

APPENDIX. CALCULATING NATIONAL LOGISTICS COSTS

Logistics costs are an important factor affecting the competitiveness of both firms and nations. Firms can enhance their market competitiveness by reducing their logistics costs, thus lowering the total costs of goods and services. Greater market competitiveness of a nation's firms can then give rise to greater national industrial competitiveness on a global scale.

Total logistics cost analysis is the key to managing the logistics function. It is important that management consider the total of all logistics costs. Controls should be instituted to minimize the total costs of logistics rather than to minimize the cost of each component. However, determining which component of logistics costs to reduce can be problematic, since there is a trade-off between cost components. In fact, attempts to reduce the cost of individual logistics activities in isolation may even lead to greater total logistics costs. Thus, at the level of the firm, attempts should be made to integrate the logistics system so as to minimize total logistics costs.

From the perspective of government policy, however, effective cost reduction in the national logistics system can be accomplished only by identifying individual components. Consequently, the calculation of individual logistics cost components has been critical to nations in their efforts to make appropriate policy decisions.

In this appendix, the concept of logistics costs is first defined. This is then followed by an overview of the national logistics methodologies of the U.S. and the Republic of Korea.

A. The concept of logistics costs

Logistics consists of activities that facilitate the movement of goods from supply to demand. As many such activities require the use of ports, port authorities have taken a particular interest in the various port activities involved in logistics.

Performance indicators of logistics activities measure the performance of a logistics system and evaluate its efficiency level. As such, performance indicators can be used in improving logistics systems within a particular firm or throughout a national economy. The major reason for measuring logistics performance is to reduce operating costs. Measuring operating costs helps to identify whether and where to make operational changes to control expenses and identify areas for improved assets.

Although logistics performance indicators can be evaluated in various ways, depending on the purpose, in general they fall into one of two categories: (1) costs indicators, which indicate costs consumed in carrying out logistics activities, and (2) service indicators, which indicate the results of logistics activities. Since business competitiveness can be enhanced through cost reductions and service improvements in logistics activities, it is important that companies and governments be competent in measuring logistics related performance.

Cost indicators are popular performance indicators, though the measurement methodology has not been standardized. Moreover, there is no guideline regarding which

indicator to use when measuring the efficiency or productivity of individual logistics activities. Logistics costs include the following:

- cost of transport activities, for each mode;
- cost of storage or warehousing activities;
- cost of time value or investment in goods in a logistics system, including the added value of transportation;
- cost of physical form changes required for effective and/or safe transport, storage, and handling;
- cost of marking, identifying, recording, analysis, as well as data transfer and handling;
- cost of stacking/unstacking activities;
- cost of added packaging required;
- cost of material transfer activities;
- cost of consolidation/deconsolidation activities;
- cost of information and telecommunications integration;
- cost of logistics system management;
- cost of unavailability of goods (when required).

In general, the costs of transport activities and non-physical handling activities, such as an inventory and related time costs, constitute the majority of logistics costs.

B. Comparison of macroeconomic logistics costs

Though business circles and government policy makers had become increasingly concerned about rising logistics costs, Haskett, of Harvard University, was troubled that the discussions surrounding logistics costs were not based on reliable statistics. Therefore, he developed a methodology to estimate macroeconomic logistics costs, one that included transportation-related infrastructure investment costs and business-related logistics costs. His attempt was the first of its kind to emphasize the importance of total logistics cost estimates that were based on annually-published official government statistics.²⁰ According to his estimates, macroeconomic logistics costs amounted to about 18.5 per cent of the national wealth invested in private and government logistics activities. Over 80 per cent resulted from investment by private enterprises or individuals, and the rest from investment by the public sector (national, state, or local governments).

Several countries, such as the United States, Japan and the Republic of Korea, publish their national macroeconomic logistics costs every year. Cass Information Systems, Inc. publishes the national logistics costs of the U.S. annually, while the Korea Transport Institute publishes those of the Republic of Korea. Recently, the Japan Institute of Logistics Systems also began to publish macroeconomic logistics costs based on the methodology that was originally developed by Haskett and further elaborated by Cass Logistics Ltd.

²⁰ J. L. Haskett, "Macroeconomic Cost of Physical Distribution." ATRF, 1962 and Haskett and others, *Business Logistics* (2nd ed.), 1973.

Because the United States, Japan and Korea employ very similar methodologies in compiling their statistics, a comparison of their results can provide a representative comparison of the efficiency of the logistics systems at an advanced economic level. In each country's compilations, logistics costs are categorized by activity, with each activity including information on its share of costs in the logistics system and its size as a percentage of GDP. Through analysis and comparison of such annual statistics, it is possible to identify trends, the strengths and weaknesses of each national economy, as well as the successes and failures of each country's logistics related policies.

Table A.1 compares logistics costs as a percentage of nominal GDP for the United States, Japan, and Korea. In the United States and Japan, logistics costs as a percentage of nominal GDP has either been steadily decreasing or remained stable. In Korea, however, logistics costs as a percentage of GDP have shown a steady increase in the 1990s.

Estimates of expenditures for transportation and logistics services are provided annually for the U.S. market by Cass Information Services, based on data from a number of public and private sector sources. The CASS's "Annual State of Logistics Report" shows that over \$ 800 billion will be spent within the U.S. for logistics performance in 1998. This represents 10.6% of GDP, down from 16.6% in 1980, i.e. before deregulation of freight transport operations.

Michigan State University (MSU) researchers have estimated that the global logistics expenditure is approaching \$ 3.5 trillion annually. The MSU's Collaboratory on the Global Logistics Market is developing methodologies to estimate and forecast the level of global logistics expenditure on a per nation, regional and aggregate basis. It is also seeking to improve understanding of the composition and trends of logistical expenditures, and to identify the so-called "battlefield" issues separating the public and private sector that impact on logistical effectiveness and efficiency. The sponsors of this initiative are still seeking collaborators from the private and public sector, including financial supports from United States and foreign stakeholders.

Table A.1. Logistics costs as a percentage of gross domestic product

Year	(Percentage)		
	U.S. ¹⁾	Japan ²⁾	Korea ³⁾
1991	10.6	10.6	14.8
1992	10.1	10.1	15.1
1993	9.9	9.8	14.8
1994	10.1	9.6	14.8
1995	10.4	9.7	15.3
1996	10.3	9.5	15.2
1997	10.1	9.6	15.4
1998	10.1	-	16.5
1999	9.9	-	16.3

Source: 1) Cass Logistics Ltd., 11th Annual "State of Logistics Report".

2) Japan Institute of Logistics Systems.

3) The Korea Transport Institute.

C. Estimates of macroeconomic logistics costs in the United States

Cass Logistics System Inc. calculates and publishes annually national logistics cost statistics for the United States in annual *State of Logistics Report*²¹. The report breaks down overall logistics costs into three key components: transportation costs, inventory carrying costs, and administration costs.

(a) *Transportation costs*

Total transportation costs include costs for both primary and secondary transportation. Primary transportation is the movement of finished goods from plants and vendors to warehouses. Primary transportation costs include costs for replenishment movement from plants or distribution centres to other plants or distribution centres, and inbound freight on purchased finished goods movement to plants or distribution centres for resale. Secondary transportation is the delivery of finished goods to customers. Secondary transportation costs include payments to carriers, pickup allowances, truck or rail equipment and operations costs, and freight allowed. Freight may originate in plants, distribution centres or terminals. Transportation costs include costs for all modes, including trucking, rail transport, water and oil pipeline, and both international and domestic airfreight transport, as well as freight forwarding and shipper-related costs.

The freight transportation costs in the Cass report account for the largest portion of logistics costs. These estimates are based on the annual *Transportation in America* report published by the Eno Transportation Foundation. Of total transportation costs, trucking costs continue to dominate the United States business logistics system, accounting for more than 80 per cent share of the nation's freight billing. Shipper-related costs include the loading and unloading of transportation equipment, as well as traffic department operations.

(b) *Inventory carrying costs*

Inventory carrying costs include the cost of money (opportunity or interest), ad valorem taxes, insurance and shrinkage. Following extensive research and analysis, Cass Logistics set this level at 18 per cent in 1974, when it started the Database. The figure still represents a reasonable measure of the cost of carrying inventory, although there have been many arguments for both lower and higher figures. Inventory carrying costs include those costs that vary with the level of inventory stored. They can be categorized into the following four groups: (1) capital costs, (2) inventory service costs, (3) storage space costs, and (4) inventory risk costs.

Capital Costs for Inventory Investment

Holding inventory ties up money that could be used for other types of investments. Consequently, the company's opportunity cost of capital should be used to reflect accurately the true cost involved. All inventory carrying cost components must be stated in before-tax numbers, since all the other costs in the trade-off analysis, such as transportation and warehousing, are reported in before-tax dollars.

²¹ This report has taken on oracle status in the profession and statistics in it are often cited in federal government reports.

Inventory Service Costs

Inventory service costs comprise taxed and insurance paid as a result of holding inventory. In general, taxes vary directly with inventory levels. Insurance rates are not strictly proportional to inventory levels, but are related to the value of certain items over a specified time period.

Storage space costs

Storage Space Costs can be incurred at four types of facilities:

- plant warehouses;
- public warehouses;
- rented (leased) warehouses;
- company-owned(private) warehouse.

Inventory risk costs

Although inventory risk costs vary depending on the company, in general, they include charges for: (1) obsolescence, (2) damages, (3) pilferage, and (4) relocation.²²

Inventory carrying costs, the cost of taxes, and obsolescence, depreciation and insurance are estimated according to the Alford–Bangs Production Handbook formula, which has been used in the methodology of *Transportation in America* since its was first published in 1973.²³ In this formula, obsolescence accounts for nearly 40 per cent of total inventory carrying costs, thus demonstrating the challenges facing inventory managers in the world of fast cycles and just-in-time procurement. Total warehousing cost estimates encompass both public warehouses and private warehouses operated by manufacturing and distribution companies. Public warehousing costs are obtained from the public warehousing services data reported by the Commerce Department’s Census Bureau.²⁴ Private warehousing costs are independently obtained from the public warehousing costs, by Cass Logistics.

(c) *Administration cost of distribution*

The third component of logistics costs, administration costs, includes indirect management personnel and support staff, including the central distribution staff, inventory planning and analysis staff, and the traffic department. Nowadays, computer software and hardware cost allocations are an important distribution expense. Such costs are included in the appropriate cost categories, with any remainder considered part of administration costs.

²² Relocation costs are incurred at the transshipment of inventory from one warehouse location to another to avoid obsolescence.

²³ They applied 25 per cent of inventory carrying rate. L. P. Alford and J. R. Bangs (eds.), *Production Handbook*, New York: Ronald Press, 1955.

²⁴ Meanwhile, Haskett applied 22 per cent in his paper, which includes warehousing costs (.25 per cent), insurance (.25 per cent), taxes (.5 per cent), depreciation (5 per cent), interest (6 per cent), obsolescence (10 per cent).

Logistics administration costs are set at four per cent of the sum of the inventory-carrying costs and transportation costs, in line with the methodology that has been consistently employed since *Transportation in America* was first published in 1973.

(d) Trends of logistics costs

According to the estimates by Cass Logistics Inc., the costs associated with the business logistics system in the United States in 1999 increased to \$ 921 billion, or 9.9 per cent of nominal GDP.

Transportation costs account for more than 60 per cent of total logistics costs, with road transport accounting for more than 80 per cent of transportation costs. Trucking costs increased by 5.9 per cent in 1999. Railroad revenues increased by 1.0 per cent, while water and oil pipeline transportation costs remained flat. Domestic airfreight revenues increased by 6 per cent, and international air freight revenues increased by 8 per cent.

In 1999, the average investment in all business inventory in agriculture, mining, construction, services, manufacturing, wholesale and retail trade stood at \$ 1.376 trillion. Inventory investment during 1999 was \$ 4.9 billion higher than the previous year. The cost of carrying inventory in 1999 includes interest at the annualized commercial paper rate of 5.1 per cent. See table A.1.2.

Table A.2. United States of America national logistics costs, 1999

	\$ Billions	
Inventory Carrying Costs (\$1.376 trillion in Total Business Inventory)		
Interest	70	(0.008)
Taxes, Obsolescence, Depreciation, Insurance	187	(0.020)
Warehousing	75	(0.008)
	Subtotal	332 (0.036)
Transportation Costs		
Truck – Intercity	300	(0.032)
Truck – Local	150	(0.016)
	Subtotal	450 (0.049)
Railroads	36	(0.004)
Water	22	(0.002)
Oil Pipelines	9	(0.001)
Air	26	(0.003)
Forwarders	6	(0.001)
	Subtotal	99 (0.011)
Shipper Related Costs	5	(0.001)
Logistics Administration	35	(0.004)
Total logistics cost	921	(0.099)

Source: Cass Logistics Ltd., *11th Annual "State of Logistics Report,"* June, 2000.

Note: Figures in parenthesis are per centage of nominal GDP.

Table A.3²⁵ shows that logistics costs as a per cent of equivalent nominal GDP declined from 16 per cent in 1981 to 10 per cent in the 1990s. Since 1982, improvements in inventory efficiency have been dramatic, as the United States business logistics system has replaced inventory with more versatile and responsive transportation services. The United States business logistics system has succeeded at keeping transportation costs stable at 6.0 per cent of GDP for the past seven years. Inventory management has also been a key factor in maintaining U.S. business logistics costs at 10 per cent of nominal GDP or lower.

Logistics is the management of inventory in motion or at rest. Inventory is in motion during transportation and at rest when it is awaiting production of finished goods and distribution at the final point of sale. The ratio of manufacturing and trade inventory-to-sales has been reduced substantially over the years as transportation facilities become more ubiquitous and as electronic communication technology facilitates the exchange of information among shippers and carriers, thus increasing the flow of deliveries. The ratio of inventory as a percentage of GDP was 7.6 per cent in 1980 and declined to 3.6 per cent in 1999, with a consequent reduction in overall logistics cost. However, this reduction in cost could have only been achieved when all transport infrastructure, effects for all stakeholders.

Table A.3. The cost of the business logistics system in relation to gross domestic product

Year	Nominal GDP (Trillions of US \$)	Inventory carrying costs (Billions of US \$)	Transportation costs (Billions of US \$)	Administrative costs (Billions of US \$)	Total U.S. logistics cost (Billions of US\$)	Logistics of GDP	Inventory as a percentage of GDP	Transportation as a percentage of GDP
1980	2.88	220	214	17	451	15.7	7.6	7.4
1981	3.17	259	228	19	506	16.0	8.2	7.2
1982	3.31	234	222	18	474	14.3	7.1	6.7
1983	3.64	211	243	18	472	13.0	5.8	6.7
1984	4	239	268	20	527	13.2	6.0	6.7
1985	4.23	227	274	20	521	12.3	5.4	6.5
1986	4.51	217	281	20	518	11.5	4.8	6.2
1987	4.74	225	294	21	540	11.4	4.7	6.2
1988	5.11	251	313	23	587	11.5	4.9	6.1
1989	5.49	283	329	24	636	11.6	5.2	6.0
1990	5.8	283	351	25	659	11.4	4.9	6.1
1991	5.99	256	355	24	635	10.6	4.3	5.9
1992	6.32	237	375	24	636	10.1	3.8	5.9
1993	6.64	239	396	25	660	9.9	3.6	6.0
1994	7.05	265	420	27	712	10.1	3.8	6.0
1995	7.4	302	441	30	773	10.4	4.1	6.0
1996	7.81	303	467	31	801	10.3	3.9	6.0
1997	8.43	315	503	33	851	10.1	3.7	6.0
1998	8.76	324	529	34	887	10.1	3.7	6.0
1999	9.26	332	554	35	921	9.9	3.6	6.0

Source: Cass Logistics Ltd., *11th Annual "State of Logistics Report,"* June 2000.

²⁵ Data Sources are National Income and Products Accounts – Levels; Survey of Current Business March 2000; U.S. Statistical Abstract; U.S. Department of Commerce, *Transportation in America*, Rosalyn Wilson, 1999 ENO Transportation Foundation, Washington, D.C.

D. Estimates of macroeconomic logistics costs in the Republic of Korea

The Government of the Republic of Korea has been particularly concerned about logistics problems since the 1980s. A sudden and rapid increase in national logistics costs during the mid-1990s convinced the government to pursue various approaches in devising solutions. The solutions it came up with include: continuous investment in infrastructure such as ports, airports, roads and railways; development of freight and logistics terminals in several provinces; and building an integrated logistics information network to be used in inducing advanced communication techniques from overseas.

However, the growth in logistics costs has weakened the international competitiveness of the Republic of Korea products and services, and has led to high domestic distribution costs. Thus, in an effort to better understand the current national logistics system and implement strategies to improve it, the Korea Transport Institute initiated a project to develop a methodology for estimating logistics costs in order to evaluate the efficiency of the logistics system of the Republic of Korea.

(a) *Methods of estimation*

Logistics efficiency is evaluated based on various logistics cost factors, such as transportation costs, inventory holding costs, packing costs, stevedoring costs, information costs and administration costs. Each cost factor is further classified as a private cost or a public cost, such as consignment. Table A.4 shows the sources of statistical data for each logistics cost factor.

1) *Transportation costs*

Transportation costs include the cost of rail, road, water and air transport, as well as agent costs and other shipper-related costs. Rail transportation costs are further divided into various categories of freight cost. Road transportation costs are evaluated separately, based on whether they are public costs or private costs. Water transportation costs include costs of inland ports, ocean freight, and domestic coastal maritime transportation. International maritime transportation costs are divided into transportation costs of domestic carriers or foreign carriers. Airfreight transportation cost is estimated in a similar way. Airfreight transportation is categorized as national transportation costs or international transportation costs, and international transportation costs are further divided into costs by domestic airlines and foreign airlines.

Rail transportation costs

Rail transportation costs are estimated using the *Railway Statistics Annual Report*, which is published by the Korean National Railroad Administration. The Report includes income and expenses in the car-load freight section and the mini-load (less than car-load) section. Also, it assumes that rail freight transportation income is equal to rail's costs, since the rail freight business section of the Korean National Railway Administration has been posting a deficit whenever rail transportation operating costs exceed rail transportation revenues. For this reason, KOTI also assumes rail transportation income to be equal to rail transportation costs.

Table A.4. Sources of statistical data for logistics costs in the Republic of Korea

Items	Class I	Class II	Class III	Sources
Transportation	Rail	Freight		Railway Statistics Annual Report
		Mini-load		
	Road	Public	Route	Transportation Industry Statistical Investigation Report
			Special	
			Zone	
			Contract	
			Other	
	Private	Operations	Own Calculation	
		Tolls	Korea Highway Corporation	
	Water	Inland port		Transportation Industry Statistical Investigation Report; Korea Vessel Agency Association
		Ocean	Domestic	
			Foreigner	
	Inland water			
Air	National		Annual Report of Ministry of Construction & Transportation	
	International	Domestic		
		Foreigner		
Agency	Agency		Transportation Industry Statistical Investigation Report	
Inventory Carrying	Custody	Public	Ordinary	Transportation Industry Statistical Investigation Report
			Cold storage	
			Dangerous	
			Agricultural	
			Other	
	Private		Korea Chamber of Commerce & Industry	
Inventory holding		Enterprise Management Analysis		
Breakage		Korea Chamber of Commerce & Industry		
Packing	Corrugated cardboard		KCCA	
	Pallet		Korea Chamber of Commerce & Industry	
Handling and Lading/ Unloading	Land and Air		Transportation Industry Statistical Investigation Report	
	Water			
Information			Korea Chamber of Commerce & Industry	
Administration			Korea Chamber of Commerce & Industry	

Road transportation costs

Public road transportation costs are computed using transportation revenue data from the following business areas: special freight, sector freight, delivery service freight, funeral vehicles, pipeline transportation business, etc. In contrast, private road transportation costs are estimated in the following way:

a. Estimation process

Compared with public road transportation costs, there is very little relevant data on private road transportation costs. Since official statistical data are not reported for public road transport costs, applying simply the cost of the public to the private cost brings the result, which disregards its characteristics. For this reason, KOTI calculates private road transportation costs using its own methodology.

b. Items included in vehicle operation costs

The Vehicle operating cost factor is classified as the cost of materials, labour costs, and expenses. Cost of materials includes the cost of fuel, miscellaneous oils, tires, tubes, etc. Labour costs include drivers and maintenance technicians. Expenses are divided into direct expenses, meaning those expenses necessary in order to operate a vehicle, and indirect costs. Direct expenses include maintenance costs, insurance costs and depreciation. Indirect costs include worker's compensation, welfare expenses and public taxes.

c. Classification of vehicles, and estimates of the number of vehicles

There are various types of freight vehicles, and they are categorized by usage and by size. Costs and efficiency of freight vehicles depend on usage and tonnage class. Thus, vehicle operation costs must be computed based on the particular vehicle's usage and tonnage.

d. Calculation of operating costs for each vehicle

- **Fuel costs**

Fuel cost is estimated as: annual average fuel used x unit cost of one litre. The corresponding amount for annual average fuel used is taken from the report *Total Investigation*, published every three years by the Ministry of Commerce, Industry and Energy. The unit cost is the retail price of low-sulfur oil, which contains a value-added tax.

- **Miscellaneous oil costs**

Miscellaneous oils include both engine oil and anti-freeze solution. KOTI calculates miscellaneous oil costs as 5 per cent of the total annual fuel costs.

- **Tire wear-and-tear costs**

Annual tire wear-and-tear costs are computed by dividing annual total driving distance by standard distance, then multiplying by the number of tyres for the appropriate tonnage class vehicle, as follows:

$(\text{Annual total driving distance} / \text{Appropriate standard distance}) \times \text{Number of tires attached to the vehicle type} \times \text{Standard unit cost per tire.}$

In figuring out the number of attached tires, KOTI uses 6 tires for vehicles under 8 tons, and 10 tires for others. KOTI also assumes 60,000 kilometres for the substitution standard distance.

- **Labour costs**

Annual labour cost is the expense for personnel used in the operation and maintenance of freight trucks. This labour cost is derived as follows:

$\text{Average monthly labour cost} \times \text{Number of personnel} \times 12 \text{ (months).}$ Base salaries and pension plan appropriations are both included.

- **Insurance**

Insurance is calculated as:

$\text{Liability} + \text{full coverage insurance (} = \text{driver insurance} + \text{substance insurance} + \text{vehicle damage insurance),}$

Where, $\text{Vehicle damage insurance} = \text{Vehicle price} \times \text{Vehicle Class insurance ratio}$

- **Repair and Maintenance Costs**

Repair and maintenance costs are calculated as follows:

$\text{Repair and maintenance costs} = \text{Public vehicle maintenance cost of repair} \times \text{Price coefficient} \times \text{Private vehicle conversion coefficient}$

- **Depreciation costs**

$\text{Depreciation costs} = \text{Redemptive amount of money} / \text{endurance year (6 years)}$

Where, redemptive amount of money is the difference between initial value and final value. Initial value is obtained by multiplying the vehicle value by 1.02 (2 per cent acquisition tax), and the final value is obtained by multiplying the initial value by 10 per cent.

- **Indirect expenses**

Public welfare costs are calculated by multiplying the sample ratio to all direct expenses (① +... + ⑦), where sample ratio is obtained by dividing public welfare expenses in transportation business sector by direct expenses in the transportation business sector.

- **Tolls**

The annual toll income of the Korea Highway Corporation is used.

Water Transportation costs

Water transportation costs are classified into domestic freight transportation costs and international maritime freight costs.

- a. **Domestic water transportation costs**

Domestic water transportation costs are computed using the transportation income of coastal shipping business and inland water transportation business from the *Transportation Industry Statistical Investigation Report*.

- b. **International maritime transportation costs**

These costs include the income from foreign trade by the maritime sector, including maritime transportation costs by both domestic and foreign shipping firms. The transportation costs of domestic shipping firms are taken from the transportation income of the international freight transportation business found in the *Transportation Industry Statistical Investigation Report*, whereas the maritime transportation costs of foreign shipping firms are calculated using data from the Korean Vessel Commercial Agent Association.

Air cargo transportation costs

These include domestic air cargo transportation costs and international air cargo transportation costs. These figures are taken from the air cargo income data of the Ministry of Construction and Transportation.

Cargo transportation agency costs

Agents do not control transportation modes. Rather, they arrange transportation services for both carriers and shippers, receiving fees for services performed. These fees are obtained from the *Transportation Industry Statistical Investigation Report*.

- 2) **Inventory-carrying cost**

Inventory-carrying cost includes capital cost on inventory investment, inventory service cost, storage cost and inventory risk cost.

Warehousing cost

Since private warehousing costs incurred by manufacturing and distribution companies for their own use are not available, these costs are estimated indirectly, using the expenditures data for public warehousing services in the *Transportation Industry Statistical Investigation Report*. Public warehouses are classified into four types, according to their function: ordinary warehousing, cold storage, dangerous commodity custody, and agricultural products warehousing.

Inventory-holding costs

Inventory-holding costs are estimated by multiplying average borrowing interest rate by inventory assets.

Inventory-risk cost

These costs are estimated by multiplying inventory assets by risk rate (damaged rate).

3) Packing costs

Packing costs are incurred for the purpose of either protecting products or efficiently handling the movement of products more efficiently. They include corrugated cardboard packing costs and pallet costs.

Corrugated cardboard packing costs are taken from the annual sales revenue figures of the Korean Corrugated Cardboard Association. Pallet costs, however, are calculated as follows:

Potential quantity of goods transported by pallet (tons) = (Road freight quantity of goods transported - Bulk freight quantity of goods transported) x Pallet coefficient of utilization (0.682).

To calculate annual numbers of pallet used, KOTI divides pallet usable quantity (tons) by units load tonnage per pallet (0.9421 tons). Then, to estimate the annual cost per pallet, KOTI divides the purchase cost (20,000 won) by the number of endurance years (2 years). Consequently, annual pallet packing costs are obtained by multiplying the numbers of pallets used in the particular year by the annual cost per pallet.

4) Handling and loading/unloading costs

The costs of loading and unloading cargo along the transportation chain are estimated by adding all handling costs for each transport mode: port handling costs, road transport handling costs, railway handling costs, and airfreight handling costs. Since private handling costs are not available, the handling costs by manufacturing and distribution companies for their business use is estimated by indirectly linking to the expenditure for the commercial handling firms, which are taken from the *Transportation Industry Statistical Investigation Report*.

5) Logistics information costs

Logistics information costs include the cost of handling and managing information for the entire logistics activities. These costs are obtained by multiplying the ratio of information cost in sales by the annual sales in the respective industry.

6) Administrative costs

Administrative costs include all costs used to support logistics activities. These costs are obtained by multiplying administration costs as a percentage of overall sales by the annual sales figure for the respective industry.

(b) Trends and analysis

Macroeconomic logistics costs in Republic of Korea are estimated using the above-mentioned methodology and by adding the following costs: transport, inventory, packing, handling, information and administration. The total cost of logistics in Republic of Korea in 1999 was estimated at 78.9 trillion won (about US\$ 61 billion). Of this amount, transport costs accounted for 69.9 per cent; inventory costs 18.1 per cent; and other costs 12.0 per cent.

Total expenditures on logistics comprised 16.3 per cent of Korea's GDP in 1999, showing a steady increase from 13.8 per cent in 1988, 14.8 per cent in 1994, and 15.4 per cent in 1997. See table A.5. This rapid growth in logistics costs as a percentage of GDP since 1988 was due mainly to an increase in transportation costs. As in the case of the United States, the transport costs continuously dominate Republic of Korea business logistics system, accounting for almost two-thirds of total logistics costs. High levels of private truck ownership and road traffic congestion are among the major factors causing the increase in transportation costs. Another major reason for the increase in transportation costs in 1999 was the sharp rise in both oil prices and labour costs. In contrast to transportation costs, however, inventory-carrying costs associated with holding goods in storage or inventory at rest have been continuously decreasing.

Table A.5. Trends of national logistics costs in the Republic of Korea, 1999*(Billions of Won and percentage)*

Year	GDP	Total logistics costs	Transport costs	Inventory carrying costs	Administration costs
1991	216,511 (100.0)	31,989 (14.8)	18,857 (8.7)	11,834 (5.5)	1,298 (0.6)
1992	245,700 (100.0)	36,995 (15.1)	23,607 (9.6)	11,950 (4.9)	1,438 (0.6)
1993	277,497 (100.0)	41,201 (14.8)	26,836 (9.7)	12,750 (4.6)	1,615 (0.6)
1994	323,407 (100.0)	47,753 (14.8)	31,037 (9.6)	14,780 (4.6)	1,936 (0.6)
1995	377,350 (100.0)	57,916 (15.3)	38,095 (10.1)	17,538 (4.6)	2,283 (0.6)
1996	418,479 (100.0)	63,754 (15.2)	42,378 (10.1)	18,824 (4.5)	2,552 (0.6)
1997	453,276 (100.0)	69,590 (15.4)	46,546 (10.3)	20,015 (4.4)	3,029 (0.7)
1998	444,367 (100.0)	74,170 (16.5)	50,244 (11.2)	20,768 (4.6)	3,158 (0.7)
1999	482,744 (100.0)	78,892 (16.3)	55,178 (11.4)	20,416 (4.2)	3,298 (0.7)

Source: Korea Transport Institute.

Note: 1. Figures in parentheses are per centage of nominal GDP.

2. Inventory-carrying costs in this table include not only inventory-carrying costs, but also packing, loading/unloading and information costs.