



A leading **trade nation**

The role of container shipping and logistics in enhancing trade and economic growth in China



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PREFACE

International companies are agents in the globalised economic system and as such they cause social and environmental externalities through their activities. It is a fundamental responsibility of companies to set systems in place to minimise negative impact and ensure compliance with regulation. In Maersk, we focus most of our sustainability effort on ensuring compliant and safe operations.

However, at the same time, companies are providers of growth, jobs and new solutions that may enhance sustainable economic development at local, national and global levels. We believe that our own understanding of the opportunities we have to enhance sustainable development through our core business is limited, and therefore shared opportunities for progress between us and the societies we are part of are not being harvested to their full potential.

In response, over the past years we have experimented with so-called 'impact studies' to better understand this. Previously, we have studied opportunities around our terminal in Apapa, Nigeria, our WAFMAX vessels serving West Africa as well as our role in Brazil. This report examines our role in China from an opportunistic point of view, focusing on where we have a material impact on China's key priorities.

EXECUTIVE SUMMARY

This study examines the importance of maritime container transport and logistics for China's trade and economic growth. It concludes that China's maritime container transport is unique on a global scale and has contributed substantially to China's trade-induced economic growth. It further concludes that logistics performance constitutes a barrier for China's competitiveness and future development.

Based on an econometric analysis, the study shows that an important determinant of China's trade competitiveness is maritime transport connectivity, defined as the access to regular and frequent liner services and the level of competition among shipping lines. The impact of better connectivity on trade accrues from lower trade costs, improved competitiveness and better transport ability.

China has long understood that the ability to transport its goods in an efficient manner was important for facilitating, maintaining and improving its position as the world's preferred manufacturer. Through a focused investment strategy and cooperation with shipping lines, China has succeeded in obtaining the best maritime container transport in the world today. The study shows that while trade between countries is attributable to many factors, this superior maritime container transport has had a significant impact on Chinese trade.

The direct impact of maritime transport costs accrues from lower trade costs and better access to markets. The results show that a 10% improvement in maritime container transport has been associated with a 3% decrease in Chinese trade costs, a 6% increase in Chinese manufactured imports and a 9% increase in Chinese manufactured exports.

Since 2004, this means that improvements in liner shipping connectivity have been associated with a 30% increase in Chinese manufactured imports and a 40% increase in exports. This constitutes approximately a fourth of accumulated year-on-year growth over the period. Converted to trade value, this year-on-year growth has resulted in additional imports and exports worth USD 686 billion corresponding to 35% of total trade growth since 2004.

Indirectly, this causes a reduced impact of distance as a barrier to trade. Improvements in China's maritime transport are shown to reduce the negative trade impacts of distance, which in effect amplify improvements in maritime transport itself. For China, this means that distance only reduces trade by half as much as it does for global trade. As such, the results show that maritime container transport has made it possible to transport China's massive imports and exports, but has also enabled additional trade for China.

Maersk Line made its first call to China in 1924. Today, Maersk Line has 1,800 employees in China with 35 locations in Chinese mainland and Hong Kong. In the

period 2000-2012, Maersk Line increased its port calls to Chinese ports by 300% and its container throughput by 270%, which has positioned the company as one of the largest shipping lines on the Chinese trade today. Given its market share, the results show that a 10% improvement in Maersk Line's services and capacity alone has been associated with a 0.8% increase in Chinese imports and a 1.1% increase in Chinese exports.

With the market for maritime container transport well functioning and saturated, the next challenge for China is for logistics to keep pace with industrial relocation and the growth of domestic demand.

Managing logistics continues to be not only a complex but also a relatively costly part of business operations, and moving goods within China remains particularly challenging. For manufacturers in China, logistics costs can amount to as much as 30-40% of production costs. In 2012, overall logistics costs constituted 18% of China's GDP, which is higher than many developed countries but also higher than average for Asia-Pacific and South American countries.

A highly fragmented logistics market and low market penetration of 3PLs are some of the key elements in explaining China's high logistics costs. Through their logistics competence and infrastructure, 3PLs can address many of China's logistics challenges and provide the required consistency and reliability in service.

Globally, surveys show that 3PLs reduce logistics costs by 15%, while at the same time increasing operational efficiency and service. This study documents how Damco achieves similar results for their clients that are sourcing or operating in China. By way of case studies, the study documents how Damco's Supply Chain Development Services to clients and their vendors optimise supply chain processes across transport modes and logistics services, resulting in higher operational efficiency and 15% lower logistics costs. Based on these impacts, it is evident that 3PLs can play an important role in sustaining and improving China's competitiveness on both domestic and foreign markets.

3PLs can also play a key role in achieving China's five-year plan objectives on environmentally sustainable development. Doing more with less to reduce waste in time, material and cost is inherently more sustainable and is in essence what 3PLs like Damco do for a living. The study shows how Damco reduces CO₂ emissions by 11%, while at the same time reducing costs by 15%. The World Economic Forum has estimated that more efficient supply chains can reduce global CO₂ emissions from transport and logistics by 50%.

In Chinese ports, Maersk Line works with terminal operators and authorities to reduce port stays by up to 30% through productivity improvements. In four main Chinese ports, this cooperation has identified ways of increasing productivity that can potentially decrease port stays by 27-40%. Through shorter port stays, Maersk's

Terminal Partnering Project will reduce emissions of harmful particles and increase port productivity. Therefore, the project contributes to achieving China's five-year plan objective to reduce energy consumption by 16% for ocean transport and 8% for ports, and berthing time by 15%. In addition, it will enable more trade; 3.2% for each 10% increase in port productivity.

1 INTRODUCTION

Since 2000, Chinese imports and exports have grown by around 600%, while container throughput in the Chinese ports has grown by around 500%. As a result, China's international trade and industrialisation strategy has always relied heavily on international container transport as an access vector to global markets.

As wages begin to skyrocket, and job creation and sustained GDP growth begin to rely more and more on internal consumption and increased imports, the continued development of China's transportation and logistics sectors remains an important enabler of China's growth and competitiveness going forward.

Maersk has served China's foreign trade for almost 90 years, with the first Maersk vessel, M.S. Sally Maersk, calling at Shanghai on March 8th 1924. The A.P. Moller - Maersk Group has expanded its business along with the remarkable economic development in China.

Although Maersk is involved in industrial production in China, its main activities here have always been related to shipping, transportation infrastructure and logistics.

The aim of this study is to generate insight into Maersk's role in the context of China's re-emergence as a global economic superpower. This is done through a brief historical summary of Maersk's past and current presence in China and then most importantly through detailed analysis that aims to understand how Maersk, as well as the shipping and logistics sectors in general, impact competitiveness, trade and economic growth in China.

The method combines econometric analysis with case studies. The econometric analysis quantifies the macroeconomic impact of liner shipping and logistics on Chinese trade and trade costs. The case study illustrates, from a micro-perspective, the many ways that logistics service providers can impact companies' financial performance via lower logistics costs, higher logistics performance and improved competitiveness. A selection of Damco's Supply Chain Development projects for large international customers with a material presence in China forms the basis for the case study.

2 SCOPE

The impact assessment sets out to understand Maersk's impacts in China from a transport and logistics perspective. However, given the broad nature of these subjects as well as Maersk's business activities in China, the study is necessarily limited in scope.

First, Maersk's container transport services in China are mostly provided by Maersk Line and Damco. Therefore, in order to ensure both in-depth analysis and representation, these two business units are the focus points of the assessment. This

means that the impacts of other business units such as APM Terminals and Maersk Container Industry – despite their material presence in China - are outside the scope of the assessment.

Second, the assessment of Maersk Line and Damco is limited to their direct and indirect impacts on trade and trade costs that are possible to measure on the basis of available data and indexes, such as the liner shipping connectivity index and the logistics performance index. This leaves out a number of important but less measurable impacts. For example, high reliability and short transit times are not included but are both critical factors to Maersk Line's customers and trade, as they reduce time to market and inventory levels. Similarly, Damco's logistics services are multi-pronged and so are their impacts on companies' competitiveness, but only logistics costs are directly included in the impact assessment.

Third, only impacts accruing from Maersk's transport and logistics services to its customers and partners are included in the assessment. Other impacts of Maersk's business units in China, such as creating jobs, training workers, building physical infrastructure, procuring raw materials, transferring technology, paying taxes, etc., are not included.

Fourth, wider economic impacts are not included in the assessment. Wider economic impacts include effects relating to increasing returns to scale, agglomeration, thickening of labour markets, and market power. They are defined as the consequences of the reduction in transport cost for production and location decisions of people and firms, and the subsequent effects on income and employment of the population at large. These impacts are relevant to China, and have been discussed in other studies, cf. Appendix C.

Fifth, and related to above, the overall economic, social and environmental impacts of China's trade-induced growth strategy are not included in the impacts assessment. China illustrates, better than any other country, the trade-offs accompanying rapid economic growth. On the one hand, China has benefited from a massive technology transfer from trade and FDI, which has boosted its productivity and resource efficiency and in turn lifted more than 500 million people out of poverty since 1978¹, something that is unprecedented in human history.

On the other hand, China's GDP growth, averaging 10% a year, has resulted in environmental pollution and rising inequality, which have spurred significant imbalances that the country is fighting to alleviate. The important question from a perspective of sustainable economic development is not whether economic activity gives rise to pollution and other negative externalities, but whether the costs of China's trade-induced growth outweigh the benefits when compared to alternative growth strategies. This question has not been part of the scope of the assessment.

¹ <http://www.worldbank.org/en/country/china/overview>

3 KEY FEATURES OF MAERSK'S PRESENCE IN CHINA

3.1 MAERSK'S BUSINESS UNITS OPERATING IN CHINA

Maersk is a global conglomerate represented in 130 countries, headquartered in Copenhagen, Denmark. Maersk consists of a collection of companies operating within the two main industries of shipping and energy.

Maersk has five core businesses, which include Maersk Line, APM Terminals, Maersk Oil, Maersk Drilling and Services and other shipping activities in which DAMCO is a part, together with Svitzer, Maersk Tankers and Maersk Supply Service. Through these companies and several others, the Group employs roughly 121,000 people and generated USD 59 billion in revenue in 2012.

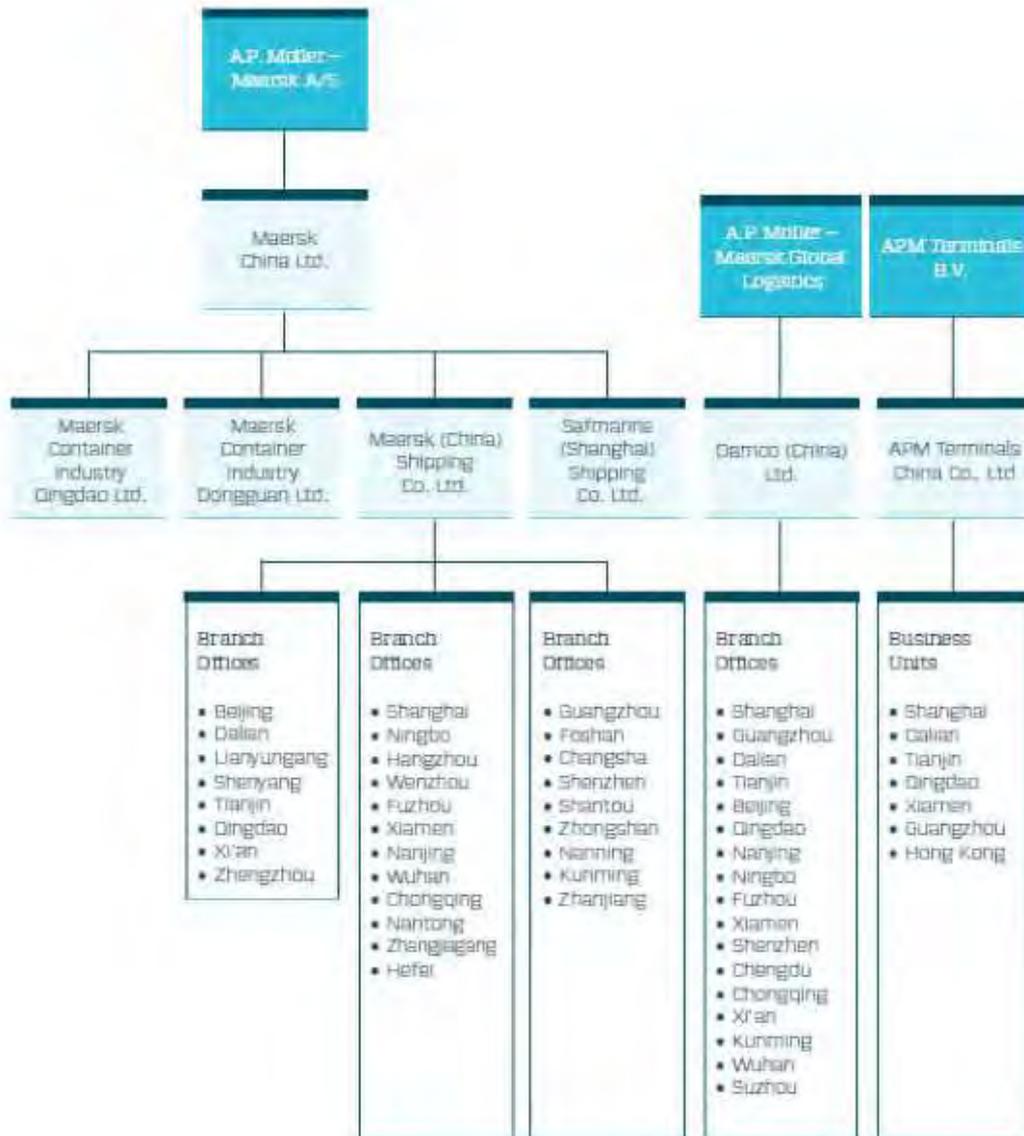
Maersk has served China's foreign trade for almost 90 years with the first Maersk vessel, M.S. Sally Maersk, calling at Shanghai on March 8th 1924. The A.P. Moller – Maersk Group has expanded its business along with the remarkable economic development in China.

Today, China is Maersk's biggest market and a strategic growth market. The market size and the special role of shipping and logistics for economic growth make China especially important for Maersk.

Maersk's business activities in China include an extensive network of branches, representative offices, wholly owned and joint ventures within transportation and logistics, industry, as well as investments in management and operation of marine terminals in key coastal cities in the region; cf. Figure 3.1 for an overview of Maersk companies and offices in Mainland China.

Since the first investments in Yantian Port in 1994, Maersk has invested in more than ten container terminals. Maersk is also a major buyer of vessels and marine equipment in China as well as products for the Group's supermarkets in Europe. To date, the Group has ordered 117 vessels from Chinese shipyards with a total value exceeding USD 3.5 billion.

Figure 3.1 Maersk companies and offices in Mainland China



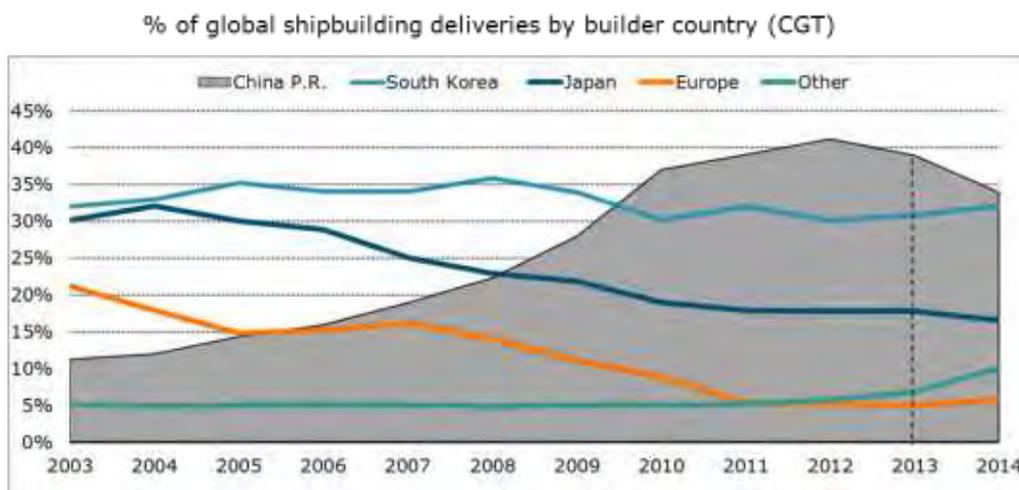
Source: Authors' analysis

3.2 MAERSK AND THE CHINESE SHIPYARDS

Maersk has gradually built up its operations in China over time. Among other things, this includes Maersk's early involvement and new orders placed at Chinese shipyards from its early start in 1996.

China's shipbuilding industry has grown at a rapid pace. In 1985, Chinese shipyards delivered around 0.9% of the all vessels globally. In 2010, China entrenched its position as the leading shipbuilding nation in the world with a market share of around 37%. Today, China is the world's largest ship producer with around 40% of the global market, cf. Figure 3.2 below.

Figure 3.2 China's trade, GDP and container port throughput, 2000-2011



Source: World Shipyard Monitor, Feb. 2013; Clarksons, Mar. 2013.

The shipbuilding industry has been and still is a key pillar in the Chinese government's economic growth strategy. In 2012, the sector contributed with an industrial output of CNY 790.3 billion², which corresponds to around 1.54% of China's GDP³ in 2012.⁴ Even though the shipbuilding industry's contribution to GDP is relatively modest, it plays an important role for the economy.

In 2012, China had 1,647 shipyards, which provided around 671,600 jobs.⁵ Today, China's shipbuilding industry is strongly export orientated with around 87% of China's total vessel order book in 2009 destined for export markets. Thus it obtains hard currency to fuel further economic growth.⁶ The shipbuilding industry also serves as a

² Equivalent to approximately USD 129.1 billion (Bloomberg exchange rate, Oct. 2013).

³ China's GDP was USD 8,358 billion in 2012 (www.worldbank.org).

⁴ See Wang (2013).

⁵ See Wang & Kyunghee (2013).

⁶ See Ecorys (2009).

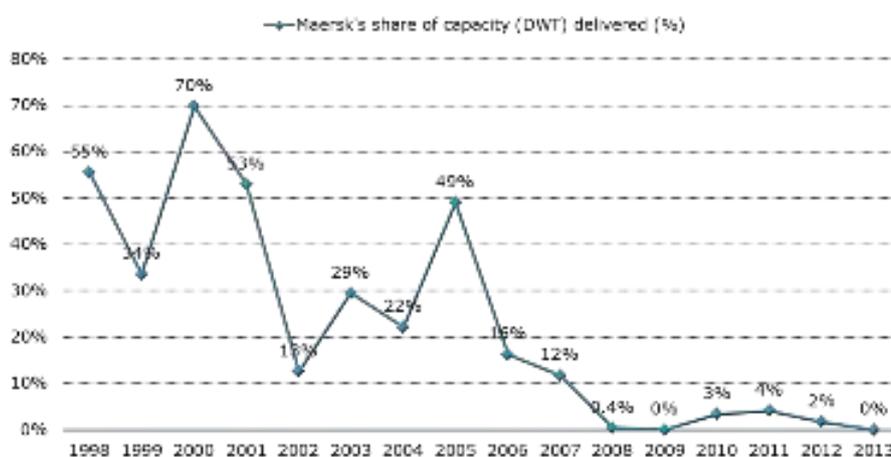
catalyst for the development of industrial capacities, for example in iron and steel, electronics, machinery manufacturing, shipping and marine equipment industries.⁷

MAERSK'S PARTNERSHIP WITH CHINESE SHIPYARDS

Maersk ordered the first of many vessels from China in 1996, when China accounted for only around 4% of global ship deliveries. Since 1996, Maersk has ordered more than 82 vessels and 35 other kinds of ships at yards in Mainland China with an accumulated value of more than USD 3.5 billion.

In particular, Maersk made an early start when ordering product and chemical tankers. Over the period 1998 to 2001, Maersk accounted for 48% of China's total product and chemical tanker deliveries (in mill Dead Weight Tonnes); cf. Figure 3.3 below.

Figure 3.3 Maersk's share of Chinese shipyards' product- and chemical tankers



Source: Maersk Broker

Maersk has been impressed with Chinese shipyards' capabilities and fast implementation of Maersk's vessel specifications. Working in collaboration, Chinese shipyards and Maersk designed and constructed product and chemical tankers that optimised efficiency, e.g. from vessels being operated by 30-40 people to only 14 people, and set new standards for "green ships" at that time.

"A.P. Moller - Maersk's cooperation with Chinese shipyards has evolved almost explosively. A few months ago, ship number 100 from a Chinese shipyard was christened and the Danish shipping giant's significance for Chinese shipbuilding cannot be overestimated. Together with the Danish orders there has also followed an important transfer of technology."

Larsen & Mortensen (2011)

⁷ See Ericson & Goldstein (2012) and OECD (2008).

During the 2000s, Maersk ordered a significant share of crude tankers. From 2006 to 2008, Maersk's share of Chinese shipyards' crude tanker deliveries varied between 11% and 33%. In addition, Maersk has accounted for a significant share of Chinese shipyards' total tug deliveries, accounting for 3-16% of all deliveries from 2008 to 2012.⁸

Maersk still orders vessels at Chinese shipyards today. However, with the tremendous growth and position of the Chinese shipbuilding industry as well as a stagnated market for shipbuilding, Maersk accounts for a minor share of China's total deliveries.

⁸ Source: Maersk Broker.

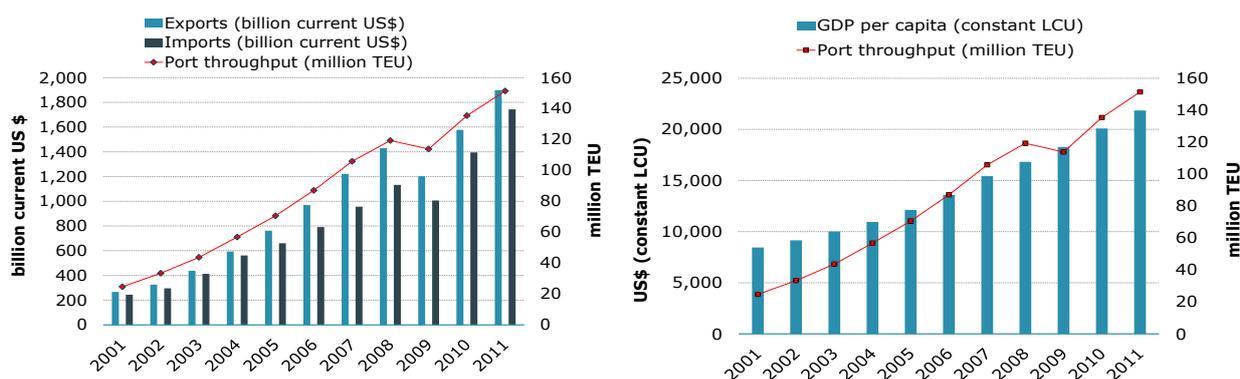
4 WHAT MARITIME CONTAINER TRANSPORT HAS MEANT FOR CHINESE TRADE

4.1 THE IMPACTS OF MARITIME CONTAINER TRANSPORT ON CHINESE TRADE

Foreign trade has played a crucial role in China's re-emergence as a global economic super power. Today, exports and imports both constitute about 25% of China's GDP, and since China's WTO membership in 2001, imports and exports have each increased by around 600% - imports from USD 240 billion to USD 1,750 billion, and exports from USD 270 billion to USD 1,900 billion.

China's international trade and industrialisation strategy relies heavily on container transport as an access vector to global markets. As such, container transport has been an important driver of trade and economic growth in China. This is evident when comparing China's foreign trade and container transport since 2001. The 600% increase in Chinese imports and exports has been followed by a 500% increase in container throughput in the Chinese ports, cf. left diagram in Figure 4.1 below.

Figure 4.1 China's trade, GDP and container port throughput, 2001-2011



Source: World Bank's World Development Indicators and Drewry Maritime Research derived from *The China Port Book* published in *Drewry Container Market Review and Forecaster*, April 2013.

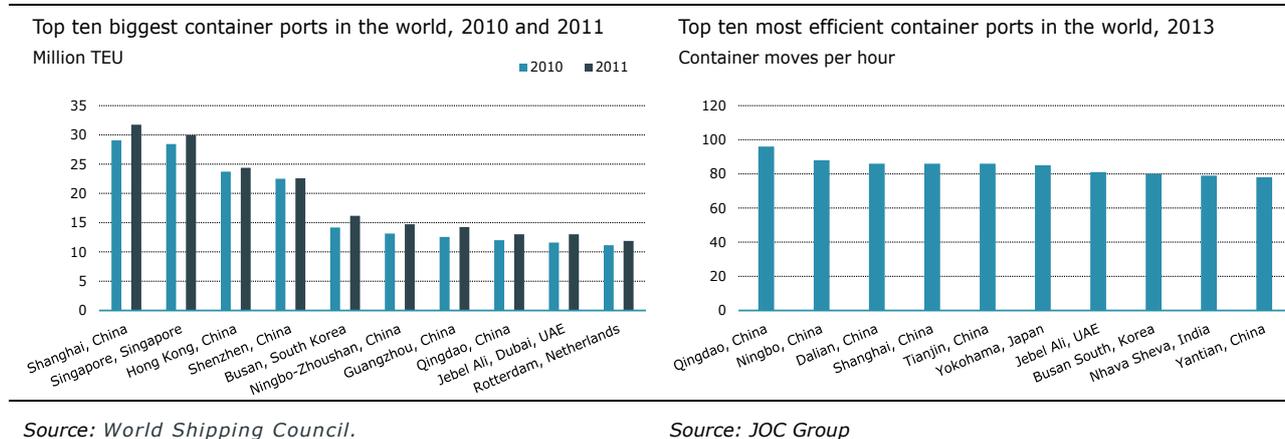
The strong growth in container port throughput and trade has also been followed by strong economic growth. While container throughput grew by 500% from 2001 to 2011, GDP per capita grew from USD 8,500 to USD 21,800 corresponding to a 160% increase, cf. right diagram in Figure 4.1 above.

China's unprecedented growth in foreign trade is not least attributable to China becoming the leading manufacturing country in the 2000s, taking on manufacturing, processing and assembly for the world. According to IHS Global Insight, China's manufacturing output accounted for 19.8% of total global output in 2010, which surpassed the US, and made China the largest manufacturing country in the world.

However, China has also long understood that the ability to transport its goods in an efficient manner was important for facilitating, maintaining and improving its position as the world's preferred manufacturer. Through a focused investment strategy, China's

has succeeded in obtaining some of the best transport infrastructure in the world. Today, some of the world's leading container ports, such as Hong Kong and Shanghai, are located in China, including six of the ten biggest and most efficient container ports worldwide, cf. Figure 4.2 below.

Figure 4.2 China hosts six of the world's 10 biggest and most efficient ports



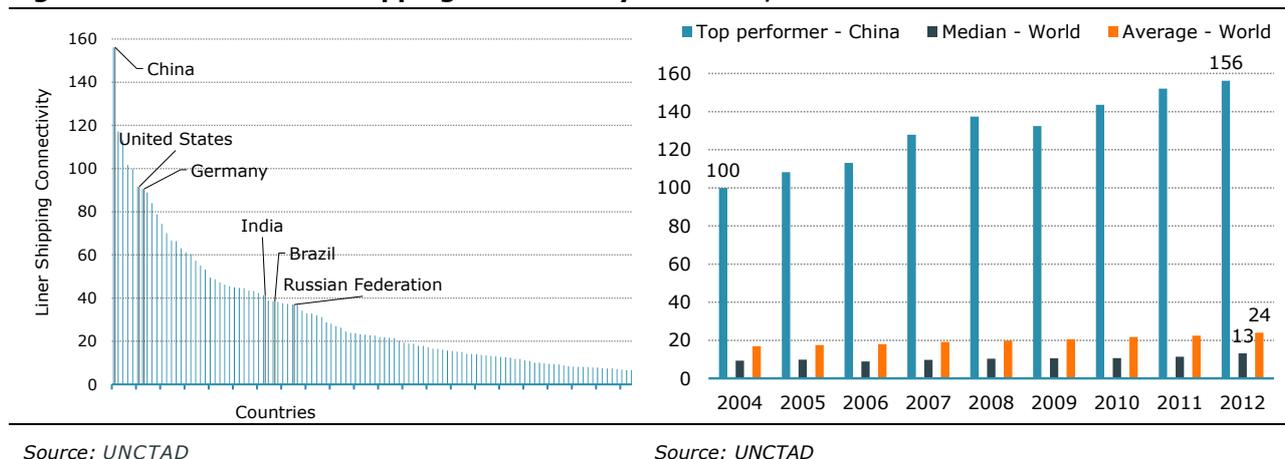
This high-quality port infrastructure has prompted the world's leading shipping lines to deliver similarly high-quality container liner capacity and services thereby creating a world-class liner shipping connectivity between China and its trading partners.

Connectivity is a broad term, and in a network, connectivity describes the ability to move a cargo from one place to another with due cost, due time and due services. Thus, when shipping lines decide to open up a new service, make extra calls to a port, or employ larger or more vessel to a service, it has an impact on a country's liner shipping connectivity.

As connectivity increases, economies of scale, higher frequencies, and more competition lead to lower transport costs, while at the same time improving companies' access to new and existing markets. Therefore, access to regular liner shipping services is a determinant of a country's transport costs and its competitiveness.

Today, China is the top performer in terms of liner shipping connectivity, cf. left diagram in Figure 4.3 below. In the period 2004-2012, China has only strengthened this status, where the country's liner shipping connectivity has increased over 50% from 100 to 156. This is more than six times above the global average of liner shipping connectivity of 24 in 2012, cf. right diagram in Figure 4.3 below.

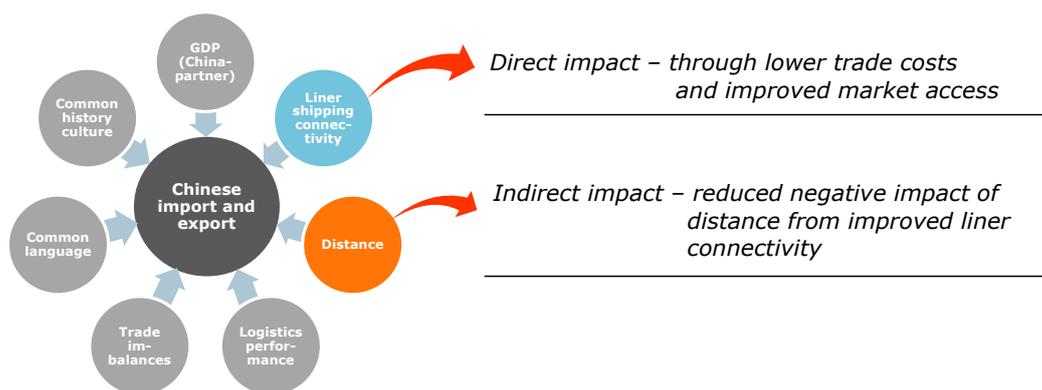
Figure 4.3 China's Liner Shipping Connectivity vs. world, 2004-2012



The question that this study tries to answer is what has this superior liner shipping connectivity done for China's import and export during the last eight-ten years? How much of the strong growth in China's foreign trade can be attributed to a well-functioning liner shipping connectivity and how much should be attributed to other factors?

In order to answer this question, econometric models of China's trade and trade costs have been estimated. By way of existing and tailor-made indexes for liner shipping connectivity, cf. Box 1, it has been possible to isolate the impact of connectivity in the models and determine its impact, cf. Figure 4.4 below and Appendix A for a detailed description.

Figure 4.4 Impact of liner shipping connectivity on Chinese trade



Note: Based on gravity model using Heckman's 2-stage sample selection estimation following Heckman (1979) and Helpman et al. (2008). Baier and Bergstrand (2009) methodology used to correct for multilateral resistance. See Appendix A for variable definitions, sources and estimation details.

Source: Authors' analysis.

The results show that liner shipping connectivity has both a direct and indirect impact on Chinese trade. The direct impact accrues from lower trade costs and better access

to markets, where a 10% improvement has been associated with 3% decrease in Chinese trade costs, a 6% increase in Chinese imports and a 9% increase in Chinese exports (all other things considered equal).

Box 1: Liner Shipping Connectivity Indexes

In this study, liner shipping connectivity is measured by two indexes complement to each other; UNCTAD's liner shipping connectivity index (UN LSCI) and a Maersk liner connectivity index based on Drewry's Maritime Research (DW LSCI).

UN LSCI describes a country's connectivity in five components; 1) number of companies providing services, 2) size of the largest ship, 3) number of services, 4) number of ships deployed on services, and 5) total carrying TEU capacity. The index covers the period 2004-2013 and includes approximately 150 countries, which makes it a powerful tool for analysing the importance of liner shipping connectivity across countries and time.

DW LSCI was created especially for this study with the aim of measuring the impact of Maersk Line and service structures. It is based on Drewry's trade capacity and service data reported in Drewry's Quarterly Container Market Review and Forecaster. It covers approximately 90 countries and a limited period of two years (2010 and 2012). The advantage of DW LSCI is an exact mapping of the actual liner shipping connections between countries, i.e. port calls, strings, services, vessels, capacities and shipping lines. This enables new connectivity indicators compared to UN LSCI and a precise mapping of the activities of the individual shipping lines hereunder Maersk Line.

Recent research has examined different aspects of how liner shipping connectivity impact costs and trade. The estimated impacts indicate that maritime transport costs and trade costs can decrease 1.5-4.0% due to a 10% improvement in liner shipping connectivity, while trade is estimated to increase about 15%. Considering the differences in data and coverage of these studies, some variation is to be expected and in the view of these differences the estimated impacts of liner shipping connectivity are relatively consistent. Thus, existing research indicate significant impacts of liner shipping connectivity and emphasises the importance of shipping liners' decisions for lowering the cost of connecting countries and facilitating their trade. See Appendix A for a detailed description.

Source: Authors' analysis.

The indirect impact accrues from distance becoming less of a barrier for reaching new and existing markets. The results indicate that improvements in liner shipping connectivity can reduce the negative trade impact of distance, which in effect amplifies improvements in liner shipping connectivity.

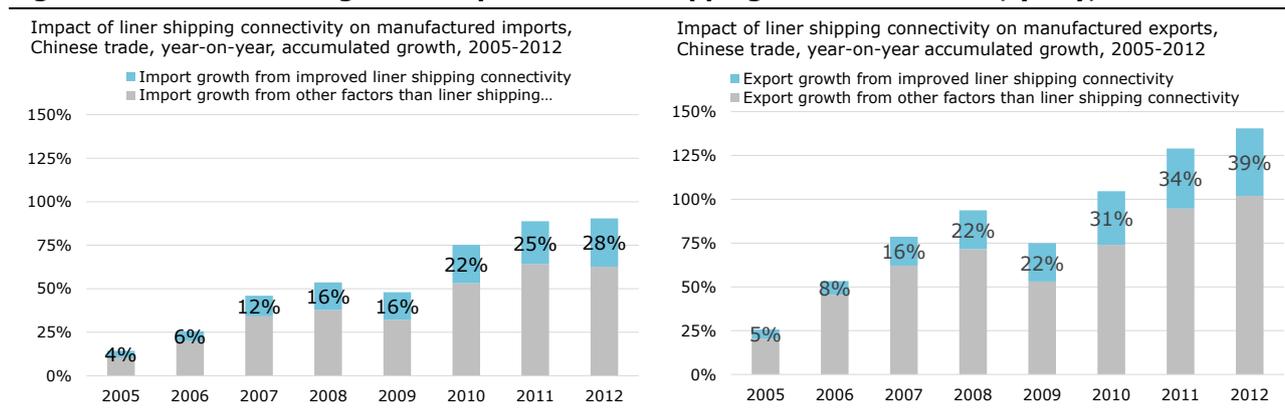
Thus, China and its trading partners has high liner shipping connectivity (index value 55 in 2012) and a low estimated impact of distance, where a 10% increase in distance has been associated with a 7.7% decrease in exports. For all 150 countries included in the analysis, the average liner shipping connectivity index was 24 in 2012, and for these countries a 10% increase in distance has been associated with a 18.6% decrease in exports.

This result is confirmed by Bahar, Manners and Nelson (2011), who found evidence of a negative relationship between efficient transport facilitation and the impact of distance. The authors show that a one standard deviation rise in logistics performance, cf. section 5.2 below, is equivalent to a reduction in distance of about 14% emphasising the "distance reducing" nature of efficient transport and logistics.

The estimates of the impacts of liner shipping connectivity make it possible to assess connectivity's total impacts on Chinese trade during the last decade.

For China and its trading partners, the liner shipping connectivity index has increased from 36 to 55 corresponding to an improvement of about 54% since 2004. This improvement means that liner shipping connectivity can have increased Chinese manufactured imports by up to 30% and exports by up to 40% since 2004 measured in accumulated year-on-year growth, cf. Figure 4.5 below.

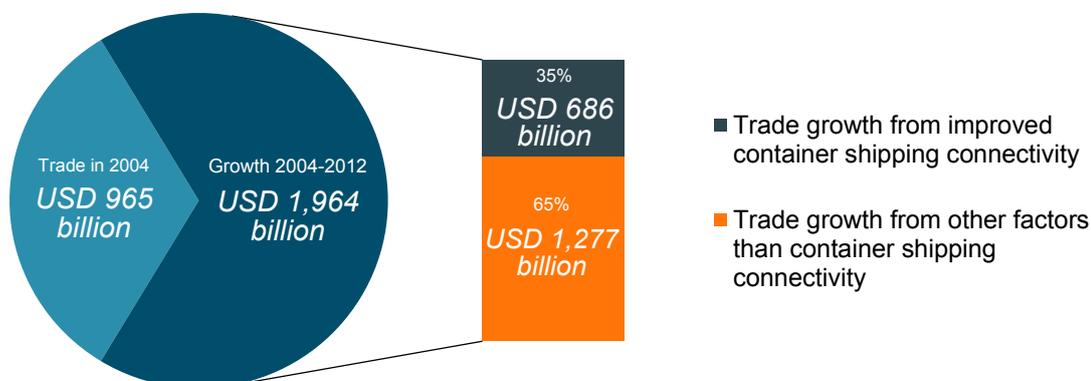
Figure 4.5 Accumulated growth impact of liner shipping on Chinese trade, y-o-y, 2005-2012



Note: Based on gravity model using Heckman's 2-stage sample selection estimation following Heckman (1979) and Helpman et al. (2008). Baier and Bergstrand (2009) methodology used to correct for multilateral resistance. See Appendix A for variable definitions, sources and estimation details.
Source: Authors' analysis.

Together, the 30% increase in imports and 40% increase in exports constitute about 25% of accumulated year-on-year growth in China's imports and exports since 2004. Converted to trade value, this year-on-year growth has resulted in additional imports and exports worth USD 686 billion corresponding to 35% of total trade growth, cf. Figure 4.6 below.

Figure 4.6 Liner shipping's share of total Chinese trade growth since 2004



Liner shipping connectivity has made it possible to transport China's massive imports and exports, but also enabled additional trade for China in two ways:

First, economies of scale, higher frequencies, and more competition has lowered transport costs, while at the same time improving access to new and existing markets. The results show that this has been associated with a 6% increase in Chinese imports and a 9% increase in Chinese exports for a 10% improvement in liner shipping connectivity. Since 2004, this means that improvements in liner shipping connectivity have been associated with a 30% increase in Chinese manufactured imports and a 40% increase in exports. This corresponds to trade worth USD 686 billion or 35% of total trade growth (all other things being equal).

Second, improvements in liner shipping connectivity have reduced the impacts of distance as a barrier to trade, which in effect has amplified improvements in liner shipping connectivity itself. This means that distance alone has reduced Chinese trade by half as much as it has global trade.

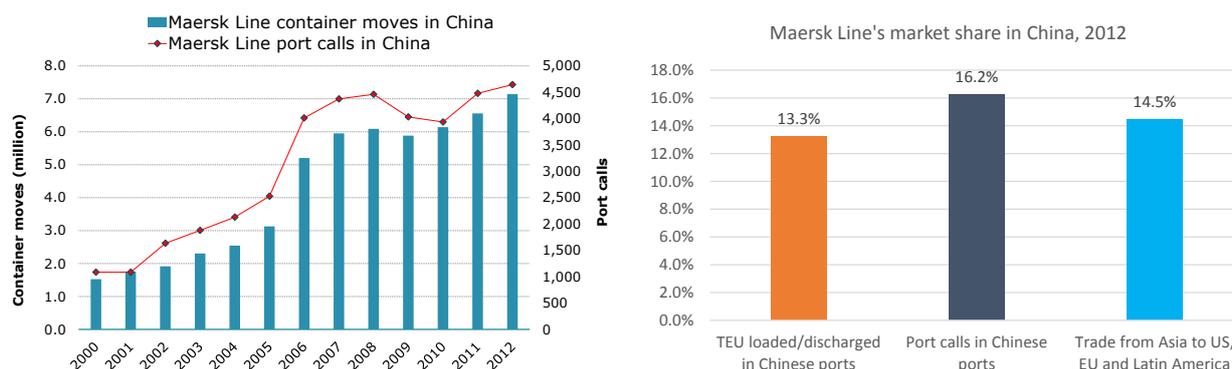
4.2 THE IMPACTS OF MAERSK LINE ON CHINESE TRADE

Maersk Line is the world's largest container shipping company serving customers all over the world. It accounts for nearly half of the Maersk Group's global revenue. It is a leader in all major global trade lanes deploying over 600+ vessels and employing 31,000 people in 325 offices around the world. In 2012, Maersk Line made revenue of USD 25.1 billion.

Maersk Line made its first call to China in 1924 and opened its first office in Mainland China in 1984. Today, Maersk Line has 1,800 employees in China with 35 locations in Chinese mainland and Hong Kong.

Maersk Line has expanded its activities in China since the beginning of the new millennium when China's foreign trade began to show double-digit growth rates. In the period 2000-2012, the company increased port calls to Chinese ports by approximately 310%, from 1,085 in 2000 to 4,645 in 2012, while container moves – an indication for container throughput – increased by approximately 270%, from 1.5 million in 2000 to 4.7 million in 2012, cf. left diagram in Figure 4.7 below.

Figure 4.7 Maersk Line in China, 2000-2012



Source: Maersk Line, World Shipping Council, CTS and JOC

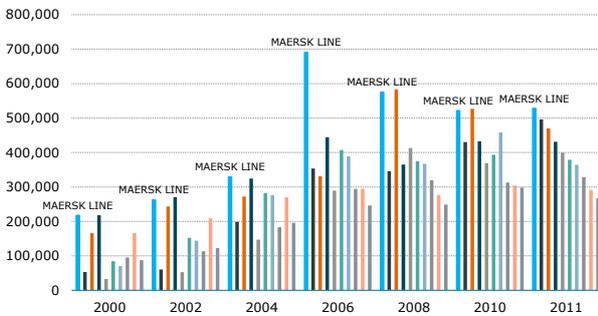
This expansion has positioned Maersk Line as one of the largest shipping lines on the Chinese trade today. In 2012, Maersk Line loaded and discharged 13.3% of all containerised goods in China, was responsible for 16.2% of all calls to Chinese ports and transported 14.5% of all containerised goods between Asia and its main trading partners, cf. right diagram in Figure 4.7 above.

China's most important trading partners are the US and the EU. In US-China trade, Maersk Line's market share was 9.7% in 2012, and the company has been the largest or the second largest shipping line for this service in terms of transported containers since 2000. In EU-China trade, Maersk Line's market share was 20% in 2012, and the company has consistently been the largest shipping line with 50-70% more transported containers compared to closest competitors since 2000. With an annual

volume of forty-foot equivalent unit (FFE) between 1.0-1.4 million, the EU-China trade is the largest for Maersk Line, cf. Figure 4.8 below.

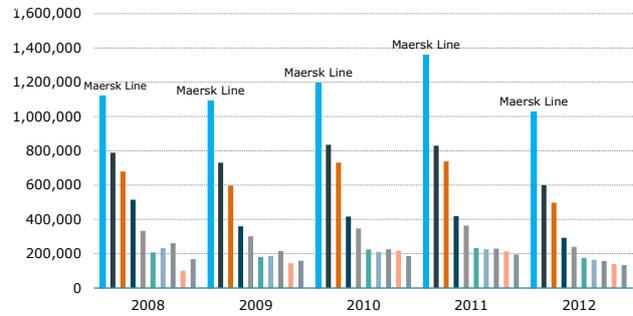
Figure 4.8 Maersk Line market share of 10% in US-Asia and 20% in EU-China

Top ten shipping lines, US-China trade, FFE, 2000-2011



Source: JOC

Top ten shipping lines, EU-China trade, FFE, 2008-2012

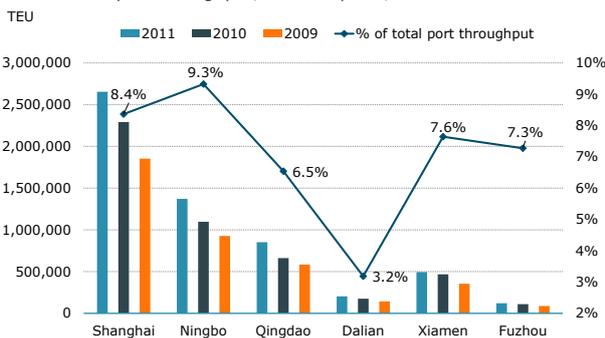


Source: CTS

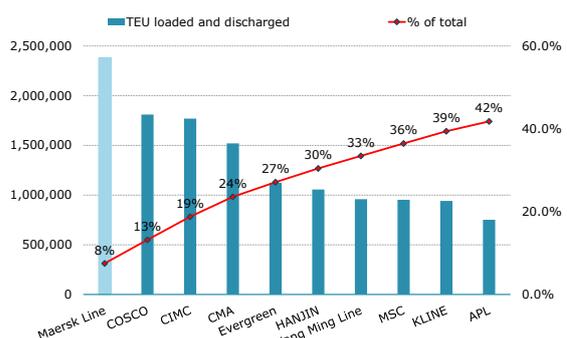
In terms of total port throughput, Maersk Line loads and discharges approximately six million TEU in six Chinese ports every year. The majority take place in the world's biggest port Shanghai, where Maersk Line has an annual port throughput of 2.7 million TEU corresponding to 8.4% of Shanghai's total annual throughput of 32 million TEU, cf. left diagram in Figure 4.9 below. Maersk Line's annual port throughput in Shanghai puts it at the top in the world largest port, where Maersk Line together with the other top ten shipping lines load and discharge approx. 42% of total port throughput, cf. right diagram in Figure 4.9 below.

Figure 4.9 Maersk Line's port throughput in China, 2009-2011

Maersk Line port throughput, Chinese ports, 2009-2011



Top ten shipping lines, port throughput (TEU), Shanghai, 2011



Source: Maersk Line, FEALOC and Drewry Maritime Research.

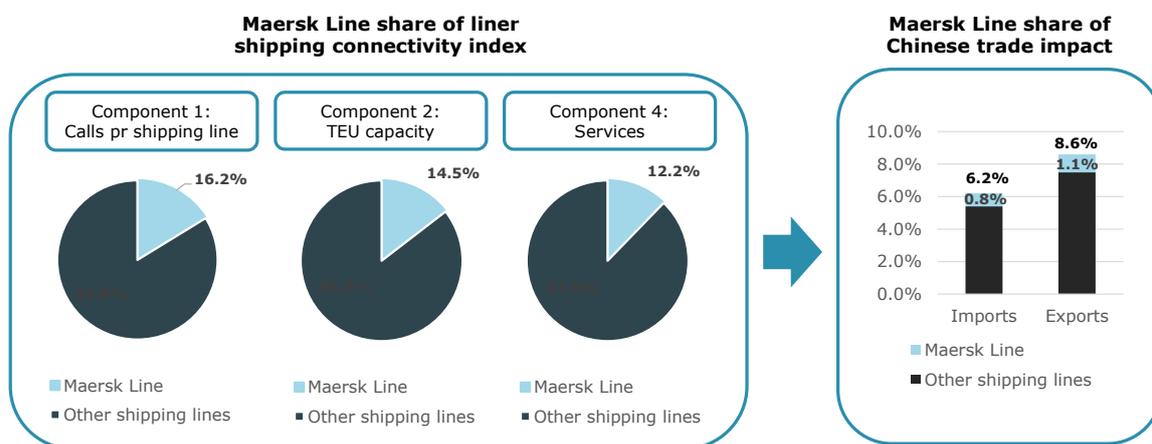
Maersk Line's massive presence in China implies that it is responsible for a significant share of the total shipping sector's impact on the Chinese trade. How much exactly can be determined using the DW LSCI.

The Drewry LSC index consists of four components, cf. Box 1 above. Using data on shipping lines' service schedules from Drewry Maritime Research, it is possible to establish Maersk Line's particular contribution to each of these four components for the Chinese trade:

- 1) Calls per shipping line: 16.2% by Maersk Line
- 2) Total carrying TEU capacity: 14.5% by Maersk Line
- 3) Number of shipping lines: Not included; Maersk Line is one shipping line out of 30+, so only marginal contribution from this component.
- 4) Number of services: 12.2% by Maersk Line

From these numbers, it is clear that Maersk Line is responsible for a substantial part of the liner shipping components in the DW LSCI, cf. Figure 4.10 below and Appendix A for a detailed description.

Figure 4.10 Maersk Line's impact on Chinese trade out of total sector impact



Source: Authors' analysis

For China and its trading partners, a 10% improvement in liner shipping connectivity has been associated with a 9% increase in Chinese exports and a 6% increase in Chinese imports. Given Maersk Line's significant market share, the company alone has been associated with a 0.8% increase in Chinese imports and a 1.1% increase in Chinese exports when it has increased its services and capacity by 10%.

5 HOW BETTER LOGISTICS CAN CONTRIBUTE TO CHINA'S FUTURE GROWTH

5.1 LOGISTICS IN CHINA TODAY

With the market for maritime container transport well functioning and saturated, the next challenge for China is for logistics to keep pace with industrial relocation and the growth of domestic demand. Managing logistics continues to be not only a complex, but also a relatively costly part of business operations and moving goods within China remains particularly challenging.

Road tolls, almost all of them imposed by provincial or city governments striving to recover the funds they invested in their motorway networks, can account for between 30-40% of transport costs for trucking companies. High fees can encourage transport companies to overload their trucks and breach safety measures.⁹

Figure 4.11 Road tolls in China

Trying to reduce road tolls in China



Source: metro.co.uk

A road toll on a motorway in Shanghai



Source: The Telegraph

In the developed world, logistics costs on average account for 10-15% of the final cost of finished goods. In the developing world, various forms of inefficiencies can result in significantly higher logistics costs, ranging from 15-25% of the cost of finished products or even higher.¹⁰ For manufacturers in China, logistics costs can amount to as much as between 30-40% of production costs.¹¹

Overall logistics costs amounted to 18% of China's GDP in 2012. This is higher than many developed countries, but also higher than average for Asia-Pacific and South American countries; cf. right diagram in Figure 4.12 below. Unfortunately, the situation is slow to improve. Since 2007, the share of logistics costs in GDP has only decreased from 18.4% to 17.8%, cf. right diagram in Figure 4.12 below.¹²

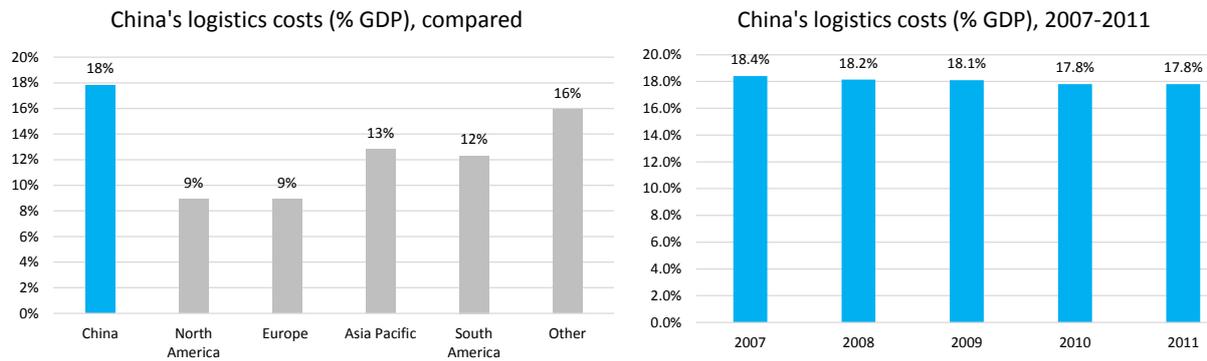
⁹ KPMG (2011).

¹⁰ Ojala et al. (2008), Guasch (2011), Memedovic et al. (2008), Capgemini & Langley (2012).

¹¹ Wong (2009).

¹² It should be noted that measuring logistics costs at a national level is complex, and difficult to compare. However, several acknowledged studies and experts use national logistics costs as comparison in the lack of alternatives. See e.g. Rantasila & Ojala (2012) and Shepherd (2011).

Figure 4.12 China's logistics costs are high and slow to improve



Source: Armstrong Associates (2012)

Source: Armstrong Associates (2012)

The problem of high logistics costs is that they make goods more expensive. In turn, this reduces China's competitiveness and makes daily life more expensive for the Chinese people through higher prices on consumer goods.¹³

The importance of logistics costs for competitiveness varies across sectors and products, and much of China's production is particularly sensitive. A large share of China's manufactured exports are products traded within international production networks based on low inventories and just-in-time production, such as textiles, clothing, fashion and high-tech. This requires good and well-functioning logistics.¹⁴

After five years of incremental but steady progress, China's competitiveness has now returned to 2009 levels. At the same time, other emerging markets – such as other Asian countries – continue to show robust growth rates.¹⁵ Thus, with rising labour costs, China needs to lower its logistics costs and improve its logistics performance if the country is to maintain a lead compared to its competitors' production cost advantages in other parts of Asia.

¹³ The impact of logistics costs on competitiveness, productivity and trade has been shown by for example Arvis, Mustra, Ojala, Shepherd & Saslavsky (2012), Farahani, Asgari & Davarzani (2009), Guasch (2008), and Barbero (2010).

¹⁴ See for example Shepherd (2011).

¹⁵ World Economic Forum: The Global Competitiveness Report 2012-2013.

5.2 THE POTENTIAL OF IMPROVING CHINA'S LOGISTICS PERFORMANCE

When companies improve their logistics performance, it can improve their competitiveness either directly, through better service such as higher reliability or shorter time to market, or indirectly, through lower logistics costs accruing from cutting waste and optimising resources.

Increased competitiveness means that companies can expand their sales and improve their financial performance. If companies source from abroad this will increase their imports, and if they sell abroad it will increase their exports, which can further improve their financial performance.

By recognising these links it is possible to measure the impact of logistics performance on trade costs and trade flows directly. This direct measurement is the approach of the econometric analysis, where logistics performance is measured by the World Bank's Logistics Performance Index, cf. Box 2 below.

Box 2: World Bank's Logistics Performance Index

The World Bank's Logistics Performance Index (LPI) compares the trade logistics profiles of 155 countries and rates them on a scale of 1 (worst) to 5 (best). The ratings are based on 6,000 individual country assessments by nearly 1,000 international freight forwarders, who rated the eight foreign countries that their company serves most frequently. The LPI consists of six components: 1) Logistics Competence, 2) Track & Trace, 3) Timeliness, 4) International shipments, 5) Infrastructure and 6) Customs.¹⁶

Although the LPI and its components offer the most comprehensive and comparable data on country logistics and trade facilitation environments, they have a limited domain of validity. First, the experience of international freight forwarders might not represent the broader logistics environment in poor countries, which often rely on traditional operators. International and traditional operators might differ in their interactions with government agencies – and in their service levels. Most agents and affiliates of international networks in developing countries serve large companies, which perform at different levels – including for time and cost – than traditional trading networks.

Using the Logistics Performance Index, recent research has examined how logistics performance impacts cost and trade. Korinek and Sourdin (2011) found that a 10% increase in the Logistics Performance Index was associated with a 64% increase in bilateral imports for the exporting country and 54% for the importing country. Behar, Manners and Nelson (2011) correct for firm heterogeneity and multilateral resistance and found that a one-standard-deviation improvement in logistics performance would raise exports by 8%. Arvis, Duval, Shepherd and Utokham (2013) found that logistics performance has a significant impact on trade costs. Thus, existing research indicates the substantial impact of logistics performance and emphasises the importance of logistics providers' decisions for lowering the cost of connecting countries and facilitating their trade.

Source: Authors' analysis.

The results of the econometric analysis show that a 10% improvement in logistics performance has been associated with a 19% decrease in Chinese trade costs and a 45% increase in Chinese manufactured exports (all other things being equal)¹⁷. These impacts occur because better logistics performance increases efficiency, and thereby reduces waste and resources and hence logistics and overall trade costs. Lower trade costs in turn lead to an increase in demand that increases trade, and thanks to the

¹⁶ See World Bank homepage for detailed description.

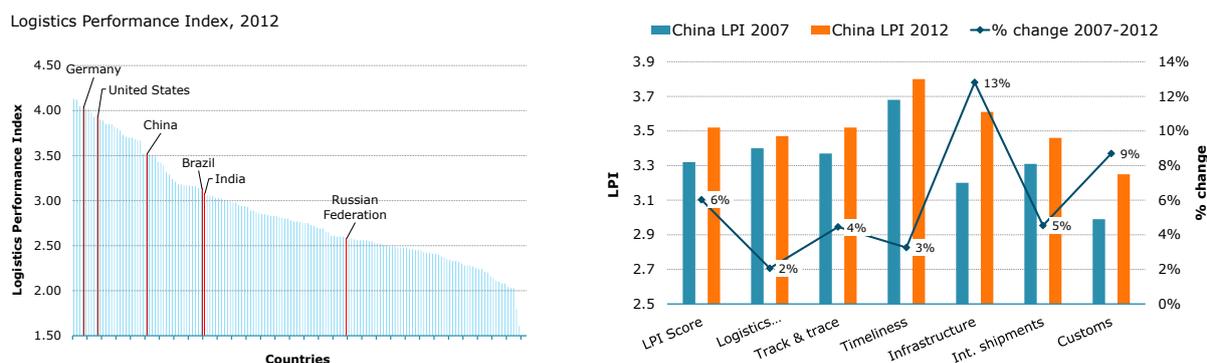
¹⁷ Korinek and Sourdin (2011) find that for a typical exporter, bilateral imports will increase more than 69% when LPI is improved 10%.

increased logistics performance, the logistics firms are in a position to actually transport this additional trade volume.

However, even though these impacts are significant, they are only a part of the potential of improving logistics in China. The Logistics Performance Index primarily measures China's logistics performance when firms import or export goods to and from China and to a lesser extent when they move goods domestically inside China, cf. Box 2 above.

Import and export mostly takes place in eastern China and southern China, where China's logistics performance is good. In 2012, China ranked 27th among the 155 countries included in the World Bank's Logistics Performance Index, cf. left diagram in Figure 4.13 below. Since 2007, China's Logistics Performance Index has increased from 3.3 to 3.5, corresponding to a 6% improvement, cf. right diagram in Figure 4.13 below.

Figure 4.13 China ranks 27th on logistics performance and is improving



Source: World Bank.

However, good logistics performance in eastern China is not enough. The gradual shift from an export-driven economy to a domestic consumption-driven economy requires broader improvements in China's logistics performance, particularly if economic growth and development shall succeed in moving west in China.

China's 6% improvement in its logistics performance since 2007 has been associated with a 27% increase in Chinese manufactured exports, corresponding to a trade value of around USD 213 billion. This illustrates the potential of improving logistics performance in China. However, if China improves logistics performance beyond its eastern and southern regions to facilitate rising domestic demand, the impact on the Chinese economy will be considerably larger.

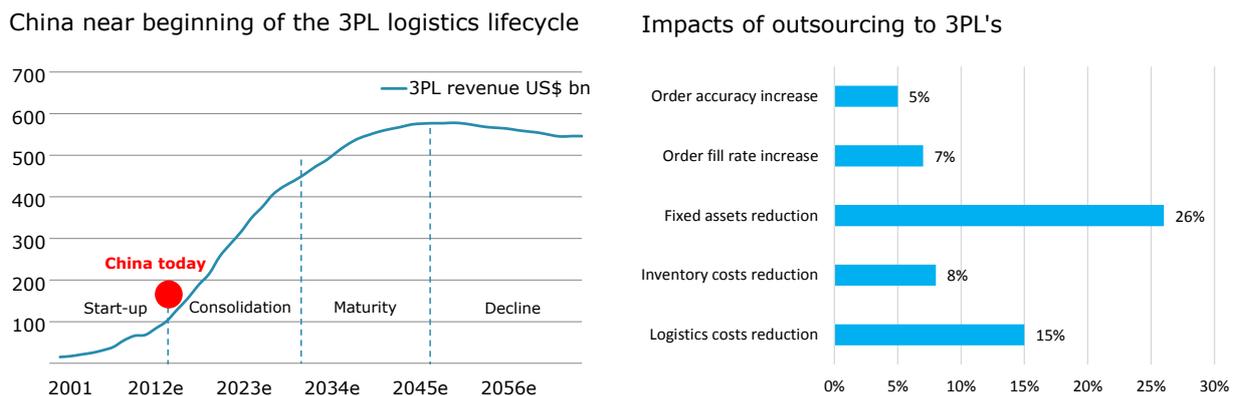
5.3 HOW 3PLS CAN CONTRIBUTE TO BETTER LOGISTICS IN CHINA

One important reason for China's high logistics cost is the fragmented nature of the sector. For companies that lack the means to handle logistics in-house, moving goods around the country can be a slow process, typically requiring multiple transfers between a host of operators. This makes it hard to keep track of shipments and offers many opportunities for waste either from theft, breakage or negligence.

China's logistics market is in its infancy and consists of thousands of low-margin players. It is characterised by a low-cost simple subcontractor outsourcing mode and low market penetration of sophisticated services such as 3PLs, cf. left diagram in Figure 4.14 below.¹⁸

The lack of integration and coordination of services across the supply chain results in lower operational efficiency and higher logistics costs. As a result, no logistics operators possess nationwide coverage and for Chinese operators service levels are often sub-standard.¹⁹

Figure 4.14 China has only recently started to reap the benefits of 3PLs



e= Morgan Stanley Research estimates for 2012-56
Source: CEIC, Morgan Stanley Research

Source: Capgemini and Langley (2013)

Through their logistics competence, infrastructure and strong global network coverage, 3PLs can address many of China's logistics challenges and provide the required consistency and reliability in service.²⁰

As such, low market penetration of 3PLs and a low outsourcing rate of logistics services are key elements in explaining China's high logistics costs. Therefore, there is

¹⁸ See Jeffries (2013), Morgan Stanley (2012), Li & Fung Research Center (2012), Liu et al. (2013) and Ojala et al. (2008).

¹⁹ See Liu et al. (2013), Li & Fung Research Centre (2012) and A.T. Kearney (2010).

²⁰ See Liu et al. (2013) and Li & Fung Research Centre (2012).

a clear pattern between spending on comprehensive logistics services such as 3PLs and total spending on the transportation of goods.²¹

According to one of the largest global annual logistics surveys, significant benefits accrue from outsourcing to 3PLs. These include a 15% reduction in overall logistics costs, 8% reduction in inventory costs, 26% reduction in fixed assets as well as higher service quality measured in terms of 5% higher order accuracy and 7% higher order fill rate, cf. right diagram in Figure 4.14 above.

These impacts occur because 3PLs can reduce logistics and inventory costs by achieving economies of scale, bundling services and specialisation. In addition, fixed assets can be reduced by outsourcing warehousing and trucking to 3PLs. Fixed costs are then transformed into a variable cost that improves return on investment. Finally, 3PLs can achieve higher service quality from specialisation in equipment, tools and human resources, add know-how, innovate existing processes and develop new business areas.

Despite a low market penetration rate, China's market for logistics today is USD 88.4 billion, making it the second largest 3PL market in the world measured in terms of 3PL revenue. It is expected to grow by around 12-16% in the next ten years and to USD 182 billion by 2016, which will make it the world's largest 3PL market.²²

A highly fragmented logistics market and low market penetration of 3PLs are some of the key elements in explaining China's high logistics costs. However, being a part of the problem also means being a part of the solution. Through their logistics competence and infrastructure, 3PL's can address many of China's logistics challenges and provide the required consistency and reliability in service. This will result in lower logistics costs and higher service and thereby higher competitiveness both on China's domestic and foreign markets.

²¹ See Morgan Stanley (2012), Jeffries (2013) and A.T. Kearney (2012).

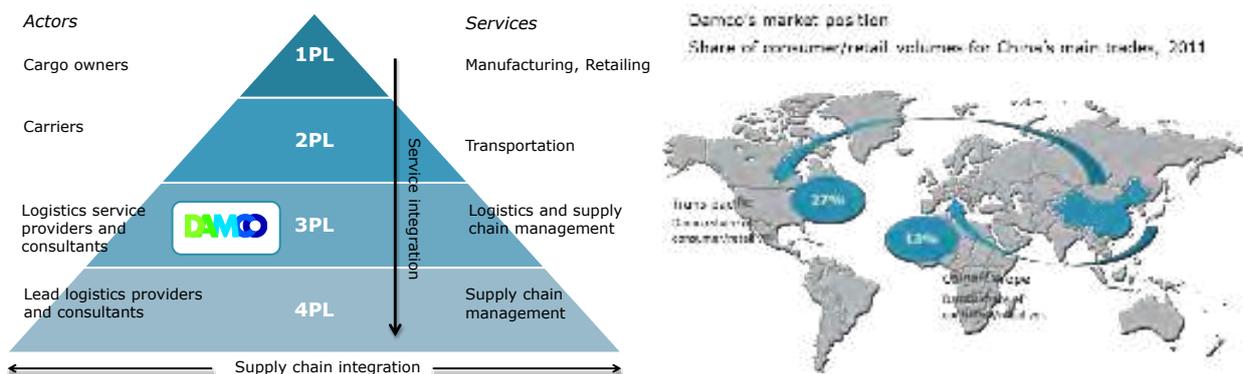
²² See Jeffries (2013) and Morgan Stanley (2012)

5.4 THE IMPACTS OF DAMCO ON THE CHINESE ECONOMY

1.5.4 DAMCO IN CHINA

Damco is specialised in providing integrated supply chain management services and offers a range of services from simple ocean freight forwarding, warehousing and trucking to integrated supply chain management and consultancy supply chain development services. This positions the company as a 3PL on the service integration scale for logistics providers, cf. left diagram in Figure 4.15 below.

Figure 4.15 Damco's services and market position in consumer and retail



Source: Model adapted from Rodrigue et al. (2013)²³

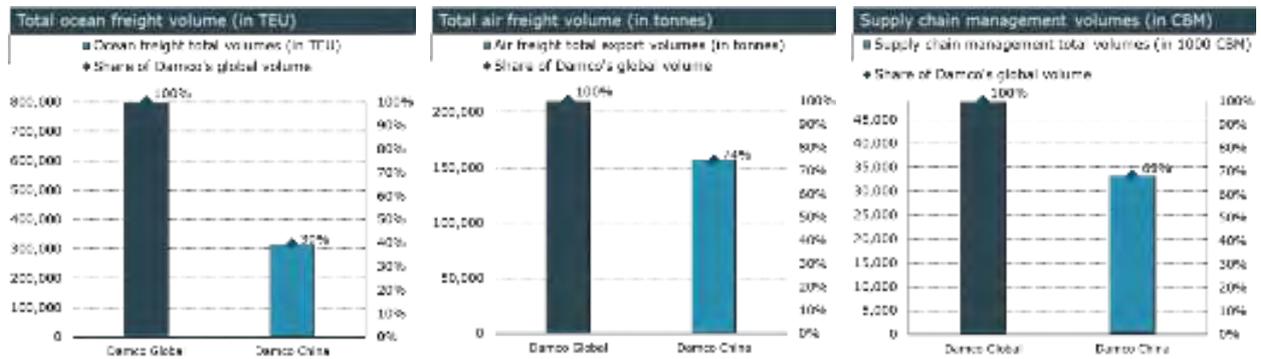
Source: In Eyefor Transport (April 2012), based on data from Transport Intelligence (2012)

Damco's clients primarily count global retailers and other large multinational companies (MNCs) within for example fashion, sports, lifestyle, technology and chemicals. Damco has a strong global market position in providing integrated supply chain management services to the consumer and retail segment. In 2011, the company moved 27% of total containers for the consumer and retail segment on the Trans-Pacific trade and 13% on the China-Europe trade; cf. right diagram in Figure 4.15 above.

For these segments, China is a key manufacturing and sourcing market, and increasingly also an attractive domestic sales market. Consequently, most of Damco's global product volume is moved through China. Today, Damco moves 314,000 TEU ocean freight in and out of China, more than 155,000 tonnes of air freight and around 33,000 CBM of Supply Chain Management volume in China, cf. Figure 4.16 below.

²³ Retrieved from http://people.hofstra.edu/geotrans/eng/ch5en/conc5en/layers_to_logistics_services.html

Figure 4.16 Damco volumes for its global and China related business



Source: Authors' analysis.

2.5.4 DAMCO'S CONTRIBUTIONS TO SUSTAINING CHINA'S COMPETITIVENESS

To understand the impacts and dynamic trade-offs of Damco's services to their clients and their vendors in China, a representative selection of Damco's consultancy Supply Chain Development (SCD) projects has been analysed.²⁴ These SCD projects illustrate the importance and potential role of 3PLs such as Damco in optimising Chinese supply chains, reducing client and vendor logistics costs, and thus improving the competitiveness of Chinese supply chains, cf. Figure 4.17 below.²⁵

Figure 4.17 The links between 3PL's and China's trade competitiveness



Source: Authors' analysis.

With 60% of the SCD projects involving global retailers, 13% involving lifestyle and 13% technology (e.g. personal computers) and 87% involving export of goods from China, the SCD projects are representative of Damco's business in China, cf. Appendix B.

²⁴ 15 SCD projects have been selected based on their relevance to the Chinese market. More than 80% of the cost savings identified in the SCD projects have been recognized by the respective clients.

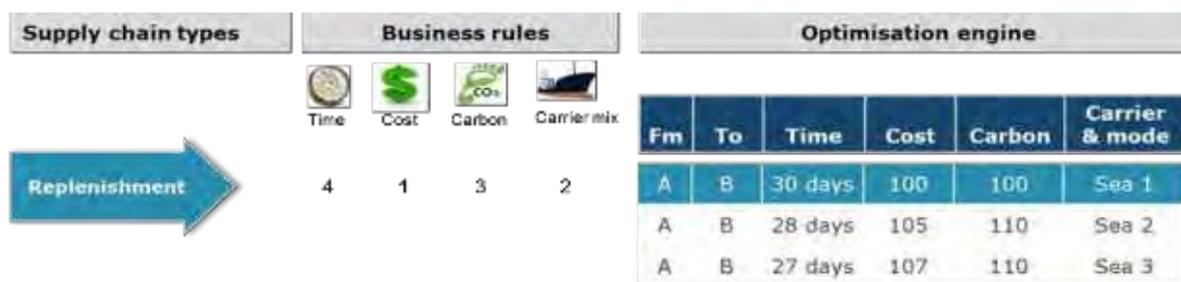
²⁵ It is important to note that the SCD projects only capture part of Damco (and 3PLs) services and related economic impacts. Damco provides a broad range of services, such as e.g. freight forwarding and warehousing that impact clients' logistics costs and fixed assets.

In these projects, Damco applies three different optimisation solutions: 1) process flow optimisation such as consolidation of shipments and port rationalisation (67% of the projects); 2) transport and warehouse network optimisation (20% of the projects); and 3) optimisation of inventory (13% of the projects), cf. Appendix B for a detailed description.

According to the client’s business and their business success criteria, Damco impacts the client’s and their vendors’ corporate performance and profitability differently in the SCD projects. Impact depends on what is most important for the client’s supply chain, and can be cost, time to market, carbon emissions and/or carrier and carrier mode (air, sea, etc.).

For example, for replenishment goods – namely goods for which demand is fairly predictable, often low cost and low margin – clients will most likely ship at the lowest cost, and here time is not of paramount importance, cf. Figure 4.18 below.

Figure 4.18 Example of business rules for a replenishment supply chain



Source: Authors’ analysis.

Across the SCD projects, Damco achieves 15% cost savings on average for their clients. The savings vary according to the client’s supply chain characteristics and, which optimisation solution is applied. Process optimisation solutions typically reduce costs by 9%, network optimisation solutions by 21% (hereof 14% on domestic transport), and inventory optimisation solutions by 26%, cf. right diagram in Figure 4.19 below.

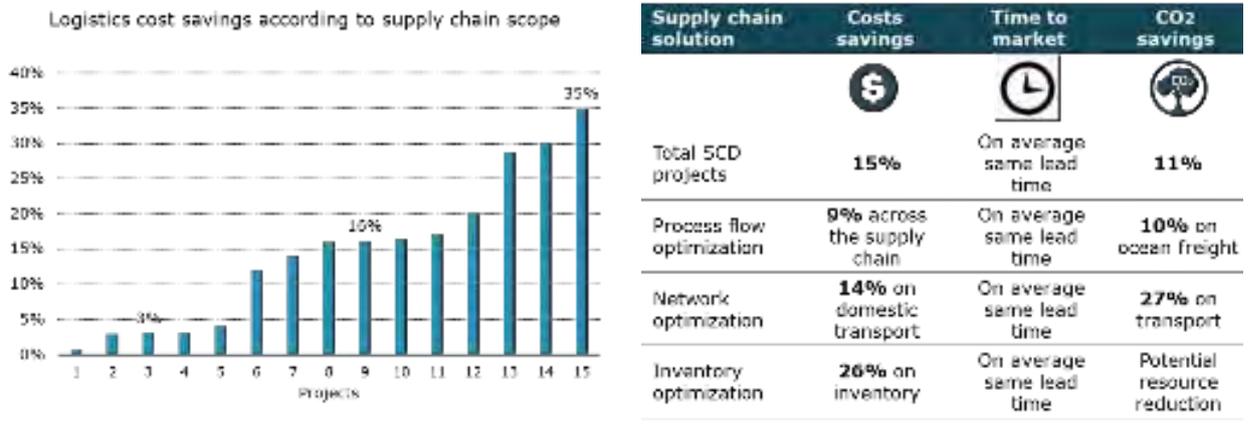
On average, all savings are achieved while maintaining the same service level to clients measured in terms of time to market.²⁶

In addition to cost savings and maintained service levels, CO₂ emissions are reduced through increased utilisation of containers or optimised transport - and warehouse networks. For process flow optimisation projects, approximately 10% CO₂ is saved on ocean transport alone, and for network optimisation approximately 27% CO₂ is saved on domestic transport. The 27% CO₂ saving on network optimisation is based on one

²⁶ See Appendix B.

observation. Drawing on several studies, WEF (2009) finds CO₂ savings of 10% from network optimisation projects.

Figure 4.19 Impacts on clients' logistics costs, time to market and CO₂



Note: The 27% CO₂ saving is based on one project observation. WEF (2009) finds an average of 10% CO₂ savings from network optimisation projects drawing on several studies.

Source: Author's analysis.

An important feature of the SCD projects is that the savings are achieved for large global clients with professional and mature supply chains, i.e. the saving must be expected to be larger for companies with less mature supply chains.²⁷

In terms of where in the supply chain cost savings are harvested, ocean freight and inventory are the main beneficiaries. For those clients that have ocean transport in scope, cost savings average 12%, while cost savings average 26% for those clients that have inventory level in scope.²⁸

Ocean transport and inventory are also two of the largest logistics cost items for manufacturers and trading companies, and particularly relevant for Chinese supply chains. China's challenge as a sourcing market is its long distance and lead-time to main markets in Europe and the US, and consequently higher transport costs and potential need for higher inventory levels compared to sourcing hubs closer to main markets, e.g. Mexico for the US or Eastern Europe for Europe.²⁹ This means that just the shipping cost can make up 8-10% of the total cost of sourcing from China.³⁰

Across the end-to-end supply chain, cost savings are mainly distributed on international transport (63%) and destination operations (29%), cf. bottom of Figure 4.20 below. This is because the majority of projects applied here involve process flow

²⁷ The average global revenue for clients across the SCD projects is USD 80 Billion.

²⁸ See Appendix B for detailed description.

²⁹ Firms increasingly show an interest in generating new efficiencies by sourcing geographically closer materials and products. This allows for faster time to market, faster replenishment/order fill rate and a lower carbon footprint

³⁰ See PWC (2008).

optimisation, where consolidation handling processes are moved upstream to China. This adds costs to Chinese operations but reduces the number of containers that flow through the supply chain, and thus reduces end-to-end logistics costs.³¹

Figure 4.20 The distribution of cost savings across the supply chain



Source: Authors' analysis.

For network and inventory optimisation projects, savings are achieved for Chinese operations (cf. bottom of Figure 4.20 above) and are an important solution in tackling China's high domestic transport (in particular trucking) and inventory costs.

5.5 SUPPLY CHAIN OPTIMISATION - A MEANS TO TACKLE CHINA'S HIGH LOGISTICS COSTS AND OFFSET EXTERNAL MARKET PRESSURES GOING FORWARD

China has been the preferred manufacturing country for decades. Foreign MNCs that manufacture and/or source products in China, such as Damco clients, have been drivers of China's export-orientated growth. In 2009, 153 of the 200 largest exporters were foreign firms.³²

The Chinese manufacturing sector accounts for almost 50% of China's GDP, and even though China aims to reduce its export dependency, the manufacturing sector will remain important for China also in the future.³³ However, one of China's biggest challenges will be to maintain its competitive edge over other low-cost manufacturing countries as wage levels increase.

Since the mid-2000s, minimum wages in China have increased by 10% per year.³⁴ This is faster than in other low-cost countries (LCC), especially since 2007 (cf. left diagram in Figure 4.21 below), but partly offset by higher productivity in China.³⁵ China's wages are still far more competitive than those in the developed world. Wage

³¹ In process flow optimisation projects, additional costs may be placed on the Chinese supplier depending on the trading term (FOB or CIF) and logistics costs split between the supplier and overseas buyer.

³² See Jeffries (2013) and Accenture (2011).

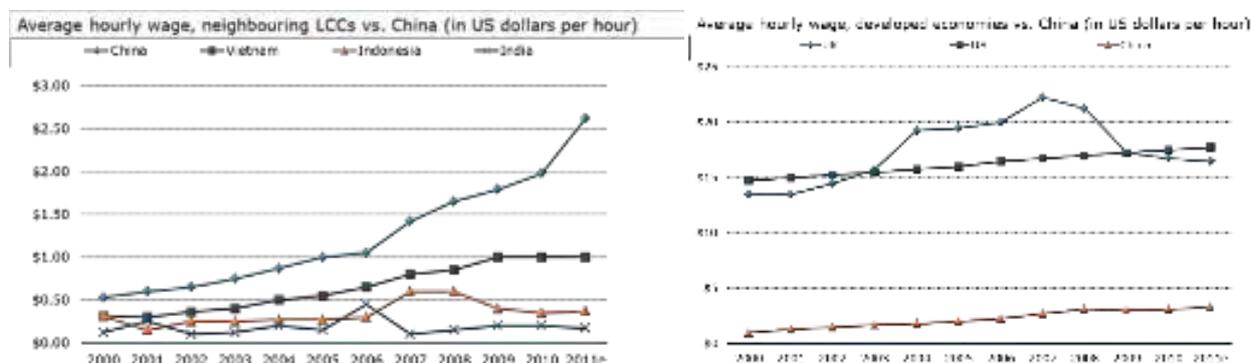
³³ See Transport Intelligence (2013), Jeffries (2013) and Accenture (2011).

³⁴ See Chang, Luo & Huang (2013).

³⁵ See Accenture (2011).

levels in China's clothing industry represent less than 9% of the average wage in the UK or US, cf. right diagram in Figure 4.21 below.

Figure 4.21 China's hourly wage rates are still competitive compared to the developed world



Source: Accenture (2011) based on ILO data and data from the General Statistical Office of Vietnam.

Wage increases are obviously expected to impact manufacturing costs. The impact will vary across industries and product categories. Companies may offset the impact on margins by improving their supply chain processes and/or seeking other productivity and efficiency gains^{36, 37}.

To understand to which extent supply chain optimisation can offset wage increases, this study analyses the impact on cost structures within three industries in China; footwear, heavy machinery and personal computers. The analysis is based on Accenture's (2011) analysis of labor cost sensitivity analysis for these three industries.

Accenture (2011) finds that assuming a minimum wage increase of 30%, the price increase required for maintaining current profit levels for companies with a strong manufacturing base in China (30-100% production in China) will range from just 1-5%, cf. Table 4.1 below.

Table 4.1 Price increase required to maintain profit levels

Minimum price increase required to maintain current profit levels at a 30% wage increase			
Industry	Clothing (footwear)	Heavy machinery	High-tech
Industry average production in China	37%	60%	90-100%
Price increase	0.7%	1.5%	4.8%

Source: Accenture (2011).

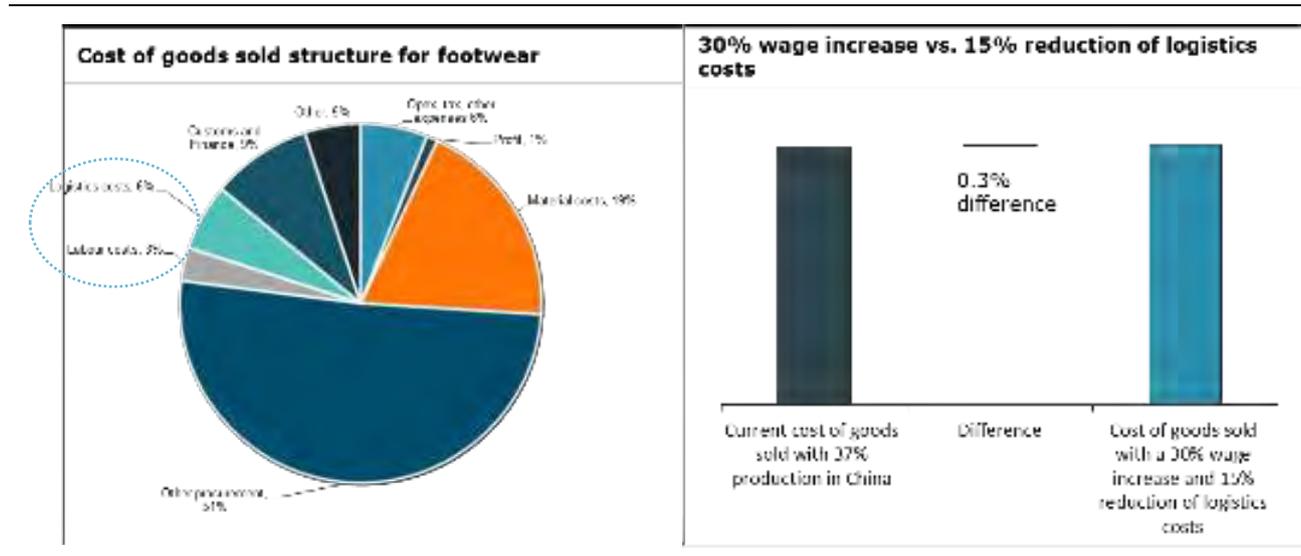
³⁶ Source: Accenture, 2011

³⁷ Improving supply chain processes has been announced as one important driver for China to remain competitive. Accordingly, the Chinese government plans to modernize logistics in China to improve efficiency and reduce China's high logistic costs (China's 12th 5 year plan, Part IV, Ch. 15, Sect. 2).

For the footwear industry in particular, assuming a wage increase of 30%, Accenture finds that cost of goods sold will increase by 1.2%, which in turn means that retail prices would need to increase by 0.7% to maintain current profit levels³⁸.

Shippers on a global average report a potential 15% reduction of logistics costs from using 3PL services³⁹ (Gag Gemini and Langley, 2012). Assuming that logistics costs account for 6% of multinationals' cost of goods sold within footwear, a 15% reduction of logistics costs can fully offset a 30% wage increase in the footwear sector (with only a 0.3% difference in cost of goods sold), cf. Figure 4.22.

Figure 4.22 Case: the footwear industry in China



Source: Accenture, 2011

Source: Author's analysis based on Accenture (2011) & Gag Gemini and Langley (2012)

For heavy machinery and personal computers, labor cost amount to around 4% and 20% of cost of goods sold respectively as opposed to 3% in the footwear industry (Accenture, 2011). Assuming that logistics costs account for 6% or above in these sectors, a 15% reduction of logistics costs will partly offset a 30% wage increase.

A logistics cost reduction of 15% can fully offset a 30% minimum wage increase of the footwear industry, and partly offset a 30% minimum wage increase in the heavy machinery and personal computers industries in China.

Thus, with trends of increasing outsourcing to 3PLs and the rise of the 3PL market in China, 3PLs can be an important element in China's future competitiveness. However,

³⁸ Source: Accenture, 2011

³⁹ Source: Gag Gemini and Langley, 2012

LCCs such as Vietnam, Thailand, Malaysia and Indonesia may become increasingly attractive as alternative sourcing locations as MNCs diversify their risk strategy.

For domestic markets and domestic distribution supply chains, 3PLs and supply chain improvements are also important elements in China's 12th five-year plan towards a consumption-driven economy.

The Chinese consumer market is expected to become the second largest in the world by 2015, with enough purchasing power to buy 14% of the world's products.⁴⁰ More than half of the world's top 50 retailers have now entered the Chinese retail market, and are growing at a rapid pace.

However, high inventory, storage and transport costs pose challenges to domestic supply chains. Inventory and storage costs amount to 35% of China's total logistics costs, and transportation costs to more than 50% of China's total logistics costs⁴¹, cf. Section 5.1.

The SCD cases illustrated how a 3PL such as Damco can achieve approximately 25% reduction on inventory and storage costs in China, and a 14% reduction on domestic transport costs, cf. right diagram in Figure 4.19 above. WEF (2009) finds a 10% reduction of logistic cost from network optimisation projects, which is applied to this case. It is estimated that such cost reductions in inventory and transport potentially can increase margins by 2-5% and 1-1.5% in domestic distribution supply chains, cf. Figure 4.23 below.⁴²

Figure 4.23 Impacts on China's domestic consumer market



Source: Authors' analysis.

⁴⁰ See Booz & Co. and Am. Cham (2012).

⁴¹ Including interest, warehousing, insurance, and IT related costs, as well as obsolescence, distribution and packaging, etc. (CFLP, 2012).

⁴² Inventory carrying cost is assumed to account for 10-19% of product value and transport costs for 5-15% of product value (See Appendix B. for further details)

Thus, if companies in China can improve transport costs and/or inventory levels by optimisation and just-in-time production strategies, it could have a potential impact on their competitiveness and growth.

In turn, this would further provide Chinese consumers with a greater range of purchasing options and create an increasingly competitive environment for companies. It would contribute further to China's imports of consumer goods that are steadily increasing, and the government's strategy to increase domestic spending that is slowly succeeding.⁴³

⁴³ See Transport Intelligence (2013).

6 MAERSK AND CHINA'S PURSUIT OF RESOURCE EFFICIENCY AND POLLUTION CONTROL

Environmentally sustainable development is a key focus area in China's 12th five-year plan. Reducing energy intensity in the economy and carbon emissions are primary goals with ambitious objectives for the transport and logistics sector:

- 1) Reduction of energy consumption per transported unit by 16% for ocean transport, 14% for river transport, and 8% in ports.
- 2) Reduction of berthing time for loading and/or unloading 1,000 tons of goods at main coastal ports by 15%.
- 3) Introduction of cold ironing or shore power, where ships at berth are provided with shore-side electrical power while their main and auxiliary engines are turned off.
- 4) Introduction of environmental assessment system, equipment standardisation (e.g. barges), truck-to-barge conversion.

For China, reducing energy consumption is not only a priority for sustaining competitiveness; it is of vital importance for the health of the Chinese population.

The Global Burden of Disease Study revealed that air pollution caused an estimated 3.2 million premature deaths worldwide in 2010.⁴⁴ According to the Health Effect Institute, nearly 40% of these premature deaths occur in China corresponding to 1.2 million people. Particulate matter (PM) is now the fourth-leading cause of death in China, behind dietary risks, high blood pressure and smoking and unless current trends change, urban air pollution is projected to be the number one killer worldwide by 2050.⁴⁵

It is clear that Maersk as a large global supplier of transport and logistics services with material presence in China can contribute to fulfilling such objectives.

6.1 EMISSIONS

Climate change is a key priority across the Maersk Group and particularly in Maersk Line, which is responsible for than 80% of the Groups carbon footprint comes from. Maersk Line has taken a leadership position in the shipping industry when it comes to combating climate change. In 2012, Maersk Line reached its 2020 target of reducing CO₂ emissions by 25% per TEU from its benchmark 2007 level. To keep momentum, Maersk Line has raised its 2020 target of reducing CO₂ emissions to a 40% reduction by 2020.

1.6.1 THE FAIR WIND CHARTER

Shipping is energy and carbon efficient but also emits much higher levels of SO_x emissions compared to other modes of transportation – up to 500 times more than

⁴⁴ <http://www.thelancet.com/themed/global-burden-of-disease>

⁴⁵ <http://www.healtheffects.org/>

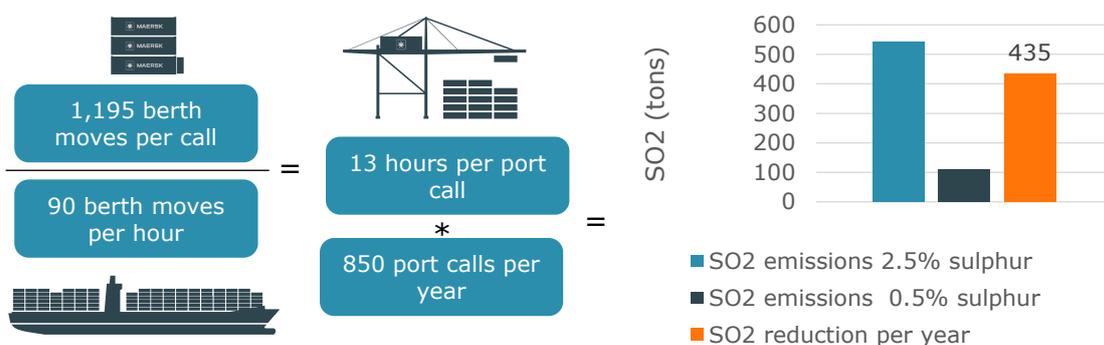
road transportation per transported unit. SO_x emissions contribute to acid rain and have a negative impact on public health, e.g. for respiratory ailments.

SO_x is causing about 520 premature deaths per year alone in the Pearl River Delta - host to three of the ten busiest container ports in the world, annually handling some 50 million TEU of containers and representing some 10% of global container traffic. These deaths could be reduced by 91% should mandatory use of fuels with lower sulphur content be introduced.

The Fair Wind Charter is a voluntary programme requiring participating shipping lines to switch to fuels with maximum sulphur content of 0.5%. Initially, the programme ran from 1 January 2011 to 31 December 2012, but the period was extended and now the Fair Wind Charter runs until the end of 2014. Having contributed substantially to its' development, Maersk Line was the first to commit to the Fair Winds Charter and implement it in practice. From the call of Eleonora Maersk on 5 September 2010 to December 2012, all Maersk Line vessels calling at Hong Kong have voluntarily switched to use of lower-sulphur marine diesel fuel while at berth.

Average sulphur content in regular Heavy Fuel Oil (HFO) used by Maersk Line is around 2.7%, whereas the fuel used after the fuel switch is marine diesel oil, which contains less than 0.5% sulphur content. Annually, Maersk Line has around 850 port calls in Hong Kong. All vessels switched to lower-sulphur fuels while at berth from 5 September 2010, which saved approximately 435 tons of SO₂ per year in Hong Kong and corresponds to an 80% emission reduction for Maersk Line, cf. Figure 6.1 below.

Figure 6.1 Maersk Line's SO₂ reductions in Hong Kong due to the Fair Wind Charter



Source: Maersk and www.martrans.org/emis.

Since Maersk Line was responsible for 9% of total container throughput in Hong Kong in 2011, this corresponds to a 2.6% reduction of total SO₂ emissions in Hong Kong port.

Maersk Line considers the Fair Wind Charter a first step in the right direction. But it is limited in scope and a temporary measure. Therefore, as next step, Maersk Line wants

to further extend the Fair Winds Charter approach to cover the entire Pearl River Delta and other ports in Asia as well as to cover vessels at sea, i.e. a solution more in the direction of an actual ECA. The process should result in a roadmap with Asian governments towards a future regulated regime for marine emissions and inspire regulators to address the issue.

Maersk Line's fuel switch in connection with the Fair Wind Charter has reduced its SO₂ emission by approximately 80% or 435 tons per year. This correspond to a 2.6% reduction of total SO₂ emissions from ocean going vessels in the Hong Kong area. Maersk Line considers the Fair Wind Charter a first step towards more binding emission control measures that will contribute more substantially to achieving one of China's key focus areas in its 12th five-year plan; to secure environmentally sustainable development.

2.6.1 THE TERMINAL PARTNERING PROJECT

In addition to lower sulphur content, emissions reduction can also be achieved by shortening port stays. The Terminal Partnering Project (TPP) is a cooperation between Maersk Line and container terminals across the world. Its overall goal is to reduce port stays by up to 30% through productivity improvements achieved by integrating the planning of Maersk Line with the operation of containers terminals.

In the four main Chinese container ports, Xiamen, Yantian, Shanghai and Hong Kong, the project has identified ways of increasing productivity that can potentially decrease port stays by 27-40%. So far 12-18% has been captured, mainly through improved vessel preparedness and to a lesser extent through terminal operations.

If a 30% reduction in port stay is achieved for these four ports, it can potentially reduce total port time for Maersk Line by 11,436 hours, cf. Figure 6.2 below.

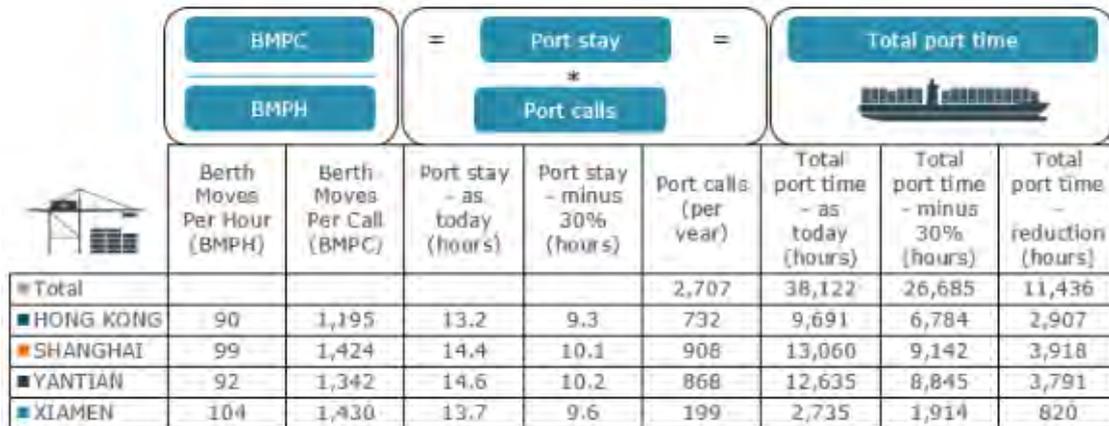
As one hour of berthing time for a typical Maersk Line vessel on the Chinese trade consumes 0.9 tons of bunker⁴⁶ and emits 0.053 tons of SO₂⁴⁷, the reduction in total port time can save up to approximately 552 tons of SO₂ per year for Xiamen, Yantian, Shanghai and Hong Kong.

However, the learning points from the cooperation between Maersk Line and container terminals will not be limited to Maersk Line vessels. Container terminals will naturally try to use it for all their port calls, and if other shipping lines are willing to optimise their planning in a way similar to Maersk Line, a 30% reduction in port stay for all port calls is possible. In this situation, there is a potential reduction in SO₂ of up to 6,450 tons per year for Xiamen, Yantian, Shanghai and Hong Kong.

⁴⁶ According to Maersk Line's statistics for Chinese ports.

⁴⁷ See <http://www.martrans.org/emis/>.

Figure 6.2 Potential reduction in total port time for Maersk Line if port stay is reduced by 30%



Source: Authors' analysis.

For Maersk Line, TPP will mean higher reliability and quicker transit times - both critical factors to Maersk Lines customers and thus to Maersk Line. An on-time delivery of 95% has become Maersk Line's key strategic priority and reducing port stays globally by 30% is considered to be a key enabler for achieving this overall objective.

For Chinese container terminals, the TPP's joint optimising processes reduces rework and increases productivity. This means higher port throughput for the same resources, which will improve Chinese container terminals' competitiveness and profit.

In addition, there is a shared benefit in terms of increased trade potential for all three parties involved in TPP. Container terminal productivity is an important component for trade costs and thereby trade flows. Blonigen and Wilson (2006) estimate that a 10% increase in port efficiency increases trade on average by 3.2%. This shows that even more modest improvements of port efficiency than those targeted by TPP are likely to generate significant increased trade potential.

Through lower port stay, Maersk's Terminal Partnering Project will reduce emissions of harmful particles and increase port productivity. In the four main Chinese container ports, a 30% reduction in port stay can potentially reduce SO₂ emissions by up to 552 tons per year for Maersk vessels. Therefore, the project contributes to achieving China's five-year plans objectives to reduce energy consumption for ocean transport and ports by 16% and 8%, respectively, and berthing time by 15%. In addition, it will enable more trade; 3.2% for each 10% increase in port productivity.

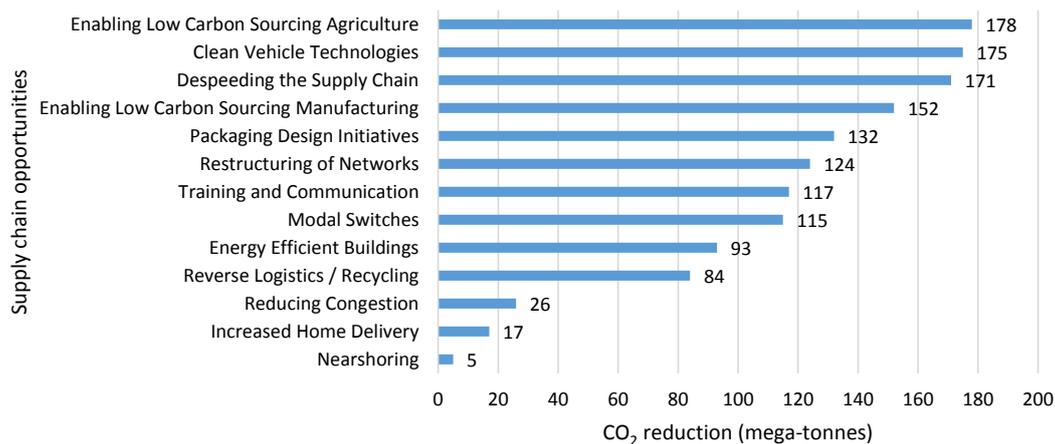
6.2 TAKING WASTE OUT OF SUPPLY CHAINS

In its 12th five-year plan, China's increased focus on environmental sustainable development has sharpened the need for more efficient logistics and transport.

Considering that 3PL's such as Damco are typically responsible for managing increasingly sophisticated global supply chains used by China and its trading partners, and that in essence 3PL's are specialised in doing more with less to reduce time, material and costs, they will play a vital role in achieving China's sustainability objectives.

A study by the World Economic Forum (2009) has estimated that the logistics and transport sector could reduce its total CO₂ emissions of 2,800 mega-tonnes by up to 50% through efficiency improvements in the supply chain. This means that up to 1,400 mega-tonnes can be cut off through measures such as low carbon sourcing, clean vehicles technologies, despedding the supply chain, etc., cf. Figure 6.3 below.

Figure 6.3 Supply chain opportunities for reducing CO₂ emissions



Source: World Economic Forum (2009), p. 4.

Most of these measures will be relevant and feasible for China. Damco has documented this through a number of Supply Chain Development (SCD) projects carried out for its customers operating in China.

Supply chain opportunities identified by the World Economic Forum (2009) include the restructuring of networks that can reduce global CO₂ by 124 mega-tonnes and corresponds to 9% of total CO₂ reduction potential, cf. Figure 6.3 above. Studies show that on average the restructuring of network gives an 11% cost reduction and a 10% CO₂ emission reduction.

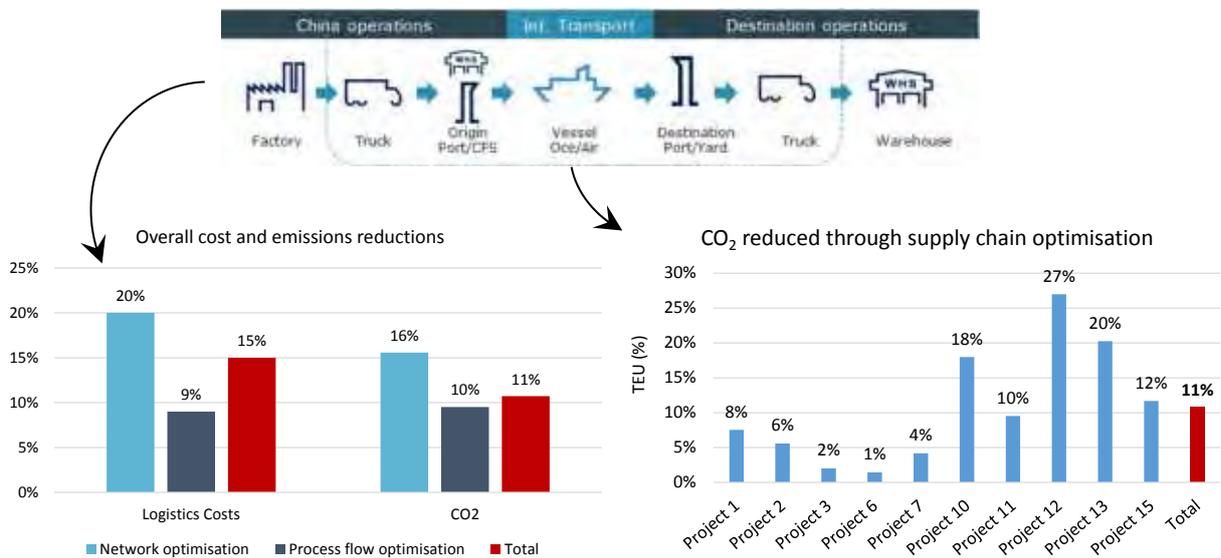
Damco has achieved similar results when restructuring supply chains for customers operating in China using different combinations of process flow optimisation and

network optimisation and inventory optimisation, all designed to lower logistics costs, resources and emissions.

Process flow optimisation implies consolidation of cargo and optimisation of packaging which reduces the number of containers flowing through the supply chain for a given cargo volume. Network optimisation implies optimisation of transport - and warehouse networks.

Process flow optimisation constitutes the majority of the SCD projects and through this Damco has reduced the number of containers needed for ocean transport, and in return reduced logistics costs and CO₂ emissions by 10% each. In a smaller number of SCD projects, network optimisation has reduced logistics costs by 20% and CO₂ emissions by 16%. In total, the SCD projects has reduced CO₂ emission by 11%, cf. Figure 6.4 below.

Figure 6.4 Damco’s supply chain optimisation in China



Source: Authors’ analysis.

Optimisation of supply chains can provide sustainable growth while ensuring competitiveness and therefore holds great potential for China. Damco’s Supply Chain Development projects for customers operating in China show how costs, resources, and emissions can be reduced by at least 10%. Since this corresponds to global reduction estimates performed by the World Economic Forum (2009), this means that supply chain efficiency improvements created by 3PL’s and other logistics professionals will be important for China in achieving its objectives on sustainable development in the transport and logistics sector.

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APPENDIX A: LINER SHIPPING CONNECTIVITY AS A DETERMINANT OF TRADE AND TRADE COSTS

Introduction

International transport costs and their determinants have become the topic of a growing recent literature. Interest in the topic arises from the desire to better understand transport costs' effect on international trade and economic development, as well as to identify possibilities to reduce transaction costs.

This is not least due the fact that artificial barriers to trade such as tariffs are becoming less significant, while increased competition has driven margins down. This has meant that the role of non-policy barriers such as transport costs have become increasingly important.

Given that most international trade continues to be seaborne, particular focus is placed on international maritime transport costs. Thus, despite a growing share of air-borne trade, maritime transport continues to be the dominant mode for the long-distance carriage of goods. In 2011, it was estimated to account for about 80% of global trade by volume and over 70% by value.⁴⁸ Of this container liner shipping accounted for about 52% of the value of maritime transport and 62% of volume.⁴⁹

When explained, maritime transport costs are typically considered to be the result of adding up marginal costs and a profit margin of the company offering a transport service, and as such to depend on demand and supply factors.⁵⁰

However, the "geography of trade", that is, the question of who trades what with whom, depends not only on the demand and supply of goods, but also on the ability to deliver the goods to the market. Therefore, access to regular liner shipping services is a determinant maritime transport costs.

Existing studies

Recent research has examined different aspects of how liner shipping connectivity (LSC) impact transport and trade costs as well as trade flows. Márquez-Ramos et al. (2006) test different sub-components of LSC and an overall LSC index for Spanish exports and find that a 10% increase in LSC typically has been associated with a reduction in maritime freight rates of approx. 1-1.5%, cf. Table A 1 below.

For Latin-America Wilmsmeier and Martínez-Zarzoso (2010) estimate that a 10% increase in their LSC index has been associated with a reduction in maritime freight rates of approx. 2.8%, while sub-components such as TEU deployed have been associated with a reduction in rates of approx. 0.6% and volume of shipments by approx. 1.5%.

⁴⁸ UNCTAD (2012).

⁴⁹ UNCTAD (2012) and Hoffmann et al. (2013).

⁵⁰ Márquez-Ramos et al. (2006).

With a global dataset for trade costs (including all costs of trade, not only maritime transport costs), Hoffmann et al. (2013) find that a 10% increase in LSC index has been associated with a reduction in trade costs of approx. 1.9%, while introduction of a first direct route between two countries has been associated with a reduction in trade costs of 2.2%.

Table A 1: The impact of liner shipping connectivity (LSC) on maritime transport costs (MTC), trade costs and trade flows

Article	Liner Shipping Connectivity (LSC)	Coefficient	Explanation	Geographical focus
Maritime transport costs				
Márquez-Ramos et al. (2006)	LSC index	Approx. -0.14	A 10% increase in LSC reduces MTC 0.8%	Spanish export to 17 countries, 2003
	- Number of lines	Approx. -0.13	A 10% increase in number of lines reduces MTC 1.3%	
	- Vessels capacity	Approx. -0.10	A 10% increase in vessel capacity reduces MTC 1.0%	
	- Port throughput	Approx. -0.15	A 10% increase in number of call reduces MTC 1.5%	
Wilmsmeier and Martínez-Zarzoso (2010)	LSC index	Approx. -0.28	A 10% increase in LSC reduces MTC 2.8%	Intra Latin-America, 1999-2004
	- TEU deployed	Approx. -0.06	A 10% increase in TEU deployed reduces MTC 2.8%	
	- Volume of shipment	Approx. -0.15	A 10% increase in volume of shipment reduces MTC 1.5%	
Hoffmann et al. (2013)	LSC index	Approx. -0.19	A 10% increase in LSC reduces trade costs 1.9%	Global, 2008
	- Direct route (1 st)	Approx. -0.22	A first direct route reduces trade costs 1.9%	
Arvis et al. (2013)	LSC index	Approx. -0.38	A 10% increase in LSC reduces trade costs 3.8%	Global, 2005
Wilmsmeier and Hoffmann (2008)	LSC index	-287 USD	An increase in LSC of one standard deviation reduces freight rate by 287 USD (out of total of 1,800 USD)	Caribbean basin
Trade flows				
Hoffmann et al. (2013)	LSC index	Approx. +1.5	A 10% increase in LSC increases trade 15%	Global, 2008

Source: Authors' analysis.

The authors also test LSC on manufactured imports and find that a 10% decrease in LSC index has been associated with an increase in trade of approx. 15%. Thus, the impact of LSC is bigger on trade volume than on trade costs. I.e. the competitive advantage that accrues from lower transport costs has a multiplicative impact on trade volume.

Using the same trade costs data as Hoffmann et al. (2013), Arvis et al. (2013) estimate that a 10% increase in LSC has been associated with a reduction in trade costs of 3.8%.

Finally, for the Caribbean basin Wilmsmeier and Hoffmann (2008) finds that an increase in LSC of one standard deviation has been associated with a reduction in freight rate of 287 USD. With a total freight rate of approx. of 1,800 USD, this reduction corresponds to approx. 16%.

As is evident from the above studies there is some variation in the estimated impacts of LSC on maritime transport costs and trade costs. However, given that the studies use different indexes for LSC and data, this is to be expected. Thus, existing studies suggest that liner shipping connectivity has been associated with reduction in maritime transport costs and/or trade cost of roughly 1.5-4.0% when liner shipping connectivity is improved by 10%.

Scope

The analysis decomposes trade flows and trade costs into various policy, geographical and historical components for global and Chinese trade. The aim is to isolate and determine the impact of liner shipping connectivity on Chinese trade and trade costs and compare the impacts to global trade.

While the decomposition uses both policy, geographical and historical variables, focus is on distance, liner shipping connectivity and logistics performance.⁵¹

In prior studies, distance has been used as a determinant for transport costs. But since transport costs can be referred to as trade driven, a measure – such as liner shipping connectivity - that represents the liner shipping network structure should be a better determinant for transport costs. The same is valid for logistics performance that represents the ability to transport goods across the entire supply chain.⁵²

Alternatively, distance can capture other barriers to bilateral trade such as information costs, business networks, cultural barriers as well as transit time. Transit time may be increasingly important due to just-in-time production and fragmentation of production. If distance is a proxy for transit time, distance should become less important the more lighter, higher value and time-sensitive imports are being shipped by air, and bulkier goods continue to be shipped via ocean.

Thus, since the impacts of distance, liner shipping connectivity and logistics performance are interrelated, focus of the analysis is on all three components.

Estimation method

The decomposition of trade flows uses gravity models. As emphasized by Shepherd (2013), the gravity model is no longer just an intuitive way of summarizing the relationship among trade, economic size, and distance. A variety of theoretical gravity models now exist, which provide firm micro foundations for gravity-like models. The

⁵¹ See Appendix A for a full description of variables in the models.

⁵² Although LPI primarily measures the performance of export and imports supply chains, cf. section 5.2.

inclusion of theory can make a major difference to the way the dataset is set up, the way in which the model is estimated, and most importantly, to the results and policy conclusions that flow from the model.

It is therefore important that work, such as this analysis, based on the gravity model make explicit reference to theory, and incorporate in so far as possible the insights that flow from it.

Thus, according to Shepherd (2013), all gravity model research should - as a starting point - now include appropriate dimensions of fixed effects, or otherwise correct for the multilateral resistance terms introduced by Anderson and Van Wincoop (2004), for example using the Baier and Bergstrand (2009) methodology.

Also, choice of estimator to use to estimate gravity models is vital. The literature in this area remains particularly unsettled, with two major contributions focusing on the Poisson estimator as a way of overcoming heteroscedasticity, and the Heckman sample selection estimator as a way of modeling zero trade flows.

The bottom line is that it is important to ensure that results are robust to estimation using different techniques. Much of the empirical literature now presents results using Poisson and/or Heckman at least as a robustness check, if not as a first line approach.

Subject to these considerations, the estimation of the gravity model uses the methodology proposed by Baier and Bergstrand (2009) to correct for multilateral resistance and endogeneity, while the Heckman 2-stage sample estimator is used to correct for the consequences of zero-trade. Heteroscedasticity is not explicitly corrected in the model, but the possible presence and implication of heteroscedasticity is tested.

Liner Shipping Connectivity Indexes

The focus of the analysis is on liner shipping connectivity and the aim is to estimate its particular impact on global and Chinese trade. Liner shipping connectivity is measured by two indexes that are complement to each other:

- 1) UNCTAD's liner shipping connectivity index (UN LSCI)⁵³
- 2) Drewry's Maritime Research liner shipping connectivity index (DW LSCI)

UN LSCI describes a country's connectivity from five components; 1) number of shipping lines providing services, 2) size of the largest ship, 3) number of services, 4) number of ships deployed on services, and 5) total carrying TEU capacity. The index is national, but bilateral values are estimated by the geometric average of national index values. The index covers the period 2004-2013 and includes 159 countries, which makes it is a powerful tool for analysis of the importance of liner shipping connectivity across countries and over time.

⁵³ <http://unctadstat.unctad.org/TableViewer/tableView.aspx?ReportId=92>

DW LSCI is a new index created particularly for this analysis. It uses Drewry's trade capacity and service data reported in Drewry's Quarterly Container Market Review and Forecaster. It covers approx. 90 countries and the years 2010 and 2012. Adding one or two years is possible, but then data changes format and content. This makes the index less suited for time series analysis.

DW LSCI provides an exact mapping of which countries that is connected on the different service strings as well as the frequencies of port calls, the capacity of the vessels calling and total carrying TEU capacity on the individual services. Also, the underlying data in the LSC index makes it possible to identify the activities of the individual shipping lines, which is important as one of the objectives of the analysis is to estimate the particular impacts of Maersk Line on China's bilateral trade. The Drewry LSC index is composed from four variables each calculated per bilateral trade;

- 1) Number of shipping lines;
 - indicates the level of competition in the market (also in the UN LSCI)
- 2) Carrying TEU capacity;
 - indicates the probability of supply of container transport being sufficient, both for the existing demand and for growth in demand (also in the UN LSCI)
- 3) Calls per shipping line;
 - indicates the level of frequency and coverage of container transport services
- 4) Number of services;
 - Indicates the probability of getting a direct connection without the need for transshipment (also in the UN LSCI)

Principal component analysis is used to construct the DW LSCI index from these four variables. As a starting point, a total of seven liner shipping connectivity variables was derived from the Drewry data, cf. Table A 2 below.

However, the principal component analysis shows that already with three variables 94% of the variation is explained and therefore a total of four components was considered sufficient for almost any application.

To construct the DW LSCI, each of the four variables are multiplied by their factor loadings and then summed. The factor loadings represent the weight given to each variable in constructing the DW LSCI.

The correlations between manufactured imports and exports, the seven liner shipping connectivity variables derived from the Drewry data, the resulting DW LSCI as well as the existing UN LSCI and the World Bank's Logistics Performance Index (LPI) are presented in Table A 2 below.

Table A 2: Correlation between trade and liner shipping connectivity indexes and components (all variables in logarithm)

LSC components (per bilateral trade)	Import	Export	Shipping lines	TEU capacity	Calls shipping line	Services	Shipping line per service	TEU capacity ship	Ships per string
Shipping lines	38%	41%	100%	72%	31%	71%	83%	27%	19%
Carrying TEU capacity	42%	42%	72%	100%	34%	56%	60%	69%	62%
Calls per shipping line	36%	36%	31%	34%	100%	21%	30%	19%	18%
Services	30%	31%	71%	56%	21%	100%	22%	25%	23%
Shipping lines pr service	30%	33%	83%	60%	30%	22%	100%	21%	11%
TEU capacity per ship	32%	29%	27%	69%	19%	25%	21%	100%	73%
Ships per string	27%	23%	19%	62%	18%	23%	11%	73%	100%
DW LSCI	45%	48%	√	√	√	√			
LSC indexes (per bilateral trade)	Import		DW LSCI	UN LSCI	LPI				
DW LSCI	45%	48%	100%						
UN LSCI	55%	58%	55%	100%					
LPI index	60%	58%	41%	81%	100%				

Source: Authors' analysis.

Table A 2 shows that the correlations between the DW LSCI and manufactured imports and exports are 45% and 48%, while the corresponding correlations for the UN LSCI are 55% and 58%. Thus, the UN LSCI is the strongest index in a partial perspective.

Also, the correlation between the DW LSCI and the LPI is 41%, while it is 81% between the UN LSCI and the LPI. This could indicate that the DW LSCI could be further improved in terms of precision. The lower correlation between the DW LSCI and the LPI does however make it easier to include them in the same model without having to deal with a high level of multicollinearity.

It should be emphasized that neither the UN LSCI nor the DW LSCI include reliability in terms of on time delivery (OTD) and transshipments. OTD is a key parameter for most businesses as it significantly influences their own reliability towards their own clients as well as their time to market and inventory levels. Transshipments is also a key parameter. With the increasing hub and spoke structure of maritime transport, an increasing share of country-pairs are connected by transshipments and is therefore important to take into consideration. Thus, omissions of these factors means that this analysis will not be able to capture the entire impact of liner shipping on trade.

Data and sources

The endogenous variables in the models are trade costs and exports and imports of manufactured goods by country *i* from country *j* in the years 2007, 2010 and 2012. The explanatory variables include liner shipping connectivity indexes, logistics performance index, and variables familiar from the gravity model literature, covering geographical, historical and cultural factors, cf. Table A 3 below.

Table A 3: Data and sources

Variable	Description	Year	Source
Exports	The exports of manufactured goods from country of origin <i>i</i> to country of destination <i>j</i>	2004-2012	UNCTAD Comtrade, SITC 6 and 8, rev. 2
Imports	The imports of manufactured goods from country of origin <i>i</i> to country of destination <i>j</i>	2004-2012	UNCTAD Comtrade, SITC 6 and 8, rev. 2
Trade costs	Inferred bilateral trade costs from the observed pattern of trade and production across countries using an inverse form of the gravity model	1997-2010	The World Bank
UN LSCI	Geometric average of country <i>i</i> 's and <i>j</i> 's scores on UNCTAD's the Liner Shipping Connectivity Index.	2004-2012	UNCTAD
DW LSCI	Liner shipping connectivity index based actual liner shipping capacity and service between country <i>i</i> and country <i>j</i> .	2010 and 2012	Authors' index based on Drewry Maritime Research
LPI	Geometric average of country <i>i</i> 's and <i>j</i> 's scores on World Bank's Logistics Performance Index.	2007, 2010, and 2012	The World Bank
Distance	Great circle distance between the two principal cities of countries <i>i</i> and <i>j</i> .	na	CEPII
Common border	Dummy variable equal to unity if countries <i>i</i> and <i>j</i> share a common land border, river or lake.	na	CEPII
Common colonial past	Dummy variable equal to unity if countries <i>i</i> and <i>j</i> were ever in a colonial relationship	na	CEPII
Common colonizer	Dummy variable equal to unity if countries <i>i</i> and <i>j</i> were colonized by the same power	na	CEPII
Common off. language	Dummy variable equal to unity if countries <i>i</i> and <i>j</i> share a common official language.	na	CEPII
Trade imbalance	Total imports/export of manufactured goods from country <i>i</i> divided by total imports/exports of manufactured goods of country <i>j</i>	2004-2007	UNCTAD Comtrade, SITC 6 and 8, rev. 2

Estimation of models for trade costs

The models for trade costs follow the setup of Arvis et al. (2013) using the World Bank's new trade costs dataset and including many of the same variables. The difference between this analysis and Arvis et al. (2013) is that the latter also include tariffs, RTA, exchange rate, air connectivity index and entry costs, not included in this analysis, while trade imbalance is included in this analysis, but not in Arvis et al. (2013).

In this analysis the models for trade costs are specified as follows:

$$\begin{aligned} \log(\text{trade costs}_{ijt}) = & \beta_0 + \beta_1 \cdot \log(\text{LSCI}_{ijt}) + \beta_2 \cdot (\text{LPI}_{ijt}) + \beta_3 \cdot \log(\text{distance}_{ijt}) \\ & + \beta_4 \cdot \log(\text{trade imbalance}_{ijt}) + \beta_5 \cdot \text{common border}_{ij} \\ & + \beta_6 \cdot \text{former colony}_{ij} + \beta_7 \cdot \text{common coloniser}_{ij} \\ & + \beta_8 \cdot \text{common off. language}_{ij} + \mu_{ijt} \end{aligned} \quad 1)$$

where trade flows_{ijt} indicates imports to country i from country j in year t.

Trade costs are decomposed in six models testing for differences between global and Chinese trade and the liner shipping connectivity indexes UN LSCI and DW LSCI, cf. Table A 4 below.

Table A 4: Overview of models for trade costs

Models	Description	LSCI	Trade	Year	Countries
Model 1	Comparison of global and Chinese trade using the UN LSCI.	UN LSCI	Global	2010 + 2012	Up to 159
Model 2		UN LSCI	Chinese	2010 + 2012	Up to 159
Model 3	Comparison of UN LSCI and DW LSCI for global trade. DW LSCI means data is restricted to max. 93 countries	UN LSCI	Global	2010 + 2012	Up to 93
Model 4		DW LSCI	Global	2010 + 2012	Up to 93
Model 5	Comparison of UN LSCI and DW LSCI for Chinese trade. DW LSCI means data is restricted to max. 93 countries.	UN LSCI	Chinese	2010 + 2012	Up to 93
Model 6		DW LSCI	Chinese	2010 + 2012	Up to 93

Source: Authors' analysis.

Due to the larger sample, model 1 and 2 are the preferred models for estimation of the coefficients for liner shipping connectivity. The results of model 1 and 2 show that a 10% improvement in liner shipping connectivity has been associated with a 3.1% decrease in trade costs for global trade and a 3.4% decrease for Chinese trade. Measured in standardized coefficients, the impact of liner shipping connectivity on trade costs is approx. identical for global and Chinese trade, cf. model 1 in Table A 5 below.

Model 1 is very similar to Arvis et al. (2013) and the estimated coefficients for liner shipping connectivity are largely identical, cf. section on existing studies above. Furthermore, the results of model 1 show that the combined impact of liner shipping connectivity and logistics performance is more significant than geographical distance in determining trade costs, which is also in accordance with Arvis et al. (2013). The sum of the standardized coefficients for the liner shipping connectivity index and

logistics performance index is -0.67 (-0.33 and -0.34), while the corresponding coefficient for distance is 0.48, cf. model 1 in Table A 5 below.

Table A 5: Estimation results for trade costs models, 2010 and 2012

	UN LSCI Global trade		UN LSCI Chinese trade		UN LSCI Global trade		DW LSCI Global trade		UN LSCI Chinese trade		DW LSCI Chinese trade	
	153 countries				93 countries							
Model	1		2		3		4		5		6	
Explanatory variables	Reg. coeff.	Std. coeff.	Reg. coeff.	Std. coeff.	Reg. coeff.	Std. coeff.	Reg. coeff.	Std. coeff.	Reg. coeff.	Std. coeff.	Reg. coeff.	Std. coeff.
Log LSCI	-0.31 (13.5)	-0.33	-0.34 (6,4)	-0.34	-0.17 (2.4)	-0.19	-0.12 (4.9)	-0.22	-0.48 (2.6)	-0.35	-0.19 (3.2)	-0.41
Log LPI	-1.78 (13.8)	-0.34	-1.85 (7.9)	-0.41	-2.35 (7.9)	-0.53	-2.49 (10.6)	-0.56	-2.35 (3.4)	-0.43	-2.86 (5.2)	-0.52
Log Distance ¹	+0.30 (19.8)	+0.48	+0.20 (4.6)	+0.23	+0.33 (8.8)	+0.65	+0.32 (9.1)	+0.61	+0.08 (0.6)	+0.10	+0.10 (0.7)	+0.13
Common border	-0.35 (4.9)	-0.11	-0.29 (2.6)	-0.12	-0.25 (2.6)	-0.15	-0.21 (2.3)	-0.12	-0.35 (1.7)	-0.19	-0.56 (2.6)	-0.30
Colonial past	-0.08 (0.6)	-0.02	-	-	-0.16 (0.8)	-0.05	-0.26 (1.4)	-0.08	-	-	-	-
Com. Coloniser	-0.12 (1.4)	-0.03	+0.08 (0,5)	0.02	-0.06 (0.4)	-0.02	-0.08 (0.6)	-0.03	-	-	-	-
Log trade imbalance	-0.00 (0.9)	-0.02	-0.00 (1.0)	-0.05	+0.00 (0.7)	+0.03	+0.00 (0.7)	+0.03	0.01 (0.8)	+0.08	0.01 (0.9)	+0.08
Com. off. Language	-0.14 (3.3)	-0.08	-0.04 (0.4)	-0.02	+0.03 (0.5)	0.03	0.11 (1.8)	0.10	0.05 (0.2)	0.02	0.26 (1.0)	0.12
Constant	+5.62 (30.1)	-	+6.6 (13.9)	-	11.32 (23.0)	-	10.67 (24.0)	-	10.33 (8.3)	-	9.21 (7.4)	-

Note: Estimation by OLS. T values reported in parentheses.

Source: Authors' analysis

Thus, despite differences in variables, comparison of results with Arvis et al. (2013) does not indicate large differences in the estimated coefficients or model fit. The coefficients of the LPI are larger due to the omission of the air connectivity index in this analysis, but this is expected.

Model 3-6 test for differences in the DW LSCI and the UN LSCI for global and Chinese trade, respectively, and focus on the relationship between liner shipping connectivity, logistics performance and distance, cf. Figure A 1 below, where the standardized coefficients for these variables are presented.

At least two results emerge:

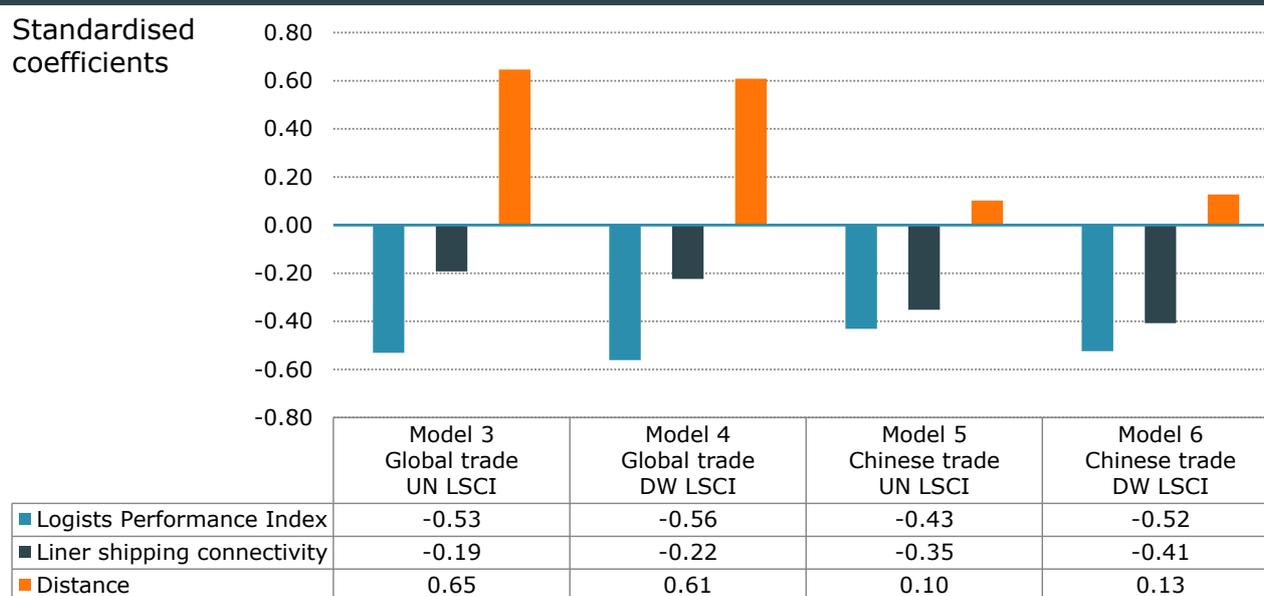
First, the UN LSCI and the DW LSCI have similar estimated impacts on trade costs. For global trade, the standardized coefficients are -0.19 for UN LSCI and -0.22 for DW LSCI, while the corresponding coefficients are -0.35 and -0.41 for Chinese trade. The relatively larger differences for Chinese trade should most likely be attributed to a smaller sample for Chinese trade compared to global trade.

Two, distance has a much smaller impact on trade costs for Chinese trade than for global trade. For global trade, the standardized coefficient are 0.65 and 0.61, while

the corresponding coefficients are 0.10 and 0.13 for Chinese trade. In model 3-6, the coefficients for Chinese trade are statistically insignificant at a 5% significance level, and that could weaken the result. However, in model 1-2, where all coefficients are statistically significant, distance also has a much smaller impact on trade costs for Chinese trade and that that strengthen and confirms the result that distance is less of a barrier for China and its trading partners.

Figure A 1: Logistics performance and liner shipping connectivity has a stronger impact on trade costs than distance. This is particular pronounced for the Chinese trade

Impact on trade costs, manufactured goods, global and Chinese trade, 2010 + 2012



Sources: Maersk based on data from UN COMTRADE, UNCTAD, World Bank, CEPII and Drewry Maritime Research
 Note: Estimation by OLS. P-values are based on robust standard errors.

In summary:

Result 1

The combined impact of liner shipping connectivity and logistics performance is more significant than distance. The lower impact of distance is more pronounced for Chinese trade than for global trade

Result 2

For Chinese trade, a 10% increase in liner shipping connectivity has been associated with a 3.4% decrease in trade costs. Due to low influence of distance, this impact will be more efficient in decreasing trade costs compared to global trade

Result 3

The two liner shipping connectivity indexes – UN LSCI and DW LSCI – are able of capturing the relationship to trade costs in a consistent manner and thereby serves as validation of the use of such ad-hoc indexes

Estimation of trade flows

The UN LSCI and DW LSCI are also tested in simple gravity models. The trade flows that the models aim at explaining are the exports and imports of manufactured goods to country *i* from country *j*. Thus, since the analysis focuses on container liner shipping, trade is limited to manufactured goods that primarily is transported in containers. Some processed agricultural products are also transported in containers, and could potentially also be included in the model in order to increase the number of observations.

The gravity models for trade flows are specified as follows:

$$\begin{aligned} Trade\ flows_{ijt} = & \beta_0 + \beta_1 \cdot (GDP_{it} \cdot GDP_{jt}) + \beta_2 \cdot \log(trade\ imbalance_{ijt}) + \beta_3 \cdot \log(LSCI_{ijt}) \\ & + \beta_4 \cdot (LPI_{ijt}) + \beta_5 \cdot \log(distance_{ijt}) + \beta_6 \cdot common\ border_{ij} \\ & + \beta_7 \cdot former\ colony_{jj} + \beta_8 \cdot common\ coloniser_{jj} + \\ & + \beta_9 \cdot common\ off.\ language_{ij} + \mu_{ijt} \end{aligned}$$

where trade flows_{ijt} indicates imports to country *i* from country *j* in year *t*.

Trade flows are similarly to trade costs decomposed in six models testing for differences between global and Chinese trade and the liner shipping connectivity indexes UN LSCI and DW LSCI, cf. Table A 6 below.

Table A 6: Overview of models for trade flows

Models	Description	LSCI	Trade	Year	Countries
Model 7	Comparison of global and Chinese trade using the UN LSCI.	UN LSCI	Global	2010 + 2012	Up to 159
Model 8		UN LSCI	Chinese	2010 + 2012	Up to 159
Model 9	Comparison of UN LSCI and DW LSCI for global trade. DW LSCI means data is restricted to max. 93 countries	UN LSCI	Global	2010 + 2012	Up to 93
Model 10		DW LSCI	Global	2010 + 2012	Up to 93
Model 11	Comparison of UN LSCI and DW LSCI for Chinese trade. DW LSCI means data is restricted to max. 93 countries.	UN LSCI	Chinese	2010 + 2012	Up to 93
Model 12		DW LSCI	Chinese	2010 + 2012	Up to 93

Source: Authors' analysis.

Due to the larger sample, model 7 and 8 are similar to trade costs the preferred models for estimation of the coefficients for liner shipping connectivity. The results of model 7 and 8 show that a 10% improvement in liner shipping connectivity has been associated with a 9.4% increase in exports for global trade and a 8.6% increase in exports for Chinese trade. Measured in standardized coefficients, the impact of liner shipping connectivity on export is almost identical for global and Chinese trade, cf. model 7 and 8 in Table A 7 below.

Model 7 and 8 are also estimated for manufactured imports, but not presented in full. The results show that a 10% improvement in liner shipping connectivity has been associated with a 7.5% increase in imports for global trade and a 6.2% increase in imports for Chinese trade. Measured in standardized coefficients, the impact of liner shipping connectivity on import is 0.12 for global trade and 0.08 for Chinese trade,

i.e. some difference in impact. These impacts are somewhat lower than Hoffmann et al. (2013) that find that a 10% increase in LSC index has been associated with a 15% increase in manufactured imports.

Table A 7: Estimation of manufactured exports, 2010 and 2012

Model	UN LSCI Global trade		UN LSCI Chinese trade		UN LSCI Global trade		DW LSCI Global trade		UN LSCI Chinese trade		DW LSCI Chinese trade	
	153 countries				93 countries							
	7		8		9		10		11		12	
Explanatory variables	Reg. coeff.	Std. coeff.	Reg. coeff.	Std. coeff.	Reg. coeff.	Std. coeff.	Reg. coeff.	Std. coeff.	Reg. coeff.	Std. coeff.	Reg. coeff.	Std. coeff.
Log (GDP _i GDP _j)	+0.76 (74.1)	+0.52	+0.64 (22.8)	+0.51	+0.79 (37.8)	+0.66	+0.79 (39.0)	+0.67	+0.86 (7.6)	+0.57	+0.79 (6.6)	+0.52
Log trade imbalance	-1.30 (65.0)	-0.31	-1.41 (28.5)	-0.46	-	-	-	-	-	-	-	-
Log LSCI	+0.94 (25.1)	+0.15	+0.86 (5.6)	+0.13	+0.62 (4.7)	+0.09	+0.28 (5.5)	+0.07	+0.55 (0.7)	+0.06	+0.46 (2.0)	+0.15
Log LPI	+3.41 (16.4)	+0.10	+4.47 (7.0)	+0.13	+3.06 (6.0)	+0.11	+3.99 (8.9)	+0.14	+1.56 (0.6)	+0.05	+2.01 (0.8)	+0.06
Log Distance	-1.86 (66.0)	-0.34	-0.77 (9.0)	-0.15	-1.29 (24.1)	-0.33	-1.18 (21.6)	-0.30	-0.66 (2.5)	-0.14	-0.54 (2.0)	-0.11
Common border	+0.04 (0.3)	+0.00	+0.09 (0.3)	+0.00	+0.60 (3.2)	+0.04	+0.57 (3.0)	+0.04	+0.40 (0.6)	+0.03	+0.97 (1.3)	+0.08
Colonial past	+1.04 (9.0)	+0.04	+1.37 (1.9)	+0.03	+0.78 (4.7)	+0.05	+0.79 (4.8)	+0.06	-	-	-	-
Com. coloniser	+0.78 (10.4)	+0.05	0.04 (0.2)	+0.00	+0.49 (2.9)	+0.03	+0.56 (3.4)	+0.04	-	-	-	-
Com. off. Language	+0.65 (12.0)	+0.06	+0.53 (2.9)	+0.06	+0.32 (3.1)	+0.04	+0.20 (2.0)	+0.02	+0.85 (1.0)	+0.05	+0.35 (0.4)	+0.04
Constant	-46.7 (90.3)	-	-31.4 (22.1)	-	-41.7 (41.9)	-	-39.6 (35.5)	-	-37.5 (8.3)	-	-30.9 (5.4)	-

Note: The estimation is Heckman's 2-stage sample selection estimation. The variables "Common colonizer" and "Colonized since 1945" have been used in the selection equation, see Heckman et al. (2008). For correction of multilateral resistance, the method proposed by Baier and Bergstrand (2009) is used. Distance is used for this correction. In model 9-12, trade imbalance is excluded due to multicollinearity with UN LSCI. The exclusion has an impact on the size of the estimated LSCI coefficients. But since the purpose of model 9-12 is a relative comparison of the UN LSCI and DW LSCI and not the absolute value of these coefficients, this is acceptable with due caution.

Source: Authors' analysis

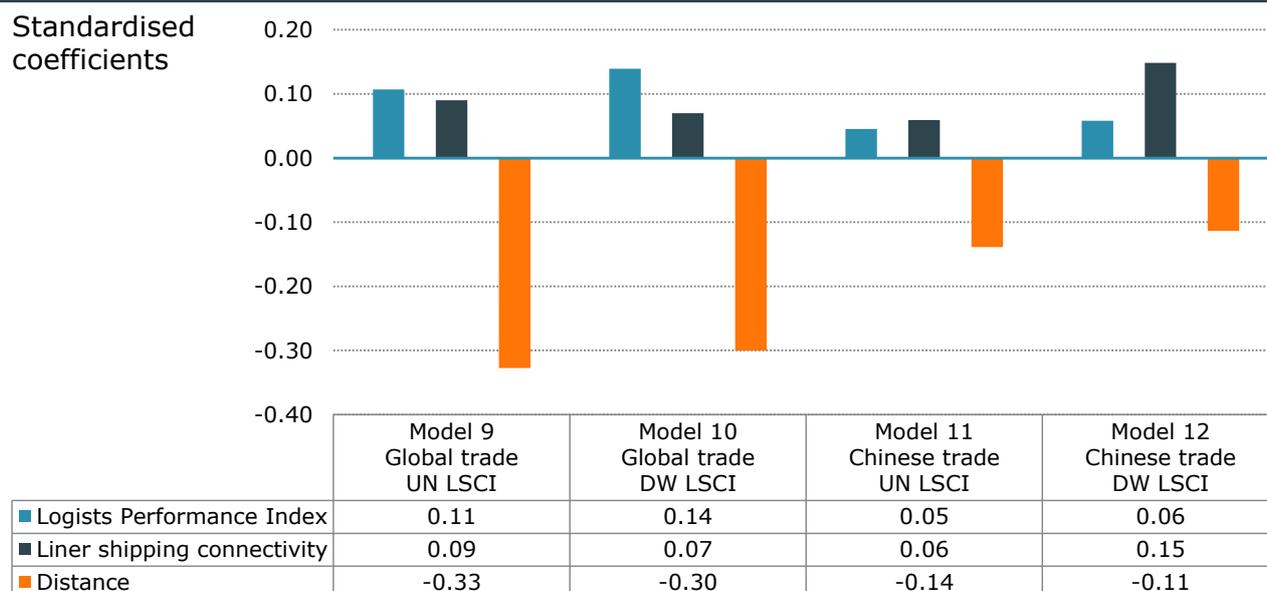
In contrast to the decomposition of trade costs, distance is more important than the combined impact of liner shipping connectivity and logistics performance for global export, cf. model 7 in Table A 7 above. But for Chinese trade, distance is – similar to the decomposition of trade costs – still of relatively minor importance compared to liner shipping connectivity and logistics performance for Chinese trade, cf. model 8 in Table A 7 above.

This result is valid also in model 9-12 and regardless of the use of liner connectivity indexes, cf. model 9-12 in Figure A 2 below. For global trade, the standardized coefficient are -0.33 and -0.30, while the corresponding coefficients are -0.14 and -0.11 for Chinese trade.

Similar to the decomposition of trade costs, the two liner shipping connectivity indexes - DW LSCI and UN LSCI - have relatively similar impacts. This is the case for global trade in model 9 and 10, but for Chinese trade on model 11 and 12, the UN LSCI is statistically insignificant. This result in a lower UN LSCI coefficient in model 11 compared to the DW LSCI coefficient in model 12, cf. Figure A 2 below.

Figure A 2: Together logistics performance and liner shipping connectivity has a stronger impact on trade than distance. But only for the Chinese trade, not for global trade

Impact on export of manufactured goods, global and Chinese trade, 2010 + 2012



Sources: Maersk based on data from UN COMTRADE, UNCTAD, World Bank, CEPII and Drewry Maritime Research
 Note: Estimation by Heckman's 2-stage sample selection estimation following Heckman et al. (2008). Baier and Bergstrand (2009) methodology used to correct for multilateral resistance.

In summary - and quite similar to the decomposition of trade costs:

Result 1

Similar to trade costs, distance means less than the combined impact of logistics performance and liner shipping connectivity. But only for Chinese trade, not global trade.

Result 2

For Chinese trade, a 10% improvement in liner shipping connectivity has been associated with a 8.6% increase in exports and a 6.2% increase in imports.

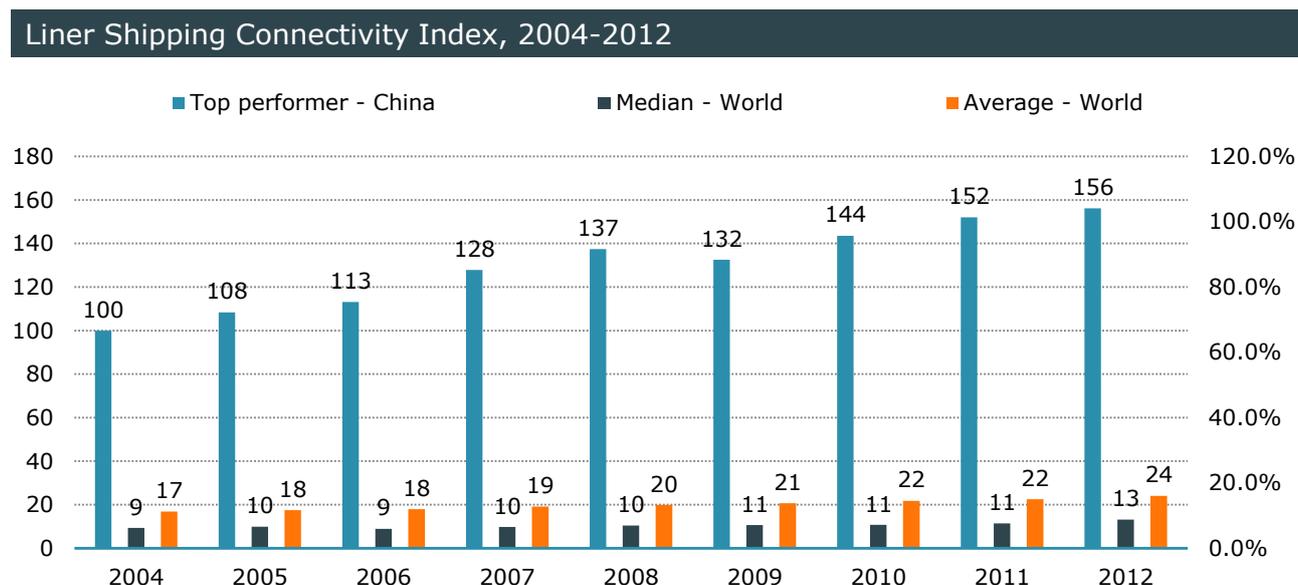
Result 3

The two liner shipping connectivity indexes - UN LSCI and DW LSCI - are able of capturing the relationship to trade flows in a consistent manner.

Distance and liner shipping connectivity

Section 4.1 showed how China is the absolute global top performer in terms of liner shipping connectivity and only has only strengthen this status over the period 2004-2012, where the country's liner shipping connectivity has increased over 50% from 100 to 156. This is approx. six time the global average level of liner shipping connectivity that increased from 17 to 24 during the same period, cf. Figure A 3 below.

Figure A 3: China's liner shipping connectivity is approx. six times higher than global average



Source: UNCTAD's Liner Shipping Connectivity Index.

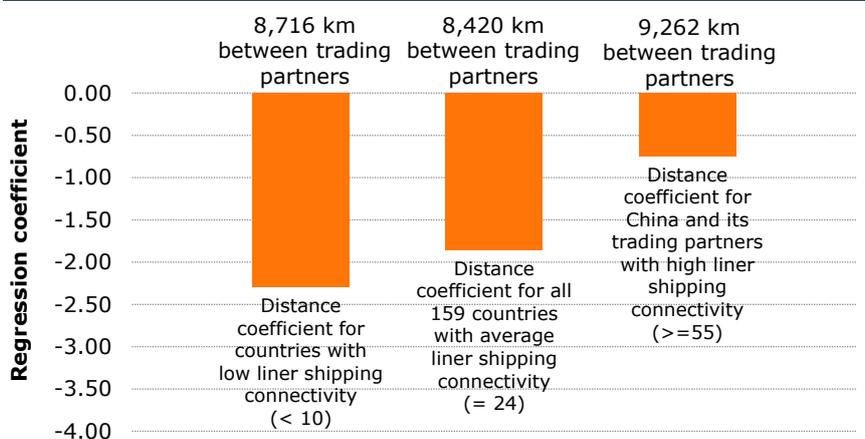
The low median value shows that liner shipping connectivity is unevenly distributed with relatively few very well-connected countries – including China - and a large group of countries not very well-connected.

Whether a country has a high or a low liner shipping connectivity has an impact on the way, distance acts as a barrier for its trade. China and its trading partners has high liner shipping connectivity (index value 55 in 2012) and a low impact of distance, where a 10% increase in distance “only” has been associated with a 7.7% decrease in manufactured exports, cf. Table A 7 above.

However, for countries with a low liner shipping connectivity (index value below 10 in 2012), a 10% increase in distance has been associated with a 23.0% decrease in exports. For all 159 countries included in the analysis, the average liner shipping connectivity index value is 24 and for these countries, a 10% increase in distance has been associated with an 18.6% decrease in exports, cf. Table A 7 above and Figure A 4 below.

Figure A 4: Distance loses impact as liner shipping connectivity improves

Distance regression coefficient at different levels of liner shipping connectivity



It is evident that the reduced impact of distance is not simply due to shorter distance between trading partners.

Actually, on the contrary, average distance is increasing as distance loses importance for high (>=55) and low (<10) connectivity countries, cf. Figure A 4.

Note: Estimation by Heckman's 2-stage sample selection estimation following Heckman et al. (2008). Baier and Bergstrand (2009) methodology used to correct for multilateral resistance.

However, if distance act as proxy for transit time, the reduced impact of distance could be due to fact that China and its trading partners transport their lighter, higher value and time-sensitive imports by air, and bulkier goods via ocean.

This way distance – as a proxy for transit time – could lose some of its importance. It is however unlikely that air transport could be the sole explanation for the significant reduced impact of distance. According to the Arvis and Shepherd (2011), China's air connectivity value is 5.7%, while the global air connectivity value is 4.0%.

Even though some of China's trading partners such as the U.S. are among the countries with the highest air connectivity in the world, it is still unlikely that air connectivity close to global average such as the Chinese, could be the sole cause of the significant reduction in the impact of distance for China and its trading partners.

Thus, other studies have found evidence for a negative relationship between transport facilitation and the impact of distance. Bahar, Manners and Nelson (2011) show that a one deviation rise in logistics performance is equivalent to a reduction in distance by about 14% emphasizing the "distance reducing" nature of efficient transport and logistics.

Thus, for China and its trading partners, distance is a significant smaller barrier to trade than for the world as a whole. While some of this attributable to the use of air transport for time sensitive goods, the results also show that distance is being reduced due to the strong increase in Chinese liner shipping connectivity.

APPENDIX B: DAMCO SUPPLY CHAIN DEVELOPMENT CASES

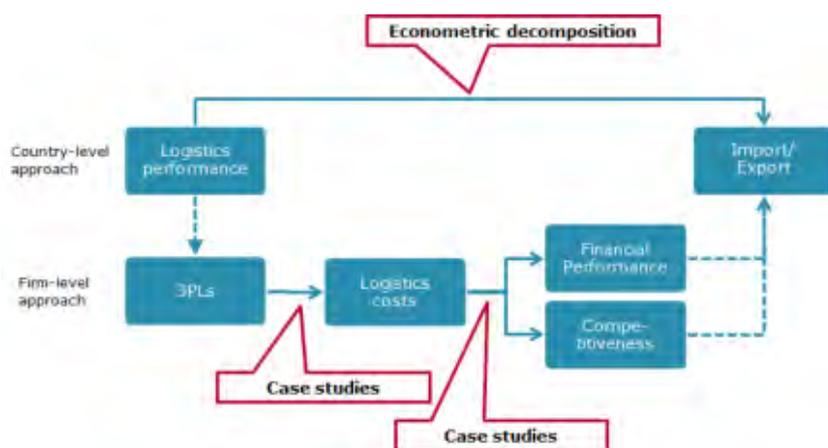
Methods for assessing logistics costs and its impact on trade

Assessing the impacts of logistics costs on trade is difficult. However, according to several sources, three main approaches can be used to measure logistics costs:

1. The micro approach that measures logistics costs as a percentage of product value. This can be obtained by for example surveying firms.
2. The Logistics Performance Index (LPI) that measures subjective notions of logistics performance by surveying freight forwarders⁵⁴
3. The macro approach that measures logistics costs as a % of GDP using national accounts.⁵⁵

The most accurate and appropriate measures are acknowledged to be the micro approach and the LPI.⁵⁶ Consequently, this study applies these two approaches to measure the impacts of logistics costs on trade in China, cf. Figure B 1 below.⁵⁷

Figure B 1: Approach to measure logistics performance and trade in China



Source: Authors' analysis.

To measure the LPI for China and its impact on trade, econometric modelling has been applied, cf. Appendix A. To measure Damco's impacts on the logistics performance of clients and their vendors, a range of Damco's Supply Chain Development (SCD) projects from 2012 to 2013 has been applied. The SCD projects

⁵⁴ Published by the World Bank: <http://web.worldbank.org>

⁵⁵ Guasch (2011); Rantasila and Ojala (2012); Shepherd (2011)

⁵⁶ Guasch (2011); Rantasila & Ojala (2012); Shepherd (2011)

⁵⁷ We also apply Chinese statistics on logistics costs as a percentage of GDP, cf. Section 5.1., to understand the size and scale of logistics costs in China.

allow for an assessment of logistics costs in Chinese supply chains from a micro level perspective using a case study approach, cf. Figure B 1 above. The rationale for applying SCD projects is two-fold:

- A key challenge in China is the fragmented nature of the logistics market and lack of 3PLs that can coordinate and integrate logistics services and logistics operators across the supply chain and across geographies. 3PLs and supply chain optimisation is announced as an important means to tackle China's high logistics costs. The SCD projects illustrate the potential benefits and role 3PLs may play in enhancing the efficiency of Chinese supply chains going forward.
- The SCD projects represent Damco's main business in China. Damco serves global retailers and other large multinationals and is specialised in providing integrated supply chain management services that exactly sets apart a 3PL operator from simple freight forwarding operators.⁵⁸

The SCD projects illustrate the importance and potential role of 3PLs like Damco in optimising Chinese supply chains, reducing clients and vendors' logistics costs, and thus, improving the competitiveness of Chinese supply chains.

Damco's Supply Chain Development projects

The study analyse 15 SCD projects selected according to their relevance to clients' operations in China. The SCD projects optimize clients' supply chains from factory to destination using different supply chain solutions. The SCD projects are scaled and customized to the specific customer needs and delivery requirements for the customers' products.

Thus, the projects' supply chain focus varies (i.e. some projects optimize the end-to-end supply chain, whereas other focus solely on optimizing domestic transport and/or inventories). The supply chain solutions applied in the projects can be grouped in to 3 types of solutions: process flow optimisation, network optimisation and inventory optimisation.

The SCD projects are representative for Damco's main business in China. 60% of the clients analysed are global retailers and the remaining other large multinationals within specific segments, cf. Figure B 2 below at the left.

The average global revenue of the analysed clients is 80 billion USD (2012). 87% of the projects represent clients' movement of containers out of China (export-driven supply chains), whereas the remaining 13% concerns clients' domestic distribution in China, cf. Figure B 2 below. Finally, in 67% of the projects Damco optimizes the clients' supply chain by optimizing process flows, while Damco optimizes transport- and warehouse networks in 20% of the projects, and finally in 13% of the projects, Damco optimizes inventory, cf. Figure B 2 below at the right.

⁵⁸ 3PLs such as Damco offer a range of services from simple freight forwarding services to sophisticated and integrated supply chain management and supply chain consultancy services

Figure B 2: SCD projects distributed on segment, market and solution



Source: Authors' analysis.

The impacts of Damco's supply chain optimisation solutions

The three supply chain solutions: process flow optimisation, network optimisation and inventory optimisation take out costs, resources and brings down CO₂ emissions along the supply chain.

Process flow optimisation

Process flow optimisation involves moving logistics processes upstream. Here shipments from multiple suppliers are consolidated into single shipments and full container loads in China. This service may also involve rationalizing the number of origin ports.

Process flow optimisation allows the shipper to achieve substantial savings on freight costs through higher container utilization. Shipment consolidation not only reduces costs, but also environmental damage from different modes of transport.

Across Damco's SCD process flow optimisation projects, end-to-end logistics costs are on average reduced by 9%. Cost savings mainly originate from international ocean freight and destination operations. International ocean freight costs are on average reduced by 11%. At the same time, there are a 10% CO₂ saving alone on international ocean freight.

Transport is the single largest logistics cost elements for firms. Thus, savings on freight can have a significant impact on competitiveness.

The main savings obstacles are increased handling costs from consolidation activities and potentially increased trucking costs depending on the set-up of the domestic transport network.

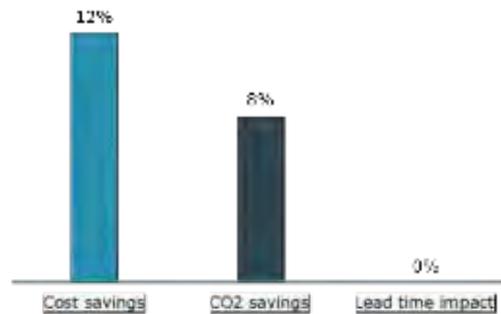
Box B 1: Case example: Process flow optimisation

The company is a global retailer within the lifestyle segment. For this project the client has an annual ocean freight volume from China to its main markets in Europe of nearly 14,000 CBM. Suppliers are mainly located in Southern China near the Pearl River delta, and thus in close proximity to some of the world's most productive ports.

Volume deployment in Southern China



Costs savings, CO2 savings and lead time



The client shipped its products via eight load ports in Southern China. Some light load volumes were shipped directly without consolidation with other shipments, and thus container utilization was relatively low for a part of the volume.

In this case, Damco suggested to migrate volume to one central load port in Southern China, which allows the client to consolidate multiple light load volumes into single shipments. The client can thereby reduce the no. of containers (TEU) for ocean freight by 8% and reduce light load volume with 90%. In total, the client obtains a 12% saving on costs and 8% saving on CO₂ emissions mainly originating from reduced ocean freight to market in Europe.

China's main obstacle as sourcing market is its long distance and high transport costs to main markets in Europe and the US. Moving logistics processes upstream may as in this case result in higher handling and transport costs in China, but with an end-to-end saving on both costs and resources that in turn improves China's competitiveness as a sourcing hub.

Source: Authors' analysis

Network optimisation

Network optimisation involves optimizing the network's nodal point's hierarchy and inter-related transport flows, which can bring about significant savings in costs, and also in carbon emissions.

Studies have shown that a restructuring of firms' As-Is networks have given an 11% cost reduction on average and also brought about a 10% CO₂ emission reduction.⁵⁹ Research shows that many networks are partially inefficient due to for example a lack of durability in supply chain strategic decisions, inertia to change and other infrastructure inefficiencies⁶⁰.

Across Damco's SCD projects, there is an average of 22% cost reduction for those projects that apply network optimisation solutions (partly combined with warehouse network optimisation and inventory optimisation). A 14% cost saving is achieved alone on domestic transport from optimizing transport networks.

⁵⁹ WEF (2009)

⁶⁰ WEF (2009).

Box B 2: Case example: Network optimisation

The company is a large producer of chemicals for agricultural crop protection. The company produces in China and also distributes to the growing agricultural chemical market in China. It distributes to around 500+ sales outlets in 200+ cities across China. Distribution in China is associated with high logistics costs⁶¹.

Network analysis

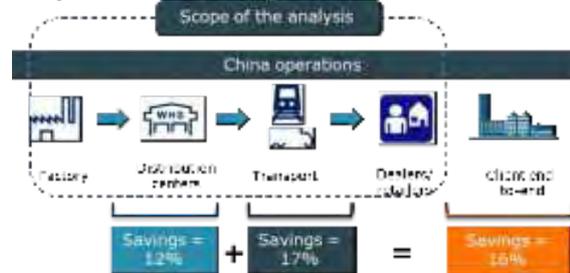


The client experienced high distribution costs. Its products were distributed through a relatively high number of distribution centers (DCs). DCs were not necessarily placed in the optimal location according to demand patterns and volume gravity centers.

In this case, the client could obtain a 16% cost saving on warehousing - and transport costs by rearranging the nodal points of its warehouse- and distribution network, and by optimizing the level of inventory and mix of transport modes. To obtain savings, the client would have to accept a minor impact on lead time from around 88% to 78% of products delivered within 3 days.

This case may impact the client's competitiveness. Cost savings may spill over and result in improved financial performance and/or lower prices for China's agricultural sector.

Scope and cost savings



Source: Authors' analysis

Inventory optimisation

Inventory optimisation involves balancing the supply and demand of goods. I.e. having the right amount of inventory at the right places to meet and quickly respond to customers service needs, while minimizing investments in inventory and transportation costs⁶².

Inventory carrying cost represents one of the largest logistics cost elements for many firms. Given the high cost of capital (especially in many developing countries), Guasch and Kogan (2006) from various studies report that inventory costs on a global average can reach up to 19% of product value (ranging from 9-50% of product value).

Inventory also represents one of the largest single investments for many firms, in particular for retailers and wholesalers, where it can account for up to 50% of their total assets.⁶³ Thus, the impacts of holding large inventories are significant for firms' competitiveness and profitability. Optimizing inventory levels can result in significant

⁶¹ Amongst other, up to 30% of road transport in China is made up of toll fees (CFLP, 2012)

⁶² If a firm wishes to place smaller orders on a more frequent basis to reduce inventory levels, a trade-off can be higher ordering costs and increased transportation costs Grant, Lambert, Stock & Ellram (2006).

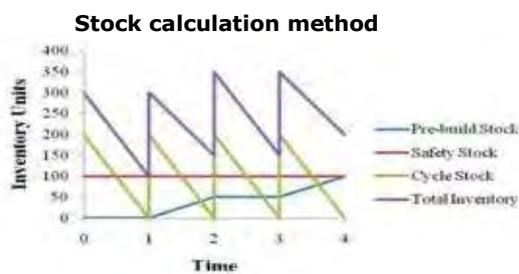
⁶³ Grant, Lambert, Stock & Ellram (2006)

logistics cost savings, improved cash flow, improved return on investment and profitability.

Inventory optimisation solutions involve calculating the optimal stock level based on historic demand data, seasonality, requirements for safety stock, etc. Across, Damco's inventory optimisation projects, inventory costs were reduced by on average 26%.

Box B 3: Case example: Inventory optimisation

The company is a global market leading retailer. The company sources its products in China and distributes globally including in China. In this particular project, the company sourced from 102 suppliers in China and distributed its products to retail chains in Asia Pacific and Oceania (and partly within China) via 3 regional distribution centers and 12 country sites. The total volume was more than 200,000 CBM at a value over USD 260 million.



The client was experiencing exceptional growth. Capacity requirements for distribution centers were estimated to grow by 124% between 2012 and 2017. Calculating optimal inventory levels was therefore key to minimizing inventory carrying costs, and improving return on investment and profits.

In this case, a recalculation of the optimal stock levels showed an opportunity to reduce stock by 28%, while maintaining same service levels to end clients. With a cost of capital at around 18%, and all other things being equal⁶⁴, inventory optimisation resulted in a 35% reduction of inventory carrying costs⁶⁵.

Balancing inventory at the optimal level may have a significant impact on the clients' profit and return on investment that may spill over to consumers from increased market competition and/or lower prices for retail products.

Source: Authors' analysis.

Damco's impact on client's logistics costs, time to market and CO₂ emissions

The estimates of Damco's impacts on clients' and their vendors' logistics costs, time to market and CO₂ emissions are based on the logistics cost and performance data provided for the SCD projects and calculations of CO₂ emissions.

Logistics costs

⁶⁴ Inventory levels depend on a number of factors and trade-offs related to the design of the whole logistics system, customer service levels, the number and location of distribution centres, production schedules, transport modes, etc. (Lambert, Stock & Ellram, 2006)

⁶⁵ Inventory carrying costs are those costs associated with the amount of inventory stored (the cost of capital, inventory service costs, storage space costs, inventory risks costs).

Cost savings have been categorized according to the scope of the SCD project, cf. Table B 1 below. Thus, the split of cost savings along the clients' supply chain depends on the type of supply chain (export from China or domestic distribution) and the project scope and applied solution in the project (i.e. inventory optimisation projects focus solely on warehousing and inventory costs, whereas process flow optimisation assess the impacts on several cost elements along the supply chain).

Table B 1: The distribution of logistics cost savings across the supply chain

Cost savings (%)		China operations			Int. Transport		Destination operations				
Project	Supply chain	Factory (pack-aging)	Trans- port	Ware- house	Origin port	Ocean	Air	Destin. port	Trans- port	Ware- house	SC scope
Project 1	Export		-4%		-13%	3%		3%			1%
Project 2	Export		4%	0.4%							3%
Project 3	Export			-174%	-3%	4%					3%
Project 4	Export		-9%		-18%	5%		10%			3%
Project 5	Export				-26%	12%					4%
Project 6	Export		-2%		2%	12%		23%	**		12%
Project 7	Export		7%	29%							14%
Project 8	Export				4%	18%		24%			16%
Project 9	Export	29% ⁴				20%			20%	11%	16%
Project 10	Export		29%		-2%	10%		34%	**		17%
Project 11	Export										20%
Project 12	Export					19%	71%	***		35%	29%
Project 13	Export			35%							35%
Project 14	Domestic		17%	12%							16%
Project 15	Domestic			30%							30%
Average savings		28%	8%	-11%	-8%	12%	71%	19%	20%	23%	15%

Note: * Savings on packaging material; **Incl. in destination port; ***Incl. in Ocean/Air
Source: Authors' analysis.

In the projects, logistics costs are defined and grouped as:

- Transport costs: includes trucking costs (and for one project origin transport also includes rail and barge costs)
- Warehousing⁶⁶ costs: includes finished goods inventory carrying costs and warehousing costs (handling cost, storage costs, etc.)
- Origin port costs: includes origin charges such as container yard - and container freight station receiving charges, other terminal handling charges and customs⁶⁷

⁶⁶ The term warehouse here includes warehouse, container freight station, and distribution center.

- Ocean freight costs: ocean freight costs and charges
- Air freight costs: air freight costs and charges
- Destination port costs: include destination charges such as demurrage costs, import duty, customs, and for some projects also haulage

Time to market

To understand the impacts and dynamic trade-offs between logistics costs, time to market and CO₂ emission, the impact on lead time has been calculated based on data provided in the SCD projects. Trade-offs between cost savings and time to market depends on the clients’ pre-defined business priorities, and the opportunities for optimizing the supply chain.

The impact on clients’ lead time in the SCD projects have been estimated based on the scorecard definitions, cf. Table B 2 below.

Table B 2: Definition of lead time score card

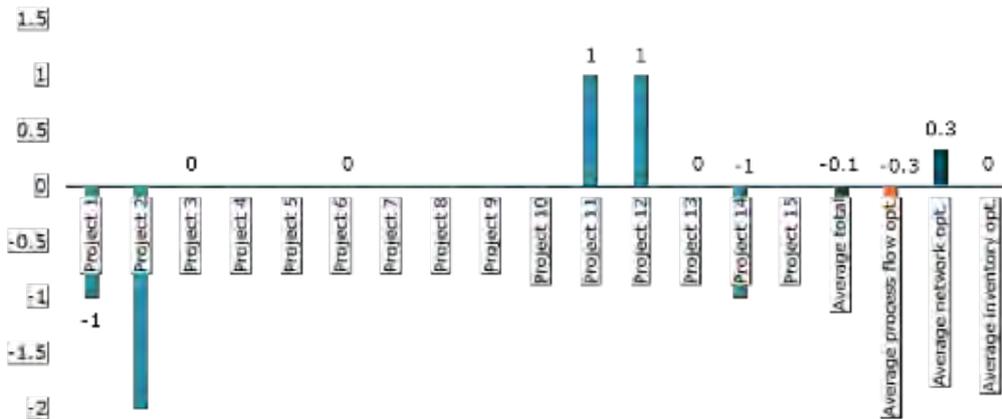
Score	Lead time impact	Average days
2	Positive impact	+3 days
1	Minor positive impact	1-3 days
0	No impact	0 days
-1	Minor negative impact	1-3 days
-2	Negative impact	+3 days

Source: Maersk

On average, cost savings are achieved while maintaining same time to market to clients. Across the projects, the average total lead time score is -0.1, while the lead time score for process optimisation projects is -0.3, for network optimisation projects equivalent to 0.3, and finally for inventory optimisation projects there is no impact on the lead time, cf. Figure B 3 below

⁶⁷ Note that CFS charges may be included in warehouse costs or in origin port costs depending on the project as we have been unable to separate these items in the data material.

Figure B 3: Lead time impact

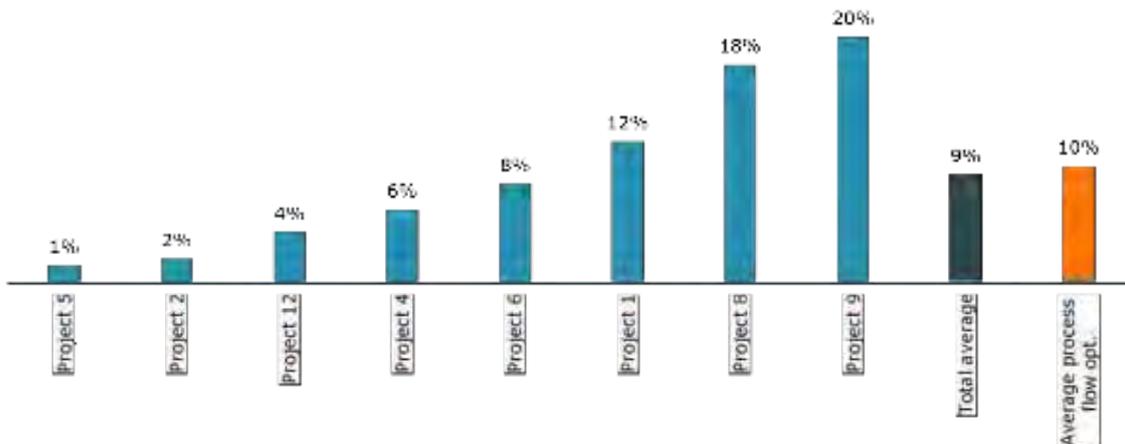


Source: Maersk

CO₂ Emissions

Across the SCD project, CO₂ savings on ocean freight amount to 12% on average that originates from optimizing supply chains. In particular, consolidation services (for which higher container utilization is achieved) reduce the number of containers that flow through the supply chain, and thus have significant impacts on ocean freight CO₂ emissions, cf. Figure B 4 below.

Figure B 4: CO₂ savings from ocean freight (%)



Source: Maersk

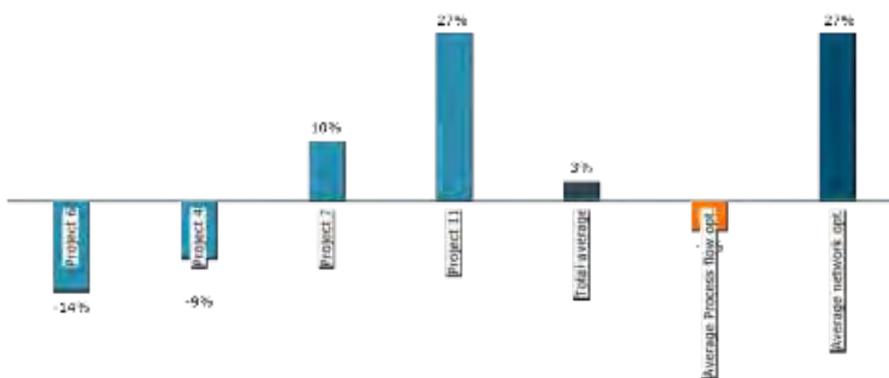
The impact on CO₂ emissions from international ocean freight is calculated based on the following formula:

$$CO_2 \text{ emission [g of CO}_2\text{]} = \text{distance travelled [Km]} \times \text{cargo volume [TEU]} \times CO_2 \text{ emission factor [g of CO}_2\text{ / (TEU} \times \text{Km)]}.$$

There exist different sources for CO₂ emission factors. The Clean Cargo Working Group's average trade lane emissions data from 2012 are applied. The CCWG hosts the industry's largest emission database.⁶⁸

To calculate the routing distance, www.dataloy.com⁶⁹ has been applied. It enables a calculation of the distance from origin port to origin destinations based on shipping routes. The calculation of distance may be conservative given that fact that it has not been possible to deploy the specific routing schedules for the vessels (and thus distance is based on direct shipping routes from origin port to destination port). Across four of the SCD projects, a 3% CO₂ saving on trucking in China is estimated, cf. Figure B 5.⁷⁰

Figure B 5: CO₂ savings from trucking in China (%)



Source: Authors' analysis.

The impact on CO₂ emissions from domestic trucking in China is calculated based on the following formula:

$$\text{CO}_2 \text{ emission [g of CO}_2\text{]} = \text{distance travelled [Km]} \times \text{cargo volume [Tons]} \times \text{CO}_2 \text{ emission factor [g of CO}_2\text{ / (Tons x Km)].}$$

⁶⁸ The Clean Cargo Working Group is the industry's largest database on carbon emission from shipping. Carbon emission factors are based on data reports from over 2,000 ships calculated from 13 of the world's leading ocean carriers, collectively representing 60% of ocean carrier capacity worldwide. Emission factors for 2011 and before can be found at the CCWG's homepage (Source: www.bsr.org).

⁶⁹ Dataloy is a software system for maritime voyage management (<http://dataloy-systems.com/>)

⁷⁰ It should be noted that the calculation is based on four observations out of eight (due to unavailable customer data)

There exist different sources for CO₂ emission factors for trucks. Maersk's global average CO₂ emission factor for dry trucks is applied, which is based on the Network for Transport and Environment's (NTM) truck emission factors.⁷¹

Supply Chain optimisation can off-set China's rising wages

Since the mid-2000s minimum wages in China have increased 10% per year.⁷² This is faster than in other low cost countries (LCC). At the same time, China's economy to a large extent rely on the manufacturing sector that account for 50% of GDP, and China rely on foreign MNCs that to a large extent has been the drivers of China's export oriented growth.

The question is whether China can maintain its competitive position as the world's manufacturing hub seen in the light of China's wage increases? To understand the extent to which improving supply chain processes and 3PLs can sustain China's manufacturing competitiveness, we put forward an analysis of the footwear, heavy machinery and personal computers industries. The analysis is based on Accenture's (2011) analysis of cost structures and labour-cost sensitivity for these three industries in China.

Based on selected MNCs' operating P&Ls, Accenture (2011) has analysed the cost of goods sold structures for original design manufactures (ODMs) including:

- Footwear: Nike, Adidas, Puma
- Heavy machinery: Caterpillar, John Deere, Terex
- Personal computers: Hewlett Packard, Dell, Apple, Lenovo (Accenture, 2011).

Figure B 6: Accenture's labour-cost analytical model



Source: Accenture, 2011

Accenture's analysis considers the impacts of a 30% increase in minimum wages for companies with a strong production base in China (i.e. 30-100% production in China).

⁷¹ <http://www.ntmcalc.org/index.html>

⁷² See Chang, Luo & Huang (2013).

Accenture (2011) finds that companies can expect to see their cost of goods sold increase by 0.2% to 2.5% for footwear, 0.3% to 3.9% for heavy machinery and 1% to 12.4% for personal computers if labour cost increase by 5-60% (Accenture, 2011). Thus, with a minimum 30% wage increase, these industries would need to increase retail prices from 0.7% up to 5% to maintain current profit levels, cf. Table B 3 below.

Table B 3: Price increase required to maintain profit levels

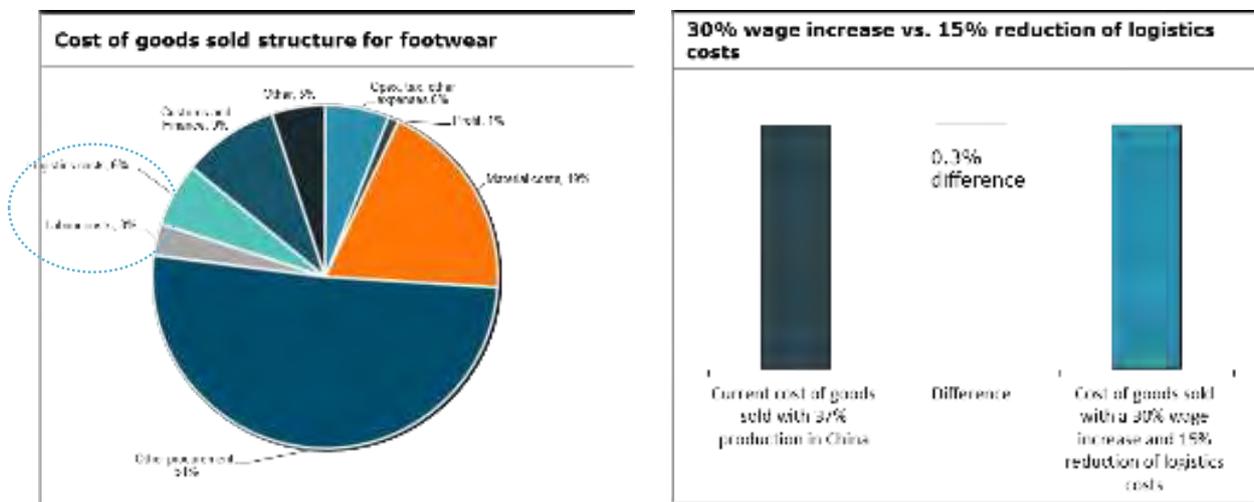
Minimum price increase required to maintain current profit levels at 30% wage increase			
Industry	Apparel (footwear)	Heavy machinery	High-tech
Industry average production in China	37%	60%	90-100%
Price increase	0.7%	1.5%	4.8%

Source: Accenture (2011).

Based on Accenture’s labour cost sensitivity analysis, this study calculates to what extent a reduction of logistics costs can offset wage increases for these industries.

On a global average, shippers report a 15% reduction in logistics costs from outsourcing to 3PLs (Capgemini and Langley, 2012), and furthermore in this study we have seen how Damco through supply chain optimisation solutions has reduced logistics costs by on average 15% for global multinationals that already have mature supply chain functions in place.

Figure 6.5 Case: the footwear industry in China



Source: Accenture, 2011

Source: Author’s analysis based on Accenture (2011) & Capgemini and Langley (2012)

For the footwear industry, we assume that logistics costs account for 6% of the industry’s cost of goods sold, based on revision of Accenture’s (2011) cost structures for the industry. Assuming that logistics costs are reduced by 15%, we calculate that a 15% reduction of logistics costs can fully offset a wage increase of 30% in the footwear industry, cf. Figure 6.5.

For heavy machinery and personal computers, a 15% reduction of logistic costs may only partly offset a minimum wage increase of 30%. This is due to the fact that the impact on cost of goods sold from a 30% wage increase is larger for the heavy machinery and personal computer industries (1.5% and 4.8% respectively), and considering that labor costs amount to a higher percentage of cost of goods sold for these industries (4% for heavy machinery and 20% for personal computers as opposed to 3% for footwear).

Supply Chain optimisation's impact on the domestic consumer market

High inventory, storage and transport costs pose challenges to China's domestic supply chains. Inventory and storage costs amount to 35% of China's total logistics costs, and transportation costs to more than 50% of China's total logistics costs⁷³, cf. Section 5.1.

In Damco's SCD project, it is found that inventory optimisation on average could result in an approximately 25% reduction of inventory carrying costs. Moreover, WEF (2009) finds that network optimisation on average result in a 13% reduction of domestic transport costs.

In this case, these results are applied to assess the potential impact of 3PLs' supply chain optimisation services on China's domestic consumer market. The estimation of the impacts on profit margins is based on a simple "all other things being equal" scenario. For the estimation of the impact of inventory cost reductions on profit margins, we assume that inventory carrying costs on average account for 10-19% of product value. This assumption is based on the work of Guasch and Kogan (2006), cf. Table B 4, and given that China has relatively high capital costs of around 18%.⁷⁴

Table B 4: Inventory carrying costs as a percentage of product value

Element	Average (%)	Ranges (%)
Capital costs	15.00%	8-40%
Taxes	1.00%	0.35-1.52%
Insurance	0.05%	0.01-0.25%
Obsolescence	1.20%	0.5-3%
Storage	2.00%	0-4%%
Totals	19.25%	9-50%

Sources: Gonzales, Guasch and Serebrisky (2007) from Guasch and Kogan (2006) based on various studies

⁷³ Including interest -, warehousing -, insurance -, and IT related costs, as well as obsolescence, distribution, and packaging, etc. (CFLP, 2012)

⁷⁴ Source: Maersk based on Damco's SCD projects

Guasch and Kogan (2006) from various sources conclude that inventory costs as a share of product value on a global average ranges from 9-50% with significant impacts on for example competitiveness and export growth.

Thus, it is calculated that a 25% reduction of inventory carrying costs⁷⁵, translates in to a 2.50% to 4.75% improvement in margin all other things being equal, based on the assumption that inventory carrying costs account for 10-19% of product value for Chinese supply chains.

For the estimation of the impact of transport costs reductions on profit margins, we assume that transport costs in China on average account for 5-15% of product value. Several sources point to high domestic transport costs in China due to high road tools and other inefficiencies in the trucking sector, cf. section 5.1. More specifically, the assumption is based on the sources and estimates below, cf. Table B 5 below.

Table B 5: Transport costs as a percentage of product value in China

Geography	Logistic costs and transport costs	Source
China	Logistics cost account for 30-40% of production costs and transport costs for around 50% of logistics costs	Wong (2009) and CLFP (2012)
China (survey of 1241 Chinese firms)	Logistics costs account for 5-20% of product value and transport costs for around 45% to 65% of logistics costs	CLFP (2010)
Totals	Range for transport costs: 2.5 – 15%	

Thus, it is calculated that a 10% reduction of domestic transport costs⁷⁶, assuming that transport costs in Chinese distribution supply chain's account for 5-15% of product value, translates in to a 0.5% to 1.50% improvement of profit margins all other things being equal.

⁷⁵ Source: Maersk based on Damco's SCD projects

⁷⁶ Source: WEF (2009)

Trade in intermediate goods between European countries accounts for 28% of total trade in intermediate goods, and intra-Asian intermediates trade accounts for another 16%.

Importing intermediates is often driven by cost reductions and/or the desire to access specialised knowledge/technologies that are abundant in other countries. By reducing costs and improving resource allocation within the investing company, imports of intermediate goods have a positive impact on corporate productivity and competitiveness.

When a company improves its productivity and competitiveness, its domestic market share increases. Its global market share would also be expected to increase for two reasons. First, improved productivity also makes the company more globally competitive. Second, the reduction of trade costs also reduces the cost of exporting as imported intermediate goods become cheaper. Overall, we would expect the company's headcount to rise due to up-scaling production.

However, when companies start to import intermediate goods, some of the intermediaries may replace in-house production and employment in the company may go down. Overall, the net impact on employment in the company is a priori indeterminate. However, the European Commission (2010) found that the employment gain from up-scaling production in the company more than balances the replacement effect, leaving a positive net impact on the company's employment.⁷⁸

For the period 1997-2004, Hijzen, Upward and Wright (2007) found no evidence that increased imports of intermediate services cause job destruction in the home country. In fact, those companies which outsource service provisions actually grow faster and have faster employment growth.

In their study of international sourcing by German companies during 1998-2004, Moser, Urban, Dieter and di Mauro (2009) also found a positive correlation between imported intermediate goods and employment in the home company.

However, gains from trade do not only accrue to EU countries. Recent evidence suggests that reduced trade costs and increased imports of intermediate goods stimulate productivity, innovation and competitiveness in countries outside the EU, cf. Table C 1 below. The positive impact may even be larger in developing countries compared to developed countries.

⁷⁸ The skill composition in the company may be changed, however, as there is a tendency for more white collar workers than blue collar workers.

Table C 1: Literature review on the productivity impacts of trade

Study	Methodology	Findings
Productivity increases when companies start importing intermediate goods		
Stone and Shepherd (2011)	Uses a company-level analysis covering more than 100,000 companies across 115 countries around the world (World Bank's Enterprise Surveys dataset).	Significant and positive impact of intermediate inputs and capital goods imports on corporate productivity and innovation. A 1% increase in the share of imported intermediate inputs raises a company's productivity by 0.3%. Similarly a 1% increase in capital goods imports raises productivity by 0.2%. The links from imported intermediates to productivity gains and innovation are stronger in non-OECD countries.
Kasahara and Rodrigue (2008)	While addressing the issue of simultaneity of a productivity shock and decisions to import intermediates, the study estimates the impact of the use of foreign intermediates on plants' productivity using plant-level Chilean manufacturing panel data.	Switching from being a non-importer to being an importer of foreign intermediates can improve productivity by 3.4 to 22.5%.
Choi and Hahn (2009)	By utilising plant-product data on Korean manufacturing, and detailed import data during 1991-1998, the study investigates the role of imported intermediates. The study investigates whether greater access to imported intermediates enhanced plant productivity and product switching behaviour.	A plant that belongs to industries with higher imported intermediate-variety growth experienced higher productivity growth. In addition, increased imported intermediate varieties had a positive impact on stimulating the product-switching behaviour of domestic plants.
Productivity increases in companies that already import intermediate goods when trade costs fall		
Amiti and Konings (2008)	Uses Indonesian manufacturing census data from 1991-2001 which includes plant-level information on imported inputs.	10 percentage point reduction in import tariffs leads to a productivity gain of 12% for companies that import their inputs – at least twice as large as any gain from reducing output tariffs.
Lai and Zhu (2011)	Uses matched Chinese company and trade data to investigate the importing channels of productivity gains from trade liberalisation.	Input tariff reductions encourage importers to increase the volume of imported inputs and capital goods improve company performance.

These findings show that internationally active countries tend to be more productive than countries, which only produce for the domestic market.

The question is whether these results also are valid for China. Table C 1 refers to Lai and Zhu (2011) that uses matched Chinese company and trade data to investigate the importing channels of productivity gains from trade liberalization. The authors find that input tariff reductions encourage importers to increase the volume of imported inputs and capital goods that subsequently improve company performance.

Sun and Heshmati (2010) uses both econometric and non-parametric approaches and demonstrates that increasing participation in the global trade has helped China obtain both static and dynamic benefits that in turn have stimulated rapid national economic growth. In their models, based on a 6-year balanced panel data of 31 provinces of China from 2002 to 2007, net export share in GDP shows a significant positive effect on efficiency. It means that the higher the net export ratio of one province, the more efficient the production of this province is.

The results are confirms that exports played an important role in China's industrialization. Before 1992, the static benefits of international trade, which led to expansion in employment and accumulation of large amount of foreign reserves, were harvested. After 1992, China implemented an outward-oriented strategy and intensified efforts to pursue free market reform, which brought about more dynamic

benefits of international trade, such as the improvement in the total factor productivity through learning by doing and accumulation of human capital.

In addition, the productivity of China's processing sectors which used a large amount of imported parts and components as resource was enhanced significantly because of the accessibility to technology-intensive intermediate goods.

Consequently, China's specialization in processing industries led to the improvement of domestic technological capability. Thanks to the advancement of technology, management and organization innovation, China's export enterprises improved productivity, which generated the spillover effects across sectors.

Therefore, China is in many ways a good case on how international trade can contribute to economic growth and how a latecomer catches up with forerunners by increasing its participation on the global stage.