faster than the cost of its two neighbouring competitors. Table 2 provides an overview of these cost changes.

Table 2: Year-on-year changes in shipbuilding costs (%)

	Wage ($/MH)	**Productivity (CGT/MH)**	**ULC ($/CGT)**	**Steel ($/CGT)**	**Equipment ($/CGT)**	**Total Cost ($/CGT)**
China	15	8	7	7	5	5
South Korea	7	6	1	14	4	4
Japan	4	6	-3	12	-3	-1

Source: Author's calculation based on data presented in Figure 1-3. Underlined labelled figure is the highest value among three countries.

It is clear that China's wages increased significantly: two times faster than South Korea and four times faster than Japan. However, China's wages are much lower, and its labour productivity has improved more quickly than in the other two countries. Therefore, low wages in China remain a fundamental source of shipbuilding cost advantage. Another cause of China's rising cost of shipbuilding is the increase in ship equipment costs. Because ship equipment holds the largest share of total costs, it is considered a limiting factor for China's cost advantage.

For Japan, two cost components have negative growth rates. Unit labour costs are shrinking because of Japan's ongoing efforts in productivity improvement. Ship equipment prices are also declining, as Japanese shipyards and ship owners gradually open up the ship equipment sector to foreign brands. Furthermore, the appreciation of the yuan and the won against the US dollar also factors in the cost increases in China and South Korea. The depreciation of the yen relative to the US dollar further contributes to the fall in Japan's costs. It is important to note that the cost ranking in Figure 1 and Figure 4 are different, proving that cost comparisons based solely on labour costs are not comprehensive and that they might be biased.

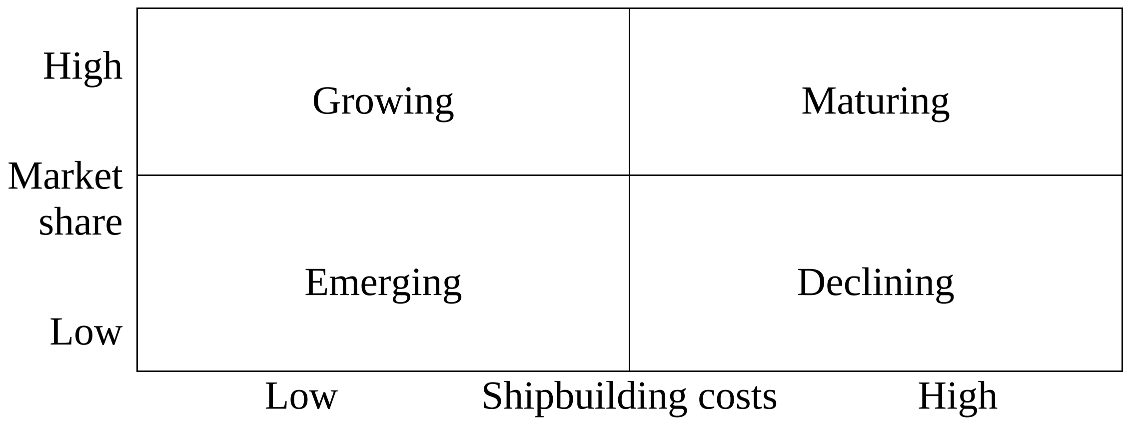
Because of the lack of data availability, this paper has used approximations for some data. To explore the impact of data on the shipbuilding cost, several sensitivity analyses were undertaken. The result shows that different shipbuilding productivities and steel prices do not significantly change the values and rankings of shipbuilding costs among the three countries. We also assume that China's cost of ship equipment increases at various rates. We therefore conclude that China's cost will surpass Japan's (1 percent increase rate in Japan) in five years if its equipment costs maintains a 4 percent increase rate. China will lose its cost competitiveness to South Korea (4 percent increase rate in South Korea) in 10 years if equipment costs increases at 7 percent.

9. Competitiveness in the shipbuilding industry

The starting point for analysing cost competitiveness is the shipyard's cost position. The increments of available capacity in the shipbuilding market can be arrayed in order of increasing shipbuilding cost (Bertram, 2003; Wijnolst and Wergeland, 1997). The market price is bounded above the cost of last required capacity to supply the market demand and below the cost of the next available entrant. With a cost lower than the market price, a shipyard is profitable. A lower cost leads to a higher return. If its cost is over the market price, a shipyard cannot cover its average variable cost and therefore faces losses. In practice, cost position of global yards is mixed. One yard in South Korea may have a lower cost than the least cost-competitive yard in China. Collecting data for all yards in the world would provide an accurate picture of competitiveness, but it is difficult to obtain all the data. Another way is to use each country as a counting unit and provide a general view of the relative cost position. Market share is one of the most important measures of business performance, and it can serve as another measure of competitive strength. Given a cost advantage, a firm is likely to increase its market share by charging a lower price than competitors (Porter, 1985).

In this study, a competitiveness analysis is conducted with a 2×2 matrix using shipbuilding cost as the horizontal axis and world market share of shipbuilding delivery as the vertical axis. Four stages of competitiveness for the shipbuilding industry are shown in Figure 5: emerging, growing, maturing and declining competitiveness. New entrants are seen as having low shipbuilding cost and relatively small market shares at the beginning of emerging competitiveness. With competitive costs and improving production capacities, new yards are likely to enlarge market shares and become more competitive. Towards the end of growing competitiveness, yards face intense challenges from new cost leaders. As their costs increase in comparison, shipyards shift their cost position to the right. This process represents the maturing competitiveness of shipyards, with high costs and dominant market shares. The high costs cause a further decline in market share and shipyards eventually shift into declining competitiveness. The stages portrayed in Figure 5 fit with the concept of an industry life cycle, which portrays the four stages of an industry's development (Porter, 1980). The matrix enables us to conduct an inter-country comparison by illustrating the relative competitiveness of each country, as well as an intra-country analysis by tracking the development of national competitiveness.

Figure 5: The four stages of shipbuilding competitiveness



To distinguish the four stages of competitiveness, we select reference points for both axes. The threshold value of shipbuilding cost is 371 US dollars per CGT, which is the cost average of the three countries for 2000-2009. The reference point for world market share is 25 percent, which is the market share average of the three countries for the same period. The shipbuilding competitiveness of China, South Korea and Japan are illustrated in Figure 6-8.

During the period studied, China's shipbuilding industry gained market share at a quicker rate. China moved from emerging to growing competitiveness in 2009. South Korea's shipyards maintained a stable market share of 33 percent while at the same time experiencing a rising shipbuilding cost. Therefore, the trend line of South Korea is quite flat compared with the rising curve of China. South Korea moved from growing to maturing competitiveness in 2006. Japan has a 'C' shape for competitiveness development, showing backward movement from 2000 to 2006. The shrinking market share was largely due to competition from China. The decreasing cost was the result of yen devaluation against the US dollar and price reduction for ship equipment. Since the equipment price rebound in 2006, Japan has levelled out at maturity and begun a declining competitiveness.

Figure 6: China's shipbuilding competitiveness

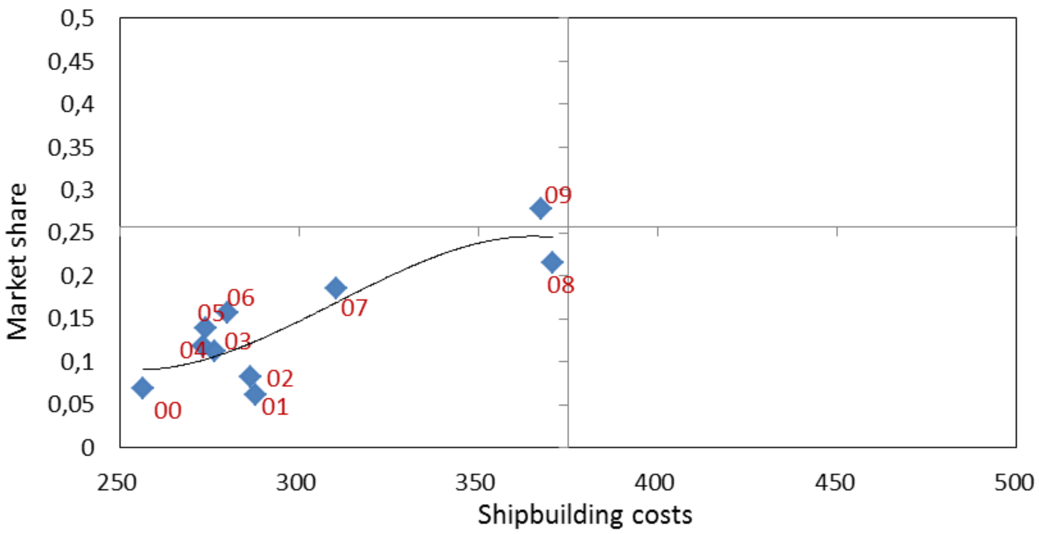


Figure 7: South Korea's shipbuilding competitiveness

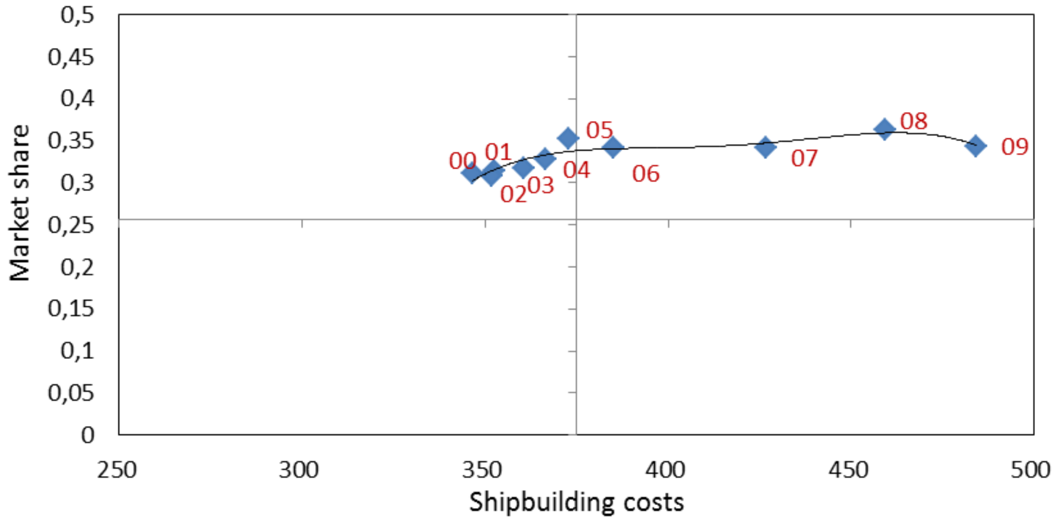
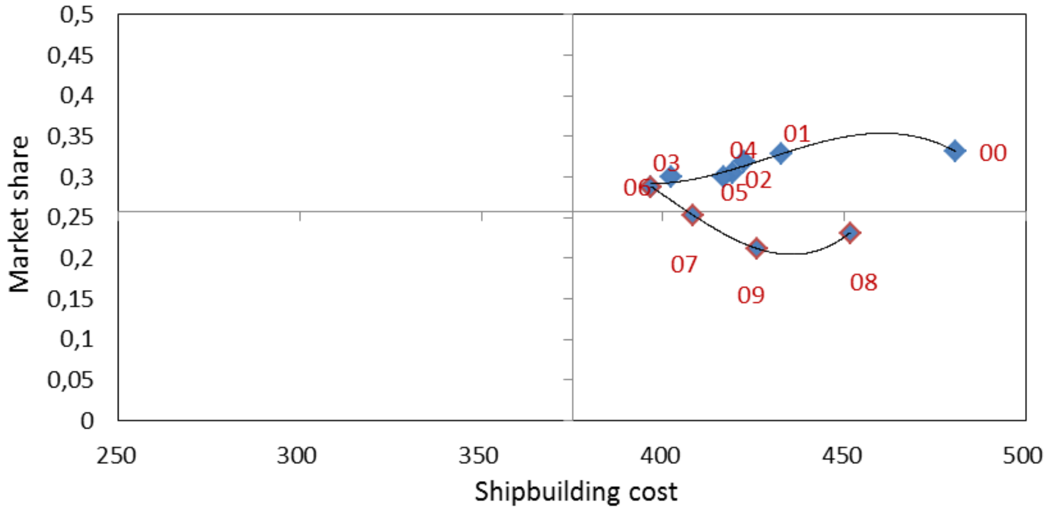


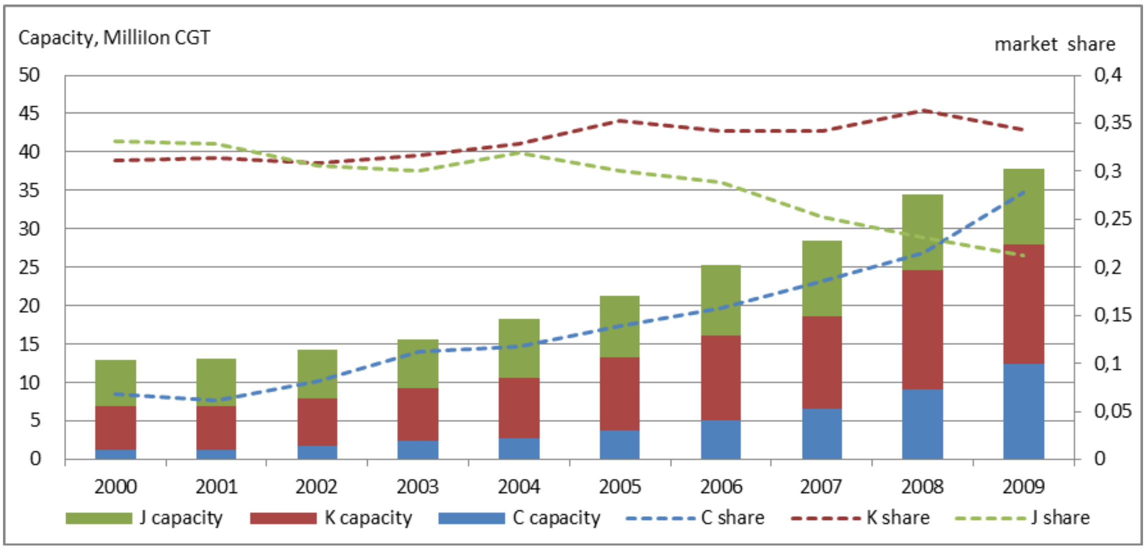
Figure 8: Japan's shipbuilding competitiveness



By reviewing industry competitiveness from the perspective of cost and market share, shipbuilding enterprises and policymakers can use the above figures as a valuable decision-making tool. As the shipbuilding industry moves through each stage, the appropriate strategies for future development vary. China's shipbuilding industry is currently transiting from emerging to growing competitiveness. It is vital for China's shipyards to secure the cost advantage in the low-end market segments, allowing them to compete against existing shipbuilders and expand market share. Attention should be focused on the limiting factors, such as cost of ship equipment, labour productivity and yuan appreciation. It is necessary for China's shipbuilding industry to establish good relationships with related industries, such as the steel and ship equipment sectors. These relationships could backup China's shipbuilders by stable supply of the shipbuilding materials at lower cost over the long term. Competitiveness also relies on strong support from the political authority. In the ship equipment manufacturing industry in particular, attracting foreign capital for setting up joint ventures will improve technical and management abilities and ultimately boost the competitiveness of China's shipbuilding industry. More investment should also be introduced to establish the research and training units for technology and productivity improvement.

One limitation of this competitive analysis is that world market share of delivery is not an independent indicator. It is strongly influenced by the national shipbuilding capacity, particularly for emerging shipbuilding nations. China had a small market share at the start of the decade (Figure 10). At that time, China had insufficient shipbuilding capacity, and capacity expansion could not keep pace with increasing orders. The shortage of capacity became a bottleneck when China's yards attempted to enlarge their market share. Finally, combining sufficient capacity with their cost advantage, China has won an increasing market share in recent years. This market share may also be affected by other factors, including subsidies, financial support and industry development policies.

Figure 9: Shipbuilding capacity and market share (J stands for Japan, K stands for South Korea and C stands for China)



Source: Clarkson Research Studies

10. Conclusion

This paper suggests a framework to assess shipbuilding cost and its impact on the competitiveness of China's shipbuilding industry. We computed a weighted sum of shipbuilding cost considering the costs of labour, steel, and ship equipment. This cost calculation shows that China has maintained a cost leading position compared to Japan and South Korea during the period from 2000 to 2009. China's cost advantage stems from its significantly lower wage. However, China's absolute cost advantage has been narrowing because of increases in wage and in the costs of ship equipment. Ship equipment, in particular, has an important role in determining shipbuilding costs. We have proven that the analysis of shipbuilding costs is far more complex than a simple comparison of labour costs. We took one step further and analysed the shipbuilding competitiveness of the three countries based on shipbuilding cost and world market share of delivery. This analysis shows that each country has progressed through different stages of competitiveness over the past ten years. China has progressed rapidly in the shipbuilding industry and has moved from emerging to growing competitiveness. The cost and competitiveness analysis presented in this paper can be used as a supporting tool for shipbuilding enterprises and policymakers.

Further research might focus on the overall competitiveness of the shipbuilding industry by including non-cost factors as well.

11. Acknowledgement

This research is partly funded by the Chinese Scholarship Council and TORM Foundation.

12. References

Bertram, V. (2003) Strategic control productivity and other competitiveness parameters. Proceedings of the Institution of Mechanical Engineers, Part M: Journal of Engineering for the Maritime Environment 217(2): 61-70.

Chou, C. C., and Chang, P. L. (2004) Core competence and competitive strategy of the Taiwan shipbuilding. *Maritime Policy & Management* 31 (2): 125-137.

ECORYS. (2009) Study on competitiveness of the european shipbuilding industry. 8 October, http://ec.europa.eu/enterprise/sectors/maritime/files/fn97616_ecorys_final_report_on_shipbuilding_competitiveness_en.pdf

Ennis, K., Dougherty, J., Lamb, T., Greenwell, C., and Zimmermann, R. (1997) Product-Oriented Design and Construction Cost Model. *Proceedings of the1997 Ship Production Symposium*, Paper No. 10.

First Maritime International. (2005) Findings for the Global shipbuilding industry base benchmarking study. Part1: Major shipyards. May 2005, http://www.nsrp.org/Industry_Initiatives/benchmarking/documents/gsibbs.pdf

Goldan, M. (1995) The Netherland's shipbuilding industry: Own solutions to competitiveness. *Proceedings of the 1995 Ship Production Symposium*, Paper No. 15.

Hengst, S., and Koppies, J. (1996) Analysis of competitiveness in commercial shipbuilding. *Journal of Ship Production* 12(2) :73-84.

Hinkelman, E. (2010) Dictionary of International Trade, 9th Edition. California: World Trade Press.

Hopeman, J., and Nielnuis, U. (2009) The future of ships and shipbuilding - a look into the crystal ball. In: H. Meersman, E. Voorde, & T. Vanelslander(eds.) Future challenges for the port and shipping sector (1). London: Informa,pp. 65-70.

Lamb, T. (2002a) Discussion paper on productivity rate.

Lamb, T. (2002b) The development of gross tonnage compensation coefficients for naval shipbuilding based on direct productivity calculations.

Lamb,T. (2007) Worldwide shipbuilding productivity status and trends. Pan American Conference of Naval Engineering, Maritie Transport and Port Engineering. 22-26 October.

Mikelis,N. (2007) A statistical overview of ship recycling. International symposium on maritime safety, security and environmental protection. Athens, September 2007. http://www5.imo.org/SharePoint/blastDataHelper.asp/data_id%3D23449/shiprecycling.pdf

Mitschke, A. (2008) The influence of national competition policy on the international competitiveness of nations. Heidelberg: Physica-Verlag HD.

Pires JR, C., and Lamb, T. (2008) Estimating performance targets for shipbuilding policies. *Management Policy & Management* 35 (5): 491-502.

Porter, M. (1980) Competitive strategy. New York: The Free Press.

Porter, M. (1985) Competitive advantage. New York: The Free Press.

Rashwan, A., and Naguib, A. (2006) Toward improving the cost competitiveness position for shipbuilding yards- part 1: Impact of technology changes. *Alexandria Enginering Journal* 45(5): 537-543.

Stopford, M. (1997) Maritime Economics 2nd Edition. London: Tayloer & Franics Group.

Stopford, M. (2009) Maritime Economics 3rd Edition. London: Tayloer & Franics Group.

Wergeland, T. (1999) The future of North European shipbuilding. Bergen, Norway: Foundation for research in economics and business administration (SNF). SNF Research report 19/99.

Wijnolst, N., and Wergeland, T. (1997) Shipping. Delft: Delft University Press.

13. APPENDIX 1 Data

Average industrial wage and shipbuilding productivity[1]

Year	China		South Korea		Japan	
	Wage ($/Man hour)	Productivity (CGT/Man hour)	Wage ($/Man hour)	Productivity (CGT/Man hour)	Wage ($/Man hour)	Productivity (CGT/Man hour)
2000	0.57	0.009	11.38	0.045	14.17	0.071
2001	0.64	0.010	12.09	0.048	14.65	0.077
2002	0.77	0.011	12.88	0.051	15.49	0.082
2003	0.86	0.011	13.38	0.055	16.01	0.088
2004	0.93	0.012	14.74	0.058	16.88	0.093
2005	0.99	0.013	16.53	0.061	17.87	0.099
2006	1.15	0.014	17.96	0.064	18.48	0.105
2007	1.35	0.015	19.44	0.067	18.74	0.110
2008	1.65	0.015	19.94	0.071	19.46	0.116
2009	1.97	0.016	21.29	0.074	20.24	0.121

Source:

Wage: OECD, Chinese National Bureau of Statistics and the Chinese Ministry of Labour and Social Security

Productivity: Chou and Chang, 2004, First Maritime International, 2005, Lamb, 2002a, Lamb, 2002b, Lamb, 2007, Pires and Lamb, 2008

14. APPENDIX 2

2.1 Conversion factors in relation to GT and LWT[2]

Vessel type	Vessel sub-type	GT	LWT	LWT / GT for vessel sub-type[3]	LWT / GT[4] For vessel type
Tankers (Crude)	VLCC[5]	159,000	35,000	*0.22*	*0.26*
	Suezmax	80,000	22,000	*0.28*	
	Aframax	45-67,000	15-18,000	*0.29*	
Tankers (Products and Chemical)	Panamax	40,000	10-13,000	*0.29*	*0.30*
	Handysize	22,000	7,000	*0.32*	
Dry bulk carries	Capesize	78-86,000	20-21,000	*0.25*	*0.28*
	Panamax	40,000	10-12,000	*0.28*	
	Handysize	22,000	7,000	*0.32*	

Source: Mikelis, N. (2007) A statistical overview of ship recycling, IMO. www.imo.org/SharePoint/blastDataHelper.asp/data_id%3D23449/shiprecycling.pdf

2.2 Conversion factors in relation to LWT and CGT

	Conversion factor	
Vessel types	CGT/GT	CGT/LWT[6]
Tankers, Crude	0.49	*1.88*
Tankers, Products and Chemical	1.07	*3.57*
Dry bulk carries	0.57	*2.04*

Source: Stopford, M. (1997) Maritime Economics 2nd Edition. London: Taylor & Francis Group

2.3 Shares of delivery by ship type and weighted conversion factors CGT/LWT[7]

Country / Year	China				South Korea				Japan			
	Bulk carrier (%)	Tanker crude (%)	Tanker product, chemical (%)	weighted CGT/LWT	Bulk carrier (%)	Tanker crude (%)	Tanker product, chemical (%)	weighted CGT/LWT	Bulk carri-er (%)	Tanker crude (%)	Tanker product, chemical (%)	weighted CGT/LWT
2000	0.49	0.16	0.35	2.22	0.15	0.64	0.21	2.99	0.60	0.25	0.15	2.33
2001	0.68	0.06	0.26	2.03	0.38	0.44	0.18	2.65	0.74	0.15	0.11	2.16
2002	0.65	0.11	0.24	2.10	0.12	0.62	0.26	2.96	0.61	0.23	0.16	2.29
2003	0.40	0.18	0.42	2.25	0.05	0.60	0.35	2.95	0.43	0.31	0.26	2.44
2004	0.49	0.15	0.36	2.19	0.10	0.42	0.48	2.66	0.60	0.18	0.22	2.23
2005	0.55	0.07	0.38	2.06	0.04	0.52	0.44	2.83	0.65	0.15	0.20	2.17
2006	0.45	0.12	0.43	2.15	0.05	0.43	0.52	2.69	0.69	0.14	0.17	2.14
2007	0.38	0.15	0.47	2.21	0.07	0.43	0.50	2.68	0.64	0.19	0.17	2.23
2008	0.44	0.15	0.41	2.20	0.05	0.33	0.62	2.54	0.59	0.24	0.17	2.31
2009	0.52	0.25	0.23	2.34	0.20	0.36	0.44	2.56	0.61	0.21	0.18	2.27
cgt/lwt	**1.88**	**3.57**	**2.04**		**1.88**	**3.57**	**2.04**		**1.88**	**3.57**	**2.04**	

Source of delivery by ship type (in CGT): Clarkson Research Service

15 APPENDIX 3

Shipbuilding cost components and market share of shipbuilding delivery

Year	China					South Korea					Japan				
	Labour ($/CGT)	Steel ($/CGT)	Equip. ($/CGT)	Cost ($/CGT)	Share (%)	Labour ($/CGT)	Steel ($/CGT)	Equip. ($/CGT)	Cost ($/CGT)	Share (%)	Labour ($/CGT)	Steel ($/CGT)	Equip. ($/CGT)	Cost ($/CGT)	Share (%)
2000	62.97	134.07	349.67	256.32	0.07	252.97	86.29	497.93	340.24	0.31	199.59	138.43	770.43	480.53	0.33
2001	65.34	141.61	401.02	289.63	0.06	250.74	71.56	517.60	346.47	0.31	191.19	109.71	696.36	432.70	0.33
2002	72.25	160.32	389.72	289.15	0.08	250.56	77.59	514.37	346.31	0.31	188.42	125.08	663.84	419.17	0.31
2003	75.18	179.85	362.29	278.85	0.11	245.10	111.88	518.07	356.54	0.32	182.33	169.02	612.18	402.39	0.30
2004	76.62	248.83	319.26	273.87	0.12	255.03	177.66	495.72	364.11	0.33	180.73	265.16	603.48	422.51	0.32
2005	76.42	246.08	318.50	272.56	0.14	270.95	164.46	506.01	369.13	0.35	180.51	251.61	599.00	416.61	0.30
2006	83.31	212.22	347.50	280.49	0.16	279.71	169.74	527.63	383.90	0.34	176.63	250.42	562.95	396.70	0.29
2007	92.55	244.23	385.35	313.73	0.19	288.48	189.88	592.21	425.87	0.34	170.01	268.74	578.93	408.32	0.25
2008	107.42	313.52	450.37	375.02	0.21	282.41	307.25	605.51	463.59	0.36	168.06	396.84	598.81	451.54	0.23
2009	121.59	221.98	486.19	370.47	0.28	288.54	206.52	689.48	482.90	0.34	166.72	273.44	611.65	425.83	0.21

Source: Labour: calculated based on the data of wage and productivity in Appendix 2.1

Steel: Steel Business Briefing (SBB)

Equipment: China Customs, Japanese Ship Machinery Export Association, and Korea Marine Equipment Association

Market Share: Clarkson Shipping Intelligence Network (SIN)

Cost: Author's calculation based on Equation (1), Table 1 and data presented in Figure 1-3

16. Notes for Appendix

1 Data showing shipbuilding productivity for 2000 and 2005 are collected from previous studies. Productivity in other years is assumed to have the same average growth rate as the available data.

2 The light weight tonnage (LWT) is the actual weight of a ship with no fuel, passengers, cargo, water, etc., on board (Hinkelman, 2010). It is the main unit used by the scrapping industry, as it is relevant to the weight of scrap metal that can be recovered from a dismantled ship (Mikelis, 2007). The light weight tonnage shown in Appendix 2.1 is measured in long tons. As this calculation is based on an approximation of conversion factors, LWT in long tons is not converted to metric tons (1.016 times of long tons) for the sake of simplicity.

3 The conversion factor for sub-type is calculated by the authors as the value of LWT divided by the value of GT (gross tonnage). Average values are adopted for LWT or GT if the values of LWT or GT are given in the interval.

4 The conversion factor for each vessel type is calculated by the authors as the average value of the conversion factor for sub-types.

5 Refers to the double-hull VLCC.

6 In this paper, the conversion factor from LWT to CGT is calculated by the authors as the value of CGT/GT (in Appendix 2.2, column 2) divided by the value of LWT/GT (in Appendix 2.1, column 6) for each vessel type.

7 Shares of delivery by ship type is the delivery of one vessel type divided by the total deliveries of three types (bulk, tanker crude and tanker product and chemical). Weighted conversion factor CGT/LWT is defined as $\text{weighted CGT/LWT} = \sum_{i=1}^{3} a_i\, s_i$, where a_i denotes the conversion factor CGT/LWT for a vessel type, and s_i denotes the share of delivery for the corresponding vessel type.

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