CHAPTER 1.4

Logistics Investment and Trade Growth: The Need for Better Analytics

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Although there is no question that trade depends heavily on logistics performance, the analytics available to analyze this dependency and to aid in optimizing decisions, particularly regarding logistics-related investments, is limited. There are three major groups of decision makers in this area. Public entities make many of the public infrastructure investment decisions (e.g., better road networks, larger ports). Logistics service providers make decisions regarding investments in assets for services that are "public" in the sense that they are offered to multiple enterprises (e.g., investment in new liner services, the purchase of post-panamax container ships) as well as decisions regarding how these assets are employed. Shippers and private investors in shipper infrastructure make decisions about "private" infrastructure to support specific enterprises (e.g., building distribution centers to facilitate the movement of imported goods to stores) as well as decisions about how to utilize existing infrastructure and logistics services in supporting their businesses.

Successful trade depends on all three of these groups making compatible decisions that enable high-performance supply chains. However, only the private investment groups have comprehensive methodologies and software that have been developed to optimize supply chain design with regard to the elements under their control. The goals and mechanisms for decision making vary greatly among the providers of logistics infrastructure to the public, but the decision-making abilities of all these providers could be dramatically improved by using models and analytics analogous to those that have been developed for supply chain design. In this chapter, we outline the requirements that such a model should fulfill and some of the obstacles faced in its construction.

HISTORICAL CONTEXT

The symbiotic relationship between logistics and trade has been evolving for more than 3,000 years. The development of boats capable of carrying goods on rivers enabled the first extensive trade routes on the Nile and other major rivers. Further improvements in small ships allowed expanded trade to the eastern Mediterranean. The development of ocean-going ships enabled the growth of great trading empires. The development of containers and cellular ships, together with specialized ports with container cranes and other supporting equipment, has enabled the vast global trade that exists today. Connecting these container ports with intermodal rail allows rapid movement of containers from China arriving at ports on the West Coast of the United States to be moved rapidly to East Coast population centers.

Air transport is an important late addition, which has evolved from the single-engine planes of the early 1900s to today's global air networks that enable trade in perishable products, including food and pharmaceuticals. Although we have retained the vocabulary of trade "routes" and supply "chains," today's logistics infrastructure is a complex network of physical infrastructure, information technology, logistics

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services, and government participation. While much of the infrastructure (e.g., ports, highways, and railroads) so critical to today's global trade was originally developed primarily to facilitate military movement, most of today's logistics infrastructure investment is motivated by the desire to attract and increase trade.

Perhaps the most remarkable development about the evolution of logistics and trade has been the change that has occurred since 1990, with China's entry into the export market. This seems to have been the "tipping point" when both governments and private entities began to realize that the logistics to enable international trade was as important to economic well-being as the capacity to generate products for trade. Since then, governments and private enterprises have increasingly realized that superior logistics performance provides a major advantage in the very competitive trade world. This has led to a strong desire to influence logistics evolution at all levels:

- China's successful investments in container ports have resulted in an increase from one port (Hong Kong) in the top 15 in 1990 to six ports today. If we take into consideration that Hong Kong was not part of China in 1990, then that would mean an increase from zero ports in the top 15 in 1990 to six ports today.
- Major government and private investments in infrastructure have improved the connectivity of the port of Los Angles so that it is now accessible to the major population areas of the United States.
- The growing trend in container shipping lines is to order and operate larger-sized, post-panamax ships.
- The expansion of the Panama Canal, to be completed in 2014, will allow the passage of ships three times as big as those permitted today.
- Several East Coast ports in the United States are attempting to get approval and funding that will enable them to handle the bigger container ships that will be able to travel through the expanded Panama Canal.
- Plans for expanding rail infrastructure in the Middle East and Russia may result in new trade routes between Asia and Europe.

Logistics improvement efforts not only require major investments, but their impact on logistics performance is several years in the future and their justification depends on assumptions about how trade will grow with and without the investments. For example, an effort is underway to deepen the Port of Savannah in the US state of Georgia to enable the larger post-panamax ships to call. The required investment is in excess of US$600 million; the earliest estimate of project completion is 2016. To justify such a large investment requires an assumption that trade growth through Savannah will generate enough container flows to and from Asia to make it cost effective for the container line companies to utilize the much larger post-panamax ships on Asia-Savannah routes when the Panama Canal expansion is complete.

What kinds of analytics are required to support logistics investment decisions such as increasing the depth of Savannah harbor? How much additional trade will this generate and where is that trade coming from? What type of logistics infrastructure and logistics services should be developed around the harbor to sustain this additional trade and reach the desired markets in a timely and cost-effective manner? What are the risks? This analysis cannot be done in isolation. It involves understanding the interests of all stakeholders:

- Government and local authorities want to develop logistics infrastructure and services to attract trade to their territories and lower the cost of doing business.
- Logistics service providers want to minimize costs and maximize profit. For example, the trend toward larger ships is mainly motivated by an expectation of reduced operating costs, but this will be profitable only given adequate volume.
- Shippers want their products delivered on time. Given the choice, they will choose the route that has the best trade-off among transportation costs, inventory considerations, and reliability of service.

The most promising approach seems to be one that can factor in the dynamics of global trade and economics (e.g., changes in the magnitude of regional trade growth) on models of existing and possibly new infrastructure and services with the possibility of studying various assumptions about both the level of services to be provided and shippers' behavior to understand how the modes and routes utilized by trade will evolve over time. Such analytical models will require extensive data on trade, trade routes, modes of transportation, and numerous cost components that may not be readily available today. These models could be used to generate best-case, worst-case, and most-probable scenarios for enlightened decision making.

The next sections present some observations of global and regional trade that, when viewed through simplistic models, could prove to be either very good or very bad for logistics investment. These models generally provide good results if the current global trends continue in the future, but they provide less reliable results if anything changes in the global environment.

TRADE DATA

Although there is a great deal of data related to international trade, they were not collected in order to support logistics investment decisions. Most of the publicly available data (e.g., the UN Comtrade database, available at http://comtrade.un.org/db/) were collected to support each country's need to control shipments across its borders and to collect customs revenues. The three common classifications of products—the Broad Economic Category (BEC), the Standard International Trade Classification (SITC), and the Harmonized System (HS)—are designed to reflect economic similarities of products but not necessarily similarities in logistics requirements. Much of the trade data express trade volumes in dollars and in weight; this conversion from

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volume to dollars and weight introduces errors into the analysis of issues such as predicting the increase in container volumes. Some individual shippers have data regarding the characteristics of their own shipments together with the specific modes, routes, times, and costs for each shipment from origin to destination. These are the ideal data for trade and logistics analytics, but they are typically proprietary and therefore not generally available to support logistics investment analytics. The only current alternative is to work with the data available, although these may not have the degree of specificity desired. In most cases it is critical to understand the limitations of the data in making investment decisions.

GLOBAL MERCHANDISE TRADE

Figure 1 represents data taken from the UN Comtrade database; Figure 1a shows merchandise trade growth in US dollars and 1b presents the same data adjusted for inflation. Inflation adjustment is desirable, but inflation is not expected to impact the logistics requirements of trade. Note that there is an approximately linear growth in total global merchandise trade except for the two economic downturns in 2001 and 2009. As a result of this growth, inflation-adjusted total global merchandise trade approximately doubled between 2002 and 2008. The economic dip in 2001 had only a minor impact on global merchandise trade, but the 2009 impact was a major setback.

It is interesting to note that, if in 2008 we had used a linear approximation of trade growth (from the data this looks very reasonable), the estimate for 2010 would have been about US$13 trillion in inflation-adjusted dollars—considerably more than the actual amount, which was about US$9 trillion. This observation is very important to take into account when using such forecasts for logistics investments. In 2010 total trade recovered to reach close to the 2008 levels, but an investment made on the 2008 forecast would be two years behind in terms of return on investment if it was possible to maintain the previous trend. Although we do not know what forecasts the container lines used for predicting the need for additional capacity, we do know that they are currently seriously over capacity on many lanes. Furthermore, they have numerous orders for large post-panamax container ships, which, when they are in service, are likely to take at least two years longer than expected to operate at the planned capacity. This points to the need for analytics that indicate not only how trade will change but also when. While recognizing the risk of forecasting trade growth based on time-series data, it is not clear how to account for the huge impact of a downturn such as the one that occurred in 2009 unless the downturn itself can be forecast. However, the new class of analytical models should allow for quickly adapting to changing conditions and repositioning the level of investments required in logistics as well as the logistics services to be offered.

TRADE BY REGION

Another important factor that drives logistics investment is trade among various regions. Figure 2 shows imports and exports by region. The following observations can be made: both imports and exports have been increasing over time for each of the six regions considered. While trade with Asia is on the rise, Europe has been and continues to be both the biggest importing and the biggest exporting region of the world—although the impact of the current economic turmoil in Europe may affect this trend going forward. The "big 3"—Europe, Asia, and North America—represent about 80 percent of all trade. Trade for the Commonwealth of Independent States (CIS), the Middle East, and South and Central America and the Caribbean (SCAC) is increasing, but more slowly than the big 3.

Trends in regional trade tell us something about regional investment in logistics. For example, prior to 2008 both imports and exports for Europe and Asia were growing at similar rates so it would have seemed reasonable that similar amounts of logistics investment would have been required to support this growth in both regions. However, in 2010 Europe had recovered only to a level below that of its 2007 trade volume, while Asia regained its 2008 level. This would indicate that there is a slowdown or postponement in Europe's growth, so there will be less need for logistics investment there than in Asia. There is nothing in the data to address the question of exactly how this investment should be placed (i.e., the kind of infrastructure that should be developed or the new services that should be offered).

It is particularly interesting to note that, in 2003, imports by Asia exceeded those of North America and the gap has widened every year since. Both imports and exports for North America are increasing but at a slower rate than those of Europe and Asia. This raises the question of whether the post-panamax ships currently on order can most profitably be applied to services in Asia rather than services between Asia and the East Coast of North America.

Container traffic from the Pacific to the Atlantic transiting the Panama Canal increased 70 percent from about 20 million long tons in 2002 to 34 million long tons in 2008. This growth caused heavy congestion in the Canal, which led to the decision for expansion. Had the downturn not occurred, the Canal would have become a major barrier to increased trade until the expansion was completed. Even with the downturn, if trade through the Canal again assumes a linear growth rate, serious congestion will likely to become an obstacle before the expansion is complete. In this case, yet another expansion would need to begin immediately to prevent the Canal from becoming a bottleneck.

Figure 3 provides the same basic data as Figure 2 but from the perspective of each region's share of world trade. The observations from this perspective seem more surprising. While Figure 2 suggests that the volumes of trade in and out of Europe and North America are increasing, both Europe and North America are declining in their share of world imports and world exports (see Figure 3). North America is losing significantly with respect to both imports and exports. In 2003 Asian imports caught up to North American imports; in 2010

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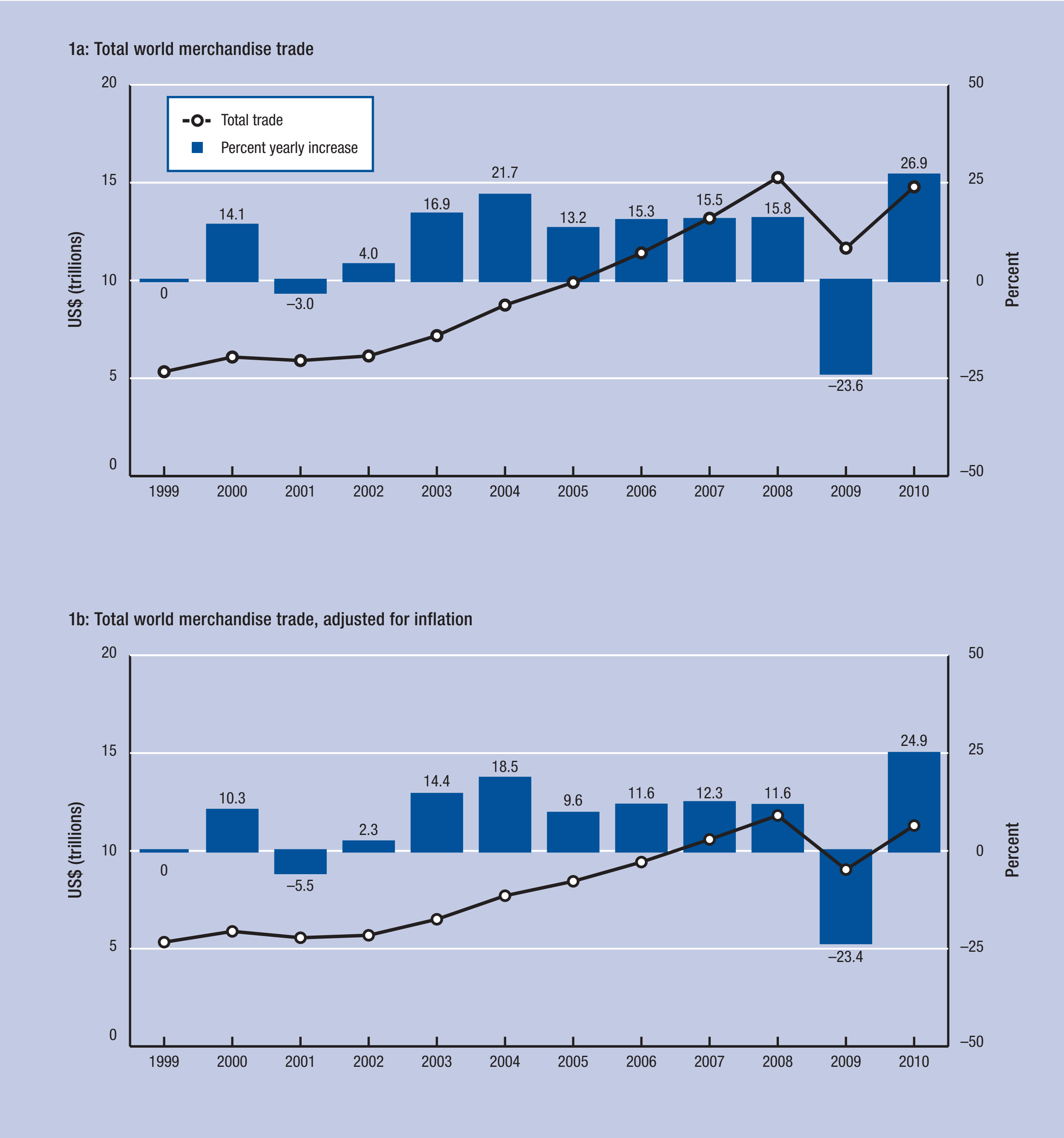
Figure 1: Total world merchandise trade, 1999–2010



Source: Data from the UN Comtrade database; authors' calculations.

Asian exceeded North American imports by about US$1.5 trillion. The share of both imports and exports in the CIS, the Middle East, and the SCAC are increasing, but the gain is not very significant since these regions have only a small share of imports and exports as their base.

Figure 3 also suggests that new investment in logistics in Asia is most likely to get higher returns, because the region sustains its development year after year. This is confirmed by the fact that 90 percent of the larger and faster-growing metropolitan economies in 2011 were located outside North America and Western Europe.[1]

INTRA- AND INTER-REGIONAL TRADE

Intra-regional trade accounts for about 52 percent of all trade worldwide. The big 3 combined—Europe, North America, and Asia—account for 96 percent of intra-regional trade, while trade among European countries accounts for more than half (approximately 57 percent) in intra-regional trade. The latter represent 70 percent of all European exports. It is interesting to note that

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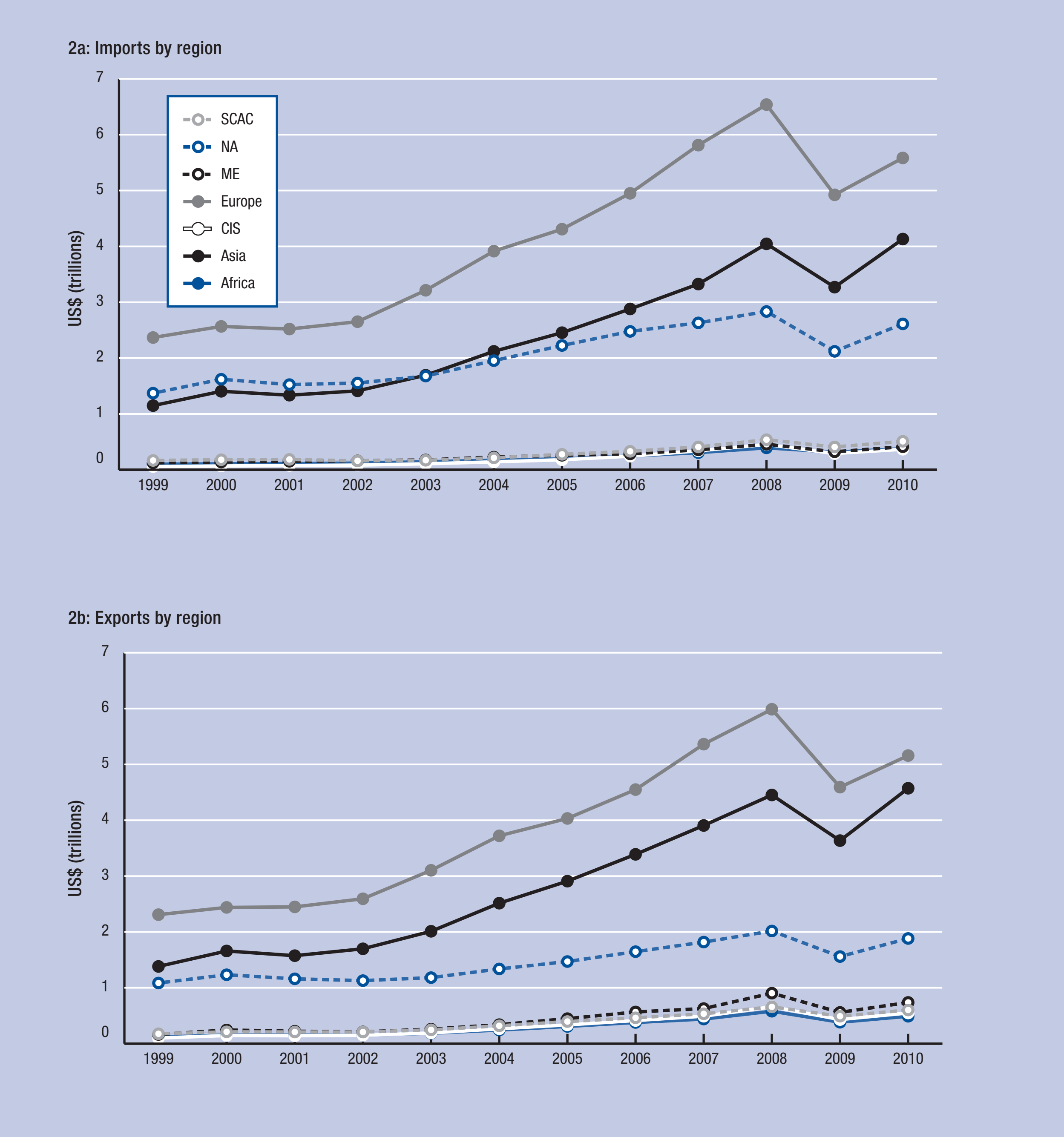
Figure 2: Merchandise imports and exports by region, 1999–2010



Source: Data from the UN Comtrade database; authors' calculations.
Notes: Values have not been adjusted for inflation. CIS = Commonwealth of Independent States; ME = Middle East; NA = North America; SCAC = South and Central America and the Caribbean.

both intra-regional trade within Europe and within North America have declining shares of global trade, whereas Asia-Asia is increasing its share of global trade.

The major inter-regional trade flows among North America, Europe, and Asia account for 25 percent of total trade. As can be seen from Figure 4, trade, as a percentage of global trade, to and from North America and Europe and to and from North America and Asia is declining, whereas trade from Asia to Europe and vice versa seems to be doing better. Asia-Europe trade is now at the same level as Asia–North America trade: it represents 6 percent of global trade and is expected to grow faster than trade between Asia and North America. Figure 4 also shows the imbalance in regional trade, with exports from Asia to Europe and North America being significantly higher than exports from these regions to Asia. The result is Asia's positive trade balance with Europe and North America. The reverse is true for North America, which suffers from trade deficits with both Asia and Europe. These imbalances result in significant transportation price discounts on the weaker lanes.

Moreover, the type of logistics infrastructure required to support intra-regional trade is quite different from the infrastructure required for inter-regional trade, as it is

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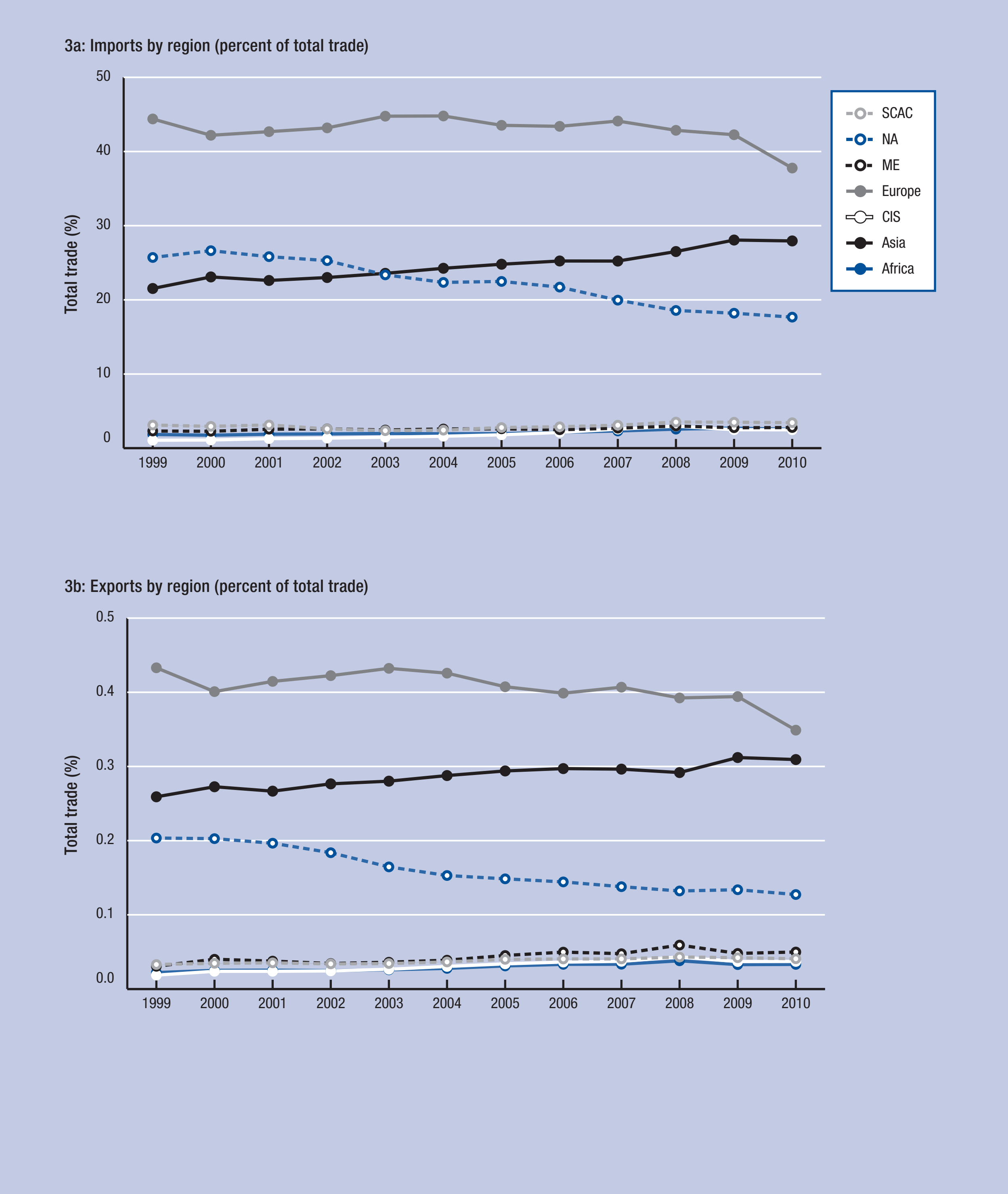
Figure 3: Merchandise imports and exports by region as a percentage of total merchandise trade, 1999–2010



Source: Data from the UN Comtrade database; authors' calculations.
Note: CIS = Commonwealth of Independent States; ME = Middle East; NA = North America; SCAC = South and Central America and the Caribbean.

highly dependent on the geography, demographics, and cultures of the participating regions.

TRADE ROUTE SELECTION

Figure 5 shows the major inter-regional trade flows that govern today's major trade routes. The main Asia-Europe trade route is via the Suez Canal. The fact that the Suez Canal can handle the largest container ships, combined with the fact that trade between Asia and Europe has increased steadily, may explain why most of the post-panamax container ships can be found on this route. Furthermore, because no binding capacity constraints currently exist, it is conjectured that the Asia-Europe route is not likely to change very much unless there are geopolitical disruptions or macroeconomic changes. Such changes would include higher transit fees, an

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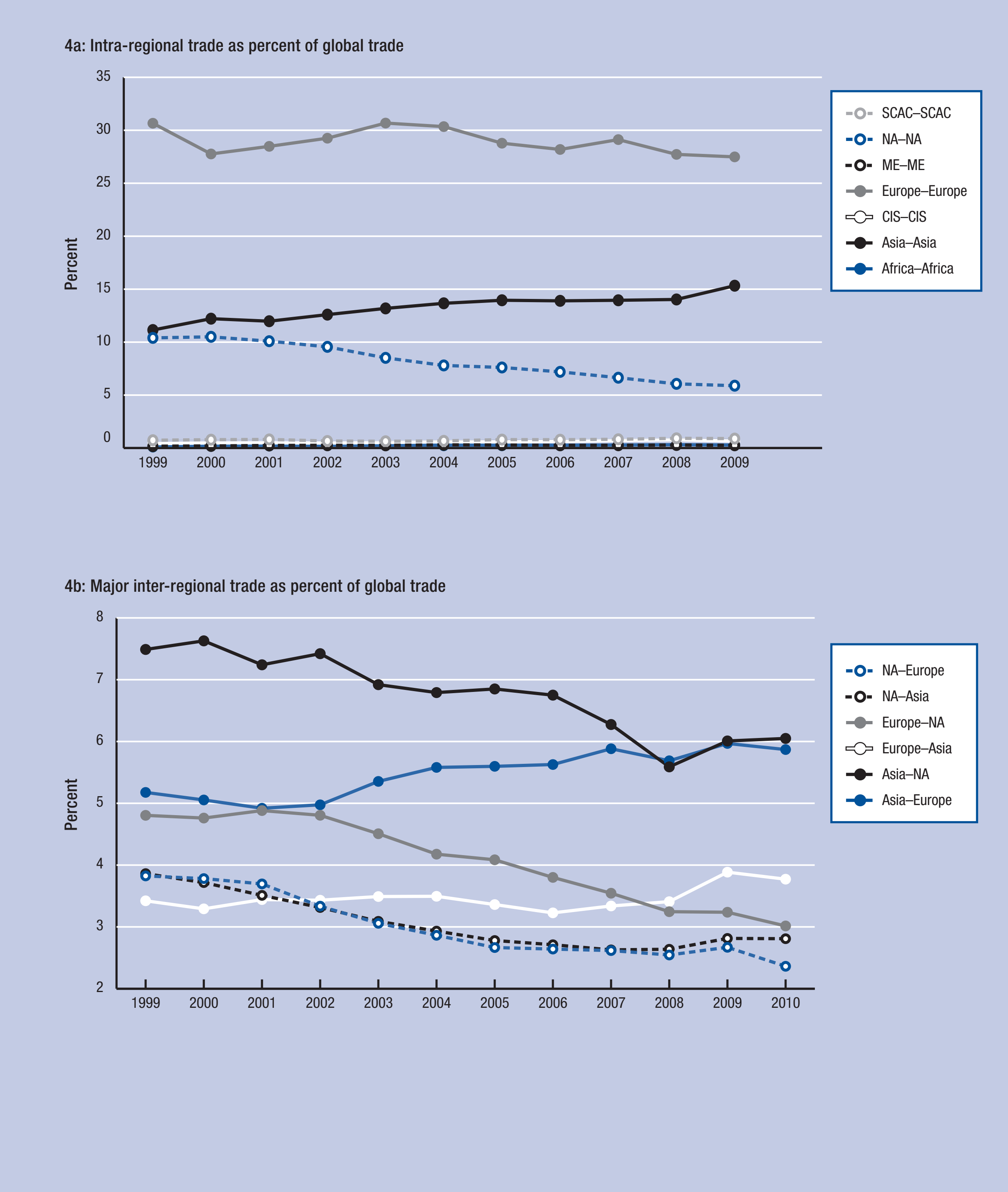
Figure 4: Merchandise trade: Intra- and major inter-regional flows, 1999–2010



Source: Data from the UN Comtrade database; authors' calculations.
Note: CIS = Commonwealth of Independent States; ME = Middle East; NA = North America; SCAC = South and Central America and the Caribbean.

increase in piracy and political instability in the regions along the trade route, and the introduction of much larger post-Suez ships in an attempt to lower the costs of shipping lines.

The Asia–North America route in Figure 5 is split between the West and East Coasts, the flow to the East Coast being through the Panama Canal. The Panama Canal expansion will permit larger ships to transit the Canal but the operational savings do not look large enough, given current volumes, to change the routing in any significant way.

CHARACTERISTICS OF DESIRED ANALYTICS

The analysis so far has focused on only one dimension: merchandise trade data as a means of understanding the evolution of trade routes and identifying where

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Figure 5: Global inter-regional merchandise trade, US dollars (billions)

Note: CIS = Commonwealth of Independent States; ME = Middle East; NA = North America; SCAC = South and Central America and the Caribbean.

logistics investment may be required. This is clearly not enough to make any meaningful infrastructure investment decisions, although it is still quite complex because of the multifaceted nature of trade.

A key element in a trade route is the container line service. Unless container lines are able to identify services that they believe will be profitable, improving port infrastructure will not result in increased trade through the port. Models are required to determine the impact of creating or expanding a container line's services (ship size, frequency, ports of call, pricing, among others) under different assumptions of trade growth, inventory cost, and connectivity with other logistics services. Container services typically make calls at each major port on the route at least weekly. For a route that takes 35 days to complete, this means employing five container ships and crews. Bigger ships means more potential revenue for each cycle, but only if there is sufficient volume to get reasonable utilization of the ships. Shippers book containers on the ships based on the transportation price, the number of days in transit, the number of days between port calls, and the connectivity to the points of origin in the exporting country and the destination in the importing country. Transportation price is a particularly difficult issue for the shipping lines, particularly since trade is often imbalanced. This imbalance results in a much lower price in one direction than the other (e.g., the cost of shipping a container from Asia to the United States is typically at least twice as much the cost of shipping the same container from the United States to Asia).

Another important consideration for shippers is the inventory carrying cost. This can influence where and how products are sourced and shipped. A reasonable approximation of inventory cost associated with a lane is given by [(transit time) + (time spent at port calls)] × (inventory rate) × (product value). Inventory rates are typically capital carrying rates and vary between 10 and 30 percent. For example, a container of product valued at US$36,000 at an inventory rate of 10 percent would have an inventory cost per day of about US$10. As a point of reference, a 40-foot container of sports shoes, depending on the brand, typically have a value of between US$350,000 and US$2,500,000, while a 40-foot container of appliances typically has a value of between US$30,000 and US$100,000. Obviously, the inventory cost per day for high-end sports shoes at US$685 per day is much more than for the appliances. The price of transporting a 40-foot container from Asia to the United States is typically US$3,500–US$4,000. For higher-valued containers, the inventory cost may well exceed the transportation cost and will therefore influence routing decisions.

CONCLUSION

For the past 20 years, a steady evolution of software systems has aided companies in locating and sizing manufacturing and warehousing facilities. These software systems now include excellent geographic information systems, road networks, transport cost estimators (particularly for trucking), optimization routines, and scenario managers. Such systems allow systematic generation and evaluation of supply chain network alternatives for companies under different scenarios. Although in the 1990s there were few data to support these systems, excellent data are now available—at

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least in more-developed countries—that enable good investment decisions for this piece of the global logistics puzzle. For the other players (public policymakers and logistics service providers) there is a critical need for new systems and data to support decision making.

The trade data mostly available today are not convenient for logistics analysis because they specify neither the points of origin and destination within countries, nor the mode and type of transport used. New systems with models and technology for assessing the analytics, similar to those used by shippers to design their supply chains, must be developed. The models will require additional data on pricing (by sea, land, and rail), tariffs, time, capacity, and frequency of service of lanes, and they must consider information on GDP, income trends, and population growth in various metropolitan areas. These new systems must combine statistical analysis, flow optimization models, and simulation capabilities, and must work on a geographic information system. They must also interface with trade and demographic databases, shipping line schedules and capacities, and other mode-pricing mechanisms.

Although using simple analytics, as was done in this chapter, provides interesting insights into ways that trade is evolving, both the systems and data to support these systems are unable to predict with any confidence how trade routes will evolve or to determine how best to take advantage of billions of dollars of public and private investment. The best approach would be to develop systems with dynamic modeling capabilities for studying different scenarios, under varying assumptions and parameters. These systems could quantify the overall risks and payoffs of the various scenarios.

NOTE

1 Istrate et al. 2012.

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Istrate, E., A. Berube, and C. A. Nadeau. 2012. *Global MetroMonitor 2011: Volatility, Growth, Recover.* Washington DC: The Brookings Institution Metropolitan Policy Program. Available at http://www.brookings.edu/~/media/Files/rc/reports/2012/0118_global_metro_monitor/0118_global_metro_monitor.pdf.

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