INTEGRATION OF FINANCIAL AND PHYSICAL NETWORKS IN GLOBAL LOGISTICS

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ABSTRACT

This paper presents and analyzes changes in global logistics markets and the financial instruments that are currently used to value and hedge the cost of capacity and services in these markets. Logistics is at the center of network-based strategies, since it is a key enabling factor for international trade in linking manufacturing sources with intermediate and final markets. The recent history of maritime and air cargo logistics is traced, and the convergence and integration of the physical and financial networks that underlie valuation and use of logistics services is described. In the process, logistics is viewed as both a key enabler of globalization and itself an interesting example of how network-based strategies and competencies have evolved.

Keywords: logistics, global supply chains, risk management, derivatives.

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1. INTRODUCTION

The last two decades have seen immense changes in the forces and institutions that govern economic activity. They encompass the on-going changes associated with the European Union, and the changes in liberalization and governance initiated by the World Trade Organization (WTO). Cross-border acquisitions and alliances, together with new markets and new forms of contracting are supporting outsourcing, unbundling, contract manufacturing and a variety of other forms of extended value constellations. On the market side, the Internet has empowered consumers and given rise to peer-to-peer networks. In the process, it has transformed whole industries – the impact of Skype on the telecommunications industry, search engines (Google) and e-Retailing, and the growth of e-Bay, to mention a few of the more evident signs of change. In tandem, revolutionary developments in transportation and integrated logistics providers such as FedEx, UPS and DHL are providing global fulfillment architectures for B2B and B2C.

Logistics is a key element of the interdependent mega-trends exhibited in Figure 1. A mere twenty years ago, logistics (maritime, air and land-based) was considered a mature industry, operated by "*real men*", which meant lots of inefficiencies and empty backhauls, huge cycles of overcapacity and undercapacity, and head-butting competition. The communications and information revolution gradually gave way to improved routing and scheduling, and eventually to improved utilization through regional coordination of capacity. But it was clearly the mega-trends of Figure 1 that took logistics to an entirely new level, driven by outsourcing and huge increases in intra-regional and international trade. Expansion of physical capabilities in international logistics began in the 1990s and has continued unabated, with Hong Kong and Dubai the most evident examples, but with increases in capacity in nearly every established port and air hub. This increase in physical capabilities was accompanied by increased sophistication and intermediation activities of brokers and forwarders, followed by the development of financial overlays and trading instruments for air cargo and shipping capacity.[1] The logistics industry is an interesting example on how physical markets have dovetailed with financial and information markets in supporting and profiting from globalization and outsourcing (as shown in Figure 1). It is also at the heart of the enabling

[1] Kavussanos and Visvikis (2006, 2008) describe the growth in derivatives trading on shipping capacity. Kaminski (2004) describes related hedging options on aviation fuel and bunker oil.

infrastructure that supports the explosion of international trade that we have witnessed in the last decade.

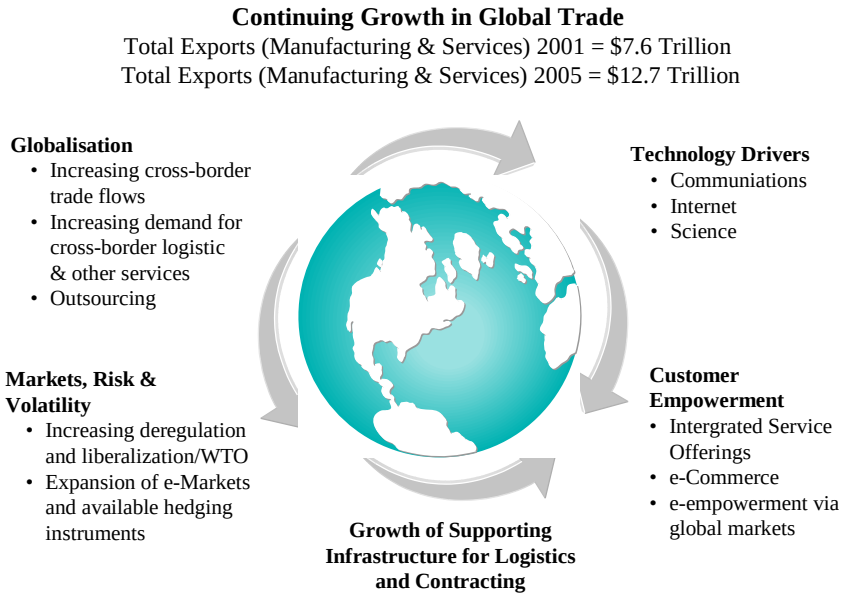


Figure 1: Key Trends Driving Profitability and Uncertainty for Management

This paper explores these issues and in particular the integration of financial and physical markets as a driving force behind the emergence of global logistics. The remaining of the paper is structured as follows: Section 2 presents an overview of the general trends in the global economy, as shown in Figure 1 above, noting the consequences of growth in international trade for changes in the accompanying logistics infrastructure. Section 3 focuses on the evolution of the air cargo and maritime container industry, and in particular the growing need for efficient operation of existing capacity and the allocation of capital to new capacity. Section 4, following the work of Kavussanos and Visvikis (2006, 2008), provides an extended analysis of the evolution of risk management techniques for hedging the most important of business sources of risk in the shipping industry; namely freight rate risk, under the framework of the integration of financial and physical contracting in logistics. Finally, Section 5 concludes with a discussion of the managerial implications of the move towards network-enabled strategies and the key role of financial and physical networks in logistics in supporting these.

2. GLOBALIZATION AND IMPLICATIONS FOR LOGISTICS INFRASTRUCTURE

Globalization and associated unbundling of value chains have been the major factors leading to the growth of logistics in the past decade. In the spirit of Adam Smith's *Wealth of Nations* (1776), the two fundamental factors driving economic growth are specialization, to reap economies of scale, and trade, to assure that the most cost effective sources for product design and manufacture can be linked to end markets. This logic has been a friendly background accompaniment to international trade growth for millennia, and especially since the industrial revolution launched mass production of sufficient volume to make international distribution the key to profitability for textiles, spices and foodstuffs. Adam Smith's logic of specialization and trade emerged from background accompaniment for local and regional economies to become the dominant theme of national economic growth in the 1990s and beyond. Signs of the increasing global economic integration are everywhere evident.

In Europe, the fall of the Berlin Wall in 1989 augured the integration of Central and Eastern Europe into the market-based and financial institutions of Western Europe, leading to the current 27-country marketplace of the European Union. In Asia, after decades of "*transition*" and uncertainty, China and India emerged from the shadows to begin their ascent to global leadership in low-cost manufacturing and information-based technology support. This is reflected in part in the huge increases in outsourcing and offshoring (e.g., OECD, 2007) evident in the past decade as low-cost sources of goods and services are increasingly being plugged into global supply chains in the unbundling strategies of companies.

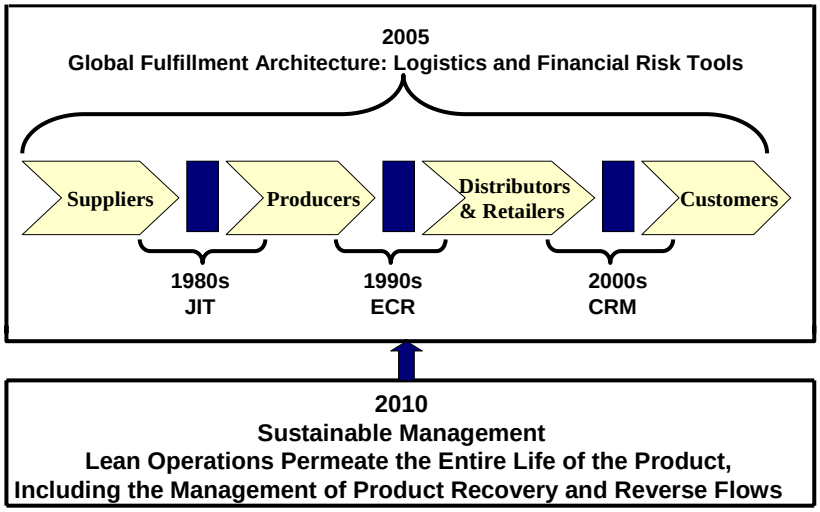
Business and entrepreneurship, within the framework of rationale trade policy, are the natural vehicles for realizing the power unleashed by globalization. Logistics has become the primary "*glue*" for integration of the multi-tiered networks of intermediate and final production and service providers associated with globalization. Logistics (the term comes from the French "*maréchal de logis*" the military officer responsible for organizing all camp facilities for troops at war) traditionally focused on the physical management of material flows. This has changed significantly in the past decade, with the new logistics now encompassing a more strategic view of the supply chain and greater emphasis on information and financial flows across the logistics network.

The integration of modern logistics with company strategies began with the pioneering work of Michael Porter who noted in his classic book on Competitive Advantage that cost and revenue drivers of profit should not be understood as abstractions reflected in the aggregate accounting structure but they should rather be identified directly with the Value Chain (Porter, 1985). In this view, quality is not something that merely appears in the final product, but it should be understood and managed as an attribute of the product that is built into it along the Value Chain. By identifying profit drivers with the Value Chain, and by further mapping the Value Chain into its constituent sub-processes (such as inbound logistics, production, outbound logistics, sales and customer support), Porter provided an improved approach to managing profitability. No longer was this to be done by command or at the company level alone. Rather, fundamental drivers of profitability (on both the cost and revenue side) were to be identified at the level of individual processes along the Value Chain and these drivers would then be managed and improved through activities in the specific parts of the Value Chain identified with the profit drivers in question.

A direct consequence of this new attention to quality and time at the process level was the wave of change that began to take hold in the 1990s under the general heading of Business Process Reengineering (BPR). BPR had been announced in Hammer (1990), and it produced further benefits by applying to other business processes, outside of the Value Chain, the same time-based and waste-minimization efforts that manufacturing had demonstrated earlier in the Total Quality Management (TQM) and Just-In-Time (JIT) revolution. It was natural that those business processes that encompassed the largest value add for the company, reflected in key metrics like Return on Assets (ROA), would become central elements on which corporate strategy and BPR activities focused. For manufacturing companies, these key business processes were associated with two fundamental areas, new product development and supply chain management. The result was the wave of supply chain rationalization that began in the 1990s. Company after company went through the progression of first rationalizing/shrinking its supplier base, then incorporating JIT between suppliers and production units, then moving to optimized logistics (including Efficient Consumer Response - ECR) between producers and distributors, then to improved Customer Relationship Management (CRM), and finally to global fulfillment architecture and supply-chain wide risk management, and finally to

sustainable operations and reverse logistics. These trends and drivers are shown in simplified form in Figure 2, based on Kleindorfer *et al*. (2005).

Figure 2: Logistics and Value Chain Restructuring 1980-2010
See Kleindorfer, Singhal & Van Wassenhove (2005)



The above account of globalization and its offshoots for business underlines the central role of logistics in enabling the unbundling/outsourcing of manufacturing and other business processes and the continuing movement towards integrated global markets. Indeed, starting with Porter's work on the Value Chain, and motivated by the huge success of the supply chain rationalizations of the 1990s, many of the most successful and innovative companies now formulate their strategies and business models in simple operational terms (Amazon.com, Dell, Li and Fung, Southwest Airlines, Toyota, Zara and many others), such as the JIT fulfillment strategies that are the hallmark of the business model of Dell Computers (cite) or the network reconfiguration strategies of Li and Fung (Fung *et al*, 2007). In this evolution, companies have moved from a narrow focus on costs of logistics to an appreciation of the customer willingness-to-pay for reliability and tailored logistics solutions and to a closer scrutiny of the total financial costs of cross-border relationships. As a result, logistics has become a central player and motive force enabling unbundled value chains and product fulfillment across the global networks in nearly every industry. Some of the details of the evolution of logistics in response to these challenges are considered next.

3. STRUCTURE AND EVOLUTION OF AIR CARGO AND MARITIME SHIPPING

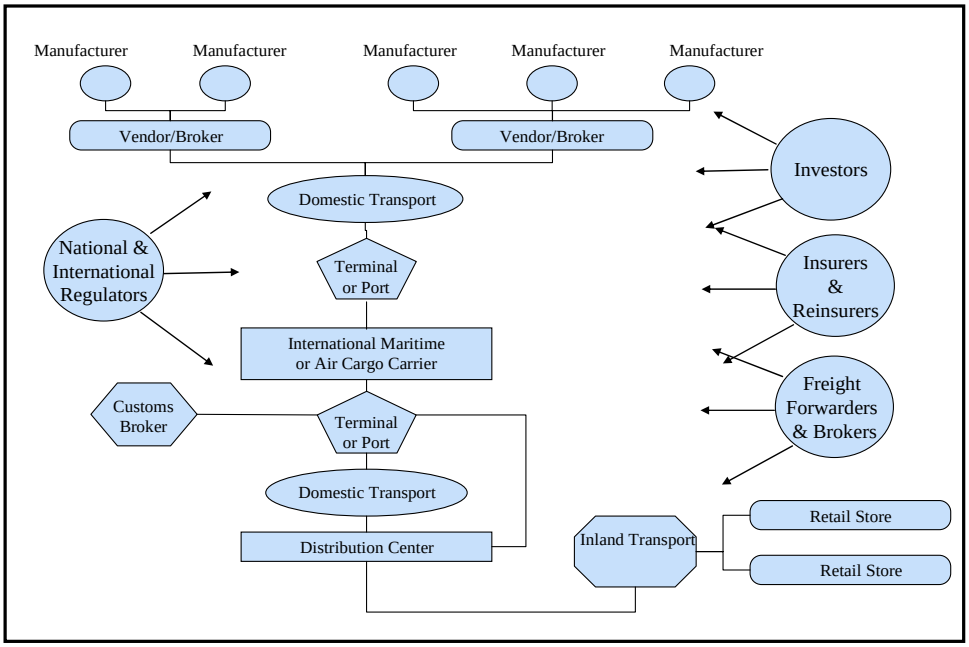
The basic structure of international logistics operations is illustrated in Figure 3. A number of different organizations and economic transactions are involved. Logistics operations entail significant investments in capacity, operating systems and control systems. Some of these are public (e.g. terminal and port facilities) and some are private. Integrated logistics operators (e.g., UPS, FEDEX and DHL in Air Cargo or Lloyds in shipping) and major brokers/forwarders (e.g., Panalpina, Kühne & Nagel) may provide or arrange for end-to-end service for certain classes of goods. Even with the assistance of integrated providers and intermediaries, however, companies that have major logistics expenses will be exposed to various elements of risk from disruptions to congestion to price and availability risks.[2] How these risks are managed, and how reliable physical availability of various logistics services is coordinated with global trade, is our central focus.

The essence of the matter is that logistics has followed the same path as other commodities in recent years.[3] Contracting for logistics services used to be only in physical terms. Whether for domestic trucking and rail, port operations, shipping or air cargo, the traditional approach was to contract with individual providers for services, usually with the assistance of a freight forwarding company. With the exponential growth of international trade in the last two decades, this piecemeal physical contracting gave way to the growth of integrated service providers and Third-Party Logistics (3PL) providers who would provide brokerage services, one-stop shopping if you will, to arrange all services end-to-end, including warehousing, customers clearance, deconsolidation and domestic transportation services. The sheer increases in volume of global trade gave rise to increasingly liquid markets for buying and selling services and underlying capacity. Initially, these markets remained primarily contract markets for physical capacity, but eventually financial instruments (as described in detail in section 4 below) began to emerge in international air cargo and maritime operations, in order to facilitate price discovery and risk management of the primary cost drivers in Figure 3. During the last decade, we have seen an explosive growth in the use of these instruments.

[2] Disruption risk management (e.g., dealing with disruptions arising from strikes, terrorism and natural disasters) is a matter of separate concern and has been the focus of heightened interest recently (Kleindorfer and Saad, 2005; Bakshi and Kleindorfer, 2007), but we will not focus on this issue here.

[3] See Kleindorfer and Wu (2003) and Geman (2005) for a discussion of the evolution of other commodity markets in this regard.

Figure 3: Multiple Actors in Global Supply Chains

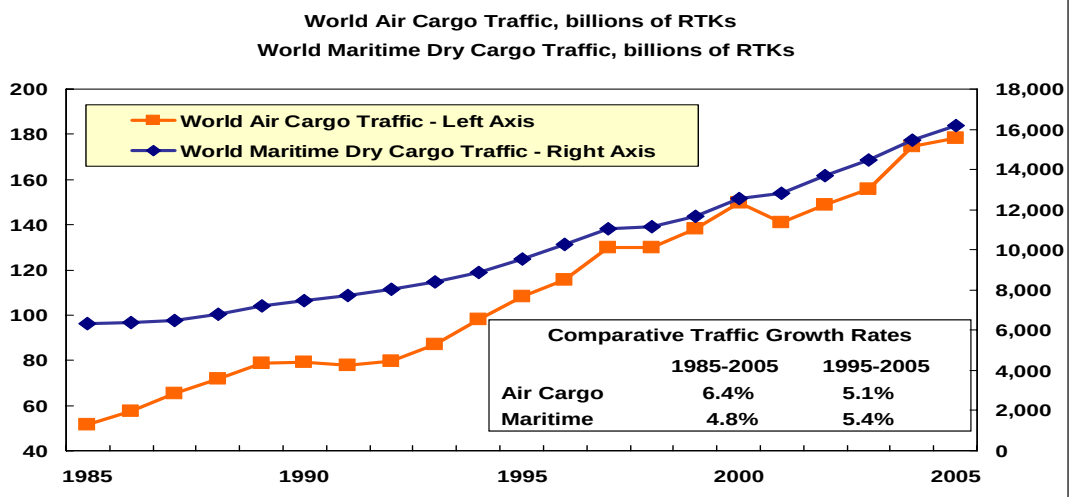


The current international logistics market looks something like this. Sellers of logistics services compete to supply buyers of such services in several interconnected market in which, in the short run, capacities and technologies are fixed. Buyers can reserve capacity through forward contracting or through various types of options obtained from any seller. Any particular buyer usually does its major business with a small set of sellers who compete for the buyer's business in the forward or contract market. However, this same buyer still has access to a larger set of sellers who compete in the shorter term market (the spot market) for various logistics services and whose actions determine a competitive spot market price. Thus, large buyers and sellers in the contract market often have durable relationships, based on satisfying credit and settlement requirements, assurance of supply, insurance, and other pre-qualification criteria. However, while such buyers may do most or even all of their business with a restricted set of sellers, they can and do still use spot markets as a second source of supply for some of their logistics services as well as a means of evaluating the price levels they receive in their contract purchases. The interaction between contracting and spot market purchases is, thus, both of interest in fine-tuning physical sourcing from sellers of air cargo and maritime capacity (e.g., by 3PL providers), as well as providing an interconnected valuation process and risk

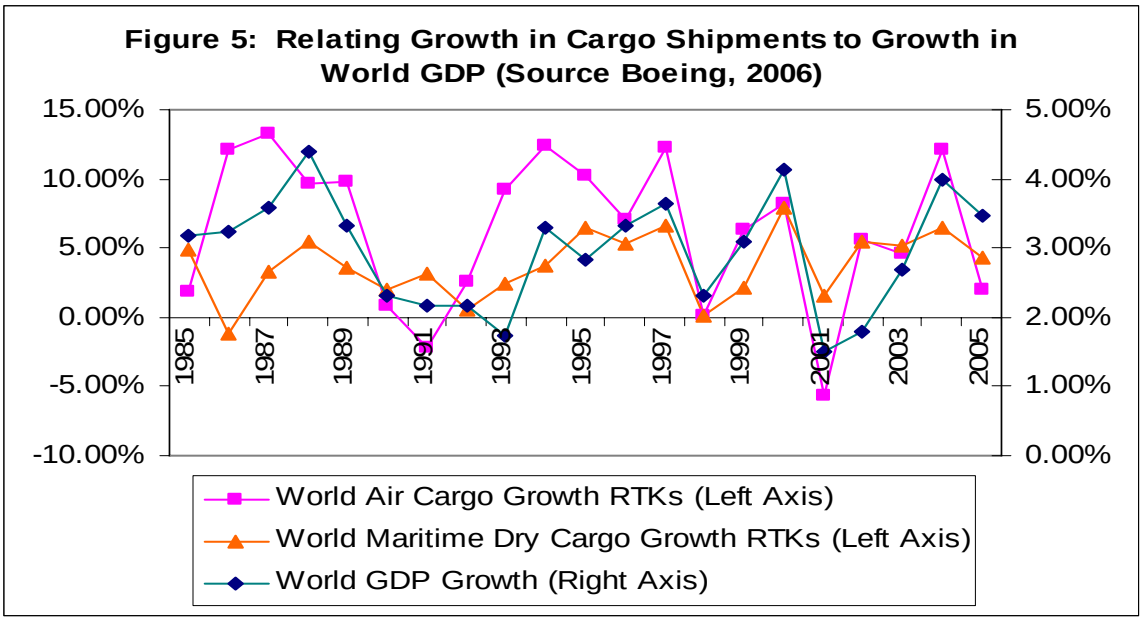
management opportunities for buyers and ultimate customers of logistics services. In an environment as complex as that depicted in Figure 3, it is obviously of great value to have market-traded instruments that provide transparent and non-manipulable information on availability of various logistics services and their prices.

The markets just described are naturally global in scope, as they are fundamentally driven by international trade. Figure 4 shows the growth in air cargo and marine cargo over the past 20 years. It is focused on dry-bulk cargo trades (i.e., merchandise), excluding crude oil and natural gas shipments (which made up roughly 40% of total international maritime cargo during this period). The results are given in revenue-tonne-kilometers (RTKs). Figure 5 presents the relationship of growth in air and maritime cargo to the corresponding growth in world GDP. The strong correlation between the world GDP and the market growth in logistics is apparent, underlining the central role of logistics as handmaiden of globalization.

Figure 4: Trends in World Air Cargo and Maritime Dry Cargo Traffic



Source: Boeing (2006)



Less apparent in these figures is the growth in the sophistication of logistics providers over this same period. This sophistication has played out differently for different branches of the global logistics system, but we can note four general areas where information technology, eMarkets and new hedging methods have revolutionized logistics across all sectors of air, maritime and surface transportation:

- Operational control of logistics, from automated warehousing and container technologies to real-time tracking and control technologies. New technologies include tamper-proof containers and RFID tracking technology, the latter of which provides significant additional benefits for inventory management and for reducing pilferage and theft. (Gaukler *et al.*, 2007). New approaches to security have accompanied these control methods as well (Bakshi and Kleindorfer, 2007).
- Capacity allocation methods, to assure efficient utilization of existing capacity in the short- and medium-run. These include assuring better contracting methods through Third-Party Logistics Providers, more complete backhaul utilization of freight capacity, as well as better control and routing of containers in cross-docking at ports and deconsolidation centers (Rushton and Walker, 2007).
- Hedging and risk management using derivative instruments to mitigate the short- and medium-run financial risks associated with contracting for physical capacity.

- Capacity planning and investment decisions for new capacity in the longer term, both for logistics capacity itself as well as for investments in logistics infrastructure.

The latter two of these areas will be explored in more detail in the next section, following Kavussanos and Visvikis (2006), as these areas represent the core elements driving the integration of physical and financial networks in logistics.

4. FINANCIAL RISK MANAGEMENT IN SHIPPING

During the last decade everyone has observed the growth of financial instruments that can be used to address the need of "*insurance*" in the constantly changing volatile business environment. This growth is being driven by an underlying demand for risk management products that reflects the fact that the overall economic environment has grown more volatile and more unstable. While risk management products based on derivatives, such as futures, forwards, options and swaps, saw their early history for agricultural commodities (see e.g., Geman, 2005), these instruments can now provide the backbone for risk management and contracting in logistics.

Derivatives are important financial instruments for risk management, as they allow risks to be separated and more precisely controlled. Derivatives are used to shift elements or risk and therefore can act as a form of insurance. Derivatives can be used by a party who is exposed to an unwanted risk (hedger) to pass this risk on to another party willing to accept it (speculator). The various users of derivatives employ them to help achieve the following objectives: hedge price risks[4], lower international funding costs, diversify domestic funding and risk management, and provide opportunities for international diversification.

Two traditional economic and social benefits are associated with derivatives. First, derivatives are useful in **managing risk**. Because derivatives are available for risk management, companies can undertake projects that might be impossible without advanced risk management

[4] Hedging means "*to secure oneself against a loss on an investment by investing on the other side*". Hedging is insuring (protecting) against changes in the market, so that the buyer or seller in the market is protected against adverse changes in prices in the future.

techniques. Second, trading derivatives contracts (which increases trader interest and trading activity) generates publicly observable prices that provide information to market observers about the true value of certain assets and the future direction of the economy. Thus, trading of derivatives aids economic agents in **price discovery** – the discovery of accurate price information – because it increases the quantity and quality of information about prices. Thus, companies and individuals can use the information discovered in the derivatives market to improve the quality of their economic decisions.

We will focus our discussion on integration of physical and financial networks in the maritime industry. As noted in Hellermann (2006), similar trends, but less developed, to those described here are emerging for air cargo logistics. In any case, as shown in Figure 4, shipping represents the major mode of transportation of international trade and represents the focal point for value-added logistics services in the global economy. This is as true for high-end items, such as automobiles, as it is for low-value commodities transported in bulk. Shipping markets are characterized as capital intensive, cyclical, volatile, seasonal and exposed to the international business environment. Therefore, the introduction of proper risk management strategies in an industry which is characterized with cyclicalities and high volatility in its prices is obviously important.

Kavussanos and Visvikis (2006) argue that the existence of derivatives products in shipping has made risk management cheaper, more flexible and available to parties exposed to adverse movements in freight rates, bunker (fuel oil) prices, vessel prices, exchange rates, interest rates and other variables affecting the cash-flow position of the shipping company and its customers. By using shipping derivatives, market participants in the shipping industry can secure (stabilize) their future income or costs and reduce their uncertainty and volatility that comes from the fluctuations in the above prices. A comprehensive and detailed presentation, with illustrative applications, of the use of derivatives for managing business risks prevalent in the shipping business, may be found in Kavussanos and Visvikis (2006, 2008). The section that follows concentrates on hedging the most important source of business risk in the shipping industry; that is, freight rate risk. We will focus on dry-bulk and tanker sectors, as these are the most liquid markets and account for roughly two-thirds of seaborne trade movements. Slightly

different considerations apply to container trade, where the markets and decisions supported are on a container basis rather than on a ship or voyage basis.

4.1. Freight Rate Derivatives Products and Markets

The volatility observed in freight rates, in the competitive shipping markets, constitutes a major source of business risk for both shipowners and charterers. For the charterer, wishing to hire in vessels for transportation requirements, increasing freight rates leads to higher costs. In contrast, for the shipowner, seeking employment for his vessels, lower freight rates involves less income from hiring out the vessels. Freight derivatives contracts can be used to hedge this source of risk in the dry-bulk and tanker sectors of the shipping industry. Currently, market participants in shipping have various financial instruments in order to protect themselves against the adverse freight rate fluctuations. These derivatives products are either exchange-based (and therefore cleared), like **freight futures and options**; OTC-traded, like **freight forwards**; and finally, OTC-traded but with a clearing mechanism, like cleared **freight forwards and options**.

Before presenting the various characteristics and markets of these products it is important to note that by comparing freight derivatives with more "*traditional*" risk management strategies in shipping, it is obvious that they offer real and improved gains for both shipowners and charterers. For example, by using a freight derivatives contract, compared to time-chartering a vessel, shipowners retain operational control of their vessels and at the same time benefit from favourable spot market conditions. On the other hand, charterers are free from the operational risks, which are present in time-charter agreements. The simple nature of freight derivatives contracts makes it easier to trade in and out of positions, compared to contracts on physical cargo. There is no physical delivery involved with freight derivatives, as they settle in cash upon conclusion of the contracts. Also, commissions payable to brokers are lower for freight derivatives compared to chartering agreements (for more details see Kavussanos and Visvikis, 2006, 2008).

The first OTC freight derivatives that has appeared in the shipping markets since 1992 is the Forward Freight Agreements (FFA) contract. FFAs are principal-to-principal private agreements between a seller and a buyer to settle a freight rate, for a specified quantity of cargo or type of vessel, for usually one, or a combination of the major trade routes of the dry-bulk or tanker sectors of the shipping industry. Since they can be "*tailored-made*", to suit the needs of their users, they have become very popular with market participants wishing to hedge freight rate fluctuations.

The dry-bulk trading routes, which serve as the underlying assets of the dry-bulk FFA contracts today, are based on the Baltic Panamax Index (BPI), the Baltic Capesize Index (BCI), the Baltic Supramax Index (BSI) and the Baltic Handysize Index (BHSI). These indices comprise freight rates designed to reflect the daily movement in rates across dry-bulk spot voyage and time-charter rates. Each route is given an individual *weighting* to reflect its importance in the world-wide freight market and routes are regularly reviewed to ensure their relevance to the underlying physical market. The relevant underlying trading routes for tanker trades are the Baltic Dirty Tanker Index (BDTI) and the Baltic Clean Tanker Index (BCTI)[5].

The following practical example illustrates their use. Assume that today is 25 September 2007 and that a charterer, which has to pay the cost of transporting his cargo of grain, believes that in one month (29 October 2007) freight rates in the trading route BPI 2a (Skaw-Gibraltar range to Far East – 45 days) may increase and that today they stand at the fair level of $78,000/day. In order to protect himself from a potentially more expensive future market he buys a FFA contract, through his freight derivatives broker, in order to hedge his physical market exposure of $3,510,000 (= $78,000/day x 45 days). The broker will match this interest by finding another party, say a shipowner, which is the provider of the shipping service by offering his Panamax vessel for hire, which believes that freight rates in the BPI 2a route may fall in two months from now. The shipowner will then take the opposite position by selling a FFA, which expires in one month, at $78,000/day agreed today.

[5] For an analytical description of the composition of the Baltic Exchange indices see Kavussanos and Visvikis (2006, chapter 3).

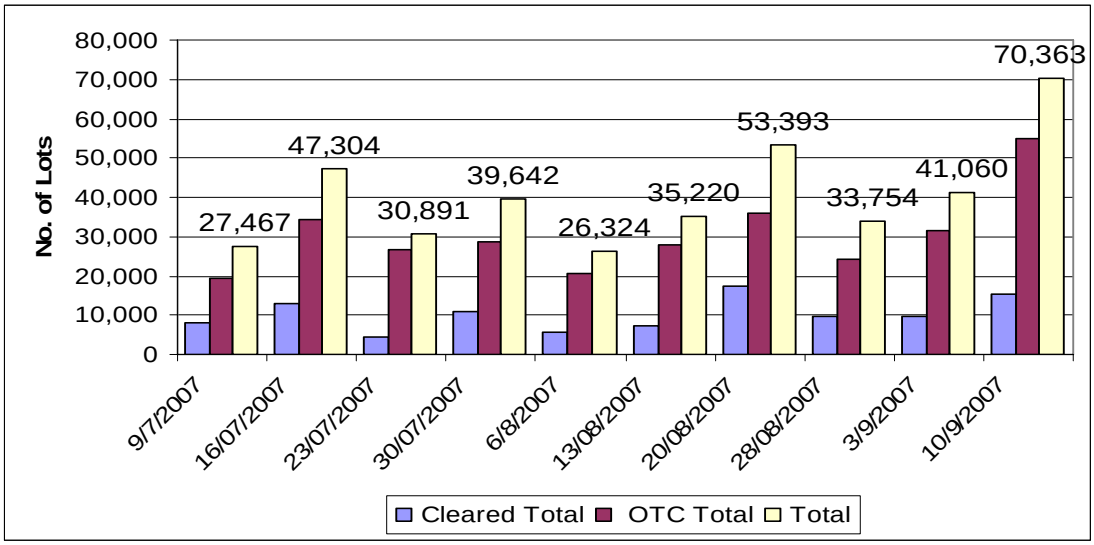
In the dry-bulk market, voyage-based contracts are settled on the difference between the contracted price and the average spot price of the route selected in the index over the last seven working days of the settlement month. Time-charter-based contracts are settled on the difference between the contracted price and the average price over the calendar settlement month. In the tanker market, a tanker FFA contract is an agreement between two parties to fix a freight rate in Worldscale units on a predetermined tanker route, over a time period, at a mutually agreed price. Settlement takes place at the end of each month, where the fixed forward price is compared against the monthly average of the spot price of the tanker route selected. If freight rates fall below the agreed rate, the charterer pays the difference between the agreed FFA price and the settlement spot price; if rates increase, then the charterer receives the difference.

During 29 October 2007, at the settlement of the FFA contract, assume that the settlement price, which is the average of the last 7 business days prior to expiry, is $91,000/day, which is higher than the fixed price of $78,000/day. As the freight market has increased, despite the opposite expectations of the shipowner, the seller (shipowner) must pay $13,000/day (= $91,000 – $78,000) to the buyer (charterer), which amounts to $585,000 (= $13,000/day x 45 days). Payment between the two parties is made by money transfer in US dollars within five business days following the settlement date. However, in the stronger physical market, the shipowner (charterer) gains (loses) $13,000/day, i.e. $585,000 more than what he was expecting. Therefore, the net effect, for both parties, is that their cash-flows from the combined FFA – spot market portfolio were stabilized by locking October's rates at $78,000/day.

Moreover, it should be noted that in OTC derivatives markets, each party accepts credit-risk (or counter-party risk) from the other party. The primary advantage of an OTC market is that the terms and conditions of the contract are tailored to the specific needs of the two parties. This gives investors flexibility by letting them introduce their own contract specifications in order to cover their specific needs. For further analysis regarding the above issues and practical examples in the FFA market, see Kavussanos and Visvikis (2006).

The current growth of the FFA trades is expected to continue, with FFAs covering increasingly larger proportions of the underlying market. The exponential rise in FFA trading and the increasing liquidity and transparency of the market create increasing benefits to both shippers and direct customers, as well as to 3PL providers and intermediaries, such as forwarders and brokers. Figure 6 presents the aggregate FFA volume figures for Cleared, OTC and Total trades from 9 July 2007 to 10 September 2007. These statistics have started being calculated this year by the Baltic Exchange, and they provide an important source of information for market participants. The figures indicate that the OTC FFA trades are still more attractive to market participants in comparison to Cleared trades, while Panamax trades represent the most liquid trades, followed by Capesize and then by Supramax.

Figure 6: Aggregate FFA Volume Figures for Total Cleared and Total OTC Trades



Note: **Source:** Baltic Exchange

- Trading volume totals are estimated by the following companies: Banchero Costa, Bernd von Blomberg, BRS Futures, Clarkson Securities, Ernst Russ, FIS, GFI Group, Ifchor SA, Icap Hyde, LCH Clearnet, NOS Clearing, Pasternak, Baum & Co, Seoul Futures, SSY, Tong Yang Futures Trading, Traditional Financial Services, Imarex.

Regarding the price discovery economic function mentioned earlier in the text, Kavussanos and Visvikis (2004) investigate the lead-lag relationships between FFA and spot markets, both in terms of returns and volatility. Results indicate that there is a bi-directional causal relationship between FFA and spot markets for all investigated trading routes, implying that FFA prices can be equally important as sources of information as spot prices are in commodity markets. Further tests suggest that causality from FFA to spot returns runs stronger than the other way.

Also results indicate that the there is a bi-directional volatility spillover between the FFA and the spot market. Thus, it seems that FFA prices for those routes contain useful information about subsequent spot prices, beyond that already embedded in the current spot price and, therefore, can be used as price discovery vehicles, fulfilling their price discovery role.

On the other hand, if someone wants to eliminate the credit risk that emanates from OTC derivatives transactions, he can approach a derivative exchange that offers freight futures contracts. Such products can be found in the organized exchanges of the International Maritime Exchange (IMAREX) and the New York Mercantile Exchange (NYMEX), where they are cleared in their associated clearing-houses. Clearing offers multilateral netting, removal of credit risk, standardised contracts, daily mark-to-market of positions and increase in trading liquidity, amongst other benefits.

The Oslo-based IMAREX exchange, using as underlying assets mostly the Baltic Exchange indices, offered the first dry-bulk and tanker freight futures contracts. It was founded in spring 2000 and started operating on November 2, 2001. The Norwegian Options and Futures clearing-house (NOS) offers clearing services to IMAREX. According to IMAREX, a trading environment is provided to the shipping market by offering trading systems and rules, guaranteed settlement through the NOS clearing-house, anonymous trading, flexible and tailored contracts, firm trading prices, professional exchange systems, and a Market Place Service (MPS) to facilitate trading of freight derivatives products not-listed at IMAREX. Customer segments at IMAREX include international shipping companies, energy companies and refiners and commodity and financial trading houses. IMAREX trading volumes have grown substantially, both as a result of considerable market growth but also due to market share growth. Market agents can select either contracts that are listed at IMAREX or non-listed contracts, which are available for trading through its MPS. Both are cleared through NOS.

Since May 2005, NYMEX, as the world's largest physical commodity futures exchange and the trading forum for energy and precious metals, started offering tanker freight derivatives. Transactions executed on the exchange avoid the credit risk issue, as its clearing-house acts as the counterparty to every trade. NYMEX introduced nine tanker freight futures contracts on its

NYMEX ClearPort(sm) electronic trading and clearing platform, beginning on May 16, 2005. They use as underlying commodities the Baltic Exchange or the Platts indices.

In response to demands from market participants, to address the issue of credit risk present in OTC FFA contracts, "*hybrid*" FFAs have also appeared, as they are traded OTC but cleared through a clearing-house. They maintain the flexibility of the traditional FFAs and, for a fee, have credit risk eliminated. These "*hybrid*" FFAs can be cleared in the London Clearing House Clearnet (LCH.Clearnet) and in the Singapore Exchange AsiaClear (SGX AsiaClear).

The LCH merged with Clearnet S.A. in December, 2003 to form the "*LCH.Clearnet*" Group. In September, 2005, the LCH.Clearnet launched a recording, clearing and settlement service for OTC FFAs. Potential members establish a relationship with a LCH.Clearnet clearing member, for the management of margin and cash-flows, agreeing the commercial terms bilaterally, with the credit risk lying between the client and the clearing member. Alternatively, interested parties can become clearing members of LCH.Clearnet (subject to bonding and other requirements). Clearing of OTC freight contracts is open to all clearing members who meet the minimum criteria set out in the clearing-house's rulebook and have been approved by the clearing-house. LCH.Clearnet announced that during 2007 over 2,500 trades took place, representing 66,000 lots with a nominal value of over $2.6bn. During June 2007 alone, open interests stood at over 35,000 lots with a nominal value of US$1.6bn. Moreover, LCH.Clearnet plans to introduce clearing for OTC freight options during late 2007. This will cover initially options in dry-bulk Capesize, Panamax and Supramax time-charter routes, with the intention to extend the facility to tanker options later on.

SGX launched SGX AsiaClear, its OTC Clearing facility for energy and freight derivatives, in May 2006. SGX was established on December 1, 1999, following the merger of the Stock Exchange of Singapore (SES) and the Singapore International Monetary Exchange (SIMEX). On November 23, 2000, SGX became the first exchange in Asia-Pacific to be listed via a public offer and a private placement. In response to Asia's OTC market needs, SGX AsiaClear offers a network of Asia-based counterparties to facilitate OTC trading and clearing activities, to enhance credit and risk management and to increase OTC operations and position-

netting efficiencies. The SGX AsiaClear facility provides central counterparty clearing for OTC FFAs. In June 2007, the SGX announced that SGX AsiaClear had secured over 100 counterparty accounts on its OTC trading and clearing network and exceeded US$1.2 billion in value of trades cleared since launch in May 2006.

Finally, besides futures and forward contracts, options contracts are further derivatives tools available for risk management and investment purposes.[6] This type of financial derivatives contracts has been used extensively in finance on a number of underlying instruments, including exchange rates, interest rates, etc. OTC freight options contracts are available since 1997 on individual routes of the Baltic dry and tanker indices, as well as on baskets of time-charter routes of the indices and on the FFA contracts available on them. They are offered by the same derivatives brokers that trade FFA contracts. The standard freight option contract is either a freight put option (floor) or a freight call option (cap). They settle the difference between the average spot rate over a defined period of time and an agreed strike price.

A shipowner anticipating falling freight rates will buy a put option, agreeing to sell his freight service in the future at a price agreed today. He will exercise the put option (to sell at the agreed price) if the market freight rate falls below the agreed (exercise) price, otherwise he will let the option to expire worthless, thus losing only the premium he paid upfront. On the other hand, a charterer will buy a call option, which he will exercise (to buy the freight service at the agreed price) if the market freight rate at expiry is higher than the agreed price, otherwise he will let the call option expire and lose only the premium.

On June 1, 2005 the first cleared tanker IMAREX Freight Option (IFO) contract was launched, cleared through NOS. The IFOs are now available for trading and clearing to all IMAREX and NOS members, and are structured as monthly call and put Asian style options[7], with monthly, quarterly and yearly maturities.

[6] See Wu and Kleindorfer (2005) and Geman (2005) for a general discussion of options products for commodities, and Spinler *et al*. (2003) for a discussion of the theoretical developments on options for logistics products.
[7] An Asian option is an option that is exercised against an average over a period of time. Asian options are often used in thinly traded, volatile commodity markets to avoid problems with price manipulation of the underlying commodity near or at maturity.

5. CONCLUSIONS

Logistics is a prime example of how globalization has driven the integration of physical and financial networks to provide primary services and supporting infrastructure, together with the tools for risk management for buyers, sellers and investors in these services. The globalization story continues. Its history illustrates the tremendous power of specialization and trade as continuing sources of economic growth. It also shows the huge synergies, and inexorable force, driving the integration of financial and physical markets. This integration is necessary to mediate the unbundling of specialization and the re-bundling enabled by orchestrated value-added networks that are interconnected by information technology and flexible logistics. Logistics has followed a similar trend to that of nearly every other commodity or near-commodity market, from purely physical and piecemeal contracting to broader more liquid markets, to the emergence of brokers and intermediaries, to full-fledged derivatives markets for valuation, sourcing and hedging.

Logistics is an infrastructural activity, deriving its basic value from the more direct value-added activities and products its supports. In this sense, logistics acts as a super-network connected to many other physical fulfillment networks (e.g., in international retail supply chains, as well as in metals, agriculture and energy) and enabling these networks to function as well as providing financial and risk overlays for the full cost of these sub-networks. As a true testament to the power of markets as integration mechanisms par excellence, the evolution of logistics markets, and their integration with other markets, is fascinating. Compared to the pre-network age of but a decade ago, the network effects of globalization, unbundling and re-bundling encompassed by the new logistics are staggering. What was previously a local and opaque evolution in pricing and availability of logistics capacity has now become more transparent and more manageable from a financial as well as a physical perspective, able to fulfill the growing role expected of it as the glue of international trade.

From a strategic perspective, a number of interesting conclusions arise from this story, and especially for major players with logistic-intensive operations. These certainly include the desirability for companies whose cost structure depends significantly on logistics to develop integrated competencies internally that mirror the integration of physical and financial markets

externally. The information is now available for pricing and hedging of logistics services in the short- and medium term. Integrating this information with strategic planning for outsourcing, offshoring and other dimensions of global operations is therefore possible, but using it effectively obviously requires new skills and competencies.

A final area that was but a gleam in the eye of environmentalists a decade ago is the determination of the environmental footprint of globalization. If the dictates of climate change mitigation continue as expected, we can expect to see the integration of carbon markets and footprints with logistics clearing houses to encompass CO_2 emission certificates, just as bunker oil and exchange rate risks have been integrated with logistics markets and pricing. This is but a further example of the evolution from the pre-network era of local pricing, piecemeal contract-based trading and local impact assessment to the post-network era of global pricing, market-based trading and global impact assessment.

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