Report No. 5206-CHA

China: Long-Term Issues and Options

Annex F: Transport

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CURRENCY EQUIVALENTS

The Chinese currency is called Renminbi (RMB). It is denominated in Yuan (Y). Each Yuan is

1 Yuan = 10 jiao = 100 fen

In early 1984 the official exchange rate of the Yuan to the US dollar was around Y 2 = $1. The internal settlement rate (ISR) of Y 2.8 = $1, however, was used in most merchandise transactions. The official exchange rate is now about Y 2.8 = $1. On January 1, 1985, the Government abolished the ISR.

FISCAL YEAR

January 1 to December 31

WEIGHTS AND MEASURES

tkm	=	ton-kilometer
pkm	=	passenger-kilometer
mu	=	0.0667 hectare (ha)
kWh	=	kilowatt hour (= 860.42 kcals)
CTK	=	converted ton-km, traffic unit (= 1 passenger-km = 1 ton-km)
mt	=	million tons
mtpy	=	million tons per year
MW	=	megawatt
kcal	=	kilo-calorie
kV	=	kilovolt
kVA	=	kilovolt-ampere

ABBREVIATIONS AND ACRONYMS

AIC	-	Average incremental cost
CASS	-	Chinese Academy of Social Sciences
CBEs	-	Commune and Brigade Enterprises
DWT	-	Dead weight ton
GDP	-	Gross Domestic Product
GNP	-	Gross National Product
GVIAO	-	Gross Value of Industrial and Agricultural Output
GVIO	-	Gross Value of Industrial Output
LRMC	-	Long run marginal cost
LRVC	-	Long run variable cost
MR	-	Ministry of Railways
MOC	-	Ministry of Communications
NMP	-	Net Material Product

CHINA: LONG TERM ISSUES AND OPTIONS

ANNEX F

TRANSPORT

Table of Contents

	Page No.
SUMMARY	vi-xiii
PART I: TRANSPORT INDICATORS: CHINA AND THE INTERNATIONAL EXPERIENCE	1
1. TRANSPORT IN THE ECONOMY	1
2. FREIGHT TRAFFIC	4
A. Freight Growth	4
B. Freight Intensity	6
C. Average Transport Distance and Modal Split	13
D. Port Traffic	20
3. PASSENGER TRAFFIC	23
A. Growth of Passenger Traffic	23
B. Travel Purpose	27
C. Modal Split	29
4. CAPITAL INVESTMENT AND PRODUCTIVITY	30
A. Infrastructure	30
B. Rolling Stock	33
C. Investment	33
PART II: FUTURE DEVELOPMENTS AND ISSUES	37
5. FUTURE TRANSPORT TRENDS	37
A. Freight Transport Demand	37
B. Modal Split	39
C. Railways	41
D. The Role of Road Transport	42
Road Infrastructure	43
Road Transport	45
E. Domestic Water Transport	47
F. Port Development	49
G. Passenger Transport	49
H. Modal Split	50

Page No.

6. TRANSPORT AND ENERGY.. 53

A. Energy Transport Issues.. 53
Coal.. 53
Petroleum.. 59
B. Energy Consumption in the Transport Sector................ 59
Railways.. 59
Road Transport.. 60

7. TRANSPORT AND INDUSTRIAL LOCATION........................ 61

A. Natural Resources.. 61
B. Heavy Industry.. 62
Cement.. 62
Iron and Steel.. 64
C. Light Industry.. 67

8. TRANSPORT AND AGRICULTURE.. 68

A. Grain.. 68
B. Fertilizer.. 72
C. Transport and Rural Development........................ 73
D. Conclusion.. 74

TABLES IN TEXT

1.1 Transport as Percentage of GDP 1
1.2 Freight and Passenger Transport Intensity.................. 2

2.1 Freight Traffic Volume.. 4
2.2 Total Freight (Billion tkm) and GNP (US$ Billion): A Cross-Country Comparison........................ 6
2.3 Freight Intensity, 1980.. 8
2.4 Total Freight, 1980.. 8
2.5 Percentage Distribution of GDP........................ 9
2.6 Freight Intensity, 1980-81.. 10
2.7 Coal Preparation in Percentage of Raw Coal.................. 10
2.8 Transport of Timber and Products........................ 11
2.9 Freight Transport Intensity, Rail Network and Heavy/ Light Industry Share by Province........................ 14
2.10 Modal Split of Freight Traffic in % of Total tkm............ 15
2.11 Rail and Road Tonnage.. 15
2.12 Japan: Coastal Shipping.. 17
2.13 India: Intermodal Share by Commodity.................. 19
2.14 US: Cement and Fertilizer Distribution by Mode, 1977....... 19
2.15 Port Traffic in Selected Countries........................ 21
2.16 Foreign Trade Component of GNP for Selected Countries....... 21

Page No.

TABLES IN TEXT (cont'd)

3.1	Passenger Traffic Volume....................................	23
3.2	Intercountry Comparison of Passenger Traffic Per Capita and GNP Per Capita..............................	25
3.3	US: Household Trips by Purpose, 1977......................	27
3.4	Intercountry Comparison of Passenger Traffic Growth Rates and Income Elasticity.....................................	28
3.5	Intercountry Comparison of Modal Split of Passenger Traffic	29
4.1	Transport Network, 1952-82..................................	30
4.2	Transport Network Density in Selected Countries............	31
4.3	Railway Traffic Density in Selected Countries..............	31
4.4	Truck Productivity in Selected Countries...................	32
4.5	Transport Rolling Stock in Selected Countries..............	34
4.6	India: Share of Public Sector Investment in Transport......	35
4.7	Annual Transport Sector Investment in Selected Countries....	35
5.1	Elasticity of Freight Transport to GVIAO...................	38
5.2	Freight Growth Scenarios....................................	39
5.3	Scenarios for Future Freight Modal Split...................	40
5.4	Domestic Water Transport....................................	48
5.5	Foreign and Domestic Trade through Major Coastal Ports......	49
5.6	Passenger Traffic Growth Scenarios.........................	50
5.7	Rail and Road Passenger Traffic............................	50
5.8	Scenarios for Future Passenger Modal Split.................	51
6.1	1982 Interregional Rail Coal Transport.....................	54
6.2	Net Interregional Coal Flows...............................	54
6.3	Coal Production and Transport-Cost Comparison..............	55
6.4	Regional Coal Production, 1980-2000........................	55
6.5	Combined Rail-Water Routes for Coal........................	57
7.1	Patterns of Coal and Timber Transport by Rail..............	61
7.2	Cement and Iron and Steel Transport by Rail................	62
7.3	Cement Price and Transport Tariffs.........................	63
7.4	Major Pig Iron Producing Provinces.........................	65
7.5	Iron and Steel Production and Rail Transport...............	66
8.1	Grain Transport...	68
8.2	Rail Transport of Grain, 1982..............................	69
8.3	Net Interregional Grain Flows..............................	69
8.4	Indicative Data on Grain Handling Facilities at Major Ports..	71
8.5	Fertilizer Rail Transport, 1982............................	72

Page No.

FIGURES

1.1 Comparative Growth of Net Material Product, Output of Agriculture and Industry and Transport in Tons and Ton-Km.... 3
2.1 GVIAO and Total Freight Growth Trend, 1952-1982.... 5
2.2 Total Freight and GNP for Selected Countries, 1960-1981.... 7
2.3 China and Japan Coastlines: Comparative Distances Between Major Ports.... 18
3.1 Passenger Traffic, 1952-1982.... 24
3.2 Intercountry Comparison of Passenger Traffic and GNP Per Capita.... 26

APPENDICES

A. Coal Transport versus Electricity Transmission.... 75

B. Statistical Tables.... 79

B.1 Intercountry Comparison of Freight Traffic Growth and GNP Elasticity.... 80
B.2 Total Freight and GNP for Selected Countries, 1960-81.... 83
B.3 Intermodal Freight Intensity by Province, 1981.... 84
B.4 Intercountry Comparison of Average Freight Distance, Selected Years, 1940-82.... 86
B.5 Short Distance Rail Transport in Large Urban Areas.... 87
B.6 Short Haul Transport on Selected Trunk Lines.... 88
B.7 Freight Turnover by Mode of Transport.... 89
B.8 US - Freight Turnover by Mode of Transport.... 89
B.9 USSR - Freight Turnover by Mode of Transport.... 90
B.10 Brazil - Freight Turnover by Mode of Transport.... 90
B.11 India - Freight Turnover by Mode of Transport.... 91
B.12 Japan - Freight Turnover by Mode of Transport.... 91
B.13 Japan - Water Transport by Commodity.... 92
B.14 Rail Freight by Commodity.... 93
B.15 USSR - Rail Freight by Commodity.... 94
B.16 India - Rail Freight by Commodity.... 95
B.17 Japan - Rail Freight by Commodity.... 96
B.18 Brazil - Rail Freight by Commodity.... 97
B.19 India - Commodity Flows and Intermodal Shares, 1978-79.. 98
B.20 Japan - Road Freight by Commodity.... 99
B.21 Intercity Passenger Traffic and Per Capita Income for Selected Countries, 1960-81.... 100
B.22 US - Household Trips by Main Purpose, 1977.... 101
B.23 Passenger Traffic by Mode of Transport.... 102
B.24 US - Passenger Traffic by Mode of Transport.... 102
B.25 USSR - Passenger Traffic by Mode of Transport.... 103
B.26 Brazil - Passenger Traffic by Mode of Transport.... 103

Page No.

APPENDICES (cont'd)

B.27 India - Passenger Traffic by Mode of Transport.......... 104
B.28 Japan - Passenger Traffic by Mode of Transport.......... 104
B.29 Railway and Road Network - Density in Selected Countries 105
B.30 Rail Density by Province................................ 106
B.31 Investment in the Transport Sector...................... 107
B.32 Freight Traffic, QUADRUPLE: Case 1 - Low Road Share..... 108
B.33 Freight Traffic, QUADRUPLE: Case 2 - Low Road Share..... 109
B.34 Freight Traffic, BALANCE: Case 3 - High Road Share...... 110
B.35 Freight Traffic, BALANCE: Case 4 - High Road Share...... 111
B.36 Road Network.. 112
B.37 Passenger Traffic, Case 1 - High Road Share............. 113
B.38 Passenger Traffic, Case 1 - Low Road Share.............. 114
B.39 Passenger Traffic, Case 2 - High Road Share............. 115
B.40 Passenger Traffic, Case 2 - Low Road Share.............. 116
B.41 Coal Production, Transportation and Consumption Summary by Province, 1980.............................. 117
B.42 Railway Energy Consumption Plan......................... 118
B.43 Cement - Production and Rail Freight Destination, 1982.. 119
B.44 Iron and Steel Products - Production and Rail Freight Destination, 1982 120
B.45 Grain - Production and Rail Freight Destination, 1982... 121
B.46 Fertilizer - Rail Freight Destination, 1982 122

MAPS

IBRD A18284 Transport Intensity, Rail Intensity and Share of Heavy Industry
IBRD 18224 Major Coal Flows, 1980
IBRD 18225 Coal Production by Region, 1980-2000
IBRD 18226 Planned Capacity Increase for Power Generation by Year 2000
IBRD 18227 Major Rail Flows of Petroleum and Products, 1980
IBRD 18228 Rail Electrification Projects - Under Construction and Near Term Plans
IBRD 18229 Coastal Shipping - Port Traffic, 1979

Errata: Map 18226 Symbol for power generation in West Henan-Anhui should be mine-mouth and not load-center

SUMMARY

1. China's annual investment in the transport sector has been small in comparison to that of other countries. The new economic policies are generating rapid economic development that is accompanied by growing demand for transport of freight and passengers. Inadequate transport systems are becoming a bottleneck in, for examples, the movement of coal from mine to user, the transport of agricultural and light industrial products from rural to urban areas and the delivery of imports and exports.

2. Massive investment in the sector is necessary though some rationalization of freight operations is possible and should certainly be pursued. Preliminary processing near the point of origin (preparation of coal, milling of lumber, etc.) would reduce the tonnages that must be shipped. Bulk handling of products like cement and chemical fertilizer would reduce the waste that occurs when bags are shipped. Use of the truck fleet (especially own-account vehicles) could be improved. Further measures to rationalize transport could be identified through distribution studies for major commodities such as coal, iron and steel, cement, fertilizer and grain.

3. It is unrealistic to think, however, that such improvements will render existing facilities sufficient to accommodate all future traffic growth. Major investments are needed to increase transport capacity and avoid stifling economic growth. In past years, China's investment in transport has averaged about 1.1% of GNP, which is low compared to other countries. Future five-year plans should consider increasing the magnitude of annual transport investments to well over 2% of GDP.

4. How could these investments be financed? Parts of the system, such as railways and ports, already generate substantial net revenues. In railways, the level of cash generation (including net operating revenues and depreciation exclusive of major repairs) amounts to over 4 billion yuan per year. For other transport facilities such as roads and ports, financing mechanisms need to be developed at all levels of Government. In particular, a review should be made of present arrangements to charge road users and consideration given to other financing alternatives such as a fuel tax.

5. The transport sector should also evolve toward more balanced allocation of traffic between modes. The responsibility system in agriculture is creating a rapid demand for road transport; water transport both coastal shipping and inland waterways, would also play a larger role to relieve the pressure on railways. The greater development of all transport modes will require inter-modal coordination. Infrastructure, as well as policies and regulations, need to be developed to promote inter-modal transfers, in cases when multi-modal services have an economical advantage.

Freight Transport

6. Transport Intensity. A number of factors affect freight transport intensity: country size; location of natural resources; industry and population; composition of GNP; the level of processing of raw materials such

as ores, lumber, agricultural products; and the degree of vertical integration of industry. The composition of GNP is probably the major factor in explaining China's high freight transport intensity. Heavy industry is more transport intensive than light industry which in turn is more transport intensive than services. When the service sector, which is unusually small in China, is excluded from GNP, the freight intensity of China appears somewhat more in line with that of other countries.

7. The location of natural resources in relation to that of population and markets is another important factor as illustrated by the movements of coal and timber. These two resources together account for over 40% of the ton-km in the freight traffic of the Chinese railways. While coal is found in many parts of China, timber is concentrated in the Northeast. As a result, the share of inter-regional transport of timber is twice that of coal and the average transport distance almost three times as long.

8. While coal is presently produced in most of China, the largest and best reserves are in north China, particularly Shanxi and Nei Monggol. A question for the future is the optimal balance between coal development near major markets in northeast and east China and coal development in Shanxi. Analyses to date show that Shanxi coal can be competitive in coastal China despite transport distance of the order of 1,000 km. Deposits in large seams are easily accessible and both investment and operating costs are lower than in other regions. In addition, coal is generally of higher quality and calorific value. Therefore further development of coal in north China appears to make good economic sense and the region is expected to account for almost 60% of the coal production increase by the year 2000. This will considerably increase inter-regional movement of coal and transport intensity per ton of output.

9. With greater concentration of coal production in north China the issue of transporting coal or electricity needs to be addressed. An analysis of this matter in Appendix A concludes that, in broad terms, rail transport would be more economical than electricity transport for coal above 5,000 kcal/kg. Since Shanxi coal is generally of high calorific value (6,000 kcal/kg or more), mine-mouth power generation and long distance transmission is likely to be justified only in the case of use of middlings, which are expected to become available in greater quantity with increased coal preparation before shipment.

10. By the year 2000, some 450-500 million tons of coal will need to be transported out of Shanxi, or over 4 times the planned volume for 1984. Increased use of coastal shipping from northern ports to southern destinations can help meet the demand, but coal will still need to be moved by rail to the ports. Therefore, substantial capacity needs to be added to the corridors leading from Shanxi to the east coast. In addition to increases in rail capacity, coal slurry pipelines are being studied, but the scarcity of water in Shanxi province may hinder such development.

11. Industrial location and plant size also affect transport patterns. The cement industry was developed in the Northeast and is only gradually becoming more evenly distributed. The raw material is usually fairly

abundant, and given the high incidence of transport cost on final product value, location of production close to markets is common in most countries. The drop in cement rail transport distance from 600 km in 1970 to slightly under 400 km now indicates that some progress has been made in dispersing production from its original concentration in the Northeast. Nevertheless, cement is transported in China over distances longer than those found economical in other countries and further rationalization appears possible.

12. Chemical fertilizer transport is an example of the effect of plant size. As 13 large plants were put in operation after 1978, chemical fertilizer moved by rail more than doubled between 1977 and 1981 from 12 to 25 million tons and average transport distance by rail increased 30%. Further rationalization of the industry is likely to reinforce these trends.

13. Both cement and fertilizer are presently transported mainly in bags, and losses during transport are high, particularly in fertilizer. For both commodities, consideration should be given to gradually increasing the proportion of bulk transport. As China is one of the largest fertilizer importers in the world, the shift to bulk handling in ports would result in immediate savings in shipping costs as well as in port capacity by reducing ship turnaround times.

14. Finally, the economic system also has a major impact on the freight intensity of the economy, as the case of iron and steel illustrates. Because of the low price of iron ore, pig iron is produced in virtually every province and 50 million tons of iron ore are transported by rail over an average distance exceeding 300 km. As smelting iron ore greatly reduces its weight, transporting 12-13 million tons of pig iron would be more economical than moving 50 million tons of ore. Iron and steel products are also traded heavily; many provinces both ship and receive iron and steel to and from almost all other provinces. Duplication of transport results from administrative rigidities and in particular the different spheres of responsibility for steel production at the national, provincial and local levels. The existing technology, with little integration in steel making also requires much transport of intermediate products. Iron and steel transport is third after coal and timber in rail transport and, together with iron ore, account for 10% of rail traffic. Any rationalization of the distribution system would provide substantial benefits.

15. The heavy freight transport demand could be better managed. To find exactly where and how, some distribution studies for the major commodities being transported such as coal, timber, cement, fertilizer, iron and steel and grain should be made. These studies would necessarily be intersectoral involving producers, users, and transport agencies. The difficulty of carrying out such studies which cut across various administrative jurisdictions is recognized, but institutes under the State Planning Commission as well as universities, research institutes or consultants should be suited for this type of work.

16. Future Trends. The discussion of freight intensity shows that future developments are likely to increase transport demand in relation to output for some products and decrease it for others. For coal, average

distances will certainly increase with reliance on concentrated mine location in North China. The same would apply to fertilizer with further concentration of production in large plants. For cement and iron and steel, however, rationalization of the industry and distribution should reduce transport demand. Overall, freight elasticity to gross value of industrial and agricultural output (GVIAO) is expected to remain near 1.0 to the year 2000. By then, domestic freight turnover could be about 3,000 billion tkm or about three times the level reached in 1983.

17. Modal Distribution. The dominance of rail in the transport sector is unique to China. Despite some reduction in share over the last 30 years rail still accounts for 66% of the traffic in ton-km, probably the highest share of any country in the world after the USSR. Government efforts have concentrated on developing the railways to serve the requirements of heavy industry for moving large quantities of coal, oil, timber, mineral ores and construction materials. The slower growth of light industry and agriculture has contributed to a relatively lower demand than in other countries for the transport of goods normally carried by road transport. Despite some possible rationalization in the transport of natural resources and industrial products mentioned above, the transport demand for these commodities and consequently rail traffic will continue to increase. It could well triple its 1980 level by the year 2000.

18. By the year 2000, however, China's transport system is likely to have evolved toward a more balanced modal allocation reflecting the more diverse needs of the economy. The new economic policy and in particular the emphasis on light industry and on the responsibility system in agriculture is creating a rapidly growing demand for road transport. With a growth rate of 10-11% p.a, the share of road transport could increase rapidly to 17-20% of domestic ton-km from 9% in 1980.

19. While it is widely recognized and agreed in China that road transport should and will play a larger role, there seems to be no concrete plan to bring this about. The complexity of the situation seems to have overwhelmed the system. It is difficult to determine which need to address first:

(a) larger trucks would be more efficient than the present ubiquitous 4-5 ton capacity model, but the roads and bridges are not built to take the corresponding axle loads;

(b) energy efficiency of trucks should be improved but that would require better fuels and therefore changes in refineries;

(c) the output of liquid fuel may not keep up with demand if road transport develops too fast.

Transport infrastructure and operating agencies seem to have very little contact with vehicle manufacturers, and they in turn have little contact with producers of refined products. Given the importance and urgency of the matter, the Government should consider developing a coordinated plan for improving roads and road transport.

20. Development of road transport should cover:

(a) infrastructure, including both major intercity highways and bridges, rural roads and terminals for forwarding road freight and for intermodal interfacing with other transport modes;

(b) vehicles, including the technological improvement of engines, the diversification of output both in terms of small 0.5 to 2 ton trucks and of heavy trucks;

(c) management and operation of the truck fleet, both under MOC and own account vehicles; and

(d) reforms of the commodity circulation system to help reduce the need for transport and multiple handling.

21. Growing road transport will greatly increase liquid fuel consumption. Supplies are already very tight and in some cases shortages constrain the use of vehicles. Even with improvement in fuel efficiency, consumption in the year 2000 could be 3 to 5 times higher than in 1980, i.e., 30 to 50 million tons. The increased provision of liquid fuel through reduction of exports or through imports may well be economically justified to avoid choking economic development. Consideration should also be given to developing a national fuel distribution system with stations open to all those vehicles entitled to procure fuel. This would increase the flexibility of trucking and eliminate the need for vehicles to carry fuel in drums when they travel beyond distances they can cover with a full tank.

22. Domestic water transport could also play a larger role. Average route density of freight traffic is only 36 million tons on coastal lines and 14 million tons on the Yangtze River. By comparison a modern, newly built single track rail line can carry up to 20 million tons p.a. and a double track line up to 90-100 million tons p.a. Coastal shipping offers an economical alternative to the congested North-South rail lines. In the South, the dense river and canal system can perform the role of roads in other areas.

Passenger Transport

23. Despite the rapid growth of passenger traffic in recent years, the mobility of people in China is still very low; it reached 270 pkm per capita in 1982 versus 785 in India, where GNP per capita is lower than in China. The international comparison shows that personal mobility is strongly related to income. In addition, elasticity relative to income is also higher at lower than at higher income levels. Assuming an income elasticity of 1.5-1.7, well below those of India and Brazil, would mean that, by the year 2000, mobility in China would be 5 times larger than now.

24. Recent developments in rural areas have generated a vastly increased demand for short distance travel which has brought about a shift toward the road mode as well as a fall in average travel distance. Road now carries 70% of the inter-city passengers but still accounts for only 31% of the passenger-km. It is likely that as income levels grow, the demand for greater mobility

will be accompanied by a demand for private vehicles as it has been in most other countries, including centrally planned economies. In many developing countries this demand has been satisfied at first by two wheelers such as motorcycles, scooters and mopeds. Personal transport could be accommodated without great problems in China's rural areas. It is only in large cities that low road density and lack of parking space would make intensive use of personal transport a critical problem. Whatever level private motorized transport eventually reaches in China, the need to build a good public transport service is imperative. Each mode of transport can contribute advantages. Bus transport can best serve rural areas and their connections with cities; rail should cater to medium distance inter-city travel; and air transport will serve the longer distance inter-city routes.

Investments

25. China's annual investment in the transport sector is small in comparison to that of other countries. At about 1.1% of GNP, it is comparable to the level of India. The percentage is about 1.4 in USSR, goes up to 2.0 in Korea and 3.3 in Brazil. It is much higher in developed countries when private vehicle purchases are included. Has this low investment in the sector made transport a bottleneck to economic development? A number of examples can be cited to support the view that it has. Last year, some 10 million tons of coal were stored in Shanxi for lack of transport; part was destroyed by spontaneous combustion. Many industries report a shortage of railcars, or at least a great difficulty to obtain sufficient cars when they need them. Production outside the plan cannot be transported by rail. Rural areas are short of transport means both for agriculture and local commune and brigade enterprises. Ports have been congested. The lack of bulk handling facilities is preventing the import of bulk fertilizer, while for grain, ship waiting time has exceeded 15 days at some ports, resulting in large demurrage charges.

26. There is no doubt that in the forthcoming decades, a much larger investment effort will be necessary in the transport sector to catch up with the backlog of present needs as well as accommodate a sharp increase in demand. Failure to do so may well affect the growth rate of the economy.

27. Railways. For railways, investments should be concentrated on increasing capacity in congested corridors east of the Beijing-Guangzhou line rather than in greatly expanding the network. Multiple tracking and electrification are likely to be the most efficient ways to increase capacity. Present work on railway routes out of Shanxi province should be sufficient to allow the lines to handle traffic until the late 1980s. Construction of a new double track line from Datong to Qinhuangdao for heavy unit trains is scheduled to start in 1985 and should be adequate to accommodate traffic in that corridor in the 1990s. Other lines from central and south Shanxi may also become necessary in the 1990s. Besides the east-west corridors out of Shanxi, capacity increases will also be needed in the north-south corridors from the Northeast to Shanghai and Guangzhou through the Beijing-Tianjin area. Rolling stock production should be stepped up greatly both for freight cars and passenger coaches. Present production is grossly inadequate. In recent years, freight car production has only been able to meet half the combined need for replacement and new additions. Present plans

for increasing passenger coach production will fall far short of needs. Electric and diesel locomotive production will also have to be stepped up. To supply short term needs imports may have to be considered for both rolling stock and locomotives, until local production capacity can be increased. For all these items, investments of Y 7 to 9 billion per year will be needed.

28. Roads. In the road subsector, the pace of construction has decreased considerably in the last few years; from 1979 to 1982 only 10,000 km of new roads were built annually. Until recently, most roads in China were under provincial and local management and financing. It is now time to attend to a national network and its financing. Improving or building some 4,000 km of crucial links in this network would cost about Y 2 billion. The upgrading of roads with high traffic volumes would cost Y 20-30 billion while building some 20,000 km of rural roads per year, which would roughly double the present rural road network by the year 2000, would cost about Y 4 billion per year. For road infrastructure alone, investments of Y 6-7 billion per year appear justified. In recent years road investment in China has amounted to less than a billion yuan. (Social labor contributions may not be included in this figure.) Financing mechanisms need to be developed at all levels of government to achieve the necessary extension of the network as well as the maintenance, strengthening and improvement of all classes of road. Truck and bus production will also need to be increased substantially. Present truck production would just cover renewals of the fleet on the basis of a 10-year life of vehicles. Since traffic is increasing, vehicles are kept well past their economic life, resulting in high cost of road transport.

29. Ports. In recent years much effort has been put into port development, and much more is necessary to modernize the ports as well as increase their capacity. The emphasis should be on bulk handling facilities and containerization to greatly reduce the turnaround time of ships in port. Estimated necessary port investment would be Y 2.0 billion per year. A necessary complement to port development is the inland distribution system, including intermodal transfer points and inland freight terminals. Dalian-Shenyang, Tianjin-Beijing and Shanghai-Nanjing are major transport corridors originating at 3 major ports. Integrated transport studies in these corridors are necessary to rationalize transport investments in the ports as well as in the modes serving the ports.

30. Multi-modal Transport. The combined use of rail and water may be particularly suitable for coal transport. However, this may not be economical on all routes. Careful analysis on a case by case basis should be performed before assigning traffic to a particular route and modal combination. For instance it appears that coastal shipping from northern ports will be more attractive than the use of the Yangtze River to deliver Shanxi coal to the Shanghai area. Northern ports are being developed for the shipment of coal; however, development of receiving ports in southern areas seems less advanced. The problem of receiving ports may not be so serious if consideration is given to simplifying unloading facilities and using self-unloading ships and floating terminals. Large coal users such as steel mills and power plants on coastal locations usually develop their own terminals. Using self-unloading ships can save costly port infrastructure such as berths, shore equipment and dredging. Floating terminals anchored off-shore or in

estuaries can transfer loads to smaller ships and barges for final distribution through rivers and canals. In addition to ports development, investments will be needed on waterways and also in ships for coastal shipping, inland navigation and foreign trade.

31. Aviation. For passenger transport, besides the development of rail and road, major investments will be needed in civil aviation including modernized airports with air traffic control and landing facilities and new, larger and more efficient aircrafts.

32. Combining the partial estimates above for railways, roads and ports, the total investments in the transport sector should be of the order of Y 15-17 billion per year between now and the year 2000. This does not include road vehicles, ships or any investments in inland waterways and civil aviation. With those included, annual transport investment could well exceed 2% of GDP which would appear very reasonable in comparison with other countries, but would be double the current percentage rate.

Transport Tariffs

33. As in any other sector, tariff-setting is important for efficient use of the transport system. A series of costing studies would be a necessary basis for rational pricing of transport services. A costing study has now started for the railways, and some studies are underway in selected ports. However, prices in the transport sector cannot be changed without changing other prices too. For instance, the low price of natural resources such as iron ore greatly contributes to the movement of ore rather than iron or steel. The price of cement produced by centrally controlled factories is so low relative to the price of cement from locally controlled factories that the centrally controlled cement can be sold competitively as far as 2,000 km from the factory, well over the economical transport distance. A change in transport tariffs would not by itself control such anomalies. Cost consciousness is not yet prevalent in management as other criteria like plan fulfillment are more important than profit making. For many products, transport cost accounts for only a small portion of the product's final value. Despite the fact that unit transport cost savings are small, they can add up to large sums when large volumes are involved; however they can have an impact only if the profit motive becomes a more important management tool. In the medium-term, administrative guidance would have, in many cases, to substitute for prices in attempts to rationalize the transport markets.

PART I

TRANSPORT INDICATORS: CHINA AND THE INTERNATIONAL EXPERIENCE

i. Part I compares China's transport indicators with those of other countries and explores prospects for future development of transport in China. The first chapter outlines the share of transport in the economy. Chapters 2 and 3 detail freight and passenger transport, their growth over time and in relation to GNP, their intensity, average distance and modal split. The fourth chapter discusses investments in the sector.

ii. International comparisons of transport indicators are difficult since transport is country specific. The size and shape of the country, the extent of its coast line, the navigability of its lakes and rivers, the location of natural resources and population, the nature and composition of the economy all affect transport, particularly the movement of freight. Therefore, we have limited our systematic analysis to large countries, namely US, USSR, India, Brazil and Japan, with occasional reference to other countries on particular topics.

1. TRANSPORT IN THE ECONOMY

1.01 The share of transport in the net material product of China (NMP) has been stable around 4% since 1952. This share in gross domestic product (GDP) in 1981 is estimated to have been no more than 4.1% even with adjustment of distorted prices. This is lower than the share in other countries used in our comparison:

Table 1.1: TRANSPORT AS PERCENTAGE OF GDP

	1950-60	1960-70	1970-77
India	4.9	5.0	5.3
Korea	4.1	5.9	6.5
Brazil	6.0	5.6	5.2
US	6.6	6.4	6.4
Japan	8.1	7.4	6.3

Source: World Tables, The Second Edition (1980), World Bank 1980.

From the above table it appears that the transport share of GDP increases in countries at low levels of income (India, Korea) and decreases when income exceeds a certain level (Brazil, Japan, US). It is surprising that the share of transport in NMP has remained constant in China since transport has been growing faster than NMP (Figure 1.1) From 1952 to 1981, NMP at constant prices increased over five times while freight tonnage increased over seven times and freight ton km over 11 times. Passenger traffic also increased more than 10 times. This would indicate that transport costs have decreased in relation to other costs, which may be explained by the high intensity with which the network and the rolling stock is used (see para. 4.02).

1.02 China's transport sector is characterized by an unusually high freight intensity, higher than in any country except the USSR. Passenger intensity is more in line with other countries, but low relative to India and Brazil. The table below relates freight and passenger traffic to GNP in 1980-81 for the various countries of our sample:

Table 1.2: FREIGHT AND PASSENGER TRANSPORT INTENSITY

	Tkm bln	Pkm bln	GNP bln US$	Tkm/$GNP	Pkm/$GNP	Traffic unit/ $GNP a/
China (81)	852	250	275	3.10	0.91	4.01
USSR (80)	6,021	891	1,393	4.32	0.64	4.96
US (81)	4,766	2,572	2,635	1.81	0.98	2.79
India (81)	266	542	159	1.67	3.41	5.08
Brazil (81)	343	450	245	1.40	1.84	3.24
Korea (81)	29	53	61	0.47	0.87	1.34
Japan (80)	439	634	1,071	0.41	0.59	1.00

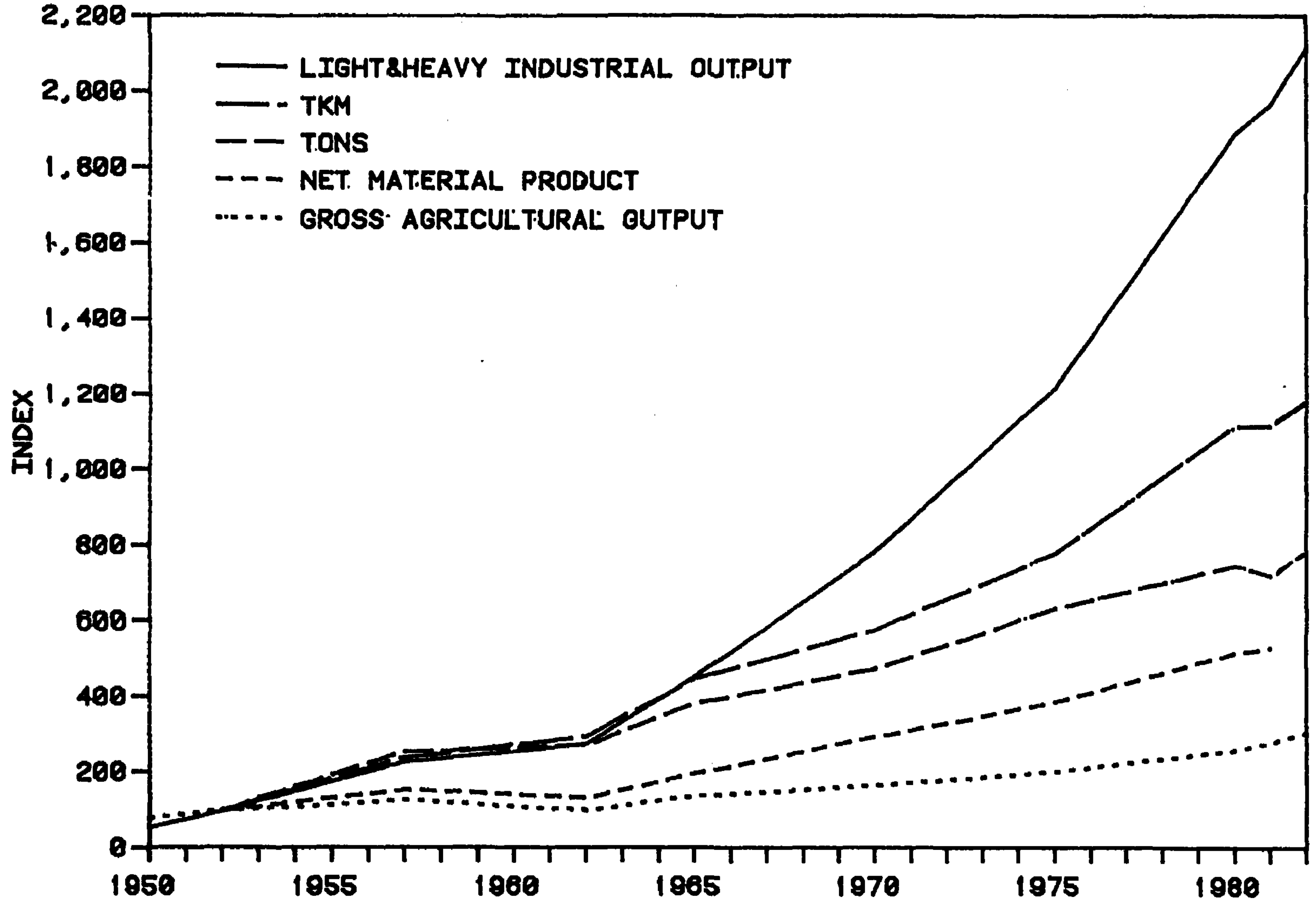
a/ Traffic unit = tkm + pkm.

Source: Appendix Tables B.2 and B.21

The apparent contradiction between the high freight transport intensity of the Chinese economy and the low contribution of transport to GDP can be explained by the dominance of rail transport in China (see para. 2.16). Rail transport is much less labor intensive than road transport and therefore has a much lower value added per ton km than road transport. In China road freight is seven times more labor intensive than rail while the value added is about three times that of rail. In the US road is about five times more labor intensive. The two following chapters analyze in more detail freight and passenger transport in China and other countries of our sample.

Figure 1.1:

COMPARATIVE GROWTH OF NET MATERIAL PRODUCT, OUTPUT OF AGRICULTURE AND INDUSTRY AND TRANSPORT IN TONS AND TONKM (INDEX 1952=100)



SOURCES: 1. STATISTICAL YEARBOOK OF CHINA, 1983.
2. CHINA: RECENT ECONOMIC TRENDS AND POLICY DEVELOPMENT ANNEX 2, TABLE 2.3.

2. FREIGHT TRAFFIC

A. Freight Growth

2.01 Domestic freight transported in 1984 reached almost 1,100 billion ton-km (tkm) a 15-fold increase since 1952, or an average annual growth rate of almost 9%. This makes China the third largest country in the world in terms of freight transport (tkm) after the USSR and the US.

Table 2.1: FREIGHT TRAFFIC VOLUME
(billion ton-km)

Year	Rail	Road /a	Domestic waterway /b	Pipe-lines	Civil aviation	Total	Ocean Shipping
1952	60.2	1.4	11.8	-	-	73.4	2.8
Modal split (%)	82.0	2	16	-	-	100	-
1977	456.8	25.1	102.1	38.7	0.1	622.8	174.1
1978	534.5	27.4	129.2	43.0	0.1	734.2	248.7
1979	559.8	74.5	139.0	47.6	0.1	821.0	317.4
1980	571.7	76.4	152.3	49.1	0.1	849.6	353.2
1981	571.2	78.0	150.7	49.9	0.2	850.0	364.3
1982	612.0	94.9	170.8	50.1	0.2	928.0	376.9
1983	664.6	108.4	181.1	52.4	0.2	1,006.1	397.7
1984	724.7	118/c	198/c	57.2	0.3	1,098.2/c	435/c
Modal split (%)	66	11	18	5	-	100	-

/a From 1979 includes all road transport not only that done by road transport departments.

/b Excludes ocean going transport which is often included in Chinese statistics. In 1979, coastal shipping accounted for 85 billion tkm and inland waterways for 54 billion tkm. The figures for 1982 were respectively 106 and 65 billion tkm.

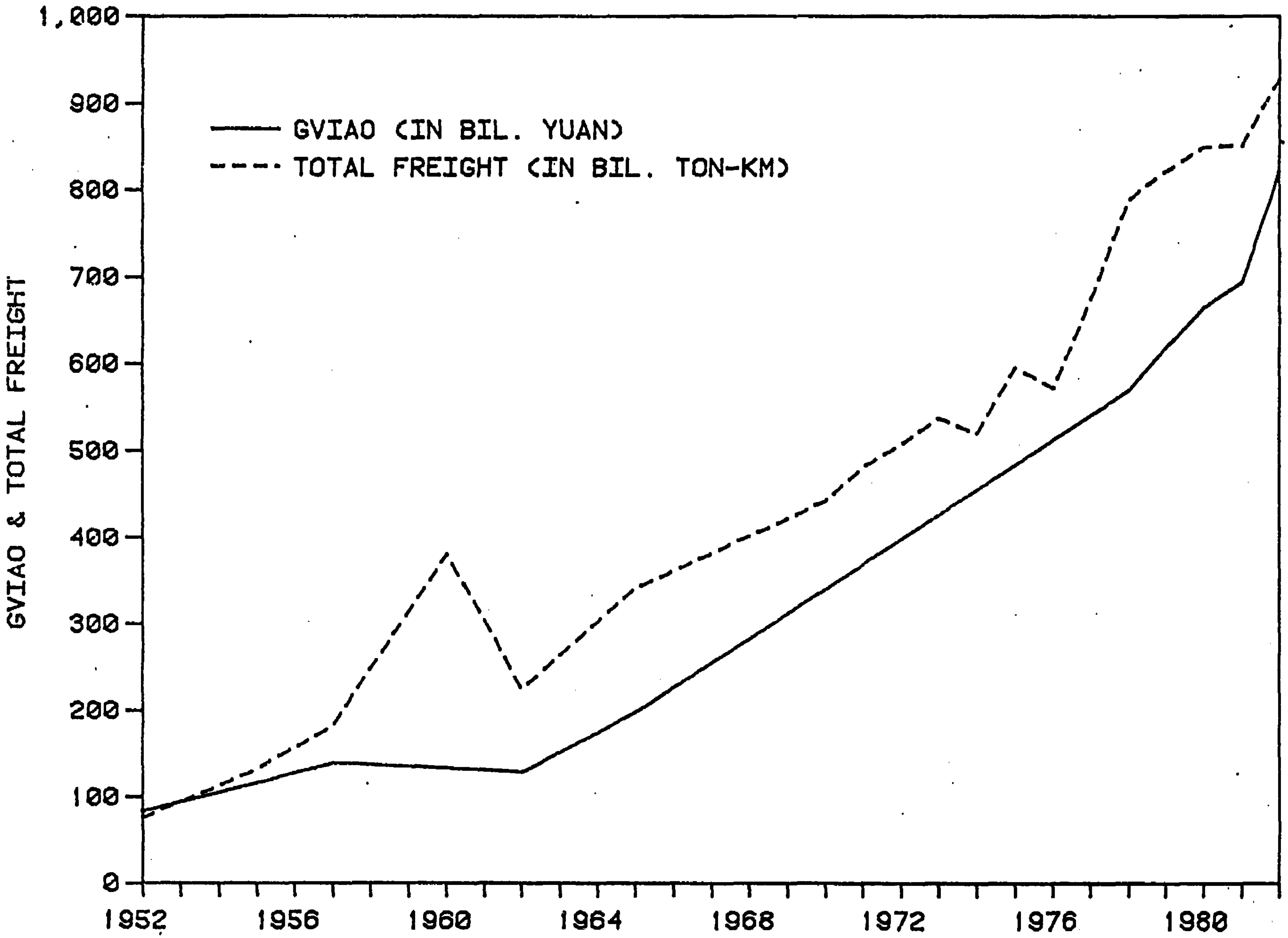
/c Estimates.

Note: These data exclude transport by traditional means which is certainly sizeable in terms of tonnage but mostly on short distance.

2.02 For the period 1952 to 1982 in China, the growth of freight transport has been somewhat higher than the growth in the gross value of industrial and agricultural output (GVIAO) (see Figure 2.1). Freight transport rose sharply between 1952 and 1960, slowed down from 1960 to 1975, and accelerated again after 1976. For the purpose of international comparison freight growth has been related to GNP in constant terms, a more commonly available measure than GVIAO. A regression analysis has been carried out with GNP in constant 1979-81 US$ as the independent variable and freight tkm as the dependent variable (Appendix Table B.1).

Figure 2.1:

GVIAO AND TOTAL FREIGHT GROWTH TREND
1952-1982



2.03 Expected freight elasticity is generally higher in the earlier stages of development; from 1960 to 1981, both Brazil and Korea had elasticities over 1, while the US and Japan were below 1 (Figure 2.2). The table below shows freight elasticities relative to GNP in various countries. The very high elasticity for the USSR reflects the emphasis placed on development of resources in the country's far eastern region which greatly increased average transport distances, at a time of slower overall economic growth.

Table 2.2: TOTAL FREIGHT (Bil. tkm) AND GNP (US$ Bil.): A CROSS-COUNTRY COMPARISON

	Years	Elasticity
China	1965-1981	1.034
US	1960-1981	0.941
USSR	1965-1980	1.427
India	1960-1981	0.921
Brazil	1960-1981	1.109
Japan	1960-1980	0.756
Korea	1961-1981	1.218

Note: The multicountry regression of freight transport (tkm) and GNP ($) gives the following equation: log of Freight Transport = -0.45 + 1.085 log of GNP (r square = 0.795) (see Figure 2.2). Further details are given in Appendix Table B.1 together with analyses of sub-periods within the 20 year spans.

2.04 It is difficult to predict freight elasticities for China. The attempt to deemphasize heavy industry combined with the campaign for industrial energy savings point toward lower freight elasticity. On the other hand, rationalization of industry, which may mean larger plants in some sectors and less regional self-sufficiency, could lead to higher freight elasticities.

B. Freight Intensity

2.05 At first sight China's economy appears highly intensive in freight transport. Expressed in ton-km of freight per dollar of GNP, China's economy is almost twice as intensive as the US, India and Brazil and eight times as intensive as Japan and Korea, both smaller size countries. High transport intensity appears in most socialist economies; the intensity in the USSR is about 40% higher than that of China. There are a number of factors affecting transport intensity: country size, location of resources and population, composition of GNP, the level of processing of raw materials such as ores, lumber, agricultural products, and the degree of vertical integration of industry. The effect of each factor is discussed below on the basis of the international comparison. An analysis of provincial transport intensity in China is also added at the end of this section.

Figure 2.2:

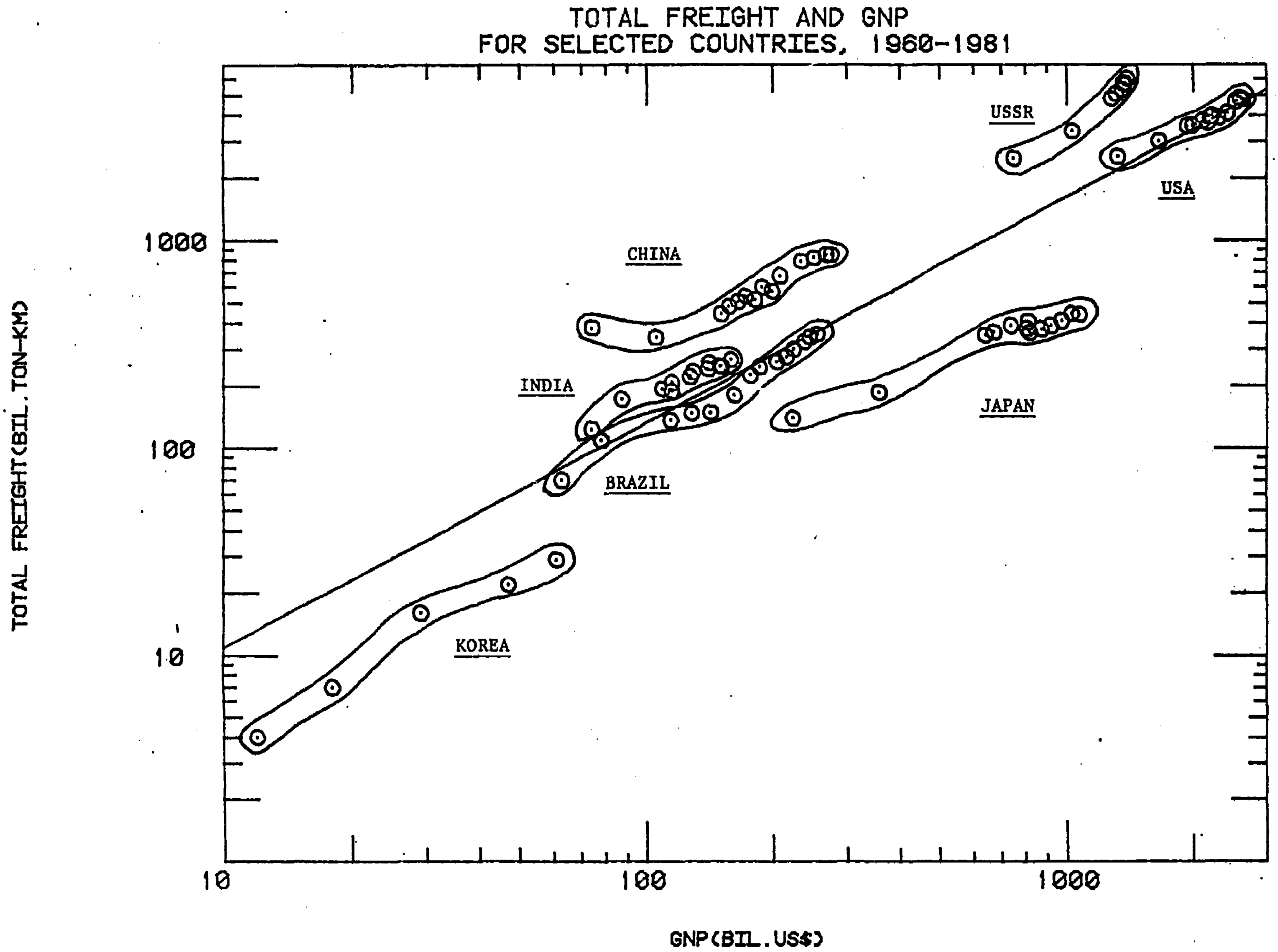

TOTAL FREIGHT AND GNP
FOR SELECTED COUNTRIES, 1960-1981
USSR
USA
CHINA
INDIA
JAPAN
BRAZIL
KOREA
1000
100
10
10
100
1000
TOTAL FREIGHT(BIL.TON-KM)
GNP(BIL.US$)

Table 2.3: FREIGHT INTENSITY, 1980

Country	TKM/$GNP
China	3.17
USSR	4.32
US	1.87
India	1.67
Brazil	1.40
Korea	0.47
Japan	0.41

Note: See Appendix Table B.2 for details, time series and sources.

2.06 Country Size and Resource Location. Country size is an obvious factor affecting transport intensity measured in ton-km. This can be illustrated by comparing freight transport in Japan versus that in the US for 1980.

Table 2.4: TOTAL FREIGHT, 1980

	Country area (million km^2)	Tons (millions)	Ton-km (billions)	Average distance (km)
Japan	0.38	5,985	439	73
US	9.36	5,501	4,827	877
China	9.60	5,457	850	156

While Japan moves a higher tonnage than the US, the average distance is less than one-tenth, reflecting not only Japan's relatively small size but also the concentration of its population along a limited portion of the eastern seaboard. Size and resource location are certainly factors in the high intensity of Soviet transport. While average distance for total Soviet freight transport is not available, the average distance for rail freight has increased from 800 km in 1965 to some 925 km in 1980; reflecting the need to exploit more distant resources in Siberia and further east particularly for coal, ores and timber.

2.07 The implications for China are again somewhat balanced. While the country is as large as the US, the population is far more concentrated. Over 70% of the population lives east of a Beijing-Guangzhou line, while in the US both the east and west coasts are highly developed. For China, this would imply generally moderate transport distances within its densely populated areas, with a smaller proportion of freight moving to and from the distant western parts of the country. Regarding resources, the most common, such as coal, are spread throughout the country. However, the conditions for coal exploitation in the Shanxi-Nei Monggol area are more favorable than in the Northeast and Southwest. Concentrating on these resources will increase transport intensity more than would the development of local production closer to demand areas or the development of industry close to primary resources. The trade-offs are between higher mining costs and lower transport costs of regional mines. The same applies to feed grains and meat production. The former are produced more efficiently in the Northeast; the latter is produced more intensively in the South. The trade-offs are between shipping grain from north to south versus shifting some of the meat production to the north.

2.08 Composition of GNP. This is probably the major factor affecting transport intensity. Heavy industry is more transport intensive than light industry which in turn is more intensive than services. Therefore it should be expected that, all other things being equal as an economy diversifies, transport intensity decreases. Such a decrease is very noticeable in Japan where freight intensity decreased from 0.62 tkm/$GNP in 1960 to 0.41 in 1980 while the service sector increased from 42% to 53% of GNP. The case is somewhat less clear in the US where a long-term decrease from 1.91 in 1960 to 1.69 in 1977 was somewhat reversed in 1981 (1.81). This can be explained by the very small changes which occurred in the sectoral composition of the US economy between 1960 and 1980. The table below gives the broad sectoral distribution of GDP in the countries of our sample.

Table 2.5: PERCENTAGE DISTRIBUTION OF GDP

	Agriculture		Industry		Services	
	1960	1981	1960	1981	1960	1981
China	47	35	33	46	20	20
India	50	37	20	26	30	37
Korea	37	17	20	39	43	44
Brazil	16	13	35	34	49	53
Japan	13	4	45	43	42	53
US	4	3	38	34	58	63

Source: World Development Report 1983, Table 3 p. 152-153.

China has the smallest service sector and the largest industrial sector among the countries included in Table 2.5. This is certainly a major factor in explaining the high freight intensity. Assuming that the service sector does not generate any freight transport, the freight intensity related to total GNP of a country where the service sector is 20% (China) would be double that of a country where the service sector is 60% (US) with the same intensity of freight for the other sectors (agriculture and industry). The freight intensity of China is thus smaller than that of the US when the service sector is excluded, but still higher than that of India. The following table shows freight intensity related to the nonservice sectors of the economy.

Table 2.6: FREIGHT INTENSITY, 1980-81

	Tkm/$GNP (1)	Non-service sectors/GDP (2)	Freight intensity excluding service sector (1:2)
China	3.17	0.80	3.96
US	1.87	0.37	5.05
India	1.67	0.63	2.65
Brazil	1.40	0.47	2.98
Korea	0.47	0.56	0.84
Japan	0.41	0.47	0.87

Source: Tables 2.3 and 2.5.

2.09 Processing of Raw Materials. Any weight-reducing processing done at the source of raw materials will reduce transport intensity. Coal, which is being transported in huge quantities in China, is a prime candidate for pre-transport treatment. The following international comparison speaks for itself.

Table 2.7: COAL PREPARATION IN PERCENTAGE OF RAW COAL

China	Japan	France	Britain	Germany	USSR
18.0	94.7	92.5	88.3	87.4	63.4

Source: Ways to Improve Economic Benefit of the Coal Industry Enterprises by Li Shaoxun and Ji Zhongshi in Research on the Economics and Management of Technology No. 4, December 31, 1982, p. 52-56.

In the case of the USSR, it is said that further coal preparation would save 20-25 million tons of transport per year; (out of a total moved by rail of over 700 million tons) and that excessive humidity and rock content mobilize 200,000 extra rail cars per year.[1/] In China a reduction in the volume of coal transported by rail of 5 to 10% would save transporting 20-40 million tons.

1/ Herve Gicquiau, "Une Crise Durable des Transports Interieurs de l'URSS", Le Courrier des Pays de l'Est no. 251, Mai 1981.

2.10 Other examples from the USSR [2/] indicate that, every year, 11 million tons of fertilizer are transported which contain only half the normal nutrient level. Also, because scrap steel is not well pressed and packed, it is estimated that 250,000 extra rail cars are needed to move the total volume of 58 million tons. Regarding timber transport, it is estimated that raw logs require 35-40% more rolling stock than would sawn timber. By contrast, the table below indicates that in the US large tonnages of primary forest and wood raw materials move only a very short distance (93 km) while smaller quantities of sawmill products and plywood move distances which, for rail transport, are comparable to those in China and the USSR for timber (which includes both logs and sawn timber). This indicates that in the US processing generally occurs near the production sites. From the US figures above, it can also be seen that the share of rail increases as the average transport distance for the product becomes longer (Modal split is discussed in more detail below).

Table 2.8: TRANSPORT OF TIMBER AND PRODUCTS

	Tons million	% rail	tkm million	Average distance km
US (1977)				
Primary forest and wood raw materials	296		27,638	93
of which by rail	45	15.2	5,235	116
Sawmill products	61		36,346	596
of which by rail	16	26.2	22,302	1,394
Millwork plywood and prefab	26		18,885	726
of which by rail	8.8	33.8	13,933	1,583
China (1981)				
timber by rail	40	-	50,000	1,250
USSR (1979)				
timber by rail	145	-	242,600	1,673

Source: 1977 Census of Transportation, Commodity Transportation Survey Summary, US Department of Commerce, Bureau of the Census, June 1981.

2.11 The 1982 Almanac of China's economy mentions iron ore and phosphate rock where dressing could save transport. However, since detailed information

2/ Herve Gicquiau, op. cit.

on raw material processing for products other than coal is lacking, it is not possible to estimate how much total transport demand could be reduced in China by processing and preparing before transport. It is probably safe to say, however, that savings could be substantial.

2.12 Vertical Integration of Industry. It is not clear to what extent this factor affects transport intensity in China, as industries tend to be more integrated than in other countries, that is, they manufacture all components in-house. If that is true, further rationalization of production may imply more transport per unit of output. For instance, if a refrigerator factory decides to buy its compressors rather than make them, transport will increase. However this may be more economical if the refrigerator factory would otherwise make compressors in uneconomic quantities. In the USSR, it appears that fragmentation in certain industries is leading to excess transport of parts and unfinished heavy steel products.[3/] Also the vertical integration within Ministries results in purchases of components without regard for transport distances, i.e. ignoring a source for the product which may be nearer but under a different Ministry.

2.13 Freight Intensity by Province. Freight intensity measured in tkm/yuan GVIAO is above the national average in the North, Northeast and three southern provinces of Hunan, Guizhou and Guangxi (Appendix Table B.3 and Map A18284). While the data on tkm by province include all modes, the road and water transport totals allocated to the provinces amount to only one-third their national totals reported in global figures. For roads, provincial figures cover only the transport bureaus under MOC; for waterways, it is not clear what is covered, but the provincial distribution probably excludes coastal shipping. If all water and road transport were recorded by province, the transport intensity of provinces in the Yangtze river basin would certainly increase and Jiangxi and Hubei could exceed the national average also.

2.14 Most provinces with a transport intensity above the national average also have above average rail network density, both in terms of population and area (Map IBRD A18284). The same provinces also tend to have a higher proportion of heavy industry than provinces with lower transport intensity. The table below shows the provinces with above and below average transport intensity along with their rail density and the share of heavy and light industry. Only in Shaanxi, Henan, Anhui and Guangxi is the share of heavy industry lower than average while transport intensity is higher. This can easily be explained for Henan by its location at the intersection of two very important rail lines; the north-south Beijing - Guangzhou and the east-west Longhai lines. The same explanation, although to a lesser extent also applies to Shaanxi, Anhui and Guangxi, where transit traffic is probably higher than average. A regression analysis shows that there is a significant relationship between transport intensity in tkm/Yuan of GVIAO and the share of heavy industrial output in a province. The equation is $Y = -0.335 + 2.544\ x$ in which Y is tkm/Yuan of GVIAO and x is the heavy industry output share in percent of total industrial output (GVIO). Details are shown in Appendix Table B.3.

3/ Herve Gicquiau, op. cit.

C. Average Transport Distance and Modal Split

2.15 References to transport distances were made in the previous section about transport intensity. Appendix Table B.4 gives average freight distances for China, US and Japan, the only countries for which information is available. For other countries, average distances are only available for rail freight. In China, average transport distance increased substantially from 159 km in 1949 to 382 km in 1982. The increase has not been gradual but in brief spurts followed by many years without change. As the economy recovered from the war, it increased rapidly to 249 km in 1951 and then remained around this level until 1962. A new surge occurred and the average reached 282 km in 1965, stagnating at this new level until 1976, probably as a result of the policy of increased regional self-sufficency. From then, it has been increasing very rapidly, adding 30% in 5 years. The present average transport distance in China is still much lower than that of the US, a country of equal size. The location of population and resources probably explain this lower figure (para. 2.07). Thus, average transport distance may well continue to increase in China with rationalization of industrial production and greater reliance on specialization of areas endowed with specific production advantages (coal in the north, feed grains in the northeast).

2.16 The dominance of rail in the sector is unique to China. Despite a reduction in share from over 80% in 1950 to 66% in 1984, rail in China still has the largest share of freight traffic of any country in the world. Conversely, the use of road transport in China is among the lowest in the world. The only country with a lower road share is the USSR mainly because of the very large share handled by pipelines (32%).

Table 2.9: FREIGHT TRANSPORT INTENSITY, RAIL NETWORK AND HEAVY/LIGHT INDUSTRY SHARE BY PROVINCE

	Transport intensity tkm/Y GVIAO	Rail per area km/sq km	Density per population km/000 pop.	Heavy/light industry ratio
North and Northwest				
Hebei	2.14	16.8	0.6	52/48
Inner Mongolia	2.39	4.0	2.3	55/45
Shanxi	1.32	13.8	0.8	68/32
Shaanxi	1.00	9.8	0.6	46/54
Gansu	1.66	5.8	1.2	77/23
Ningxia	1.99	6.7	1.1	67/37
Northeast				
Liaoning	1.26	25.2	1.1	64/36
Jilin	1.28	19.3	1.6	57/43
Heilongjiang	1.28	10.8	1.5	66/34
Central				
Henan	1.50	22.5	0.5	45/55
Anhui	1.01	10.0	0.3	45/55
Southwest				
Guizhou	1.17	8.1	0.5	57/43
Guangxi	1.07	8.9	0.6	37/63
Hunan	0.97	12.2	0.5	53/40
NATIONAL AVERAGE	0.85	5.6	0.5	49/51
Central and South				
Shandong	0.56	11.7	0.2	44/56
Jiangsu	0.44	7.1	0.1	39/61
Zhejiang	0.55	8.3	0.2	35/65
Fujian	0.61	8.6	0.4	37/63
Jiangxi	0.83	8.6	0.4	49/51
Hubei	0.74	8.9	0.3	48/52
Guangdong	0.36	5.2	0.2	35/65
Sichuan	0.48	5.2	0.3	49/51

Note: Further details are given in Appendix Tables B.3 and B.30.

Source: Statistical Yearbook of China 1981.

Table 2.10: MODAL SPLIT OF FREIGHT TRAFFIC /a
IN % OF TOTAL TKM

	Rail	Road	Water	Pipeline
China (1982)	66	10	18	5
India (1981)	63	33	4	-
USSR (1982)	57	7	4	32
US (1981)	31	18	31	19
Brazil (1981)	23	60	13	3
Japan (1980)	9	41	51	-

/a Rounded figures. Further details, as well as time series and sources are given in Appendix Tables B.5 to B.10.

2.17 Considering tons rather than ton km gives a higher share to the road mode in China, but this is also typical of all other countries.

Table 2.11 RAIL AND ROAD TONNAGE

	Rail	Road	Road/rail
	-- million tons --		ratio
China (1980) a/	1,113	3,855	3.5
USSR (1979)	3,687	23,000	6.2
Korea (1982)	47	356	7.6
Japan (1980)	74	5,318	72.0
US (1977 industrial products only)	548	1,891	3.5

/a The road figure for China includes 760 million tons handled by the Highway Transport Departments and 3,095 million tons by own account trucks, according to surveys conducted by MOC.

The above statistics may not be entirely comparable in coverage. Some deal with intercity traffic only (Korea, US); others like Japan probably include trips within urban areas. In Japan, almost 30% of the road tonnage consists of sand, gravel and stone moving an average distance of only 16 km. The figure for the US covers only industrial products and thus falls far short of total road transport which includes large quantities of primary materials moving short distances. The figures above confirm that modern road transport in China is still very small. However, the total tonnage moved on roads is probably much higher when one considers all the traditional modes, including agricultural tractors which represent most of the traffic on many roads in China.

2.18 The burden placed on the Chinese railway by short distance traffic is well known. Hauls shorter than 100 km accounted for 23% of total rail freight traffic and amounted to 250 million tons in 1980; hauls shorter than 50 km accounted for 14% of rail traffic. The same problem appears to affect the USSR with its railway transporting 380 million tons (13%) within less than 50 km and 700 million tons (24% of total) within less than 100 km. In India, however, tonnage moved less than 100 km accounts for only 6% of total rail traffic while 50% of the traffic moves over 700 km. In China much of the short haul rail traffic happens in and around large metropolitan areas such as Beijing, Tianjin, Shanghai, and Taiyuan. For instance, 49% of the 30 million tons loaded in the Beijing urban area are moving over distances less than 50 km. Percentages are 33% and 25% respectively for Tianjin and Taiyuan. Major commodities in this metropolitan rail transport are construction materials, coal, ores, oil and steel generally moving from sidings to sidings (Appendix Table B.5). On a sample of main lines, short haul traffic ranges only from 0.5% to 11% of total traffic, except for some short movements of ore and coal between a mine and a plant on two of the lines (Appendix Table B.6). Therefore, little capacity could be saved by removing short haul traffic on trunk lines; but the situation would need to be studied in large metropolitan areas.

2.19 In almost all countries, the rail share of traffic has decreased markedly over the last 20-30 years (Appendix Tables B.7 to B.12). The most striking case is Japan where the share of rail dropped from 51% in 1955 to 9% in 1980. The exception to this trend is Brazil which, however, does not have a major railway infrastructure and where the share of rail increased from 19% in 1960 to 23% in 1981. Most of the shift from the railways has been toward road transport, except in USSR where pipelines account for 32% of total transport. As illustrated by the international experience, there is a large potential for the development of road transport in China. In India, road transport has proven more economical than rail for most commodity movements up to 200 to 250 kilometers. For some commodities, particularly perishable fruits and vegetables and small machinery, road transport has a comparative advantage over rail for distances up to 450 km (see para. 2.22). The average distance for road transport of industrial products in the US is 235 km, within the economic range indicated for India. In comparison, average road transport distance in China is a mere 35 km, up from 10 km in the 1950s. The average is apparently only 18 km in the USSR. Increasing the share of road transport in China will face a number of problems, i.e., the need for major development efforts on the road network; the production of vehicles, particularly fuel efficient ones; and the demand for liquid fuel, which could easily amount to 10 times the present level (a more detailed discussion of the last two topics is in the "Energy Consumption in the Transportation Sector" paper).

2.20 In Japan, the shift from rail has brought traffic not only to roads but also to coastal shipping which has replaced rail as the dominant mode and accounts now for 51% of the traffic (the share of rail in 1955). In 1980, coastal shipping in Japan moved 450 million tons over an average distance of 470 km (Appendix Table B.13). In comparison, the two transport bureaus under the Ministry of Communication in China moved only 50 million tons in 1979 albeit over distances exceeding 1,000 km. The figure may somewhat understate the total amount of coastal shipping as some will be done by agencies not under central authority. Nevertheless, there seems to be scope for further increasing coastal shipping in China. The distances for coastal shipping in Japan and China are very comparable. The distance between the new industrial port of Tomakomai in Hokkaido to Nagasaki in Kyushu is equivalent to that between Qingdao and Guangzhou (Figure 2.3). In Japan, five commodities account for some 80% of the coastal shipping traffic:

Table 2.12: JAPAN: COASTAL SHIPPING
(Major Commodities in % of Total)

	1965			1980		
	Rank	tkm billion	% of total	Rank	tkm billion	% of total
Coal	1	23.7	29.3	5	12.3	5.8
Iron & steel	2	14.2	17.6	3	31.5	15.0
Petroleum products	3	11.8	14.7	1	58.3	27.7
Cement	4	6.3	7.8	4	20.6	9.8
Non metallic minerals	5	6.1	7.6	2	46.7	22.2
Total		62.1	77.0		169.4	80.5

Note: See further details in Appendix Table B.13.

Traffic for these five commodities increased about three times in 15 years or at an average annual rate of 7% p.a. In the case of China, coal, petroleum products and grain are very good candidates for increased transport by coastal shipping.

2.21 Modal split varies greatly from commodity to commodity. Typically, bulk commodities are more economically carried by either rail or water transport than by road, even over short distances. Indeed, in most countries, including China, about three quarters of all rail traffic is comprised of at most 10 commodities. As shown in Appendix Tables B.14 to B.18 these commodities are the same for all countries and their ranking is fairly stable. They consist of coal, petroleum, ores, timber, iron and steel, cement, construction materials, grain and fertilizer.

2.22 Modal split by commodity requires special studies and surveys which are not readily available in many countries. A survey conducted in India for interregional freight traffic, dividing India into 289 regions, shows the following modal split for various commodities in 1978-79.

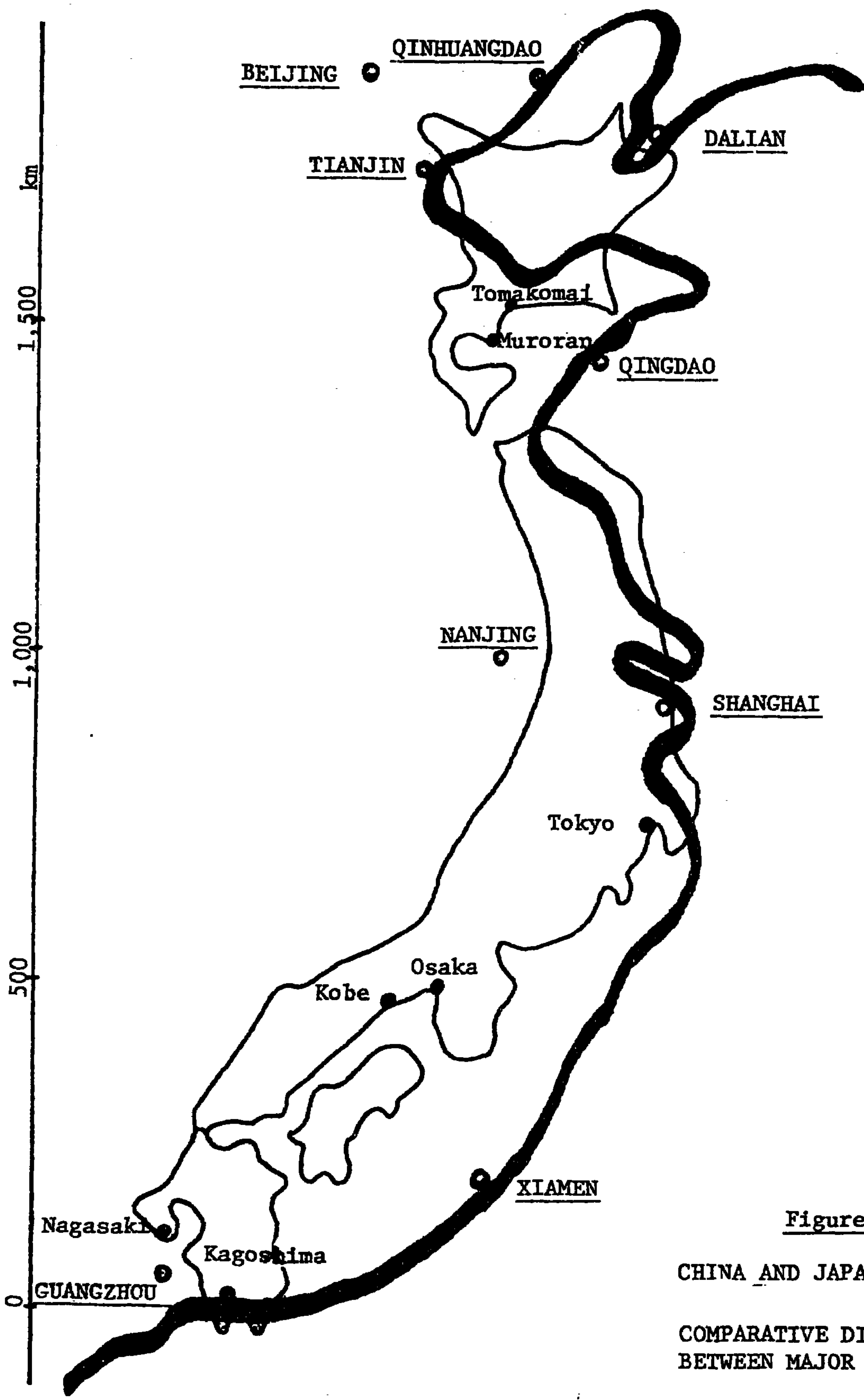


Figure 2.3:

CHINA AND JAPAN COASTLINES:

COMPARATIVE DISTANCES
BETWEEN MAJOR PORTS

Table 2.13 INDIA: INTERMODAL SHARE BY COMMODITY

	Rail	Road
	--- share in % ---	
Minerals, coal, iron and steel, salt, cement, mineral oils, fertilizers, stones and products of agriculture	>80	<20
Electrical equipment, leather goods, hides, edible oils, chemicals and drugs, non-ferrous metals, livestock, tyres and tubes, machinery	40-60	40-60
Automobile and parts, milk and products, textiles, tea and coffee, paints and dyes, cycles and parts, fruits and vegetables, manufactured articles	4-30	70-96

Source: Report of the National Transport Policy Committee, May 1980, p. 24, see also Annex Table 2.19 for detailed figures.

2.23 As a further example, the table below shows the modal split for cement and fertilizer distribution in the US. Cement is distributed over rather short distances. Because of the ubiquity of the basic raw material, the industry locates near markets and, therefore, the most common transport mode is road (83% of the total). For fertilizer, the average distribution distance is almost three times that for cement. As a result, much larger proportions of the product go by rail and water than for cement.

Table 2.14: US: CEMENT AND FERTILIZER DISTRIBUTION BY MODE
US 1977

	Cement				Fertilizer			
	tons million	%	tkm million	Av. dist	tons million	%	tkm million	Av. dist
Total	86.8	100	15,114	174	47.9	100	22,782	476
Rail	7.9	9	2,440	309	21.2	44	15,614	737
Road								
Common	42.7	49	6,626	155	9.2	19	2,037	221
Private	29.1	34	3,435	118	9.3	19	1,309	141
Water	6.8	8	2,613	384	5.3	11	3,760	709
Other	.3	-	-	-	2.9	6	-	-

Source: US Census of Transportation, 1977. Op. cit.

2.24 By comparison, the average transport distance of cement by rail in China is 395 km in 1981, substantially higher than in the US despite the fact that a higher percentage of the production moves by rail in China (30% versus 9% in the US). This long distance is somewhat puzzling since plant size in China is smaller than in the US and indeed much of the production occurs in very small plants. One possible explanation is that there may be cross hauls of cement as a result of the structure of administration. For the USSR, the data is only available for construction materials as a whole, including cement. The average rail transport distance is a very high 480 km. A comparable average for China, adding cement and construction materials, would be only 245 km. Construction materials consisting of sand, gravel and bricks would generally be expected to move only very short distances, and primarily by road. In Japan, sand, gravel and stone account for almost 30% of the tonnage transported by road (1,492 million tons in 1980), but move on average only 16 km (Appendix Table B.20).

2.25 For fertilizer, the average rail distance in China, 731 km, is very comparable to that in the US (737 km) and both are considerably lower than averages for the USSR (1,079 km) and India (1,015 km). In average rail distance, the location of the plants and their average size have a major impact on a particular country's transport pattern. Distribution studies for specific commodities have been done in many countries. Coal, cement, fertilizer, and grain are all potential candidates for similar studies in China in view of their dominance in the transport system.

D. Port Traffic

2.26 Port traffic in China is still low, mainly as a result of the self-sufficiency policy and the little development of coastal shipping mentioned above. It is increasing rapidly, however, having grown over 50% since 1976, from 142 million tons to 219 million tons in 1981 for the centrally administered coastal ports. The Government has recognized the importance of having adequate ports to handle the traffic generated by its change in trade policies and major capacity investments are taking place in many ports. The present five-year plan envisages the construction of 132 new berths by 1990. Looking at port development in other countries, it can only be expected that further large port investments will be needed in China over the next two decades to keep up with expanding trade and increase the use of coastal shipping.

2.27 Recent figures on total port traffic in selected countries are as follows:

Table 2.15: PORT TRAFFIC IN SELECTED COUNTRIES
(million tons)

	Total	Foreign trade	Domestic
China 1982	238a/	82	156
Japan 1979	2,885	815	1,225
US 1980	1,950	n.a.	n.a.
India 1978-79 major ports	70	n.a.	n.a.
Korea 1980	79	n.a.	n.a.

a/ Coastal ports only. In 1981 Changjiang river ports handled 87.9 million tons.

n.a.: Not available.

Japan underwent the most explosive growth in port traffic in recent years. Traffic increased 10 times between 1955 and 1975, from 250 million tons (about China's present level) to 2,500 million tons. This is equivalent to an average annual growth rate of over 12%. Over a twenty year period between 1960 and 1980, port traffic in the US more than doubled from 942 million tons to 1,950 million tons. This corresponds to an average growth rate of 4% p.a. It is not surprising that this figure is lower than for Japan as the US economy was already more developed in 1960 and port traffic was then four times that of Japan. Also Japan imports most of its raw materials and energy.

2.28 Port traffic is related in part to foreign trade, in part to the development of coastal shipping, both of which have increased rapidly in Japan over the last 20 years. The table below shows the relative share of foreign trade in the GNP of selected countries.

Table 2.16: FOREIGN TRADE COMPONENT OF GNP FOR SELECTED COUNTRIES
(in % of GNP)

	1960		1980	
	Exports	Imports	Exports	Imports
China	2.37	2.48	6.46	6.91
Brazil	10.14	11.66	8.84	11.04
US	5.85	6.75	10.23	11.22
Japan	5.44	9.55	13.78	14.68
Korea	2.59	10.34	37.70	44.78
India				

Source: World Bank EPD data base.

2.29 While the figure above may be lower than other estimates, China's foreign trade is still low by international standards. However, a continuation of the present economic policies is likely to foster foreign trade increase at a rate higher than that of the overall economy. Coastal shipping may also grow faster than overall economic growth. Combined, these two factors will generate a growth in port traffic which may well be 50% higher than the growth in GNP, i.e., between 10 and 12% p.a. This would mean that port traffic in the year 2000 could be five times the present level. While some rationalization may be possible to reduce transshipments between seaward and inland waterway traffic, traffic demand would still imply the need for very large port investments to avoid bottlenecks that would stifle economic development.

3. PASSENGER TRAFFIC

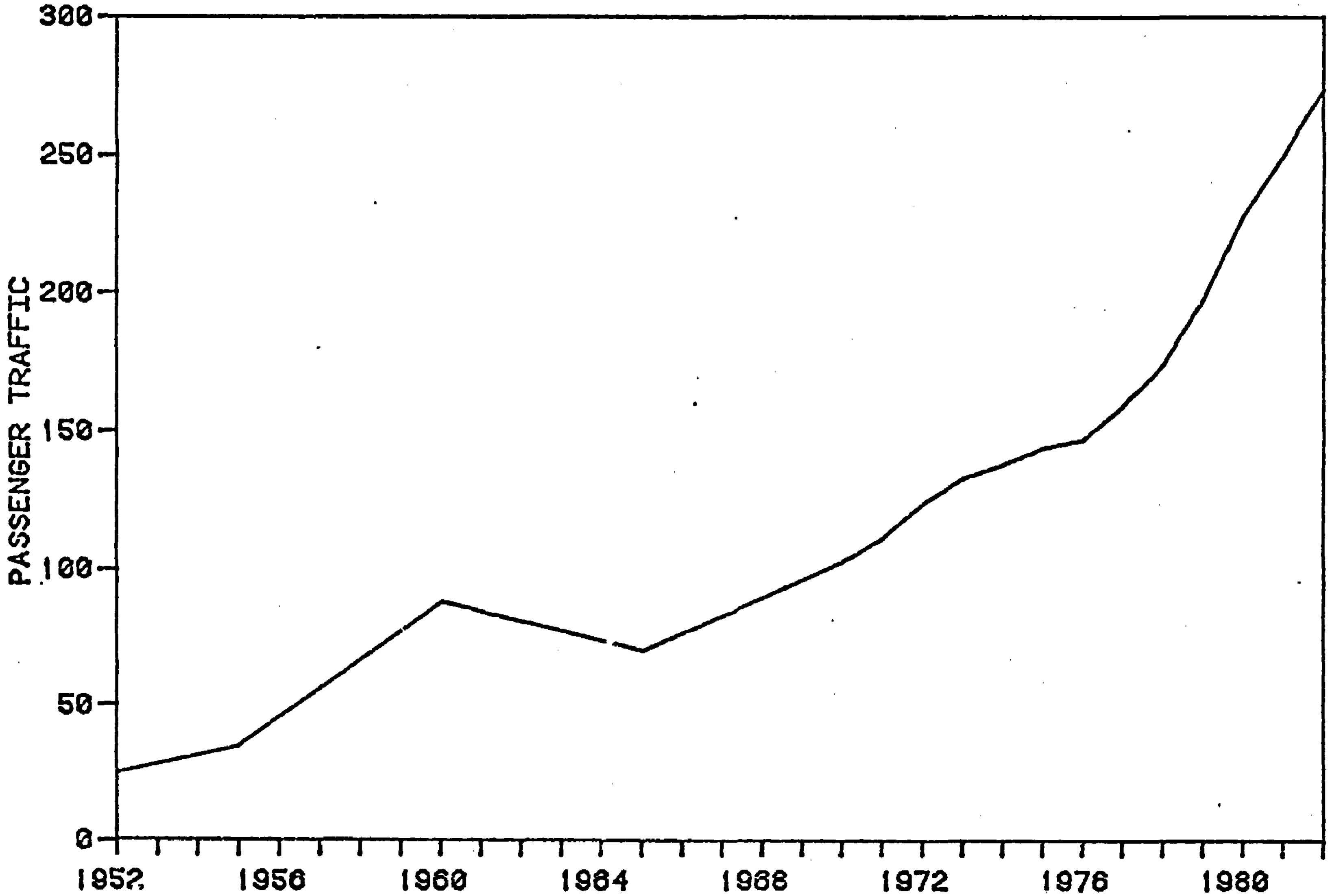
A. Growth of Passenger Traffic

3.01 Passenger traffic reached 274 billion passenger-km (pkm) in 1982, an 11-fold increase since 1952 and an average annual growth rate above 8%. Growth of passenger traffic has been more erratic than that of freight. For instance, the traffic levels reached in the early 1960s were not achieved again until the early 1970s. Since 1978 however, the growth has averaged an impressive 12% p.a., well over twice the overall rate of economic growth (Figure 3.1, Appendix Table B.21). This illustrates the potential demand for travel as income grows. It is likely that this growth would have been even higher had there not been limited capacity in passenger services.

Table 3.1: PASSENGER TRAFFIC VOLUME
(billion passenger-km)

Year	Rail	Road	Waterways	Aviation	Total
1952	20.1	2.3	2.5	-	24.9
Modal split %	81	9	10	-	100
1977	102.3	44.8	9.8	1.8	158.7
Modal split %	64	28	7	1	-
1979	121.6	60.3	11.4	3.5	196.8
1980	138.3	72.9	12.9	4.0	228.1
1981	147.3	83.9	13.8	5.0	250.0
1982	157.5	96.4	14.5	6.0	274.4
1983	177.6	110.6	15.4	5.9	309.5
1984	204.6	129.4	15.2	8.4	357.6
Modal split %	57	36	4	2	100
Growth rates % p.a.					
1952-77	6.7	12.6	5.6	-	7.7
1979-84	11.0	16.5	5.9	19.2	12.7
1983-84	15.2	17.0	-	42.4	15.5

Figure 3.1: PASSENGER TRAFFIC
SELECTED YEARS, 1952-1982
(IN BILLION PASS-KM)



3.02 Despite the rapid growth in passenger traffic, the mobility of people in China is still very low; it reached 270 pkm per capita in 1982 versus 785 in India where GNP per capita is lower than in China. The table below shows the mobility and GNP per capita in the countries used as comparators.

Table 3.2: INTERCOUNTRY COMPARISON OF PASSENGER TRAFFIC PER CAPITA AND GNP PER CAPITA

	Year	Pkm/capita	GNP/capita
CHINA	1981	252	278
India	1981	785	232
Korea	1981	1,368	1,576
USSR	1980	3,356	5,244
Brazil	1981	3,735	2,027
Japan	1980	5,416	9,173
US	1981	11,193	11,465

Note: The multicountry regression of mobility (pkm/capita) versus income (GNP/capita) gives the following equation: Mobility = -26.62 + 0.865 Income (r square = 0.91) (see Figure 3.2). (Although the best fit is for natural numbers, the graph is in log scale for presentation purposes.) Further details as well as time series and sources are given in Appendix Table B.21.

The low mobility in China most likely results from demand restraint combined with inadequate supply of passenger transport capacity. Demand restraint is partially a consequence of the comparatively low share of GNP going to household consumption, perhaps 50% in China as compared with some 70% in India. The mobility in the USSR is also low; it is just below that of Brazil where per capita income is only half that of the USSR. 4/ The comparison of mobility across economies indicates that it is generally lower in centrally planned economies than in market economies (Figure 3.2).

3.03 As indicated above, personal mobility is strongly related to income levels. Elasticity relative to income is also higher at lower income levels than at higher ones. Countries at low levels of income show increasing elasticities as income grows (China, India, Brazil, Korea) while higher income countries have decreasing elasticity (US, Japan). Detailed elasticity figures derived through regression analysis are given in Table 3.4 for seven

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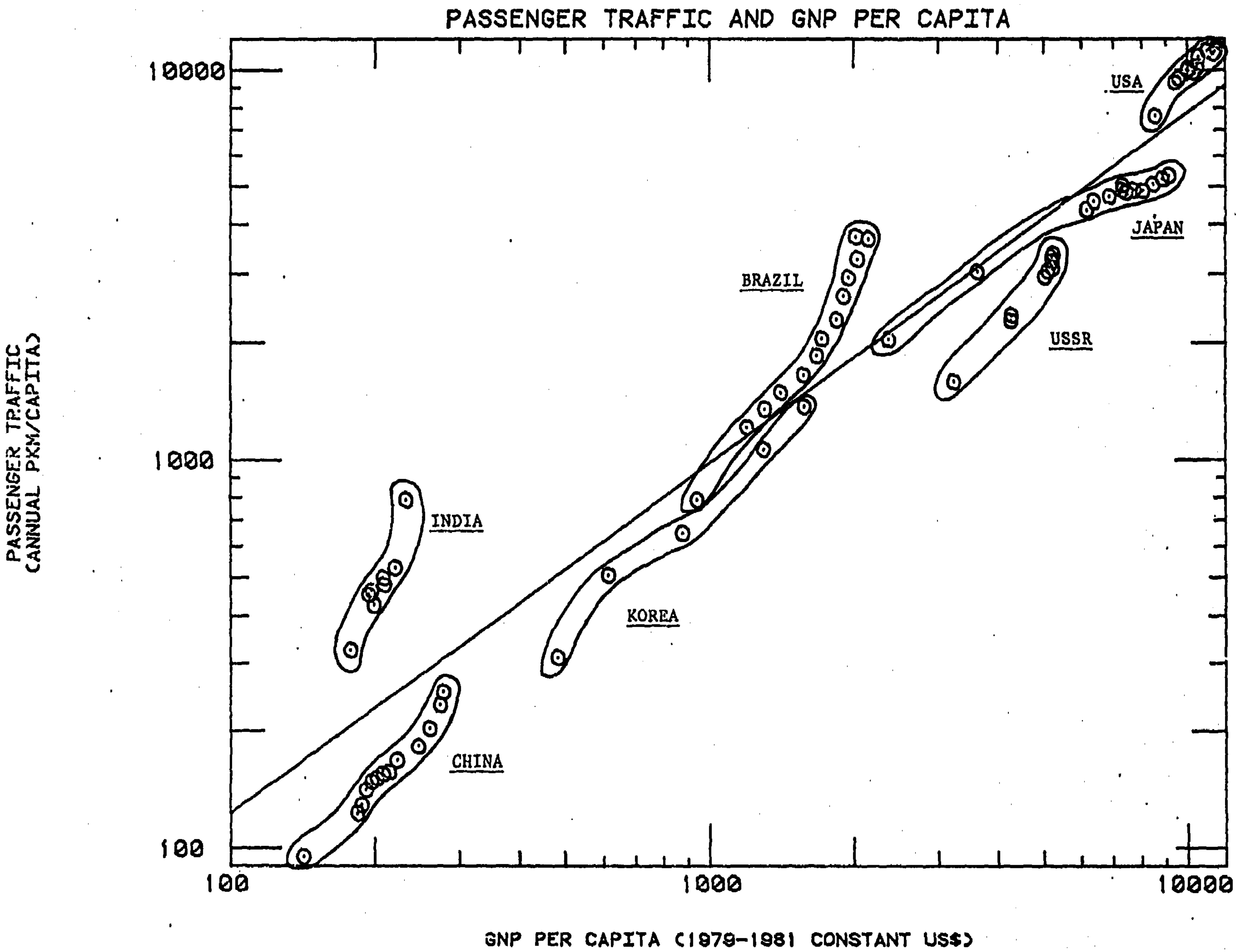
4/ USSR statistics do not include travel by private car, which has been estimated to add about 10% to the total pkm (Soviet Economy in the 1980's: Problems and Prospects Part 1, Joint Economic Committee Congress of the United States, December 31, 1982).

Figure 3.2: INTERCOUNTRY COMPARISON OF



countries. It shows that over the last 15-20 years, elasticities have been rising in India, Brazil and Korea and dropping in Japan and the US. Almost everywhere, increase in mobility has been accompanied by a strong demand for personal transport. An inter-country comparison shows that the income elasticity of personal transport is substantially higher than that of public transport.[5/] For the 34 countries in the sample, personal transport has an income elasticity of 2.0 while rail and air transport have elasticities of 1.2 and local transport has 1.0. There is no doubt that as income levels increase in China, similar pressure for personal transport will materialize.

3.04 The implications of this analysis for China are clear; there is a very high potential demand for personal travel as income rises. At China's level of income, the international comparison indicates that elasticities of travel would also be increasing over quite an income range before they start tapering off. Taking an income elasticity of 1.5, which is well below elasticities in India and Brazil, and assuming a 7% growth of GNP would mean an annual growth in mobility of 10% resulting in a mobility 5 times larger than now by the year 2000. This would mean about 1,250 pkm per capita, the level of mobility reached in the USSR between 1960 and 1965 and in Brazil in 1970. How much of this demand will be apparent in China will depend upon Government policies including how willing the Government is to invest in the infrastructure and rolling stock necessary to satisfy even a modest demand by international standards.

B. Travel Purpose

3.05 Little information is readily available on the purpose of personal travel. Below are the results of a household survey conducted in the US in 1977.

Table 3.3: US: HOUSEHOLD TRIPS BY PURPOSE, 1977
(in millions)

	Total Trips	Visit to Relatives	Recreation	Business	Other
	312.5	136.6	72.7	86.7	16.5
in %	100.0	43.7	23.3	27.7	5.3

Note: See further details and source in Appendix Table B.22.

5/ Irving B. Kravis, Alan Heston and Robert Summers, World Product and Incomes, Johns Hopkins University Press, Table 9.4.

Table 3.4: INTERCOUNTRY COMPARISON OF PASSENGER TRAFFIC GROWTH RATES AND INCOME ELASTICITY

	Growth rates			
	Total passenger-km	Passenger-km/capita	GNP/capita	Elasticity/a
China				
1965-81	8.28	6.29	4.29	1.09
1966-76	6.98	4.67	3.80	0.92
1977-81	11.98	10.67	5.78	1.45
1978-81	12.84	11.46	4.16	2.10
India				
1965-81	8.01	5.69	1.67	7.29
1965-75	6.98	3.94	1.62	4.92
1976-81	11.89	9.57	2.21	12.00
USSR				
1965-80	3.61	5.15	3.27	0.85
1965-75	7.37	6.39	4.46	0.76
1975-80	3.59	2.70	0.91	1.50
US				
1965-81	3.53	2.45	1.85	1.17
1965-75	3.97	2.88	1.63	1.31
1976-81	1.83	0.77	1.69	0.53
Brazil				
1965-81	12.75	10.28	4.91	2.46
1965-72	12.44	9.69	5.97	1.51
1973-76	14.02	11.52	5.54	2.37
1977-81	11.23	9.25	1.48	4.34
Japan				
1960-80	7.23	6.02	7.01	0.55
1960-70	11.13	9.96	9.99	0.70
1970-80	3.46	2.23	4.11	0.33
Korea				
1961-81	9.95	7.70	6.10	0.93
1961-71	10.13	7.64	6.13	0.81
1971-81	9.70	7.78	6.05	1.03

/a Elasticities are not the ratio of the pkm/capita to GNP/capita, they are derived from regression analyses of mobility as a dependent variable of income. The equation being of the form: Pkm/capita = a + b GNP/capita.

It shows that most trips were made to visit relatives followed by business trips. Purely recreational trips amount to less than one quarter of the total. There is no doubt that personal travel is an important ingredient in economic activity as well as for the basic livelihood of the people. A survey of rail passengers in the Shanghai Railway Administration indicates that 31% of the trips are made for business.

C. Modal Split

3.06 Similar to freight, China holds the world record for rail use in passenger travel. Only India still has a substantial portion of rail usage, while rail travel has dropped considerably in Japan and virtually disappeared in the US.

Table 3.5: INTERCOUNTRY COMPARISON OF MODAL SPLIT OF PASSENGER TRAFFIC a/
(in % of total pkm)

	Rail	Road	Water	Air
China (1982)	57	35	5	2
India (1976)	41	58	-	1
USSR (1980)	37	44	1	18
Japan (1980)	26	68	1	5
Brazil (1981)	3	95	-	2
USA (1982)	1	85	-	14

/a Rounded figures. Further details as well as time series are given in Appendix Tables B.23 to B.28.

3.07 In all countries including China, the rail share of traffic has decreased markedly over the last 20-30 years (Tables 3.3 to 3.8). The advent of the private car has of course nearly ended rail travel in the US, prevented its development in Brazil, and greatly reduced its use in Japan. In China and India the role of buses has increased sharply. The share of bus passengers in China increased from 5% in 1950 to 35% in 1982, and from 25% to 60% in India in pkm. In passengers transported, buses in China transport almost three times as many passengers as the railways. Given the relatively low density of the railway system and the fact that most trips are relatively short distances (average distance is 155 km for rail and 32 km for road), the share of bus travel will continue to increase rapidly in China. This will compound the burden of freight traffic on roads. With increased production and income in the rural areas, the demand for personal travel to markets and towns will be very large and for most areas can only be handled by bus.

3.08 Aviation is another mode where China is lagging behind other countries. Only 4 million passengers were carried in 1981, versus 5.3 million in India with a much lower population, and 267.3 million in the US. Given the distances in China, there is certainly great scope for further development of aviation.

4. CAPITAL INVESTMENT AND PRODUCTIVITY

A. Infrastructure

4.01 China's transport network has developed rapidly over the last 30 years.

Table 4.1: TRANSPORT NETWORK, 1952-1982

	Railways	Roads	Inland Waterways	Pipelines
	'000 km			
1952	22.9	126.7	95	-
1957	26.7	254.6	144	-
1965	36.4	514.5	158	-
1978	48.6	890.2	136	8.3
1979	49.8	875.8	108	9.1
1980	49.9	888.3	109	8.7
1981	50.2	897.5	109	9.7
1982	50.5	907.0	109	10.4

Source: China National Economic Development, Part III, p. 24, National Statistics Bureau 1983.

Nevertheless, the density of the network is still very low compared to that of other countries. Both in density per area and population, China falls below other countries in our sample. India, with a lower income per capita has a transport network 2.5 times as dense as that of China per head of population and over 5 times as dense per land area. The US, which has the densest network per capita of our sample (30 times as dense as China), also has 7 times more km of rail and road for an area the size of China. Adding some 100,000 km of inland waterways would only marginally improve the picture in China. Also, other large countries such as the US and USSR have even larger navigable inland water networks than China. Appendix Table B.30 gives the rail density by province in China. Provinces in north, northeast and northwest China generally have rail densities above national average both in terms of population and area. Because of their low population, western provinces also have high rail densities per population but not by area. Guangxi also exceeds both national averages. Central and southern provinces exceed the average density per area but are below average in density per population (see also para. 2.14).

Table 4.2: TRANSPORT NETWORK DENSITY IN SELECTED COUNTRIES

	Density per '000 inhabitants			Density per '000 km^2		
	Rail	Road	Total	Rail	Road	Total
China (1981)	0.05	0.91	0.96	6	93	99
Korea (1980)	0.08	1.24	1.32	32	480	512
India (1979)	0.09	2.43	2.52	19	488	507
USSR (1979)	0.53	5.41	5.94	6	64	70
Japan (1980)	0.21	9.52	9.73	63	2,944	3,007
Brazil (1980)	0.25	11.82	12.07	3	164	167
US (1979)	1.60	28.02	29.62	38	673	711

Note: See further details and sources in Appendix Table B.29.

4.02 Because the transport network is still small in China, it is used very intensively, at least for railways. China has the second highest freight density in the world after the USSR, and the second highest passenger density after India. Locomotives and rolling stock also have very high utilization factors in comparison with other countries. Nevertheless, there is probably considerable scope to increase even further the traffic densities on China's railways. Comparisons of freight densities with other countries are not appropriate, except for the USSR, since most major railway systems were built before the introduction of motorized road transport some 60 years ago. The extensive railway networks of industrialized countries are today only justifiable on a "sunk" cost basis, i.e. disregarding initial investment costs. Due to intermodal shifts, rail traffic densities have remained low, except in the USSR and China which did not inherit an extensive railway network by today's standards.

Table 4.3: RAILWAY TRAFFIC DENSITY IN SELECTED COUNTRIES

	Net tkm/route km	Pkm/route km	Total traffic units/route km
	million		
China (1981)	12.0	3.0	15.0
USSR	24.7	2.4	27.1
US	7.7	0.1	7.8
Romania	6.9	2.1	9.0
India /a	4.5	4.4	8.9
Brazil	1.2	0.7	1.9

/a Broad gauge only.

4.03 Although little statistical information is available on road traffic, visual inspection indicates that roads are also used intensively in China. Because of the low density of the network and therefore lack of alternative routes, existing roads are used both by motorized and non-motorized traffic with the result of greatly reducing the speed of motorized traffic. In recent years, a number of corridors have emerged where a modern road, reserved to motorized traffic, would be justified. Trucking, however, is one area where intensity of use appears low in China. The total output of road freight transport in China and India was about the same in 1979-80, around 77 billion tkm, although in India this level was achieved with only 30% the number of trucks available in China.

Table 4.4: TRUCK PRODUCTIVITY IN SELECTED COUNTRIES

	Trucks 000	Output bln tkm	Productivity per truck 000 tkm
China	1,300	76.4	59
India	368	77.0	209
USSR	5,053	408.0	81

4.04 China's low productivity in trucking results from a number of factors: (a) the predominance of small trucks in China; (b) the low utilization resulting from the predominance of trucks for own-account use rather than for common carrier services; (c) the high incidence of empty running; and (d) the short average transport distance by road which means that much of the truck time is used in loading/unloading and waiting. Another factor affecting productivity, as calculated here with regard to the entire fleet, is the availability of trucks for service or conversely the proportion of the fleet under maintenance or repairs. No information on this is available, except that a smaller problem seems to have occurred in the USSR in the 1960s when the average percentage of the truck fleet at work was less than 65%.6/ A comparison with developed market economies is difficult; in the US for instance more than half the "trucks" are used for personal transportation, that is like cars. Heavy trucks (over 12 t gross weight, empty weight + max. load) average 55,000 km p.a. Assuming an average load of 10 tons would give a productivity of 555,000 tkm.

6/ Holland Hunter, Soviet Transport Experience: Its Lessons for Other Countries, Brookings Institution, Washington, D.C. 1968.

B. Rolling Stock

4.05 The stock of vehicles in China has increased substantially since the early 1960s but it is still low in comparison to that of other countries (Table 4.5). Efforts are being made to increase output of locomotives, freight cars, passenger coaches, trucks and buses, while improving their quality and efficiency. Imports will continue to be needed until domestic production can be built up to the necessary levels.

C. Investment

4.06 From 1953 to 1980, some Y 110 billion or 15.0% of all new investment coming under the heading "State Capital Construction" went into the transport sector (Appendix Table B.31). In comparison, transport investment constitutes 10-14% of annual domestic investments in developed economies. It is often double these percentages in other LDCs.[7/] China's share would then appear somewhat on the low side. However, "State Capital Construction" probably excludes some of China's fixed investments by the lower levels of Government; it also excludes renewals which in many countries are included in investments. In recent years, with the exception of 1981, annual investments in the transport sector have averaged about Y 6 billion. About half that amount has been allocated to railways, and roughly 20% each to ports, waterways and roads.

7/ George W. Wilson, Economic Analysis of Intercity Freight Transportation, 1980, p. 275.

Table 4.5: TRANSPORT ROLLING STOCK IN SELECTED COUNTRIES

	Rail			Road	
	Locomotives	freight cars	passenger & rail cars	Trucks	Buses
		('000)			
China (1980)	10,000	260	15	1,300	110
India (1980)	10,847	548	39	368	117
Korea (1982)	508 (1979)	16	2	264	66
USSR (1980)	43,770	n.a.	n.a	5,053	951
Japan (1980)	4,386	102	47	8,778	232
Brazil (1980)	n.a.	n.a.	n.a.	947	122
US (1982)	26,797	1,019	4	26,213 (1977)	529 (1980)

Note: n.a. = not available

Sources:
1. Almanac of China's Economy 1982
2. Japan Statistical Yearbook, 1982, pp. 283-287.
3. SAR-India - Railway Modernization of Maintenance Project II, p. 47
4. Report of the National Transport Policy Committee (May 1980) p. 185
5. Statistics of Railroads of Class I in the US years 1972 to 1982, pp 8-10.
6. Kulp, G. and M.C. Holcomb, Transportation Energy Data Book, 6th edition, p. 84 and 89.
7. Soviet Economy in the 1980s: Problems and Prospects, Joint Economic Committee Congress of the US, December 31, 1982, p. 224 (trucks). Buses estimated by totalling 15 years of net annual supplies.
8. USSR Facts and Figures Annual, pp. 293 & 421
9. SAR - Korea - National Provincial and County Roads Project, December 2, 1983. p. 35
10. SAR-Korea - Seventh Railway Project, April 1, 1980, Table 2-11.
11. World Road Statistics, 1981, p. 64.

4.06 Transport investments generally account for higher proportion of total investment in the early stages of development. An example of this is India.

Table 4.6: INDIA: SHARE OF PUBLIC SECTOR INVESTMENT IN TRANSPORT

	Transport Share %
1951 to 1956	22.1 to 23.5
1966 to 1978	14.1 to 16.0
draft sixth plan 1978-83	12.1

Source: Report of the National Transport Policy Committee, Planning Commission, Government of India, New Delhi, May 1980.

By contrast, transport investment in the USSR since 1950 has been held below 10% of total investment. A slight increase reflecting the pipeline boom has taken place since 1976, with an average of 11.1% for 1976-79.

4.07 Below is the average annual investment in the transport sector in recent years for selected countries. It is difficult to obtain total investment in the transport sector of developed market economies since there are so many actors involved. To give some order of magnitude, in the US, state highways departments have invested some US$15 billion p.a. in roads in recent years; the private sector has invested some US$29 billion and private car purchases run at US$75 billion. These three figures add up to almost US$120 billion, about 40 times the amount of China's annual investment. In Japan, road investment was over US$20 billion in 1979 and port investment has been running at US$2 to 2.5 billion p.a. in recent years despite the fact that port traffic is now increasing less rapidly than in the 1960s and 1970s.

Table 4.7: ANNUAL TRANSPORT SECTOR INVESTMENT IN SELECTED COUNTRIES

	Billion US$
China	3.0
Korea (1977-81)	1.2
India (1978-83)	1.8
Brazil (1974-78)	8.0
USSR (1979) /a	20.0

/a 15.2 billion roubles estimated equivalent to US$20 billion.

4.08 China's annual investment in the transport sector is small in comparison to that of other countries. At about 1.1% of GNP it is comparable to the level of India. The percentage is about 1.4 in the USSR, goes up to 2.0 in Korea and 3.26 in Brazil. The incomplete figures given above for the US already add up to 4.6% of GNP, while in Japan public investment in roads and ports only amounts to 2% of GNP. This excludes private investments and in particular all road vehicles, rail rolling stock and ships. With those included the investment ratio to GNP may well be near that of the US. The high level of investment in the transport sector of market economies represents the widespread use of private automobile, and in this sense the figures are not particularly relevant for China at this stage. Nevertheless, even without private cars, the demand for transport investment will remain high in China. In view of some of the points made above, particularly concerning ports, roads, and passenger traffic, investments could well be higher than in the past to avoid constraints on economic development.

PART II

FUTURE DEVELOPMENTS AND ISSUES

i. Part I of this annex placed the Chinese transport sector in the perspective of international comparators. This second part discusses what the expected economic developments in China to the year 2000 will mean for the transport sector. Chapter 5 relates the development of freight and passenger transport to macro-economic indicators and provides estimates of transport demand. It also predicts the future role of various modes and in particular the importance of the emerging road sector. Finally, Chapters 6, 7 and 8 highlight some transport issues related to planned developments in other sectors such as energy, industry and agriculture.

5. FUTURE TRANSPORT TRENDS

A. Freight Transport Demand

5.01 Transport demand will continue to grow rapidly in the future, simply because the whole economy is likely to continue to expand rapidly (see the illustrative projections in Chapter 2 of the Main Report and Annex D). How rapid freight transport growth will be, however, is very difficult to assess. In addition to the complexity of forecasting the economic growth rate, the future elasticity of transport demand with respect to economic growth could vary widely. Elasticity will be affected by the pattern of growth, both in sectoral composition (for example, heavy industry is much more transport-intensive than the service sectors) and in spatial location (which influences average transport distance). It will also be affected by reform of economic management, which will, on the one hand, tend to increase transport requirements because of increased specialization and exchange. On the other hand, reform could substantially reduce wasteful use of transport facilities through, for example, less cross-hauling, more preliminary processing, and improved location planning.

5.02 The possible magnitude of the combined impact of changes in the growth pattern and system reform on freight transport demand is illustrated by the international comparisons in Table 1.2, which show the USSR's use of freight transport per dollar of GNP to be more than double that of all market-regulated economies (and ten times that of Japan). The same point is illustrated by recent experience in China. Table 5.1 shows that the elasticity of freight transport demand with respect to GVIAO, which averaged 1.10 in 1952-1977, has been only 0.67 in 1979-84.

Table 5.1: ELASTICITY OF FREIGHT TRANSPORT TO GVIAO

	Growth rates % p.a. GVIAO	Ton/km	Elasticity
1952-77	8.1	8.9	1.10
1977-82	8.3	8.3	1.00
1979-84	8.9	6.0	0.67

5.03 The illustrative projections of freight transport demand in Table 5.2 thus span a fairly wide (but perhaps still insufficient) range of possibilities. Cases 1 and 2 correspond with the QUADRUPLE scenario presented in Chapter 2 of the Main Report (which involves the quadrupling of GVIAO between 1980 and 2000), but with two alternative assumptions about the elasticity of transport demand in relation to GVIAO. Cases 3 and 4 correspond to the BALANCE scenario, in which national income (GDP) grows at the same rate, but with faster growth of the service sectors, offset by slower growth of industry (and with greater overall economic efficiency). GVIAO accordingly grows more slowly than in QUADRUPLE, and hence so does freight transport demand, given the same pair of elasticity assumptions as in Cases 1 and 2.[1/]

1/ In the model used to make the QUADRUPLE and BALANCE projections (see Annex D), passenger and freight transport are combined, different transport modes are not distinguished, and the volume of transport is measured by, in effect, gross transport revenues at constant prices. This measure grows at an average annual rate of 7.5% in QUADRUPLE and 7.2% in BALANCE. These growth rates are appreciably higher than those for freight transport ton-km in Table 5.2, for two reasons. First, is that they include passenger transport, which is projected to grow faster than freight transport. The second and more important reason is the changing modal split of freight transport: the increased share of road (a much more expensive mode) relative to rail raises the average price per ton-km, and hence causes transport revenues (even at constant prices for individual modes) to increase faster than the number of ton-km.

Table 5.2: FREIGHT GROWTH SCENARIOS

	1980		2000
QUADRUPLE			
GVIAO growth		7.2%	
Case 1			
Freight elasticity		0.95	
Freight growth		6.8%	
Freight tkm (billions)	850		3,200
Case 2			
Freight elasticity		0.85	
Freight growth		6.1%	
Freight tkm (billions)	850		2,800
BALANCE			
GVIAO growth		6.4%	
Case 3			
Freight elasticity		0.95	
Freight growth		6.1	
Freight tkm (billions)	850		2,800
Case 4			
Freight elasticity		0.85	
Freight growth		5.4	
Freight tkm (billions)	850		2,400

Note 1: The freight elasticities above are averages for the two decades of 1.0 and 0.9 in cases 1 and 3 and 0.9 and 0.8 in cases 2 and 4.

Note 2: Chinese statistics typically aggregate domestic and ocean transport to and from overseas destinations although they are quite different in nature Oceangoing transport is related to foreign trade rather than to domestic growth and developments and therefore needs to be forecast separately from domestic transport. The figures above exclude overseas shipping.

B. Modal Split

5.05 The modern transport system has been developed largely to serve heavy industry's need to move large quantities of coal, oil, timber, mineral ores, construction and industrial materials. Efforts have concentrated on developing the railways first and to a much lesser extent inland waterways and coastal shipping. The relatively slower growth of light industry and agriculture has contributed to relatively lower demand than in other countries for the transport of foodstuffs and consumer goods which are usually carried by road transport. The result of these developments is a domestic transport system heavily dominated by rail (para. 2.16).

5.06 By the year 2000, China's transport system will have evolved toward a more balanced modal allocation reflecting the more diverse needs of the economy. Road transport share should increase rapidly in order to satisfy the transport demand of light industry and agriculture. A share of 17-20% of domestic ton-km by the year 2000 would correspond to only a 10-11% annual growth rate in traffic, not so extraordinary considering both the low base and recent growth rates. Road freight ton-km increased more than 40% between 1980 and 1983. The share of domestic water transport is also expected to increase slightly while the share of pipelines will decrease.

Table 5.3: SCENARIOS FOR FUTURE FREIGHT MODAL SPLIT

	1980		2000			
			low road share		high road share	
	tkm (bln)	%	tkm (bln)	%	tkm (bln)	%
			QUADRUPLE Case 1		BALANCE Case 3	
Rail	572	67	1,890	59	1,570	56
Road /a	76	9	540	17	570	20
Water	152	18	670	21	580	21
Pipeline	49	6	100	3	80	3
Total	849	100	3,200	100	2,800	100
			Case 2		Case 4	
Rail			1,660	59	1,350	56
Road			480	17	480	20
Water			580	21	500	21
Pipeline			80	3	70	3
Total			2,800	100	2,400	100

/a In 1983 road traffic had already reached 108 billion tkm.

Note: Cases 1, 2, 3 and 4 have the same total freight as in para. 5.03. Figures above have been rounded. See also Appendix Tables B.32 to B.35 for further details and modal growth rates.

C. Railways

5.07 Despite some possible rationalization in the transport of natural resources and heavy industrial outputs, there is no question that the transport demand for these commodities will continue to increase. Therefore, although the rail share is expected to decrease, rail traffic will continue to increase substantially and could nearly triple its 1980 level by the year 2000 (Table 5.3). Coal will remain the dominant commodity. With expected year 2000 production of 1200-1400 million tons, rail loadings of coal could be 800 to 930 million tons, assuming that loadings remain at about two thirds of output (see para. 6.10). In recent years marginal transport distance for coal has been around 620 km, while the average has increased from around 360 km in 1978 to 460 in 1983. Average distance is expected to increase in general, as some of the short distance traffic shifts to road, but the situation will vary with each commodity.

5.08 The example of the USSR provides an indication of what increases in traffic and, in particular, freight densities could be accommodated on China's railways over the next 10-15 years. In the twenty years between 1955 and 1975, the USSR tripled railway freight densities from 8 to 24 million tkm/route km, or about twice the present freight densities in China. The technological change that permitted this dramatic increase was the replacement of steam locomotives by electric and diesel locomotives combined with some double tracking. In the ten years following the decision to replace steam traction, the share of steam traction in total freight movement fell from 85% to 15%, while freight density doubled from 8 to 15 tkm/route km. With the total network expanding by only 14% over these 20 years, most railway investments were for new locomotives, line electrification and double tracking of existing lines - relatively modest investments given the resulting large increase in freight carrying capacity. The share of electrified lines rose from 4% to 28% of the total during this period, and double tracked lines increased from 24% to 32% of the total network.

5.09 China's policy for railway investment emphasizes further increases of capacity on existing lines and general improvements in efficiency of freight traffic rather than expansion of the network. Steam traction will be gradually reduced to handle only 20% of the total traffic in the year 2000 versus 80% in 1980. Electric traction will dominate with 43%; diesel will have 37% (see para. 6.22). To achieve these ratios, electric and diesel locomotive production will need to be stepped up considerably from present levels, and imports may be needed in the interim. Double tracking may rise to 25% of the network by the end of the century from about 18% at present while the network would expand to 60,000 km by 1990 and 75-80,000 km by the year 2000.[2/]

5.10 Massive investments in line capacity increases (electrification, station and yards lengthening, double tracking) as well as in motive power and

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2/ Seiichi Nakajima, "Reform of China's Transport System," JETRO, China Newsletter, March-April 1985, quoting Renmin Ribao.

rolling stock will continue to be needed well into the future. The shortage of freight cars seems to be particularly acute. Although increasing now, production in the early 1980's was only around 10,000 p.a. On a thirty-year life cycle, renewals alone would require over 8,000 cars per year while additional traffic at a 5% p.a. growth rate would require at least an additional 20,000 cars p.a. for a total well above recent output. The present short turn-around time of 3 days is commendable from a railway operator's point of view but is not necessarily the most efficient way to operate the transport system from the user's point of view. The difficulty of obtaining cars at a specified time is being reported by many rail users as detrimental to their operations. "Average daily shipping requests, for instance, work out to be more than 80,000 carloads, but no more than three-fourths such requests, or some 60,000 carloads are met."3/ Car ownership by large users may be considered to alleviate the shortage more rapidly.

5.11 In the aggregate, the investment levels required to handle the rail freight traffic corresponding to the QUADRUPLE scenario, that is 1775 billion tkm (mid-point between Case 1 and 2 of Table 5.3) can be estimated as follows on an annual basis over the next 15 years:

	Yuan billion p.a.
Infrastructure including electrification double tracking, station lengthening, yards new lines	5.5
Freight cars	1.2
Locomotives	1.2
Total:	7.9

In addition to the above, there should be investments in passenger coaches estimated at 0.5 billion p.a. (see para. 5.37) and in MR factories manufacturing rolling stock, motive power and other equipment. In the BALANCE scenario, rail freight traffic would only be 80% of that in the QUADRUPLE scenario and required investments may be reduced in roughly the same proportion.

D. The Role of Road Transport

5.12 The new economic policy and, in particular, the emphasis on light industry and on the responsibility system in agriculture, is creating a rapidly growing demand for road transport. Light industrial products need to move rapidly from producer to consumer between cities and often across provincial boundaries. Agriculture inputs and outputs and sideline products need to move between rural and urban areas mostly on relatively short distances. Therefore the development of roads should be on two fronts:

3/ Ibid.

(i) the improvement and strengthening of major intercity highways (including bridges); and

(ii) the development and expansion of rural road networks.

Besides road infrastructure, improvements are also needed in road transport. Vehicle technology and fleet management and operation are the major fields that need government attention in the near future.

5.13 While it is widely recognized and agreed in China that road transport should and will play a larger role, there seems to be no well-defined plan to bring this about. The complexity of the situation seems to have overwhelmed the system. It is difficult to determine which need to address first:

(a) larger trucks would be more efficient than the present ubiquitous 4-5 ton model, but the roads and bridges are not built to take the corresponding axle loads;

(b) energy efficiency of trucks should be improved but that would require better fuels and therefore changes in refineries;

(c) the output of liquid fuel may not keep up with demand if road transport develops too fast.

Agencies in charge of road infrastructure and road transport seem to have very little contact with vehicle manufacturers, and they in turn, have little contact with the producers of refined products. Given the importance and urgency of the matter, the Government should consider developing a coordinated plan for road and road transport covering all the elements listed above.

Road Infrastructure

5.14 As indicated in para. 4.02, road density in China is still low in comparison with other countries. Furthermore, the pace of new road construction in China seems to have decreased considerably in the last few years. From 1975 to 1979, 23,000 km were added every year to the network while from 1979 to 1982 only 10,000 km of new roads were built annually (Appendix Table B.36). Until recently, most roads in China were virtually under provincial and local management. Most of the financing came from the road maintenance fee levied on all vehicles at the provincial level, supplemented by communal labor in the case of rural roads. As a result, most roads radiate from provincial capitals and form a number of separate networks, often with only a few interconnections. This has served China adequately in the past by concentrating scarce resources on high return investments (i.e., roads close to provincial capitals which generally have higher traffic levels than those at the periphery). Roads were therefore built according to traffic demand rather than to administrative rank. With the growth and diversification of the economy, the role of road transport is increasing rapidly and the demand for truck transport across provincial lines is beginning to be felt.

5.15 It is thus an opportune time to start giving more attention to a national road network and its financing. A recent first step was the designation of 110,000 km as national roads and the identification of some 4,000 km of this network which are either missing or in poor condition. Their upgrading cost would be in the order of US$1 billion. Many of these links are inter-provincial. The standards, to which their improvement is necessary, should still be determined through technical and economic feasibility studies rather than on the basis of their administrative classification as national roads. In addition to these missing links, there are also some 7,000 km of roads with traffic above 5,000 vehicles per day which need to be improved, and some 80,000 km of gravel roads with traffic in excess of 500 vehicles per day, which should be paved to reduce vehicle operating costs and fuel consumption. Many bridges also need upgrading and replacement. To upgrade these roads would cost some US$10-15 billion.

5.16 There are no statistics on the length of rural roads in China. An estimate based on technical standards, including low-class gravel roads and earth roads would give 470,000 km while an administrative classification indicates that commune roads total 290,000 km. In comparison, India has over 900,000 km of rural roads and Brazil 1.2 million km. Thailand, which is smaller in area than Sichuan province, has over 100,000 km. The cost of rural roads in China averages around US$100,000/km with great variations depending on topography and materials. Some roads in Shandong province cost as little as US$30,000/km while others in Sichuan may be five times more expensive. Constructing some 20,000 km per year would roughly double the present network by the year 2000 and cost about US$2 billion p.a.

5.17 Massive road investments will be needed from now to the year 2000 to accommodate the transport demand of industry and agriculture. In the 25 year period from 1952 to 1976, total highway expenditures in the US amounted to US$331 billion; of which $93 billion was contributed by the Federal Government and $288 billion by state and local authorities.[4/] In Japan, road investment was over US$20 billion in 1979 alone. In recent years road investments in China have amounted to less than half a billion US dollars (social labor contributions may not be included in these figures). Improving or building some 4,000 km of crucial links in this network would cost about Y 2 billion. The upgrading of roads with high traffic volumes would cost Y 20-30 billion. Building some 20,000 km of rural roads per year, which would roughly double the present rural road network by the year 2000, would cost about Y 4 billion per year. For road infrastructure alone, investments of the order of Y 6-7 billion per year would be justified. Financing mechanisms need to be devised to achieve the necessary extension of the network as well as to maintain, strengthen and improve all classes of roads.

5.18 It seems appropriate that the Central Government contribute financially to the development, improvement and maintenance of the national

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4/ T.S. Khatchaturov and P.B. Goodwin, The Economics of Long Distance Transportation, Proceedings of a conference, p. 27.

road network, similarly to its contribution to the rail network and to a major system of national ports and waterways. At the local level (below provincial and county), there is no system for raising funds. Some township roads in Jiangsu province have been built partially with funds from Commune and Brigade Enterprises (CBEs), partially with material and labor provided by the brigades. With the responsibility system now in place in rural areas, fulfilling the obligation to supply social labor for the development and upkeep of rural roads has become inconvenient for many rural residents. The possibility of replacing labor contributions with taxes should be considered.

<u>Road Transport</u>

5.19 Most Chinese trucks have a 4-5 ton capacity. To accommodate flexibly and effectively the varied demand for road transport services, a variety of models at both ends of the spectrum should be developed:

(i) heavy vehicles to move industrial products including containers, in particular their inland distribution over medium distance from ports; and

(ii) light pickup trucks in the 0.5 to 2.0 ton range for the transport of freight and passengers in rural areas.

The heavy trucks are likely to have diesel rather than gasoline engines and thus would improve the fuel efficiency and reduce road transport costs.

5.20 On most roads, particularly in eastern China and rural areas in the vicinity of towns and cities, motor vehicles cannot reach economic travel speeds due to the large number of slow-moving tractors, bicycles, hand and animal drawn carts, and pedestrians. While non-motorized modes of transport will be used for a long time to come, some phasing out of the small walking tractors should be implemented soon. These tractors are highly energy inefficient, using up to three quarters as much fuel as a 4-ton truck while carrying only 1 ton. Furthermore, because their maximum speed is only 15 km per hour they contribute greatly to road congestion. They should be replaced by small pick-up trucks in the 0.5 to 2.0 ton range, which could serve to transport both freight and passengers. The reason walking tractors can compete with trucks despite their high energy inefficiency is that the price of diesel for agricultural use has been subsidized at a much lower price than gasoline. These tractors however are used predominantly for transport and not for agriculture. It is estimated that they consume 27% of the diesel oil in China. Again, proper pricing of fuels would help to foster the switch to appropriate trucks. Also the loads are small and would not always justify the use of a truck. Furthermore, it is probably very difficult to get a truck from the transport bureaus for goods outside the plan such as the typical farm to market products.

5.21 The question of liquid fuel supply for road vehicles is raised in Chapter 6, which deals with the energy consumed in the transport sector. Besides the issue regarding the total supply of fuel for the road sector there is that of the location of this supply. At present, trucks travelling beyond their full tank range have to carry their own additional supply of fuel in drums. In this practice, not only is truck capacity used inefficiently but also a safety hazard is created by the trucks carrying large quantities of fuel. Consideration should be given to developing a system of pumping stations available to all those vehicles entitled to procure fuel so that trucking could be used most efficiently.

5.22 Public carrier road haulage plays a relatively small role in China. Government transport bureaus at provincial, municipal and county levels operate only 14% of all trucks and carry only 20% of the cargo. However, since they usually work over longer distances, they perform 33% of all road ton-km. Tariffs are high and uniform, service is not always available and is administratively cumbersome. Therefore, enterprises have had strong incentives to purchase their own vehicles, and the fleet of own account or social trucks has grown rapidly.

5.23 The utilization factors of these social trucks are substantially lower than that of the public carriers. Loading factor is estimated by the Ministry of Communication at only 30% versus over 60% for public trucks. Their maintenance is reportedly less consistent and their fuel consumption is generally higher. However, until the level of service -- including flexibility and pricing -- is improved, there will be little enticement for enterprises to make greater use of public carriers. In any case, if more efficient use of trucks can only come with great constraints on flexibility, the losses in timeliness of delivery may well offset the savings in transport costs.

5.24 A number of measures are being discussed in China to improve the efficiency of road transport, namely:

(a) increasing the load factor of trucks;

(b) improving the quality of service;

(c) adjusting prices of transport and fuels (for instance, fuel price for tractors is now much lower than that for trucks, but tractors are often used for road transport);

(d) devising taxing policies and allocating trucks and fuel (in particular restricting the number of trucks allocated for own account trucking);

(e) redistricting the administrative organization of trucks to reflect economic areas rather than present town, county and provincial boundaries;

(f) centralizing truck dispatching and management for own account trucks

Most of these measures would lead to improvements in road transport and particularly the efficiency of vehicle use. However, the various parties concerned may find the measures difficult to implement and to adopt, and would certainly require considerable time to do so.

5.25 In Jiangsu province some progress has already been made on (f). In particular, one township has regrouped its own account trucks into a trucking company, thus, greatly increasing the use of this capital. This greater use of the trucks, however, raises the problem of fuel procurement mentioned above. The example is nevertheless well worth considering for duplication in other regions. At present, permits are needed for trucking across provincial lines. Ways to simplify such bureaucratic procedures should be found to ease the flow of goods.

5.26 Finally, there are measures outside the transport sector, including reforms of the commodity circulation system which would help reduce the need for transport. Recent experiences with trade centers for manufactured goods indicate that new channels can be opened with fewer intermediate links between producers and buyers, i.e., goods flow directly from origin to destination without intermediate handling, storage and retransport. The restructuring of economic areas in Jiangsu province around cities from the former system of prefectures also seems to have reduced some of the double handling of many commodities. These practices should be extended as they will surely reduce transport intensity.

E. Domestic Water Transport

5.27 While there has been some growth in recent years, this mode is still not used to its full economic advantage. Average route density of freight traffic is only 36 million tons on coastal lines and 14 million tons on the Yangtze River. By comparison, a single track rail line can carry up to 20 million tons p.a. and a double track line 90 to 100 million tons p.a.

5.28 The network of navigable inland waterways has been decreasing yearly since 1960 when it slightly exceeded 170,000 km. In 1982, it had been reduced by more than one third to 109,000 km. Part of this reduction is attributed to the building of dams and other works for irrigation and power. These works are under the responsibility of a different ministry than that controlling water transport, therefore the needs of transport are often overlooked. With the great increase planned in hydropower development to the end of the century, it is very important that the use of waterways for transport be recognized and included at an early stage in the planning of these works, to arrest and reverse the trend indicated above whenever economically justified.

5.29 As a result of the decreasing navigable distance the tonnage moved on inland waterways has stagnated since 1978. However, the total ton km increased as a result of increased average distances.

Table 5.4: DOMESTIC WATER TRANSPORT

Year	Inland Waterways Tons (mln)	Inland Waterways tkm (bln)	Inland Waterways Average distance (km)	Coastal Shipping Tons (mln)	Coastal Shipping tkm (bln)	Coastal Shipping Average distance (km)
1978	327.6	51.3	157	68.7	77.9	1,134
1979	321.2	54.5	170	68.6	84.5	1,232
1980	311.9	57.2	183	72.0	95.1	1,321
1981	298.4	56.5	189	71.2	94.2	1,323
1982	320.3	65.1	203	77.0	105.7	1,373

5.30 Coastal shipping has grown faster than inland shipping in recent years. As mentioned in para. 2.20, it is particularly well-suited to serve the 8 coastal provinces which together with Tianjin and Shanghai accounted for over 50% of the GVIAO in 1982. Cargoes suitable for coastal shipping are coal, oil, timber, steel, grain and ores. In 1982 these six major commodities accounted for 80% of MOC controlled coastal shipping and 71% of locally controlled coastal shipping traffic with coal and oil accounting for, respectively, 52% and 55%.

5.31 Coastal shipping provides an economical alternative to the congested North-South Railways such as Beijing-Guangzhou and Beijing-Shanghai (Map IBRD 18229). Industries located along the coast and rivers can avoid inland transport of goods to and from ports by taking advantage of water transport. At present there are already six steel mills and as many oil refineries located on the Yangtze river. Fertilizer plants and other chemical factories are also located on the water. Baoshan steel mill traffic will be 97% by water. In a city such as Wuxi, in Southern Jiangsu province, over three quarters of the transport is by water.

5.32 In the next twenty years, it will be important for the coastal region, including its hinterland accessible by water, to make the best use of water transport by considering it in the early stage of planning industrial location. Some of the ideas discussed in para 6.13-6.14 regarding self-unloading ships, and floating terminals can apply to commodities other than coal for reducing infrastructure investment. Other types of vessels such as ocean going barges should also be considered to connect coastal shipping directly with inland waterways, thus avoiding costly transhipments in congested ports such as Shanghai. The opening of new ports presently under construction in the lower reaches of the Yangtze river in Jiangsu province will also help to decongest Shanghai, provided the waterways radiating from these ports are improved to adequate standards. There may be a need to adopt unified standards for navigation channels under various authorities so that major tributaries can be navigated by the same vessels as those operating on the main river courses. Finally, modern inter-modal terminals will be an essential complement to the waterway system for interfacing with the land transport modes, rail and road.

F. Port Development

5.33 In 1952 only 44% of foreign trade was waterborne; the rest came overland from the USSR, Korea and Vietnam. Now 90% of the foreign trade is waterborne. Foreign trade measured in US dollars tripled from 1952 to 1972 (growth rate less than 6% p.a.) but increased over 6 times from 1972 to 1982 (20% p.a.). In terms of cargo volume, however, the effect is somewhat moderated by the increasing value of commodities traded. In 1962, the average cargo value was US$117 per ton while in 1980 it reached US$404 per ton. Total foreign trade tonnage handled through the 15 major ports under MOC's control doubled between 1977 and 1982 (15% p.a.).

Table 5.5: FOREIGN AND DOMESTIC TRADE THROUGH MAJOR COASTAL PORTS
(Million Tons)

	1977	1978	1979	1980	1981	1982
Foreign	40.6	56.4	70.7	75.2	75.0	81.5
Domestic	119.1	141.9	141.9	142.1	144.3	156.1
Total	159.7	198.3	212.6	217.3	219.3	237.6

Source: Ministry of Communications

5.34 Foreign trade is expected to continue growing in stride with the economy as a whole, quadrupling by the year 2000. Domestic water transport is also likely to increase its share of total freight traffic. These two elements combined will continue to generate large demand for port capacity. Port traffic could well increase to 5 times its 1980 level before the end of the century. As discussed earlier, there are alternatives to traditional port infrastructure which should be considered to minimize investment costs. The latter will nevertheless have to remain substantial, around Y 2 billion per year, to avoid bottlenecks that would stifle economic development and trade.

G. Passenger Transport

5.35 Passenger demand for transport is expected to grow even faster than freight as people's incomes grow. Between 1978 and 1983 passenger-km increased at over 12% p.a. The international comparison in Chapter 3 indicates that increased incomes universally lead to higher demand for personal travel, although not necessarily exclusively for travel by public transport. The elasticities of demand are also much greater at lower than higher income levels. In China, the elasticity of passenger-km to GNP per capita has been well above unity, and even reached 2.0 from 1978 to 1981. A quadrupling of the economy in 20 years could well be accompanied by a passenger travel demand increasing at over 10% p.a. Total passenger turnover could be in the range of 1,100 to 1,500 billion pkm, or about 4 to 5 times the 310 billion pkm reached in 1983.

Table 5.6: PASSENGER TRAFFIC GROWTH SCENARIOS

	1980		1990		2000
Income/capita growth		6.2%		6.2%	
Case 1					
Passenger transp. elasticity		1.7		1.5	
Passenger transp. growth		10.5%		9.3%	
Passenger-km. (billions)	228		620		1,510
Case 2					
Passenger transp. elasticity		1.5		1.2	
Passenger transp. growth		9.3%		7.4%	
Passenger-km. (billions)	228		555		1,140

H. Modal Split

5.36 Public buses now transport three times as many passengers as the railways, a complete reversal from the early fifties. However, the railways still dominate in terms of passenger-km due to the longer average trip distance. Their share is fast decreasing from 65% in 1976 to 57% in 1983. The recent developments in rural areas have generated a vastly increased demand for short distance travel to cities and other markets. This has brought about a shift toward the road mode and decline in average travel distance to 64 km in 1982 from 73 km in 1976, despite a slight increase in rail travel distance.

Table 5.7: RAIL AND ROAD PASSENGER TRAFFIC

	Average Distance (km)		Rail/Road Share in % /a	
	Rail	Road	no. of pass.	pkm
1976	134	37	35/54	65/27
1982	157	32	23/70	57/35

/a Remainder to 100% consists of waterways and aviation.

5.37 These trends can be expected to continue and the share of road transport to increase substantially by the year 2000. Indeed road transport is very efficient for the movement of passengers. For instance, while the ratio of energy consumption favors railways for freight it is reversed for passenger transport as the vehicle weight per seat is lower for buses than for trains. Because buses are smaller units, they can be scheduled more frequently to reach more dispersed destinations more often than trains, thus greatly increasing the flexibility and quality of service. Furthermore, passenger trains occupy more line capacity than freight trains as a result of their higher speeds.

Table 5.8: SCENARIOS FOR FUTURE PASSENGER MODAL SPLIT

	1980		2000			
			low road share		high road share	
	pkm (bln)	%	pkm (bln)	%	pkm (bln)	%
Case 1						
Rail	138	60	760	50	695	46
Road /a	73	32	630	42	695	46
Water	13	6	60	4	60	4
Air	4	2	60	4	60	4
Total	228	100	1,510	100	1,510	100
Case 2						
Rail			570	50	525	46
Road /a			480	42	525	46
Water			45	4	45	4
Air			45	4	45	4
Total			1,140	100	1,140	100

/a In 1983 road traffic had already reached 111 billion pkm.

Note: Cases 1 and 2 have the same total passenger-km as in para. 5.28. Figures above have been rounded. See also tables 5.6 to 5.9 for further details and modal growth rates.

5.38 The above table assumes a continuation of the present policy of exclusive reliance on public transport and use of automobiles limited to official business. It is likely that as income levels grow, the demand for geater mobility and for private vehicles will increase as it has in most other countries including centrally planned economies. The USSR had some 7 million private cars in 1980. In India, the move to private personal transport has gone through two-wheelers such as motorcycles, scooters and mopeds, which are less expensive than cars and totaled 1.5 million by the late 1970s. This may well be suitable for the southern regions of China where the climate is not too harsh in the winter. Personal transport can be accommodated without great problem in rural areas. It is only in large cities with low road density and lack of parking space that greatly increased use of personal transport would raise very difficult space problems. Whatever level private motorized transport eventually reaches in China (small tractors are already playing this role in rural areas albeit very inefficiently, para. 5.14), the need to build up a good public transport service is imperative. Each mode of transport can contribute certain economic advantages.

5.39 For road transport, experiments have been made in rural areas around Zhengzhou in Henan province to organize better bus services and relieve the railways from short distance services. This certainly seems to be a move in the right direction. Results should be studied carefully to determine whether the experiments could be extended to other areas.

5.40 Despite its expected reduced share, railway passenger traffic between major cities will continue to grow rapidly as economic exchanges multiply, for instance between coastal cities and interior provinces. The scenarios above indicate a range of traffic, in the year 2000, 4 to 5 times the 1980 level. Restricting travel of managers, technicians, workers and students as well as of their families would greatly reduce the flow of information and the development of less advanced areas. Therefore, it is important that future railway plans include substantial development of rail passenger facilities including infrastructure and rolling stock. In particular, planned targets for increasing production capacity of passenger coaches appear much too low in relation to estimated needs.

5.41 Finally, civil aviation should also be developed faster with emphasis on the longer distance inter-city routes.

6. TRANSPORT AND ENERGY

6.01 Nowhere is the need for transport felt more strongly than in the energy sector. Millions of tons of coal already mined are being lost through auto combustion in Shanxi for lack of transport, while industry is short of energy. Energy and transport are closely related in two ways: first, the transport of energy from producers to consumers; and second, the consumption of energy in the transport sector. This chapter discusses the future of these two sectors and the issues that are shared between them.

A. Energy Transport Issues

6.02 Coal and oil account for a major share of the traffic moving by rail (44% of the total tkm), inland waterways and coastal shipping and of course pipelines. Lately, due to rail congestion, some coal has also been transported by road over relatively long distances. In 1983, for instance, Shanxi shipped 8.5 million tons of coal to other provinces by truck.

Coal

6.03 The two major issues concerning coal transport are:

(i) The optimal balance between coal development near major consumption areas (Northeast and East) and coal development in Shanxi (including western Nei Monggol and northern Shaanxi). Coal in Shanxi is abundant and of good quality, therefore both development and operating costs of mines are lower than elsewhere. However, transport distances to large consuming areas are in excess of 1,000 km.

(ii) The trade-off between coal and electricity transport. North China has high quality coal exploitable at low cost. The problem is the trade-off between the transport of coal to industries and power plants at load centers and the transport of electricity from mine-mouth generating plants. A major problem of mine-mouth generation is that the coal rich region is poor in water resources.

6.04 In 1980, north China, including Shanxi province, accounted for one third of total coal production in China. Major coal routes are illustrated in Map IBRD 18224 and interregional coal transport volumes by rail are given below (see also Appendix Table B.32).

Table 6.1: 1982 INTERREGIONAL RAIL COAL TRANSPORT
(Million Tons)

Destinations Origins	N-E	N	E	S-C	S-W	N-W	Total
Northeast	75.4	2.0	-	-	-	-	77.4
North	22.0	109.3	21.1	15.0	0.3	1.9	169.6
East	-	0.6	67.1	1.1	-	-	68.8
South-Central	1.4	0.4	3.4	54.7	0.2	0.1	60.2
South West	-	-	-	3.4	25.5	-	28.9
North West	0.7	1.9	3.3	1.9	-	25.8	33.6
Total	99.5	114.2	94.9	76.1	26.0	27.8	438.5

Source: Ministry of Railways.

6.05 The inter-regional flows can be summarized as follows:

Table 6.2: NET INTERREGIONAL COAL FLOWS

	N-E	N	E	S-C	S-W	N-W
	------------- million tons					--------------
Shipped to other regions	2.0	60.30	1.7	5.5	3.4	7.8
Received from other regions	24.1	4.90	27.8	21.4	0.5	2.0
Net flows	-22.1	55.40	-26.1	-15.9	2.9	5.8

6.06 When considering the issue of local production near consumption centers versus production in North China, it is necessary to compare the total cost of coal mining and transport to the final users. Because most rail lines out of the coal producing areas of North China are at or near capacity, the appropriate transport cost to use in the comparison is the long run variable cost (LRVC) based on the construction of new lines. Such cost would vary from place to place depending on local conditions and topography. Calculation of a rough order of magnitude indicates that LRVC of about 2 to 2.5 fen/ton km would be adequate for the above comparison (Appendix A). This would mean that local production cost, say in Liaoning Province approximately 1,000 km away from the Shanxi coal fields, could be about Y 20 per ton higher than in Shanxi and still be competitive. Below are some notional costs of coal production and transport that would face coal users in the Northeast. Coal production costs vary over a large range, and so do transport costs. A coal mine which is not on the railway can face very high transport cost to move coal by road. Delivery over 100 km by road in the Northeast can be as expensive as bringing the coal from Shanxi by rail. Therefore, comparison should really be made on a case-by-case basis.

Table 6.3: COAL PRODUCTION AND TRANSPORT COST COMPARISON

	Coal production cost LRMC /a	Transport costs to Northeast	Total
	----------	Yuan/ton	----------
Shanxi Province	40-44	25	65-69
Northeast	60-70	5	65-75

/a Long Run Marginal Cost (LRMC) has been calculated using the average incremental cost (AIC) method; discounting (10% was used here) all incremental costs of coal production (capital and operating) and dividing this total by the discounted value of incremental outputs.

6.07 Despite the reservations about making any generalization, the figures demonstrate that Shanxi coal can be competitive in coastal China despite the transport distance. Deposits in large seams are easily accessible and both investment and operating costs are lower than in other regions. In addition, Shanxi coal is generally of higher quality and calorific value. Therefore, further development in north China appears to make good economic sense. Indeed, the region is expected to account for almost 60% of the coal production increase by the year 2000 (Map IBRD 18225).

Table 6.4: REGIONAL COAL PRODUCTION, 1980-2000

	1980 actual	2000 low	Increase	In % of total increase	2000 high	Increase	In % of total increase
	------	million tons	------		--million	tons--	
Northeast	98	181	83	14.3	185	87	11.2
North	205	550	345	59.5	715	510	65.5
East	106	171	65	11.2	175	69	8.8
Middle South	98	131	33	5.7	140	42	5.4
Southwest	65	82	17	2.9	85	20	2.6
Northwest	49	85	36	6.2	100	51	6.5
Total	621	1,200	579	100.0	1,400	779	100.0

6.08 With the greater concentration of production in the North, inter-regional flows of coal will increase greatly by the year 2000. Therefore, the second issue of transporting coal or electricity needs to be discussed. Much research and study on this is being done in China and an analysis in Appendix A illustrates the effect of various parameters and indicates orders of magnitude. The analysis shows that for coal above 5000 Kcal/kg, rail transport (on single track railway lines) would be more economical than electricity transport. If double track lines are used as in the case of Shanxi province, rail transport is economical for coal of even lower calorific value. Since Shanxi coal is generally of higher calorific value (6,000 kcal/kg or more), mine-mouth power generation and long distance transmission is likely to be justified only in the case of use of middlings, whose availability should increase as a result of a greater washing effort. Present plans for coal washing facilities (300 million tons by the year 2000) would justify 20-25, 1000 MW of mine-mouth power plants.

6.09 In its preliminary plans, the Ministry of Power envisages the development of 45-60,000 MW of thermal capacity (of which 25-35,000 MW of thermal capacity in North China, i.e., Shanxi and adjacent areas of Nei Monggol and Shaanxi), and 50-60,000 MW at load centers (MAP IBRD 18226). The latter would require transport of some 150-200 million tons of coal (calculated on the basis of 3 tons of coal per installed kW). In the above total, major load centers in the Northeast, East and South account for 20-30,000 MW, requiring 60 to 90 million tons of coal annually. Most of this coal will come from the North.

6.10 Future coal flows will generally follow the same pattern as the present ones, but with large increases on the lines out of Shanxi province and surrounding areas. Increased use can be made of coastal shipping from northern ports to southern destinations, but coal will still need to be moved via rail from the mines to the ports. The Ministry of Railways (MR) expects that the percentage of coal production transported by rail (now 66% of raw coal production) will not change greatly by the year 2000. This appears realistic; on one hand increased mine-mouth power generation will reduce the need for transport but on the other hand, greatly increased reliance on Shanxi coal will increase it. Furthermore, all new generating capacity in coal producing areas will not be exactly mine-mouth and will still require coal transport.

6.11 The high production scenario of 1,400 million tons of coal by the year 2000 is likely to be required to sustain the target of quadrupling GVIAO. With this scenario, 715 million tons or over half the total coal production is expected to come from north China (Table 6.4). This means that some 450-500 million tons would need to be transported out of Shanxi and adjacent areas of Shaanxi and Nei Monggol or about 4 to 5 times the 1984 planned volume. The predominant directions of flow will be east and south, since the larger deficit areas will be in east and south-central China with smaller ones in the Northeast and Southwest.

6.12 With projects presently under construction or about to start, the rail capacity for coal transport from Shanxi should be near 300 million tons by the early 1990s. This includes the electrification of the existing double track line between Datong and Qinhuangdao and the new double track electrified line planned in the same corridor. The latter would be suitable for heavy unit train operation and have a capacity of over 100 million tons p.a.

Construction to start in 1985 is estimated to cost some Y 6 million/km. Other lines are also planned from south and central Shanxi province.

6.13 To handle the 450-500 million tons, it would be necessary to (a) construct another double track electrified line for heavy unit trains similar to the Datong-Qinhuangdao line to carry another 100 million tons plus p.a. Such a line should probably go in a southeastern direction; and a possible route is the Shuoxian-Shizhiazhuang-Yanzhou corridor which is presently under consideration; and (b) further increase the capacity of existing lines by double tracking and electrification, or even further multiple tracking if conditions permit. Slurry pipelines may also contribute to relieve the pressure on railways. The major problem seems to be the shortage of water in Shanxi province.

6.14 In addition to the above lines out of Shanxi, for shipments to south central China, the north-south rail capacity will also need to be increased. Besides electrifying the existing lines and lengthening stations for operating larger trains, a new line may well become necessary in the 1990s. Plans are being made for such a line, running between the two existing north-south lines, and sections are already under construction in Anhui province. Construction of extensions to the North may have to be accelerated at least to connect with the Lianyungang-Baoji line. For shipments to the Northeast, rail capacity will need to be increased north of Qinhuangdao. Some of the coal can also be shipped to Dalian and Yingkou for coastal uses in Liaoning province.

6.15 The combined use of rail and water transport may be economical on some routes but not necessarily on all; therefore careful, case by case analysis should be performed before traffic is assigned to any particular route and modal combination. For instance, it appears that coastal shipping from northern ports will be more attractive than the use of the Yangtze River to deliver coal to the Shanghai area. The Government estimates that for Datong-Shanghai, combined rail/water transport (through Qinhuangdao port) could be 20% cheaper than direct rail haulage. While the first two routes below can be considered for joint transport, the third one is obviously not economical. Rail distance to Wuhan is only 10 km shorter than to Nanjing and there are still 800 km by water.

Table 6.5: COMBINED RAIL-WATER ROUTES FOR COAL

	Rail (km)	Water (km)	Total distance (km)
1. Datong to Shanghai	1,840		1,840
Datong-Qinhuangdao-Shanghai	620	1,350	1,970
2. Taiyuan to Shanghai	1,500		1,500
Taiyuan-QingDao-Shanghai	920	750	1,670
3. Taiyuan-Nanjing	1,190		1,190
Taiyuan-Wuhan-Nanjing	1,180	800	1,980

6.16 The order of magnitude of coal that could be economically transported to east and south China by a combination of rail and water transport could be around 100 million tons by the year 2000. Northern ports such as Qinhuangdao, Shijiusuo and Lianyungang are being developed for the shipment of coal, and plans are being made for a coal terminal in Qingdao. With these developments, capacity for shipping coal from the North will be around 40-45 million tons; and would have to be increased by some 60 million tons by the year 2000. Development of receiving ports in southern areas seems less advanced, but the problem of receiving ports in the South may not be so serious if consideration is given to simplifying coal unloading facilities with self-unloading ships. To relieve port congestion, large coal users such as steel mills and power plants on coastal locations usually develop their own terminals. The use of self-unloading ships can save costly port infrastructure such as berths for along-side mooring, shore equipment and dredging. The only infrastructure needed to receive self-unloading ships consists of mooring dolphins, a coal hopper and a conveyor belt on a simple trestle. The trestle for the conveyor belt can extend to deep water, reducing dredging cost considerably. The extra cost of a 50,000 DWT self-unloading ship compared to a regular ship is only about US$5 to 6 million. This could be much less than the extra port infrastructure cost that would be required by conventional ships for the level of traffic which may be required by a power plant for instance. Turnaround time in ports can also be reduced greatly with self-unloading capacities of 2-3,000 t/hour, thus, allowing more efficient use of ships.

6.17 Besides specialized facilities for large users, the use of floating terminals should also be considered for transhipment to smaller vessels. Such floating terminals could be anchored off-shore or in river estuaries (Yangtze, Pearl River). They could be fed by self-unloading ships from the North and could then load smaller ships and barges for final distribution through rivers and canals. The advantages of these floating terminals are the same as those mentioned above -- reduced port infrastructure and reduced dredging. In addition, they can be established much more rapidly than fixed port infrastructure can be constructed. Furthermore, they can be moved should markets change over time. The combination of these solutions would greatly reduce the investments needed to develop coal receiving facilities as well as reduce the time needed to place them into service.

6.18 The development of the transport infrastructure which China needs is not an insurmountable task provided there is adequate planning. The new Datong-Qinhuangdao line for heavy unit trains should be available in the early 1990s. Another similar line could be available by the year 2000 along with further improvement to existing lines, and the new north-south line, provided investment in railways is increased and kept to Y 7-9 billion per year at today's prices. For coal ports in the north, the increased capacity of some 60 million tons would require 5-10 berths, which is technically feasible. Costs will vary greatly with location and may range from Y 150-200 million per berth with all related equipments. The same capacity has to be developed for receiving coal in the South, and the alternatives mentioned above may help to minimize costs.

Petroleum

6.19 Most crude oil is transported by pipeline except the Xinjiang crude which is moved to Lanzhou by rail. Petroleum products, however, are generally moved by rail (Map IBRD 18227). Intention to build product pipelines has been reported and this should be actively pursued to relieve the railways in congested corridors such as Shenyang to Dalian and Beijing to Shijiazhuang and points south.

6.20 A major transport issue, which is under study, is the dilemma between rail and pipeline transport from the far west, should major discoveries be made in the Karamay area. The capacity of the railway line (single track) is limited by the difficult topography restricting train weight. Distances are very long and development costs of either the rail or pipeline alternative will be large. The first step is likely to be the increase of rail capacity by working on critical bottleneck sections.

B. Energy Consumption in the Transport Sector

6.21 At present, transport in China consumes a lesser percentage of total energy than in many other countries. Only 8% of final commercial energy is consumed in the transport sector in comparison to 22% in India and over 20% in many other developing countries. Similarly, transportation accounts for only 25% of petroleum products consumption in China while shares of 40% are common in other countries. The reason for this low share of energy consumption in transport results mainly from the very low share of road transport in total freight and passenger traffic. With even modest (in comparison with other countries) road transport development by the year 2000, transport may well become the largest user of liquid fuels. This section presents briefly the energy consumption of the railways and then the prospects and problems facing road transport development.

Railways

6.22 Appendix Table B.42, gives the present (1980) and forecast (1990 and 2000) energy consumption by the railways. The plan indicates the emphasis on electric traction which is expected to handle 43% of the total year 2000 traffic. To achieve this will require electrification of 1,000 km of line per year, between now and the year 2000. This contrasts with the electrification pace of the 6th Five Year Plan of 500 km p.a. Each potential electrification project will need to be studied on its own economic merits. At this rate nearly 20,000 km or about one third of the network would be electrified by the year 2000. The estimated electricity consumption would only be about 2% of the total estimated electricity demand and therefore not a problem in general. Again particular locations may be more difficult than others and case studies are needed. Existing electrified lines together with electrification projects presently under construction or planned for the near term are shown on Map IBRD 18228.

Road Transport

6.23 A very critical issue for road transport development is the supply of liquid fuel. It is possible that shortages of fuel already constrain the use of trucks and buses. This affects mostly the newly established enterprises and transport companies which lack historical fuel quotas. In the case of one township's new transport company, fuel allocation accounts for only one third of its needs; the rest must be acquired through barter at a great cost of time and effort. Total fuel consumption for trucks and buses was estimated at around 10.5 million tons in 1980 for an estimated truck and bus fleet of about 1.6 million vehicles. Assuming an average consumption of 20-25 kg/100 km, the present total consumption would allow every vehicle to travel 26,000 to 33,000 km/year or about 70 to 90 km/day. While this may do for own account vehicles, it appears on the low side for public carriers and for buses.

6.24 Total truck transport of freight in ton/km has increased 39% in the two years 1981 to 1983. Road transport demand can be expected to continue growing much faster than the economy as a whole, especially given the low base from which it is starting. A growth rate of some 10% p.a. to the year 2000 would still give a very modest share to the road mode in comparison with the share in other countries today (see para 2.16 and also further discussion on modal split in Chapter 5).

6.25 Conservative estimates show that road transport in the year 2000 could be 4 to 6 times higher than the 108 billion tkm and 111 billion pkm already reached in 1983. The impact on liquid fuel consumption will be very large despite some possible energy savings. Such savings can be obtained through a series of measures such as better engines, shift to larger and more energy efficient trucks, improved load factors and finally improved roads. Using conservative projections of road transport growth, petroleum product demand in road transport in the year 2000 could well be 3 to 5 times higher than in 1980, i.e. 30 to 50 million tons even with substantial energy conservation. This would increase the oil distillates consumption in transport from about 38% of national distillate use in 1980 to almost 50% by 2000.

7. TRANSPORT AND INDUSTRIAL LOCATION

A. Natural Resources

7.01 As discussed in Chapter 2, the location of natural resources and patterns of regional development greatly influence transport intensity, transport distance and modal choice. In this chapter, the implications of industrial location for transport are illustrated by some specific examples. The two commodities which rank highest in the freight traffic of the Chinese railways (in ton-km) happen to be coal and timber, natural resources whose transport patterns illustrate well the effect of location. Coal is found in many parts of China while timber is concentrated in the Northeast. As a result, the share of inter-regional transport of timber is twice that of coal and the average transport distance almost three times as long (1,230 km versus 445 km). Out of the 23 million tons of timber loaded in the Northeast, almost 10 million tons are shipped to other regions of China; including over one million tons going to the South (over 2,000 km) and 0.6 million tons to the distant Northwest (3,000-4,000 km).

Table 7.1: PATTERNS OF COAL AND TIMBER TRANSPORT BY RAIL (1982)

	Coal		Timber	
	Million tons	%	Million tons	%
Intra-provincial	261.86	60	14.14	34
Intra-regional (excluding intra-prov.)	95.92	22	12.21	30
Inter-regional	80.64	18	14.63	36
Total	438.42	100	40.98	100
Average distance (km)	445		1,228	

7.02 In the future, the greater reliance on coal production in north China mentioned in Chapter 6 will increase the inter-regional movement of coal. For timber, transport patterns could change substantially as China is likely to import more timber. Processing of imports should be located in coastal areas, preferably near the ports to minimize transport of raw materials. Due to administration there is some duplicated timber transport which could be reduced. Timber is often transported from the forests to a city, stored and then redistributed, rather than moved directly to final destination. In addition, out of the 40 million tons handled by the railways, 30 are raw timber and only 10 are products. Further processing near logging areas would also save transport.

B. Heavy Industry

7.03 The location of industry is only partially dictated by the location of natural resources. Other factors are the availability of labor, proximity to markets and availability and cost of transport. The location criteria of light industry are very different from those of heavy industry because inputs and outputs are lighter, less bulky and more sensitive to the quality of transport service than to transport costs. For heavy processing and weight-reducing industries such as cement and iron and steel, input transport costs are a major component of total production costs. For cement, delivery costs are also quite high in relation to the value of the commodity. A US study 5/ estimated a freight index as the ratio of freight rates to ex-factory product value for 100 different industries. This index is highest for cement: 51.5 cents for the transport of 1 dollar worth of cement; for steel, the index is only around 4 cents per dollar. Therefore, it can be expected that all efforts would be made to minimize transport distance for cement while the problem is somewhat less important for raw steel and steel products. The contrast in the pattern of transport of cement and iron and steel for China is illustrated by the following figures.

Table 7.2: CEMENT AND IRON AND STEEL TRANSPORT BY RAIL (1982)

	Cement		Iron and Steel	
	Million tons	%	Million tons	%
Intra-provincial	16.78	67	24.30	41
Intra-regional (excluding intra-prov.)	5.32	21	16.44	28
Inter-regional	2.90	12	18.02	31
Total	25.00	100	58.76	100
Average distance (km)	395		768	

As expected, the proportion of inter-provincial and inter-regional rail transport and the average transport distance of iron and steel are almost double those for cement.

Cement

7.04 Raw material for cement is found almost everywhere. Therefore, in view of the high freight index for product delivery mentioned above, location of production close to markets is common. In China, cement transport patterns

5/ F.M. Scherer et. al. The Economics of Multiplant Operations, Harvard University Press, 1975.

are affected both by the historical development of the cement industry and by the quality and pricing of the product. As a result, transport distances by rail are much higher than in other countries (para. 2.24). While cement is produced in every province of China, Liaoning is still the largest producer, with over 8 million tons in 1982 or almost 9% of the national output. Liaoning is also by far the largest shipper of cement beyond regional borders (over 1 million tons; see Appendix Table B.43). Some of this cement may well travel over 1,000 km to places such as Shandong and Jiangsu. Other long distance cement shipments originate in Henan and Hubei. Conversely, North China is short of production and over one-quarter of rail delivered cement comes from outside the region. The Northwest is also short of local production and deliveries from other regions also imply very long transport distances. These production location patterns reflect historical developments, particularly in Liaoning province.

7.05 The other factors affecting cement transport in China are price and quality. Cement is produced both in centrally controlled large plants and in locally controlled small and dispersed plants. The large plants manufacture good quality cement and sell it at a low fixed price of about 50 Y/ton or half the FOB world market price. Local plants usually produce lower quality cement, but because of the overall shortage they sell it at prices ranging from 60 to 90 Yuan per ton. Centrally controlled cement production accounts for about 25-30% of the total. This corresponds also to the share of production transported by rail -- 26.3% of production in 1982. Given this quality and price situation, it is desirable for users to obtain as much centrally controlled cement as possible, even over long distances. The example below shows that without even accounting for quality differential, centrally controlled cement delivered by rail can compete with local cement delivered by road anywhere in China, well beyond distances found economical in other countries.

Table 7.3: CEMENT PRICE AND TRANSPORT TARIFFS

	Local cement delivered by road	Centrally controlled cement delivered by rail /b	
	50 km/a	2,500 km	3,000 km
Cement price Y/t	80	50.0	50.0
Transport tariff	10	35.2	42.3
Delivered Price	90	85.2	92.3

Note: Taking some Y 10 for final delivery from railroad station (including trucking and extra handling) would still leave centrally controlled cement competitive well over 2,000 km.

/a Assume road tariff of Y 0.2/tkm.
/b Based on December 1983 rail tariffs in Yuan per ton for car load.

7.06 From the brief discussion above, there appears to be considerable scope for the rationalization of cement distribution in China. The drop in average rail transport distance from over 600 km in 1970 to slightly under 400 km now indicates that some progress has been made in dispersing production from its original concentration in the Northeast. Certainly more can be accomplished in the future, by further developing the production in regions which are short of cement, but rational cement pricing would also have a major impact on distribution patterns.

7.07 Another area where considerable cost savings can be made in cement distribution is in the proportion of bulk and bagged cement. In developed countries, 80% or more of the cement is delivered in bulk while in China most of it is still delivered in bags. Savings in bagging, handling and spoilage costs can be substantial. Further down the distribution chain, ready-mix concrete, prepared in specialized plants, is also more economical and of better quality than concrete mixed on the construction site. Such ready-mix concrete plants are also best suited to receive bulk cement.

Iron and Steel

7.08 Iron smelting is a highly weight reducing process. In China, because most of the ores have relatively low iron content, the weight reduction is even greater than elsewhere. In the late 1960s blast furnace operation in the US required about 3 tons of input per ton of iron; in China, the average seems closer to 5 tons, including 4 tons of iron ore[6/]. One would thus expect to find iron making concentrated near iron ore resources. This is only partially true; while two-thirds of the pig iron is produced in five provinces and Beijing, every other province and special city except Qinghai and Tibet also produce pig iron. This is a result of past policies in provincial self-sufficiency as well as low prices for natural resources and raw materials.

6/ F.M. Sherer et. al. op. cit. p. 29.

Table 7.4: MAJOR PIG IRON PRODUCING PROVINCES

	Pig Iron Production - 1982 Million tons	%
Liaoning	9.63	27
Hubei	3.34	9
Beijing	2.92	8
Sichuan	2.85	8
Hebei	2.19	6
Anhui	2.14	6
Subtotal	23.07	64
Others	12.44	36
Total	35.51	100

Source: Statistical Yearbook of China, 1983, p. 263.

7.09 From a transport point of view, it would be more efficient to concentrate pig iron production near ore resources. This excludes plants which will use mainly imported ores and which are located on the coast where they can have their own port facilities. There are 16 provinces plus Tianjin which produce less than one million tons each of pig iron per year. To supply the plants in these areas, the railways transport almost 50 million tons of iron ore an average distance exceeding 300 km. Only about 7 of these 50 million tons travel short distances between mines and mills. It would certainly be more economical to transport only the 12-13 million tons of pig iron than the 50 million tons of ore. Associated economies of scale in iron making may, in many cases, contribute further savings.

7.10 When it comes to steel products, Liaoning is still first in production with 6 million tons and 21% of the total production. However, Shanghai is a close second in production with over 4 million tons and 15% of production (Shanghai produces only 1.7 million tons of pig iron). Rail movements of iron and steel are massive. In 1982, 59 million tons moved an average distance of 768 km.

Table 7.5: IRON AND STEEL PRODUCTION AND RAIL TRANSPORT

Production (million tons)			Rail Transport	
Pig Iron	Steel Products	Total	million tons	in % of total production
35.5	29.0	64.5	58.8	91

7.11 Rail loadings alone are almost equivalent to the combined total production of iron and steel products. The reasons for such massive transport of iron and steel are partly technological and partly administrative. In China, between 20 and 25% of the pig iron is not used to make steel. Many simple tools are still made of iron and so are many water and heating pipes used in capital construction. In addition, iron and steel production is not integrated. Therefore, more iron enters the transport sector than it would in other countries. Assuming that 50% of the pig iron is transported by rail, i.e., 18 million tons, still leaves over 40 million tons transported for the 29 million tons of steel products, or a factor of 1.4 tons transported per ton of output. It is likely that some raw steel is also transported as an intermediate product, but there appears to be some scope for reducing the total volume transported.

7.12 Almost 60% of the steel transported by rail moves inter-provincially and over 30% moves inter-regionally. An example of this criss-crossing movement of iron and steel through China is Beijing's shipping of a total of 2.7 million tons of iron and steel by rail to destinations which include every province and special city (except Tibet which has no rail). Beijing receives 1.5 million tons from 21 provinces and special cities. This is not an isolated case, as many provinces also trade iron and steel with most other provinces. Some duplication of transport results from long-standing relationships between producers and users and from administrative rigidities. In addition to plants under the Ministry of Metallurgy, there are many small local plants as well as plants under other ministries. Material allocations to the small local and provincial industries cover only part of their needs. The rest has to be obtained through the market and often over long distances.

7.13 While it can be argued that iron and steel is a very broad category covering all sorts of intermediate goods, semi-finished and finished products, and that many inter-provincial and inter-regional exchanges can not be avoided, it would be interesting to study the matter in more detail to see what rationalization of the system is possible. Iron and steel transport is third after coal and timber in ton-km moved by rail and accounts for over 7% of total rail traffic. Any rationalization of the system would, if not reduce eventual transport investments, at least postpone the need for capacity-increasing investments by a number of years. Rail tariffs cover short run marginal cost, but at 16.7 Yuan for 1,000 km, they only account for slightly over 2% of the product value (rolled steel average prices of Y 700-800/ton). Even if tariffs were increased to reflect long run marginal cost, they would never reach a level where they would by themselves provide sufficient incentive to rationalize trade in iron and steel.

7.14 In the future, technological changes will contribute to a reduction in transport demand for intermediate products as new iron and steel plants will be integrated, and the proportion of iron not used for steel will decrease. Administratively, however, the treatment of the industry as one system for the purpose of rationalizing production and transport planning will be much more difficult. Local plants as well as those under different ministries help solve the problems of their own locality or organization and they would be hard to integrate without affecting the interest of these organizations. In any case, transport is only one factor to be considered in the total cost of producing steel and steel products and the eventual rationalization of the industry.

C. Light Industry

7.15 Light industry is tied not to the location of raw materials but to the proximity of markets and availability of skilled labor and management. Products are lighter, more fragile and of higher value than the products discussed above. Therefore, transport cost accounts for a much smaller proportion of the total delivered product cost. For consumer durables such as refrigerators, washing machines, and television sets, the freight indices referred to in para. 7.03 are between 1 and 2% of the product value (the indices were 4% for steel and 50% for cement). The factors determining modal choice are therefore not so much transport cost as the quality and speed of service. Road transport clearly outcompetes rail on these grounds. Door to door transport offers speedy service and the single handling reduces chances of breakage. Except in a few cases of large factories having private sidings, rail transport will involve first trucking to a station, temporary storage, if rail cars are available, and loading to rail cars. These same steps would be repeated at the other end, thus greatly increasing the chances of damage to the product.

7.16 China's economic reform emphasizes the industrialization of the countryside, i.e., people can leave the land but not the rural areas (li tu bu li xiang). This emphasis creates rapidly increasing transport demand for inputs and outputs of local enterprises (CBEs). Because the railway is operating at capacity on many lines and is devoted to the transport of bulk commodities and products under central planning and allocation, it is very difficult for CBEs to use the railways for their inputs and outputs. In any case, for the reasons given above, road transport has a distinct advantage. This advantage is well-recognized and can be illustrated by an example of CBE-made machinery being shipped from Jiangsu to the Beijing-Tianjin area by road, precisely to save time in transit and reduce the chances of damage.

8. TRANSPORT AND AGRICULTURE

8.01 There are parallels between transport requirements of industry and those of agriculture. The need to transport large quantities of bulk inputs and outputs corresponds to the needs of heavy industry while the distribution of all other products and produce corresponds to the needs of light industry. This chapter discusses issues related to the transport of grain and fertilizer at the national level and questions related to rural development and transport needs at the local level.

A. Grain

8.02 The major grain producing area is a belt across the middle of China from Shandong and Jiangsu in the East to Sichuan in the West. In this belt, 7 provinces produce almost 50% of the grain in China. Outside this area, sizeable grain production is also found in the northeast region and in Guangdong province. Most of the longer distance transport of grain is overseen by government agencies. The Government estimates that these agencies transport the equivalent of 40% of total production; for 1982-83 this would mean some 140 million tons. This figure includes repeated transport which is transport using more than one mode of transport and also retransport from storage. Little information exists on grain transported by farmers, but quantities are probably small and so far have been moved only short distances.

8.03 For grain transported by Government agencies, the modal distribution can be estimated as follows on the basis of percentages for the 1982-83 procurement year.

Table 8.1: GRAIN TRANSPORT

	%	Million tons	Intra-provincial	Inter-provincial
Road	62	87	87	-
Rail	25	35 /a	18	17
Water	13	18	13	5
Total	100	140	118	22

/a In 1982, rail transport of grain amounted to some 35 million tons, including the inland distribution of imported grain. Therefore, this figure for domestic grain rail transport appears somewhat high.

The estimate of modal distribution between intra-provincial and inter-provincial transport given in Table 8.1 is based on the total share, i.e. 84% intra- and 16% inter-provincial, and in data for the railways. It is likely that modest amounts of road transport also cross provincial lines, but rail accounts for almost 80% of all inter-provincial movements of grain. Water transport of grain takes place mostly on inland waterways in south China. Very little grain moves by coastal shipping now, although this is growing in response to good grain harvests in the Northeast and growing demands for coarse grains in animal feeding in the South and Southeast.

8.04 The 1982 pattern of rail transport of grain is given in the origin-destination table below (see also Appendix Table B.45).

Table 8.2: RAIL TRANSPORT OF GRAIN, 1982

Destination/ origin	NE	N	E	S-C	S-W	W	Total
	million tons						
Northeast	10.87	0.90	0.17	0.07	0.14	0.33	12.51
North	0.47	5.31	0.08	0.13	0.27	0.58	6.93
East	0.47	1.04	4.79	0.48	0.12	0.75	7.66
South-Central	0.22	0.72	0.24	3.56	0.65	0.29	5.62
Southwest	0.03	0.04	0.01	0.01	0.91	0.02	1.06
West	-	0.07	-	0.02	0.01	0.73	0.87
Total	12.06	8.08	5.29	4.27	2.10	2.70	34.65

Note: Rows do not add up exactly as minor movements less than 10,000 tons may not be identified.

The inter-regional flows can be summarized as follows:

Table 8.3: NET INTER REGIONAL GRAIN FLOWS

	NE	N	E	S-C	S-W	W
	million tons					
Shipped to other regions	1.64	1.62	2.87	2.06	0.15	0.14
Received from other regions	1.19	2.77	0.50	0.71	1.19	1.97
Net flows	0.45	-1.15	2.37	1.35	-1.04	-1.83

The North and Northeast regions are both shipping and receiving grain from other regions, exchanging wheat and corn for rice. The North is a substantial net importer, receiving grain from all other regions. The East and South-Central regions are primarily exporters with very little grain coming from other regions, while the West and Southwest are primarily importers with little outflows.

8.05 In the future, a general accentuation of these patterns is likely. In particular, the grain trade between north and south China would need to be greatly expanded. The northern provinces produce almost two-thirds of China's tuber and oil seeds and over two-thirds of the soybean. However, they produce only 25% of China's pork. Pork production is concentrated in east and south China. Assuming the current spatial distribution of coarse grain, oilseed, and meat production is maintained over the next 20 years, the southern region would require another 60 million tons of feedgrain by the year 2000.[7]

8.06 While there could be some increase of meat production in the North and of feedcrops in the South, it may prove more economical to transport coarse grains from the North to the South. Given the congestion of north-south railway lines and the good inland water transport systems of south China, much of this increase in grain flows from the North should probably go by coastal shipping with final distribution by inland waterways. Plans for the new grain terminal at Dalian in Liaoning province, conceived originally for grain imports only, are being modified for reverse operation which would allow future grain shipments to the South. At present, Dalian only ships some 170,000 tons of grain in coastal trade. Similar facilities should be considered in connection with grain import terminals in the North, i.e., Qinhuangdao and Tianjin. At the receiving end, simple terminals similar to those mentioned earlier for coal could be used in conjunction with self-unloading ships. Transhipment through floating terminals would enable final distribution by inland water transport which is very suitable in southern provinces. These simple terminals would greatly relieve the pressure on existing ports.

8.07 Storage has also become a critical issue with the rapid increase in grain production in recent years. Modern storage facilities in convenient locations can significantly assist the transport sector. Storage can reduce transport demand peaks and modern handling facilities can speed loading and unloading of vehicles, rolling stock and ships while increasing the proportion of the commodity transported in bulk rather than in bags. Distribution studies linking storage and transport are the best vehicle to tackle this type of problem.

8.08 Grain imports have also increased rapidly from levels fluctuating between 4 and 8 million tons in the 1960s and 1970s to over 13 million tons in 1980 and 1981. The major grain entry ports and their operational characteristics in 1981 were as follows:

7/ Demand for Agricultural Products in the Year 2000, prepared by AEPA3.

Table 8.4: INDICATIVE DATA ON GRAIN HANDLING FACILITIES AT MAJOR PORTS

Port	Maximum vessel size ('000 dwt)	Through-put in 1981 (mt)	Effective transfer rate ('000 t/day)	Conveying mechanism	Average turn-around at berth (days)	Average waiting time at anchorage (days)	Storage capacity Silos ('000 t)	Storage capacity Ware-house ('000 t)
Zhanjiang	30	0.8	7	Grab	4	7	-	20
Huangpu (Guangzhou)	25	0.8	8	Suckers	3	7	28	10
Shanghai	30	1.1	5	Suckers	6	15-30	40	30
Luhuashan	80	0.6	4	Grabs	10	7	-	-
Qingdao	30	1.0	4.5	Grabs	7	7	-	5
Tianjin (Xingang)	25	2.5	8.0	Grabs	3	15-30	-	-
Qinhuangdao	34	1.7	6.0	Grabs	7	15	-	-
Dalian	35	3.0	4.5	Grabs	7	15-30	-	20
Total		11.5						

Source: China Business Review, January-February 1983, p. 20.

Most grain receiving ports are equipped with grabs, few have yet installed continuous unloaders and silos. Handling is thus relatively slow and cumbersome. Grain is often discharged directly in rail cars with much dust and loss of grain combined. This process requires that rail cars be on hand for a ship's arrival and also involves lengthy unloading of ships. This contributes to port congestion and high shipping charges. In 1982, total demurrage charges for foodstuffs were estimated at almost $100 million; while only 20% of total grain imports were carried by non-Chinese bottoms.

8.09 Measures are being taken to rationalize handling at a number of ports. Taking such measures should be further encouraged as cost savings of modern grain handling facilities are substantial. As the level of grain imports will continue to fluctuate, the possibility of moving more domestic grain by coastal shipping should also be considered. It is expected that the restructuring of Chinese consumption patterns for agricultural products will require much larger volumes of agricultural imports (feed grains, protein meals, fertilizer) and exports (rice, pork, processed products).

B. Fertilizer

8.10 Fertilizer produced in China consists primarily of nitrogen and phosphate with small amounts of potash from Qinghai province. In 1983, total production reached 13.8 million tons of nutrients, while imports totalled 2.8 million tons. There are no statistics of the total product weight equivalent to the nutrient weight above, but it is roughly estimated that 1983 domestic production amounted to 64 million tons (46 million tons of nitrogen and 18 million tons of phosphate) and imports reached 5-7 million tons.

8.11 In China, 50% of nitrogen fertilizer is produced in 13 large and 55 medium-size plants and 50% in 1,300 small plants. The latter have a market area of only 25 km around the plant and their production is probably transported in parts by non-motorized traditional transport means. The 13 large plants were all commissioned after 1978 and had a large impact on the pattern of fertilizer transport. Chemical fertilizer moved by rail more than doubled between 1977 and 1981 from 12 to 25 million tons. Over the same period, average distance also increased 30% from 560 km to 730 km. In addition the railways transport some 10 million tons of phosphate rock.

Table 8.5: FERTILIZER RAIL TRANSPORT, 1982

	Million tons	%
Intra-provincial	12.7	51
Intra-regional (excluding intra-provincial)	4.9	20
Inter-regional	7.4	29
Total	25.0	100

NOTE: Further details in Appendix Table B.46.

8.12 China's fertilizer application is high in comparison with many developing countries, but still low by the standards of Japan and Korea. Domestic production is still trailing demand and China is one of the world's largest importers of fertilizer. Further consumption increases are expected, albeit at a lower rate than in recent years. Total consumption is forecast by the Ministry of Agriculture to double by the year 2000 to some 34 million tons of nutrients. This increase of 17 million tons of nutrient is estimated to generate a corresponding gross weight increment of some 40 million tons. Therefore the gross weight of fertilizer to be distributed by the year 2000 could exceed 110 million tons.

8.13 In 1982, production from large and medium-size plants can be estimated at 23 million tons gross (50% of the total estimate of 46 million gross tons). Including imports, the total transported beyond local areas would be around 30 million tons and the rail share (25 mt) over 80%. It is planned that most of the 40 million ton increment will come from large plants and imports. A continuation of the present modal distribution would mean that an additional 32 million tons of fertilizer would need to be moved by rail by the year 2000. This is without accounting for a possible gradual replacement of small local plants by more efficient larger plants requiring more long distance transport. Location of some of the new plants on the water, particularly in southern China, would facilitate an increasing use of water transport.

8.14 Another issue is the loss in transport of chemical fertilizer. A study by the Chinese Academy of Social Sciences (CASS) estimates that combined losses in packing and transport generally amount to some 20% and sometimes as high as 30-40%.[8/] China imports mostly bagged fertilizer; considerable cost savings could be achieved by switching to bulk imports. Consideration should also be given to developing port, storage and bagging facilities to reduce losses in transport and reduce multiple handling of bags to and from storage.

8.15 China plans to develop phosphate mines in Yunnan, Guizhou, Hubei, Sichuan, Shaanxi, and Jiangxi. Given the generally low P_2O_5 content of phosphate rock in China, beneficiation before transport should be considered. However, the location of phosphate mines developed to date makes this difficult. The mines are generally located far from both domestic and imported supplies of sulphur which is required for phosphate fertilizer production. Again an inter-sectoral study examining mining, plant location, marketing and transport would help to provide a basis for making decisions about where to develop new mines and plants and how to meet needs for transport and storage. Such a study is proposed to be included in the Bank-assisted Fertilizer Rehabilitation and Energy Saving Project.

C. Transport and Rural Development

8.16 The new economic policies, particularly the responsibility system, are generating rapid development in rural areas. Accompanying this development is a growing demand for transport of both freight and passengers. There is growth not only in agricultural production but also in sideline activities and, in more developed areas such as Jiangsu and other provinces, also in small industries. The transport demand of these areas is for the movement of a great variety of goods, many of which are perishable, in fairly small lots, over short to medium distances (5-100 km), to and from dispersed origins and destinations. This freight pattern is overlayed and often combined with the movement of people accompanying their goods to markets. The best way to serve such demands is with a very dense transport network combined with vehicles of different shapes and sizes providing great flexibility of operation. For most areas this means road transport. In parts

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8/ Bruce Stone, An Examination of the Prospects for Demand for Chemical Fertilizer in the People's Republic of China, a paper prepared for the World Bank, December 14, 1983.

of southern China richly endowed with dense networks of rivers and canals, water transport can play the role that roads would play in other areas.

8.17 Changing food consumption patterns also create the need for a rapid growth in cold storage capacity and refrigerated transport by various modes. The development of such special refrigerated vehicles will have to be emphasized in the next few years.

D. Conclusion

8.18 The discussion in this chapter of grain and fertilizer, as well as those from industry using cement and iron and steel in Chapter 7 illustrate the strong impact that decisions in other sectors have on transport. Intersectoral planning and coordination is necessary when making decisions to create or expand production. In efforts to improve efficiency and minimize cost, trade-offs should be considered between location of production, plant size and technology, storage and transport, and production and transport costs.

COAL TRANSPORT VERSUS

ELECTRICITY TRANSMISSION

1. The cost of mining Shanxi's abundant coal reserves combined with the cost of transporting it by rail or using the coal for power generation and transporting power to, say, the northeast power load centers, is often less than the cost of mining coal at the load centers themselves. The relative economic attractiveness of these two options for Shanxi coal is considered in this exercise. Alternative A involves transportation, by a new single track rail line, of 5,000 kcal/kg coal from Shanxi to the northeast power grid to generate electricity at the load center. This is a relatively unfavorable assumption since most investments to transport coal out of Shanxi are more likely to be for electrification of existing lines, or for additional double-track electrified lines, both with considerably lower (about one half) investment costs per ton capacity. Alternative B involves mine-mouth electricity generation in Shanxi and transmission of electricity to the northeast.

2. These alternatives will be evaluated under a series of simplifying assumptions:

(a) Distance: Due to different gradient tolerance, alignment of railway and transmission lines results in a 1,100 km railway line and a 1,000 km transmission line;

(b) Type of Lines: A single-track electrified railway line, with a capacity of 30 million tons of coal per year (on the basis of unit train operation); nine 500 KV transmission lines;

(c) Load Factor: Since mine-mouth power plants are generally conceived as base-load plants, a load factor of 70% (6,120 hours/year) is assumed;

(d) Construction Costs:

- Railway line at Y 3.6 million/km, to require 330 locomotives (at Y 1.2 million each) and 14,300 coal cars (at Y 36,000 each);
- Transmission line at Y 300,000/km and substation at Y 120/kVA;
- Power plant: in Northeast China Y 1,200/kW, in Shanxi Y 1,260/kW to account for higher cost of water and transportation of materials and equipment to Shanxi;

(e) Losses: 2% of coal is lost during transportation and 8% of electricity is lost during transmission;

(f) Efficiency: Plants generate at 340 gr of standard coal equivalent (7,000 kcal/kg) per kWh; and

(g) Construction Time: The railway takes 5 years to build and 3 more to achieve full capacity. Transmission lines take 4 years to build and 3 years more to achieve full capacity.

Evaluation

3. Since the benefits of the two alternatives are virtually the same, the evaluation will concentrate on costs, and only on cost items that differ.

4. Alternative A. Given losses in transportation and efficiency, 61.8 billion kWh are generated in the Northeast,[1/] at 6,120 hour/KW/year (70% load factor); capacity is 10,100 MW. The relevant railway capital costs are:

Cost of line (3.6 x 1,100)	=	Y3,960 m
Cost of locos (1.2 x 330)	=	396 m
Cost of cars (0.036 x 14,300)	=	515 m
Total Capital Costs		$4,871 m

Yearly replacement costs are assumed at Y 10 million after the tenth year. Therefore, the yearly capital charge (at 10% opportunity cost of capital) =

$$\frac{\text{Present Value (capital cost)}}{\text{Present Value (tonnage transp.)}} = \text{Y 22.8 per ton transported or about 2 fen per ton-km.}$$

5. Operating costs are 0.7 fen per ton-km. Total long-run marginal cost for the railway is thus 2.70 fen per ton-km or Y 29.7 per ton transported.

6. In addition, the loss of coal during transportation comes to Y 0.8 per ton transported, given an economic price of coal for Shanxi of Y 40/ton.

7. Total cost of Alternative A = Y 29.7 + Y 0.8 = Y 30.5 per ton.

8. Alternative B. In order to make the same amount of power available in the Northeast as under Alternative A, the mine-mouth power plant needs to be 8% larger and must generate 66.7 billion kWh with a capacity of 10,900 MW. Nine 500 kV lines will be required.

Cost of lines (9 x 300,000 x 1,000)	=	Y 2,700 m
Cost of station (120 x 1.2 x 10,900,000)	=	1,570 m

9. To make this alternative comparable with Alternative A, the cost of the 800 MW of additional power generation capacity (Y 1,008 m)[2/] and the extra

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1/ $30 \text{ m} \times \frac{1,000}{0.68} \times 0.98 \times \frac{5,000}{7,000}$

2/ 1,260 x 800,000

cost of constructing the plant in Shanxi (Y 606 m)3/ need to be added to capital costs under Alternative B. Total capital cost is therefore 4,270 + 1,008 + 606 = Y 5,884 m. The Present Value of capital costs divided by the Present Value of equivalent coal transportation is Y 25.70 per ton.

10. Operating costs are 1% of the cost of the line and gear per year, or Y 1.42 per equivalent ton of coal transported;4/ also to be included as cost under Alternative B are the operating costs for generating the additional 4.9 billion kWh lost during transmission, which come to 2% of pertinent initial investment, and the related cost of coal burnt, or Y 0.68 5/ and Y 3.10 6/ per equivalent ton transported. Total recurrent cost is therefore 1.42 + 0.68 + 3.10 = Y 5.20 per ton transported.

11. Total cost of Alternative B = Y 25.7 + Y 5.2 = Y 30.9 per equivalent ton transported.

12. Under these assumptions the two alternatives are about equal, with a slight edge for Alternative A, even though this represents a rather unfavorable case for the railroads. Aside from the various unit costs used, the relative merits of these alternatives appear to be sensitive to:

(a) calorific value of coal (the higher the calorific value, the better Alternative A looks);

(b) power plant load factor (the higher the load factor, the better Alternative B looks); and

(c) difference in distance due to alignment (the greater the difference, the better Alternative B looks).

13. For the large quantities that need to be transported from Shanxi, not only one but several double-tracked railways will be required over the next 15 years. The capacity of a double-tracked electrified line is about three times that of a single-tracked line, while investment costs are less than twice as high. Transport costs (LRMC) on a double tracked line are only 60-70% of those indicated in Alternative A (i.e. about Y 20/t), and the break-even point with respect to the calorific value of coal declines to about 3,500 kcal/kg, well below virtually every type of coal except coal preparation wastes (middlings). The unit costs of other capacity augmenting investments

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3/ (1,260 - 1,200 (10,100,000)

4/ $4{,}270\text{ m} \times \frac{0.01}{30\text{ m}}$

5/ $1{,}008\text{ m} \times \frac{0.02}{30\text{ m}}$

6/ $4.9\text{ m} \times \frac{0.68}{1{,}000} \times \frac{7{,}000}{5{,}000} \times \frac{1}{30\text{ m}} \times 20$

(e.g., electrification of existing railways lines) are similar to the costs of new double-track railways per unit of capacity, and systems-wide LRMC are therefore closer to those of new double-tracked rail lines, or about one-third less than long-distance electric power transmission. Mine-mouth power plants are therefore justified mainly for using coal preparation wastes, very low quality fuels, or serving local electric power needs.

14. Other important factors such as the size of the system or the exact location of power plants can also affect the relative merits of the above alternatives. For example, if the size of the system in question is much smaller, then one railway line will not be fully dedicated to coal, making low-cost, high-density unit train transportation difficult to accommodate within the system. Alternative B shows more flexibility in adjusting to various system sizes, but there may be significant constraints to locating power plants exactly at the mine-mouth. Water availability is a common constraint. Thus the cost of transporting coal from the mine to another location in the vicinity might have to be added to Alternative B. More comprehensive analysis should include consideration of a variety of additional costs or benefits, such as land use implications, or, in the case of power transmission, possible additional benefits resulting from increasing grid integration.

APPENDIX B

STATISTICAL TABLES

Table B.1: INTERCOUNTRY COMPARISON OF FREIGHT TRAFFIC GROWTH AND GNP ELASTICITY

	Years	Elasticity /a	Annual Growth Rates (%) GNP	Freight
China	1965 - 1981	1.034	6.20	5.87
	1965 - 1976	0.860	5.98	4.77
	1977 - 1981	0.835	7.23	6.07
	1978 - 1981	0.495	5.53	2.59
USA	1960 - 1981	0.941	3.33	3.07
	1965 - 1975	0.880	2.71	2.07
	1976 - 1981	1.748	2.77	4.12
USSR	1965 - 1980	1.427	4.20	6.09
	1965 - 1975	1.229	5.44	6.86
	1976 - 1980	2.746	1.27	4.31
India	1960 - 1981	0.921	3.71	3.74
	1960 - 1970	1.122	3.95	4.61
	1965 - 1975	0.610	3.86	2.54
	1976 - 1981	0.519	4.27	2.68
Brazil	1960 - 1981	1.109	6.68	7.86
	1960 - 1970	1.057	6.11	6.87
	1965 - 1975	0.897	9.08	8.44
	1976 - 1981	1.472	3.73	5.70
Japan	1960 - 1980	0.756	8.16	5.92
	1960 - 1970	0.887	11.12	9.71
	1965 - 1975	0.885	2.47	6.86
	1976 - 1980	0.877	5.33	4.16
Korea	1961 - 1981	1.218	8.47	10.41
	1961 - 1971	1.576	9.22	14.87
	1971 - 1981	0.782	7.72	6.13

/a Elasticities are not the ratio of the GNP and freight growth rates, they are derived from regression analyses of freight as a dependent variable of GNP.

Table B.1 (cont.)

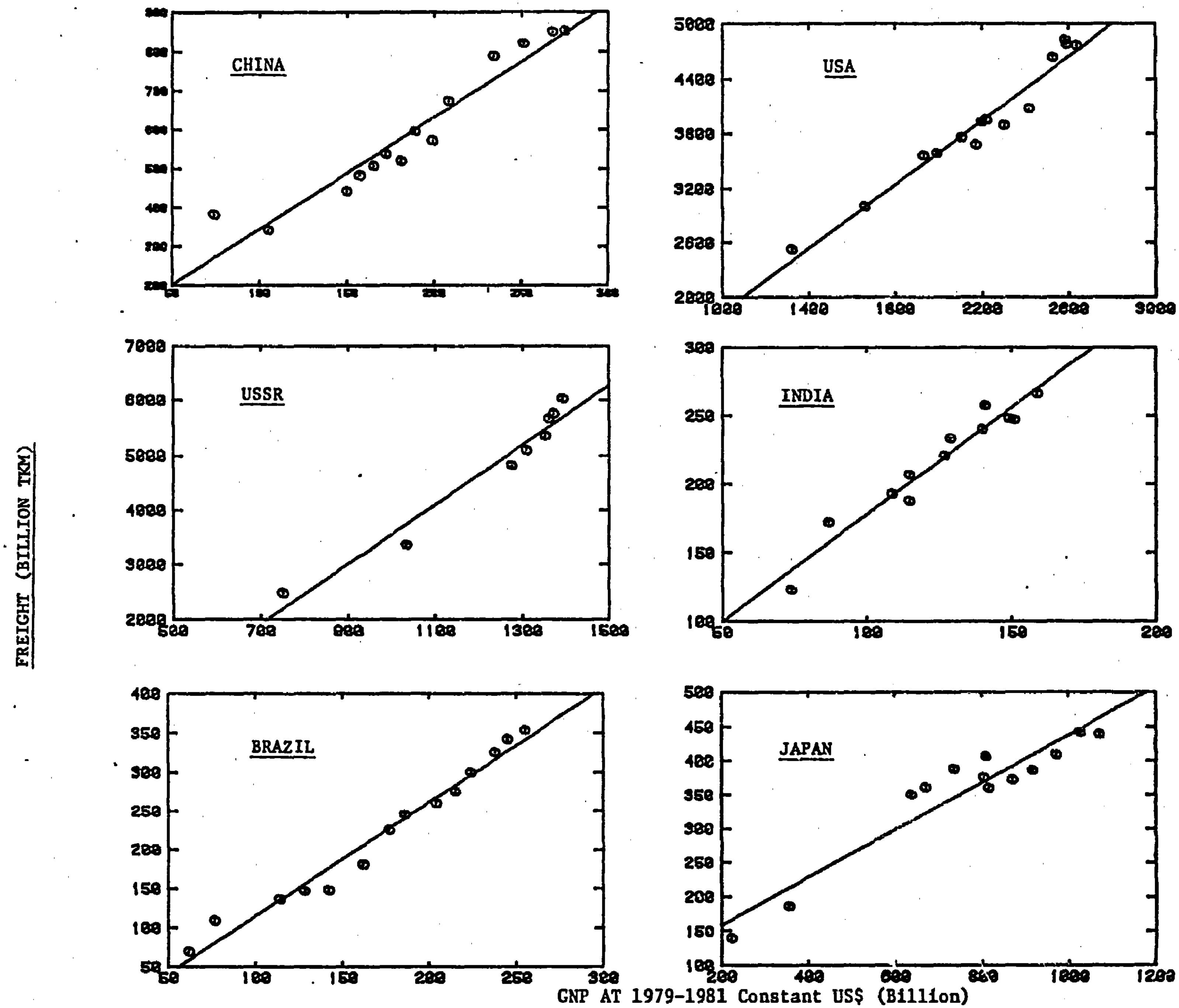

Table B.1 (cont.)

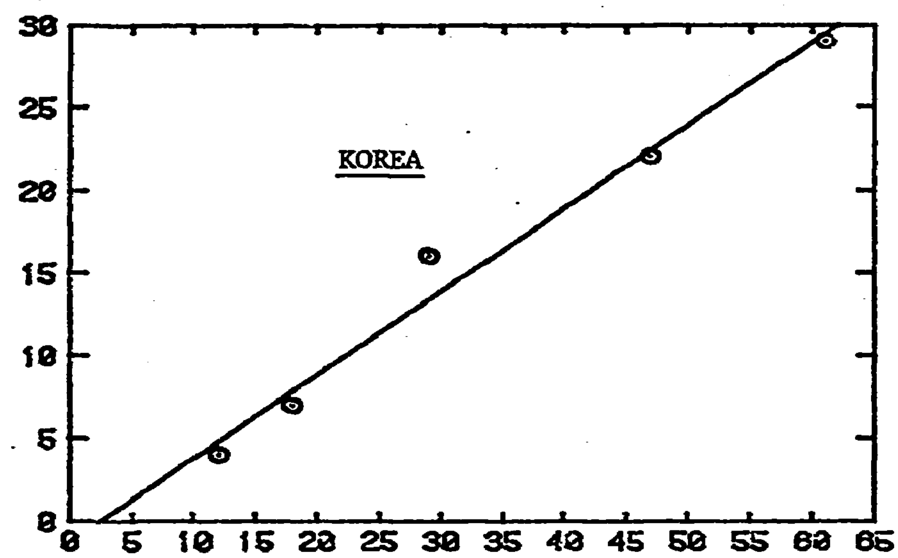

Table B.2: TOTAL FREIGHT (BIL. TKM) AND GNP (BIL.US$) FOR SELECTED COUNTRIES, 1960-1981

YEARS	CHINA Freight (1)	CHINA GNP (2)	CHINA Tkm/$GNP (3)	USA Freight (4)	USA GNP (5)	USA Tkm/$GNP (6)	USSR Freight (7)	USSR GNP (8)	USSR Tkm/$GNP (9)	INDIA Freight (10)	INDIA GNP (11)	INDIA Tkm/$GNP (12)
1960	381	74	5.15	2526	1324	1.91		629		123	74	1.66
1965	342	105	3.26	3001	1662	1.81	2480	751	3.30	172	87	1.98
1970	442	150	2.95	3560	1932	1.84	3366	1034	3.26	193	109	1.77
1971	481	157	3.06	3507	1991	1.80	3610				112	
1972	507	165	3.07	3760	2105	1.79	3810				111	
1973	537	172	3.12	3955	2221	1.78	4134			188	115	1.63
1974	519	181	2.87	3929	2198	1.79	4452			207	115	1.80
1975	595	189	3.15	3683	2171	1.70	4815	1275	3.78	221	127	1.74
1976	571	199	2.87	3894	2299	1.69	5006	1309	3.89	233	129	1.81
1977	673	208	3.24	4081	2418	1.69	5342	1353	3.95	240	140	1.71
1978	789	234	3.37	4638	2526	1.84	5664	1362	4.16	248	149	
1979	821	251	3.27	4786	2589	1.85	5755	1373	4.19	257	141	1.82
1980	850	268	3.17	4827	2584	1.87	6021	1393	4.32	247	151	
1981	852	275	3.10	4766	2635	1.81	6229			266	159	1.67

YEARS	BRAZIL Freight (13)	BRAZIL GNP (14)	BRAZIL Tkm/$GNP (15)	KOREA Freight (16)	KOREA GNP (17)	KOREA Tkm/$GNP (18)	JAPAN Freight (19)	JAPAN GNP (20)	JAPAN Tkm/$GNP (21)
1960	70	63	1.11	4	12	0.33	139	223	0.62
1965	109	78	1.40	7	18	0.37	186	358	0.52
1970	136	114	1.19				351	640	0.55
1971	147	128	1.15	16	29	0.55	162	672	0.24
1972	148	142	1.04				309	736	0.53
1973	180	162	1.11				407	810	0.50
1974	225	177	1.27				376	805	0.47
1975	245	186	1.32				361	817	0.44
1976	260	204	1.27	22	47	0.46	373	870	0.43
1977	275	215	1.28				387	917	0.42
1978	299	224	1.33				410	972	0.42
1979	326	238	1.37				442	1026	0.43
1980	355	255	1.39				439	1071	0.41
1981	343	245	1.40	29	61	0.47		1102	

Notes: (1) Chinese Statistical Yearbook, 1981. p.279. Oceangoing freight was excluded from the total freight. Highway freight turnover for 1960-1978 was increased to reflect the freight for own account trucking which is not available in the Statistical Yearbook. Estimates were made based on its relationship to common carrier freight given for 1979-1982.

(2) (5) (11) (14) (17) (20) -- GNP for all countries except USSR, was taken from EPD Data Bank - Atlas GNP at constant US dollars (using the domestic GNP deflator for the base period 1979-1981). GNP for USSR at 1980 US dollars was taken from USSR Facts & Figures Annual.

(3) (6) (9) (12) (15) (18) (21) -- Freight/GNP.

(4) Transportation in America, July 1983. p.7. The 1950 water freight includes an estimate of 235 ton-miles for domestic coastwise freight made according to previous trend.

(7) Soviet Economy in the 1980's: Problems & Prospects, Part I, Joint Economic Committee Congress of the US, Dec. 1982, p.219, Maritime freight was excluded from the total freight.

(10) SAR-India-Railway Modernization & Maintenance Project II, Oct. 26,1982 (p.77).

(13) 1960-1965, Transport Sector of Brazil, May, 1974.
1970-1976, GEIPOT, 1979 (p.446). Based on the reports of GEIPOT, 1982, the highway freight was overstated for previous years. Hencce, the highway freight in this table for 1970-1976 was reduced based on its share in total freight for 1979-1981.
1977-1981, GEIPOT, 1982 (p.644).

(16) SAR-Korea-Provincial and County Roads Project, November 23, 1982,p.33. The first two figures are for years 61 & 66

(19) Japan Statistical Yearbook, various issues.

12/29/83

Table B.3 : CHINA - INTERMODAL FREIGHT INTENSITY BY PROVINCE - 1981

Province	Railway	Road	Water	Total	GVIAO	Intensity
	Bil.Ton-km				Bil.Y	Tkm/Y
Beijing	12.56	0.75		13.31	23.50	0.57
Tianjin	14.47	0.61	0.01	15.09	21.80	0.69
Hebei	68.66	1.42	0.98	71.06	33.20	2.14
Shanxi	21.81	0.83	0.00	22.64	17.20	1.32
Inner Mongolia	23.98	0.42		24.40	10.20	2.39
Liaoning	66.13	0.92	0.38	67.43	53.50	1.26
Jilin	24.01	0.45	0.04	24.49	19.10	1.28
Heilongjiang	42.07	0.62	0.81	43.50	34.10	1.28
Shanghai	3.21	0.83	1.63	5.67	64.20	0.09
Jiangsu	18.83	1.20	9.96	29.98	67.40	0.44
Zhejiang	12.13	0.87	5.19	18.18	33.10	0.55
Anhui	22.00	0.92	1.90	24.82	24.60	1.01
Fujian	5.55	0.93	2.02	8.50	14.00	0.61
Jiangxi	11.65	0.61	1.63	13.89	16.80	0.83
Shandong	26.33	2.59	1.23	30.15	54.30	0.56
Henan	53.78	1.30	0.12	55.20	36.80	1.50
Hubei	21.69	1.09	3.98	26.76	36.00	0.74
Hunan	26.87	0.79	2.26	29.93	30.70	0.97
Guangdong	8.03	0.81	4.50	13.34	37.00	0.36
Guangxi	13.66	0.59	2.25	16.51	15.40	1.07
Sichuan	18.61	2.01	1.61	22.23	46.70	0.48
Guizhou	9.32	0.51	0.09	9.92	8.50	1.17
Yunnan	5.19	1.55	0.02	6.76	13.00	0.52
Tibet		0.37		0.37	0.74	0.50
Shaanxi	14.95	0.58	0.01	15.54	15.50	1.00
Gansu	16.43	0.47		16.90	10.20	1.66
Qinghai	0.56	0.27		0.83	2.00	0.41
Ningxia	3.88	0.10		3.97	2.00	1.99
Xinjiang	4.91	0.86		5.77	7.50	0.77
Subtotal	571.25	25.27	40.61 b/	637.13	749.04	0.85
Enterprises under the ministries		0.04 a/	474.38 c/	474.41 c/		
Total	571.25	25.30	514.99 c/	1111.54	749.04	

Note: GVIAO = Gross Value of Industrial and Agriculture Output for 1981.

Source: Chinese Statistical Yearbook 1981, pp. 19, 281 & 282.

1/23/84

a/ only road transport bureaus under MOC
b/ probably only bureaus under MOC, total is 152.8
c/ includes ocean shipping 363.2 bil. tkm

Table B.3 (cont.)

OBS	PROVINCE	FREIGHT Total 100 mil tkm	FREIGHT Rail tkm	GVIAO	GVIO Total	GVIO Heavy	GVIO Light	GVAO	FREIGHT 10th tons	HEAVY IND. Share	FREIGHT/GVIAO tkm/Yuan
				¥ 100 million							
1	TOTAL	6371.3	5712.09	7490.0	5178.0	2515.0	2663.0	2311.94	197473	0.455709	0.85054
2	BEIJING	133.1	125.58	235.0	217.0	116.0	101.0	18.33	3046	0.534562	0.56639
3	TIANJIN	150.9	144.67	218.0	199.0	82.0	117.0	18.16	1828	0.412060	0.69230
4	HEBEI	710.6	686.62	332.0	218.0	114.0	104.0	113.78	9962	0.522936	2.14035
5	SHANXI	226.4	218.06	172.0	119.0	81.0	38.0	53.36	11921	0.680672	1.31628
6	INNER MON	244.0	239.78	102.0	60.0	33.0	27.0	41.69	3911	0.550000	2.39216
7	LIAONING	674.3	661.32	535.0	451.0	288.0	163.0	84.34	12663	0.638581	1.26037
8	JILIN	244.9	240.09	191.0	134.0	77.0	57.0	57.34	4890	0.574627	1.28220
9	HEILONGJ	435.0	420.69	341.0	250.0	166.0	84.0	90.71	9321	0.664000	1.27566
10	SHANGHAI	56.7	32.11	642.0	609.0	260.0	349.0	33.09	1204	0.426929	0.08832
11	JIANGSU	299.8	188.26	674.0	466.0	181.0	285.0	207.62	3332	0.388412	0.44481
12	ZHEJIANG	181.8	121.27	331.0	214.0	74.0	140.0	117.42	1495	0.345794	0.54924
13	ANHUI	248.2	219.97	246.0	130.0	58.0	72.0	116.19	3738	0.446154	1.00894
14	FUJIAN	85.0	55.54	140.0	82.0	30.0	52.0	57.63	1268	0.365854	0.60714
15	JIANGXI	138.9	116.51	168.0	92.0	45.0	47.0	76.54	2126	0.489130	0.82679
16	SHANDONG	301.5	263.31	543.0	344.0	150.0	194.0	199.00	5306	0.436047	0.55525
17	HENAN	552.0	537.75	368.0	204.0	92.0	112.0	163.52	6614	0.450980	1.50000
18	HUBEI	267.6	216.88	360.0	246.0	118.0	128.0	114.08	3093	0.479675	0.74333
19	HUNAN	299.3	268.74	307.0	176.0	94.0	82.0	131.43	3622	0.534091	0.97492
20	GUANGDONG	133.4	80.31	370.0	250.0	88.0	162.0	120.27	2951	0.352000	0.36054
21	GUANGXI	165.1	136.61	154.0	82.0	30.0	52.0	71.91	1735	0.365854	1.07209
22	SICHUAN	222.3	186.11	467.0	275.0	134.0	141.0	191.59	4269	0.487273	0.47602
23	GUIZHOU	99.2	93.19	85.0	44.0	25.0	19.0	40.79	1481	0.568182	1.16706
24	YUNNAN	67.6	51.94	130.0	71.0	36.0	35.0	58.90	1470	0.507042	0.52009
25	TIBET	3.7	.	7.4	1.1	0.7	0.4	6.24	.	0.636364	0.50000
26	SHAANXI	155.4	149.48	155.0	105.0	48.0	57.0	50.03	2212	0.457143	1.00258
27	GANSU	169.0	164.29	102.0	74.0	57.0	17.0	28.02	1950	0.770270	1.65686
28	QINGHAI	8.3	5.55	20.0	12.0	7.0	5.0	8.15	206	0.583333	0.41500
29	NINGXIA	39.7	38.77	20.0	12.0	8.0	4.0	7.55	1245	0.666667	1.98500
30	XINJIANG	57.7	49.09	75.0	41.0	22.0	19.0	34.26	813	0.536585	0.76933
31		.	.	.	.	.	.	.	.	.	.

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MODEL: EQ1
DEP VARIABLE: INTENSE
                     SUM OF          MEAN
SOURCE      DF      SQUARES        SQUARE       F VALUE      PROB>F
MODEL        1     2.181899      2.181899         9.136      0.0053
ERROR       28     6.687197      0.238828
C TOTAL     29     8.869097
    ROOT MSE       0.488701      R-SQUARE        0.2460
    DEP MEAN       0.966649      ADJ R-SQ        0.2191
    C.V.           50.55618

                  PARAMETER      STANDARD    T FOR H0:
VARIABLE    DF     ESTIMATE         ERROR   PARAMETER=0   PROB > |T|

INTERCEP     1    -0.335539      0.439966       -0.763       0.4521
SHARE        1     2.543944      0.841620        3.023       0.0053
```

Table B.4: INTERCOUNTRY COMPARISON OF AVERAGE FREIGHT DISTANCE, SELECTED YEARS, 1940-1982

	CHINA			USA			JAPAN		
	Freight			Freight			Freight		
YEARS	Bil. Tkm.	Mil.Tons	Avg.Dist	Bil.Tkm	Mil.Tons	Avg.Dist	Bil.Tkm	Mil.Tons	Avg.Dist
1940				1400	1495	936			
1945				1860	2128	874			
1950	45	216	208	1710	3043	562			
1955	125	569	220	2470	3567	692	85	821	104
1960	355	1705	208	2526	3606	700	139	1533	91
1965	322	1209	266	3000	4435	676	186	1626	114
1970	415	1499	277	3560	5060	704	351	5259	67
1975	554	2001	277	3683	4962	742	361	5030	72
1976	529	1994	265	3894	5280	738	373	5000	75
1977	623	2213	282	4081	5486	744	387	5101	76
1978	734	2452	299	4638	5710	812	410	5541	74
1979	821	2438	337	4786	5806	824	442	5957	74
1980	850	2362	360	4827	5501	877	439	5985	73
1981	852	2274	375	4766	5359	889			
1982	928	2429	382						

Sources: (1) Chinese Statistical Yearbook, 1981.
(2) Transportation in America, July 1983.
(3) Japan Statistical Yearbook, various issues.

11/7/83

Table B.5: SHORT DISTANCE RAIL TRANSPORT IN LARGE URBAN AREAS
('000 tons)

	Beijing area	Tianjin area	Taiyuan area
Tons loaded	29,670	18,561	20,888
Unloaded in Area /a			
Tons	14,606	6,124	5,208
% of total loaded	49.2	33.0	24.9
Of which:			
Coal	3,558	-	5,060
Coke	388	-	-
Oil	1,255	16	-
Iron and steel	1,557	1,008	45
Ores	-	32	-
Nonmetallic ores	1,748	54	-
Construction material	4,487	3,420	13
Cement	1,059	-	5
Timber	95	150	1
Fertilizer	113	39	-
Grain	57	910	2
Cotton	-	3	-
Salt	-	8	-
Others	289	484	82
Tons Unloaded			
Total	51,672	46,149	15,136
% loaded in area	28.3	13.3	34.4

/a This local traffic moves on average less than 50 km.

Table B.6: SHORT HAUL TRANSPORT ON SELECTED TRUNK LINES
('000 tons)

Line	Section	Traffic: Tons	Traffic: Of which /a short distance	Traffic: Percentage
Beijing-Shandong	Beijing-Longjiaying	49,728	9,071	18.0
(Excluding 5.4 mt of coal to one power station)				7.3
Beijing-Guangzhou	Changchoudian-Anyang	23,970	4,891	20.0
(Excluding 2.8 mt of coal and ore to Handan Iron and Steel Co.)				8.7
Shanghai-Ningpo	Nanjing-Nanxiang	8,622	190	2.2
Beijing-Baotou	Shinan-Konquan	51,855	3,039	5.8
Zhejiang-Jiangxi	Hangzhou-Xintangbian	5,634	52	1.0
Tianjin-Pukou	Tianjin West-Dezhou	5,496	588	11.0
Shijiazhuang-Dezhou	Shijiazhuang-Dezhou	819	4	0.5
Shijiazhuang-Taiyuan	Shijiazhuang-Taiyuan	27,810	572	2.0

/a Less than 50-60 km.

Table B.7: CHINA - FREIGHT TURNOVER BY MODE OF TRANSPORT

YEARS	Billion Ton-km Rail	Road	Water	Pipeline	Air	Total	Percentage share Rail	Road	Water	Pipeline	Air	Total
1950	39.40	2.70	5.10	-	-	47	83.47	5.72	10.81	0.00	0.00	100.00
1955	98.20	10.20	23.40	-	0.01	132	74.50	7.74	17.75	0.00	0.01	100.00
1960	276.70	39.60	65.00	-	0.03	381	72.56	10.38	17.05	0.00	0.01	100.00
1965	269.80	28.50	43.30	-	0.03	342	78.97	8.34	12.67	0.00	0.01	100.00
1970	349.60	41.40	51.20	-	0.04	442	79.05	9.36	11.58	0.00	0.01	100.00
1975	425.60	60.00	81.80	26.20	0.06	594	71.69	10.11	13.78	4.41	0.01	100.00
1976	386.90	63.00	85.50	35.70	0.07	571	67.74	11.03	14.97	6.25	0.01	100.00
1977	456.80	75.30	102.10	38.70	0.08	673	67.88	11.19	15.17	5.75	0.01	100.00
1978	534.50	82.20	129.20	43.00	0.10	789	67.74	10.42	16.38	5.45	0.01	100.00
1979	559.80	74.50	139.00	47.60	0.12	821	68.18	9.07	16.93	5.80	0.01	100.00
1980	571.70	76.40	152.30	49.10	0.14	850	67.29	8.99	17.93	5.78	0.02	100.00
1981	571.20	78.00	152.80	49.90	0.17	852	67.04	9.15	17.93	5.86	0.02	100.00
1982	612.00	94.90	170.80	50.10	0.20	928	65.95	10.23	18.41	5.40	0.02	100.00

Source: Chinese Statistical Yearbook, 1981. p279.

Notes: (1) Oceangoing freight was excluded from the total freight.
(2) Highway freight turnover for 1960-1978 was increased to reflect the freight for own account trucking which is not available in the Statistical Yearbook. Estimates were made based on its relationship to common carrier freight given for 1979-1982.

Table B.8 : USA - FREIGHT TURNOVER BY MODE OF TRANSPORT

YEARS	Billion Ton-km Rail	Road	Water	Pipeline	Air	Total	Percentage share Rail	Road	Water	Pipeline	Air	Total
1940	610	100	595	95	0.03	1400	43.57	7.14	42.50	6.79	0.00	100.00
1945	1112	108	436	204	0.14	1860	59.78	5.81	23.44	10.97	0.01	100.00
1950	961	278	642	208	0.48	2089	45.99	13.30	30.73	9.95	0.02	100.00
1955	1015	359	769	327	0.79	2471	41.08	14.53	31.12	13.23	0.03	100.00
1960	932	459	766	368	1.43	2526	36.89	18.17	30.32	14.57	0.06	100.00
1965	1140	578	787	492	3.07	3000	38.00	19.27	26.23	16.40	0.10	100.00
1970	1241	663	957	693	5.31	3559	34.87	18.63	26.89	19.47	0.15	100.00
1975	1221	730	909	816	6.00	3682	33.16	19.83	24.69	22.16	0.16	100.00
1976	1287	821	951	829	6.28	3894	33.05	21.08	24.42	21.29	0.16	100.00
1977	1342	893	961	879	6.73	4082	32.88	21.88	23.54	21.53	0.16	100.00
1978	1397	964	1327	943	7.64	4639	30.12	20.78	28.61	20.33	0.16	100.00
1979	1492	978	1331	978	7.47	4786	31.17	20.43	27.81	20.43	0.16	100.00
1980	1500	893	1480	946	7.79	4827	31.08	18.50	30.66	19.60	0.16	100.00
1981	1487	869	1493	909	8.01	4766	31.20	18.23	31.33	19.07	0.17	100.00

Source: Transportation in America, July 1983.(p.7).

Note: (1) The 1950 water freight includes an estimate of 235 ton-miles for domestic coastwise freight made according to previous trend.

11/7/83

Table B.9: USSR - FREIGHT TURNOVER BY MODE OF TRANSPORT

YEARS	Billion Ton-km Rail	Road	Water	Pipeline	Air	Total	Percentage share Rail	Road	Water	Pipeline	Air	Total
1965	1994	143	134	208	1.3	2481	80.40	5.76	5.40	8.39	0.05	100.00
1970	2550	221	174	419	1.9	3366	75.76	6.56	5.17	12.45	0.06	100.00
1975	3307	338	222	945	2.6	4814	68.69	7.02	4.61	19.63	0.05	100.00
1976	3367	355	223	1139	2.7	5087	66.19	6.98	4.38	22.39	0.05	100.00
1977	3403	373	231	1332	2.8	5342	63.71	6.98	4.32	24.94	0.05	100.00
1978	3504	395	244	1519	2.9	5664	61.86	6.97	4.31	26.81	0.05	100.00
1979	3421	408	233	1689	2.9	5754	59.45	7.09	4.05	29.36	0.05	100.00
1980	3517	432	245	1824	3.1	6021	58.41	7.18	4.07	30.30	0.05	100.00
1981	3582	454	255	1935	3.2	6229	57.50	7.29	4.09	31.06	0.05	100.00
1982	3684	471	263	2058	3.3	6479	56.86	7.26	4.06	31.76	0.05	100.00

Source: Soviet Economy in the 1980's: Problems and Prospects, Part I, Joint Economic Committee Congress of the US, p.219

Note: Maritime freight is excluded from the total freight.

Table B.10 :BRAZIL - FREIGHT TURNOVER BY MODE OF TRANSPORT

YEARS	Billion Ton-km Rail	Road	Water	Pipeline	Air	Total	Percentage Share Rail	Road	Water	Pipeline	Air	Total
1960	13	42	15	-	0.10	70	18.66	59.83	21.37	0.00	0.14	100.00
1965	18	75	16	-	0.10	109	16.50	68.74	14.67	0.00	0.09	100.00
1970	30	82	22	2	0.20	136	22.03	60.21	16.15	1.47	0.15	100.00
1975	59	147	32	7	0.52	246	24.03	59.87	13.03	2.85	0.21	100.00
1976	63	156	33	8	0.66	261	24.17	59.85	12.66	3.07	0.25	100.00
1977	61	168	37	8	0.69	275	22.21	61.16	13.47	2.91	0.25	100.00
1978	64	182	41	11	0.79	299	21.42	60.91	13.72	3.68	0.26	100.00
1979	74	194	47	11	0.92	327	22.64	59.34	14.38	3.36	0.28	100.00
1980	86	209	48	12	1.02	356	24.16	58.70	13.48	3.37	0.29	100.00
1981	79	205	46	11	1.05	342	23.10	59.93	13.45	3.22	0.31	100.00

Notes: (1) 1960-1965, Transport Sector of Brazil, May,1974.
(2) 1970-1976, GEIPOT, 1979 (p.446).Based on reports of GEIPOT, 1982, the highway freight was overstated for previous years. Hence, the highway freight in this table for 1970-1976 was reduced based on its share in total freight for 1979-1981.
(3) 1977-1981, GEIPOT, 1982 (p.644).

11/7/83

Table B.11 : INDIA - FREIGHT TURNOVER BY MODE OF TRANSPORT

	Billion Ton-km				Percentage Share			
YEARS	Rail	Road	Other	Total	Rail	Road	Other	Total
1950	44	6		50	88.00	12.00		100.00
1955	60	9		69	86.96	13.04		100.00
1960	88	35		123	71.54	28.46		100.00
1965	117	55		172	68.02	31.98		100.00
1970	127	66		193	65.80	34.20		100.00
1975	148	73		221	66.97	33.03		100.00
1976	157	76		233	67.38	32.62		100.00
1977	163	77		240	67.92	32.08		100.00
1978	155	94		249	62.25	37.75		100.00
1979	156	101		257	60.70	39.30		100.00
1980	159							
1981	174	92	12	278	62.59	33.09	4.32	100.00

Source: SAR - India - Railway Modernization & Maintenance Project II, Oct. 26, 1982 (p. 1 & 17).

Table B.12: JAPAN - FREIGHT TURNOVER BY MODE OF TRANSPORT

	Billion Ton-km				Percentage Share			
YEARS	Rail	Road	Water	Total	Rail	Road	Water	Total
1955	43	10	32	85	50.82	11.15	38.03	100.00
1960	55	21	64	139	39.24	14.97	45.79	100.00
1965	57	48	81	186	30.76	25.98	43.26	100.00
1970	63	136	151	351	18.09	38.77	43.14	100.00
1975	47	130	184	361	13.14	35.96	50.90	100.00
1976	46	133	194	373	12.41	35.53	52.06	100.00
1977	41	143	202	387	10.68	37.01	52.31	100.00
1978	41	156	212	409	10.07	38.14	51.80	100.00
1979	43	173	226	442	9.76	39.14	51.11	100.00
1980	38	179	222	439	8.59	40.77	50.64	100.00

Source: Japan Statistical Yearbook, various issues.

Table B.13 : JAPAN - WATER TRANSPORT BY COMMODITY

Commodities	1965 Bil.Tkms.	1965 Mil.Tons	1965 Avg.Dist	1970 Bil.Tkms	1970 Mil.Tons	1970 Avg.Dist	1975 Bil.Tkms	1975 Mil.Tons	1975 Avg.Dist	1980 Bil.Tkms	1980 Mil.Tons	1980 Avg.Dist
Coal	23.65	30.94	764	20.49	25.73	797	11.06	13.21	838	12.31	15.50	794
Iron & Steel	14.21	25.63	554	21.27	40.59	524	25.09	47.41	529	31.50	57.21	551
Petroleum Products	11.81	39.26	301	27.08	100.88	268	51.76	137.55	376	58.34	143.84	406
Cement	6.26	11.42	548	14.82	31.98	463	12.40	22.73	546	20.63	39.65	520
Nonmetallic minerals	6.14	16.31	377	21.40	50.60	423	41.94	73.49	571	46.68	80.96	577
Metallic Minerals	2.83	4.68	605	4.34	6.19	702	1.30	2.13	613	0.86	0.98	875
Machinery	2.68	8.24	326	5.86	10.20	574	2.94	4.40	668	2.92	5.35	545
Sand, Gravel & Stone	2.12	13.05	163	4.00	27.16	147	3.10	23.25	133	6.47	45.92	141
Paper & Allied Products	1.65	1.99	827	2.54	3.42	741	2.66	3.87	687	3.78	4.22	894
Logs & Lumber	1.41	3.49	405	2.45	5.53	443	2.49	9.07	275	0.86	3.23	265
Chemical Drugs	1.16	3.40	343	3.21	7.38	435	4.75	11.53	412	6.65	15.34	433
Others	6.71	21.26	316	15.06	32.41	465	13.22	28.72	460	19.76	38.19	517
Total	80.63	179.66	449	142.51	342.08	417	172.71	377.34	458	210.73	450.38	468

	1965 Rankings	1965 % Share	1970 Rankings	1970 % Share	1975 Rankings	1975 % Share	1980 Rankings	1980 % Share
Coal	1	29.32	4	14.38	5	6.41	5	5.84
Iron & Steel	2	17.62	3	14.93	3	14.53	3	14.95
Petroleum Products	3	14.65	1	19.00	1	29.97	1	27.68
Cement	4	7.76	5	10.40	4	7.18	4	9.79
Nonmetallic Minerals	5	7.62	2	15.01	2	24.28	2	22.15
Metallic Minerals	6	3.51	7	3.05	11	0.75	10	0.41
Machinery	7	3.33	6	4.11	8	1.70	9	1.38
sand, Gravel & Stone	8	2.63	8	2.81	7	1.79	7	3.07
Paper & Allied Products	9	2.04	10	1.78	9	1.54	8	1.79
Logs & Lumbers	10	1.75	11	1.72	10	1.44	11	0.41
Chemical Drugs	11	1.44	9	2.25	6	2.75	6	3.15
Total		91.67		89.44		92.34		90.63

Note: Rankings are based on the freight turnover in ton-kms.
Data are based on the Transport of Coastwise Shipping Survey.

Sources: Japan Statistical Yearbook, 1967(p.282), 1971(p.280), 1977(p.272), 1982(p.294).

12/27/83

Table B.14 : CHINA - RAIL FREIGHT BY COMMODITY

Commodities	1970 Bil. Tkms	1970 Mil.Tons	1970 Avg.Dist	1975 Bil.Tkms	1975 Mil.Tons	1975 Avg.Dist	1980 Bil.Tkms	1980 Mil.Tons	1980 Avg.Dist	1981 Bil.Tkms	1981 Mil.Tons	1981 Avg.Dist
Coal	96	254	377	110	316	349	177	415	426	183	412	445
Petroleum	35	37	946	41	62	662	30	56	541	29	50	576
Timber	32	29	1129	39	35	1114	51	42	1208	50	40	1228
Iron & Steel Products	26	31	859	34	42	818	47	61	770	42	55	768
Construction materials	16	89	182	25	136	187	33	159	210	30	140	218
Metallic Ores	15	41	364	18	52	338	19	59	319	16	53	307
Nonmetallic Ores	12	32	381	19	47	407	25	60	411	24	58	418
Grain	10	21	476	13	22	571	22	32	702	25	34	720
Cement	8	13	605	6	16	350	9	24	381	10	24	395
Salt	6	9	705	5	9	596	5	9	548	5	9	600
Fertilizer	6	10	590	6	11	578	16	22	710	18	25	731
Others	87	101	869	108	119	906	137	148	925	138	148	929
Total	350	666	526	425	867	490	571	1086	526	570	1049	544

	1970 Rankings	1970 % Share	1975 Rankings	1975 % Share	1980 Rankings	1980 % Share	1981 Rankings	1981 % Share
Coal	1	27.43	1	25.93	1	30.95	1	32.14
Petroleum	2	10.00	2	9.69	5	5.27	5	5.04
Timber	3	9.26	3	9.18	2	8.97	2	8.68
Iron & Steel Products	4	7.51	4	8.05	3	8.20	3	7.44
Construction materials	5	4.63	5	5.98	4	5.83	4	5.33
Metallic Ores	6	4.23	7	4.12	8	3.29	8	2.88
Nonmetallic Ores	7	3.51	6	4.54	6	4.31	7	4.25
Grain	8	2.83	8	2.94	7	3.87	6	4.33
Cement	9	2.23	10	1.32	10	1.58	10	1.68
Salt	10	1.77	11	1.25	11	0.89	11	0.95
Fertilizer	11	1.69	9	1.48	9	2.75	9	3.14
Total		75.09		74.47		75.90		75.86

Note: Rankings are based on the freight turnover in ton-kms.

Sources: SAR - Ministry of Railways

12/20/83

Table B.15: USSR - RAIL FREIGHT BY COMMODITY

Commodities	1965 Bil.Tkms	1965 Mil.Tons	1965 Avg.Dist	1970 Bil.Tkms	1970 Mil.Tons	1970 Avg.Dist	1975 Bil.Tkms	1975 Mil.Tons	1975 Avg.Dist	1980 Bil.Tkms	1980 Mil.Tons	1980 Avg.Dist
Coal	374	553	678	425	614	692	498	717	695	599	732	818
Petroleum	280	222	1262	354	303	1169	481	389	1238	461	423	1090
Mineral bldg. Mat.	227	573	395	300	691	434	441	947	465	457	957	477
Iron & Steel	141	112	1261	192	142	1357	258	183	1411	279	192	1456
Timber	263	175	1502	295	179	1647	308	187	1645	252	147	1714
Ores	109	191	572	170	246	690	232	308	754	237	316	749
Grain	84	89	946	111	106	1049	128	122	1048	137	135	1014
Fertilizer	47	43	1084	71	71	1000	112	106	1057	125	116	1079
Others	426	458	929	578	545	1060	779	662	1175	894	712	1256
Total	1950	2415	807	2495	2896	861	3237	3621	894	3440	3728	923

	1965 Rankings	1965 % Share	1970 Rankings	1970 % Share	1975 Rankings	1975 % Share	1980 Rankings	1980 % Share
Coal	1	19.20	1	17.02	1	15.38	1	17.41
Petroleum	2	14.38	2	14.19	2	14.87	2	13.40
Mineral bldg. Mat.	4	11.62	3	12.03	3	13.61	3	13.27
Iron & Steel	5	7.22	5	7.70	5	7.98	4	8.12
Timber	3	13.49	4	11.81	4	9.51	5	7.32
Ores	6	5.61	6	6.79	6	7.17	6	6.88
Grain	7	4.29	7	4.46	7	3.95	7	3.99
Fertilizer	8	2.38	8	2.84	8	3.47	8	3.63
Total		78.19		76.83		75.93		74.01

Note: Rankings are based on the freight turnover in ton-kms.

Source: Soviet Economy in the 1980's: Problems & Prospects, Part I, Joint Economic Committee Congress of the US, Dec. 1982, p.222.

Table B.16: INDIA - RAIL FREIGHT BY COMMODITY

Commodities	1969			1975			1976			1977			1978			1979			1980		
	Bil.Tkms	Mil.Tons	Avg.Dist	Bil.Tkms	Mil.Tons	Avg.Dist	Bil.Tkms	Mil.Tons	Avg.Dist	Bil.Tkms	Mil.Tons	Avg.Dist	Bil.Tkms	Mil.Tons	Avg.Dist	Bil.Tkms	Mil.Tons	Avg.Dist	Bil.Tkms	Mil.Tons	Avg.Dist
Coal	31	53	565	38	64	586	39	67	576	41	69	588	36	64	566	35	62	569	36	64	564
Foodgrains	13	15	870	16	16	957	19	20	940	23	20	1179	21	17	1228	24	18	1277	24	18	1328
Steel Plants	9	26	369	12	28	422	13	33	439	14	31	452	14	30	453	13	28	448	13	28	462
Cement	6	11	509	9	12	741	9	14	672	9	14	676	9	12	724	7	10	740	7	10	770
Iron Ore for Export	5	9	602	7	11	637	6	10	649	7	11	670	7	10	670	6	9	667	7	11	654
Petroleum Products	5	9	564	7	12	607	8	12	613	8	13	626	10	14	679	10	14	727	12	15	795
Fertilisers	4	5	826	6	7	861	7	8	923	8	8	988	9	9	1035	9	8	1122	9	8	1059
Other goods	37	49	760	41	47	876	42	48	861	40	46	879	39	44	892	40	43	926	39	42	923
Total	111	174	637	135	197	686	144	215	678	150	211	713	144	200	720	144	193	748	148	195	754

	69		1975		1976		1977		1978		1979		1980		1981	
	Rankings	% Share	Rankings	% Share	Rankings	% Share	Rankings	% Share	Rankings	% Share	Rankings	% Share	Rankings	% Share	Rankings	% Share
Coal	1	27.98	1	27.95	1	26.94	1	27.01	1	25.23	1	24.51	1	24.64	1	0.00
Foodgrains	2	11.86	2	11.49	2	13.06	2	15.30	2	14.25	2	16.32	2	15.45	2	0.00
Steel Plants	3	7.85	3	8.67	3	10.07	3	9.58	3	9.58	3	8.68	3	8.67	3	0.00
Cement	4	5.69	4	6.38	4	6.39	4	6.12	5	6.18	6	5.14	7	4.87	6	0.00
Iron Ore for Export	5	4.78	5	5.34	7	4.44	7	4.72	7	4.79	7	4.31	6	4.94	7	0.00
Petroleum Products	6	4.51	6	5.26	5	5.28	5	5.46	4	6.95	4	7.22	4	7.92	4	0.00
Fertilisers	7	3.43	7	4.60	6	5.00	6	5.39	6	6.18	5	6.39	5	6.03	5	0.00
Other goods																
Total		66.10		69.68		71.18		73.39		72.97		72.57		73.53		0.00

1981		
Bil.Tkms	Mil.Tons	Avg.Dist
44	76	578
26	22	1376
15	33	456
8	11	731
7	11	581
12	17	719
10	10	1015
41	43	952
164	221	743

Note: Rankings are based on the freight turnover in ton-kms.

Source: SAR - India - Railway Modernization & Maintenance Projects II, Oct. 26,1982. p.31.

11/11/83

Table B.17 : JAPAN - RAIL FREIGHT BY COMMODITY

Commodities	1965 Bil. Tkms	1965 Mil.Tons	1965 Avg.Dist	1970 Bil.Tkms	1970 Mil.Tons	1970 Avg.Dist	1975 Bil.Tkms	1975 Mil.Tons	1975 Avg.Dist	1980 Bil.Tkms	1980 Mil.Tons	1980 Avg.Dist
Logs and lumber	4.40	11.90	369.50	3.45	8.47	407.13	1.11	2.93	378.66	0.47	1.60	292.42
Coal	3.37	33.11	101.77	1.93	18.70	103.38	0.75	6.72	111.82	0.59	5.89	100.49
Chemical Fertilizer	2.54	6.98	363.99	3.02	8.53	353.80	2.59	6.30	411.12	2.11	5.37	393.03
Cement	2.53	14.51	174.19	2.32	16.39	141.58	1.96	14.21	138.04	1.80	14.99	119.85
Fresh & Frozen Fish	2.13	2.55	835.29	1.74	1.64	1061.47	0.56	0.48	1163.90	0.18	0.20	943.59
Paper	2.05	3.27	626.76	3.26	4.54	717.78	2.73	3.91	698.19	2.13	3.19	668.13
Chemical Drugs	1.88	4.47	420.71	2.35	5.75	409.19	1.79	4.18	426.83	1.60	3.65	438.97
Integrated Steel & Steel Pr	1.77	4.12	429.44	2.62	5.80	450.96	1.61	3.50	460.55	1.10	2.37	462.84
Rice	1.67	4.55	367.33	2.04	4.96	411.81	1.98	3.72	532.83	1.83	3.00	610.74
Mineral Oil	1.58	8.82	179.00	2.41	15.14	159.46	2.44	15.63	156.04	2.38	16.50	144.07
Others	3.35	17.30	193.73	3.29	19.56	168.14	2.23	20.49	108.70	1.68	17.65	95.13
Total	27.26	111.56	244.35	28.44	109.49	259.73	19.75	82.07	240.62	15.87	74.40	213.30

	1965 Rankings	1965 % Share	1970 Rankings	1970 % Share	1975 Rankings	1975 % Share	1980 Rankings	1980 % Share
Logs and Lumber	1	16.13	1	12.13	8	5.63	9	2.94
Coal	2	12.36	9	6.80	9	3.80	8	3.73
Chemical Fertilizer	3	9.32	3	10.62	2	13.11	3	13.29
Cement	4	9.27	7	8.16	5	9.94	5	11.32
Fresh & Frozen Fish	5	7.81	10	6.13	10	2.84	10	1.16
Paper	6	7.51	2	11.46	1	13.84	2	13.45
Chemical Drugs	7	6.90	6	8.27	6	9.04	6	10.11
Integrated Steel & Steel Pr	8	6.49	4	9.20	7	8.16	7	6.91
Rice	9	6.13	8	7.18	4	10.03	4	11.54
Mineral Oil	10	5.79	5	8.49	3	12.35	1	14.98
Total		87.71		88.43		88.72		89.42

Note: Rankings are based on the freight turnover in ton-kms.
Data refer to the revenue freight carried from the national or connected private railways through the national railway lines.

Sources: Japan Statistical Yearbook, 1982, p.284-285.

12/27/83

Table B.18 : BRAZIL - RAIL FREIGHT BY COMMODITY

	1970	1975	1980	1982		
Commodities	(Bil. Ton-km)			Bil.Tkms	Mil.Tons	Avg.Dist
Iron Ore	18.13	43.25	54.82	46.38	82.78	560.27
Cement	1.30	1.94	3.00	3.70	6.26	591.98
Coal	0.71	1.03	2.11	2.17	11.14	195.06
Steel Products	0.67	0.86	3.82	2.99	8.42	355.44
Petroleum Products	0.41	2.61	5.66	5.59	11.64	480.45
Others	9.01	8.93	17.45	17.03	47.71	356.86
Total	30.23	58.62	86.86	77.86	167.94	463.64

	1970		1975		1980		1982	
Commodities	Rankings	% Share	Rankings	% Share	Rankings	% Share	Rankings	% Share
Iron Ore	1	59.97	1	73.78	1	63.11	1	49.29
Cement	2	4.29	3	3.31	4	3.45	5	3.73
Coal	3	2.36	4	1.76	5	2.43	3	6.63
Steel Products	4	2.21	5	1.46	3	4.40	4	5.01
Petroleum Products	5	1.37	2	4.45	2	6.52	2	6.93
Total		70.19		84.77		79.91		71.59

Note: Rankings are based on the freight turnover in ton-kms.

Sources: 1. The 1970, 1975 and 1980 rail freight are taken from Sintese Ferroviaria Brasileira, Ministerio dos Transportes. Data represent rail freight for the three major railway companies: RFFSA, FEPASA, EFVM (p.38).

2. The 1982 rail freight is taken from unpublished data of RFFSA which represents total rail freight in Brazil.

12/28/83

Table B.19: INDIA: COMMODITY FLOWS AND INTERMODAL SHARES (1978/79)

	Total freight traffic		Average distance	Percentage share	
	Mln tons	Mln ton-km	(km)	Rail	Road
Iron ore	17.2	9,052	526	99.3	0.7
Limestone and dolomite	6.9	2,516	365	92.4	7.6
Coal	69.3	46,332	669	92.2	7.8
Cement	15.4	9,452	614	77.9	22.1
Mineral oil	17.9	9,676	541	73.2	26.7
Fertilizers	11.6	9,213	794	71.9	28.1
Iron and steel	15.2	12,778	841	64.3	35.7
Foodgrains	23.7	22,681	957	59.3	40.7
Stones and marbles	6.7	1,940	290	49.4	50.6
Wood and timber	6.6	3,723	564	38.6	61.4
Building materials	7.9	1,909	242	13.1	86.9
Fruits and vegetables	7.9	4,206	532	8.9	91.1
Provisions and households	6.9	3,826	554	8.3	91.7
Other	61.8	43,465	703	52.3	47.7
Total	275.0	180,769		66.9	33.1

Source: Report of the National Transport Policy Committee, May 1980, p. 96.

Table B.20 : JAPAN - ROAD FREIGHT BY COMMODITY

	1967			1970			1975			1980		
	Bil.Tkms	Mil.Tons	Avg.Dist	Bil.Tkm	Mil.Tons	Avg.Dist	Bil.Tkm	Mil.Tons	Avg.Dist	Bil.Tkm	Mil.Tons	Avg.Dist
Sand, Gravel & Stone	14.31	833.16	17.18	22.80	1056.67	21.58	19.82	1197.05	16.56	24.23	1492.28	16.24
Logs & Lumber	7.79	250.13	31.14	10.21	323.86	31.53	7.80	211.63	36.86	8.09	193.39	41.83
Food	6.37	175.64	36.27	9.62	231.70	41.52	7.53	193.03	39.01	13.23	258.77	51.13
Ceramics	6.33	264.61	23.92	10.82	415.67	26.03	9.28	412.52	22.50	11.24	500.08	22.48
Machinery	6.16	122.43	50.31	11.62	204.31	56.87	8.41	183.62	45.80	14.65	272.59	53.74
Iron & Steel	3.99	122.77	32.50	7.10	182.27	38.95	4.84	140.30	34.50	6.96	156.47	44.48
Chemicals & Allied Products	3.59	88.68	40.48	6.25	139.56	44.78	5.56	111.44	49.89	9.18	143.60	63.93
Vegetables & Fruits	2.95	85.15	34.64	3.58	113.83	31.45	4.63	85.59	54.10	6.42	88.68	72.40
Petroleum Products	2.68	92.98	28.82	5.03	143.53	35.04	3.11	126.81	24.52	4.25	151.89	27.98
Others	26.92	1236.94	21.76	48.89	1814.67	26.94	58.72	1730.88	33.92	80.65	2060.21	39.15
Total	81.09	3272.49	24.78	135.92	4626.07	29.38	129.70	4392.87	29.53	178.90	5317.96	33.64

	1967		1970		1975		1980	
	Rankings	% Share	Rankings	% Share	Rankings	% Share	Rankings	% Share
Sand, Gravel & Stone	1	17.65	1	16.77	1	15.28	1	13.54
Logs & Lumber	2	9.61	4	7.51	4	6.01	6	4.52
Food	3	7.86	5	7.08	5	5.81	3	7.40
Ceramics	4	7.81	3	7.96	2	7.15	4	6.28
Machinery	5	7.60	2	8.55	3	6.48	2	8.19
Iron & Steel	6	4.92	6	5.22	7	3.73	7	3.89
Chemicals & Allied Products	7	4.43	7	4.60	6	4.29	5	5.13
Vegetables & Fruits	8	3.64	9	2.63	8	3.57	8	3.59
Petroleum Products	9	3.30	8	3.70	9	2.40	9	2.38
Total		66.80		64.03		54.73		54.92

Notes: Rankings are based on the freight turnover in ton-kms.
Data are based on the Survey of Motor Vehicle Transport.

Sources: Japan Statistical Yearbook, 1969(p.271), 1972(p.273), 1977(p.267), 1982(p.289).

12/27/83

Table B.21: INTERCITY PASSENGER TRAFFIC(BIL. PKM) AND PER CAPITA INCOME(US$) FOR SELECTED COUNTRIES, 1960-1981

YEARS	CHINA Traffic (1)	Population (2)	Pkm-PC (3)	GNP-PC (4)	USA Traffic (5)	Population (6)	Pkm-PC (7)	GNP-PC (8)	USSR Traffic (9)	Population (10)	Pkm-PC (11)	GNP-PC (12)
1960	88			110	1257			7326				2962
1965	70	736	95	142	1476	194	7595	8553	367	232	1581	3238
1970	103	839	123	184	1900	205	9266	9422	553	243	2276	4259
1971	111	859	129	188	1972	208	9494	9588	587	245	2394	4278
1972	124	877	141	192	2086	210	9937	10029	625	247	2525	
1973	133	895	148	197	2159	212	10187	10482	657	250	2631	
1974	138	910	151	202	2102	214	9832	10276	703	252	2787	
1975	144	924	155	208	2179	216	10091	10054	747	254	2937	5011
1976	147	936	157	214	2349	218	10771	10542	780	257	3038	5099
1977	159	947	168	222	2460	220	11171	10977	803	259	3099	5224
1978	174	958	182	246	2576	223	11571	11348	842	262	3218	5208
1979	197	969	203	260	2558	225	11367	11505	871	264	3296	5199
1980	228	980	233	274	2507	228	11013	11349	891	266	3356	5244
1981	250	991	252	278	2572	230	11193	11465		268		5265
1982	274				2635							

YEARS	INDIA Traffic (13)	Population (14)	Pkm-PC (15)	GNP-PC (16)	BRAZIL Traffic (17)	Population (18)	Pkm-PC (19)	GNP-PC (20)	KOREA Traffic (21)	Population (22)	Pkm-PC (23)	GNP-PC (24)	JAPAN Traffic (25)	Population (26)	Pkm-PC (27)	GNP-PC (28)
1960	114			170	39			877	8	26	310	483	157	93	1681	2366
1965	158	487	324	178	66	84	781	942	15	29	506	615	262	98	266[illegible]	3625
1970	232	548	424	199	116	96	1210	1196	21	33	647	876	451	104	4345	6133
1971		560		199	132	98	1340	1305					481	105	4574	6362
1972		572		194	150	101	1492	1414					507	108	4712	6869
1973	269	584	461	197	170	103	1651	1571					527	109	4830	7448
1974	268	596	450	194	194	105	1839	1677					541	111	4891	7310
1975	290	609	477	209	221	108	2046	1718					558	112	4985	7325
1976	309	621	497	208	252	110	2290	1847	38	36	1060	1299	559	113	4943	7716
1977	335	634	528	220	294	112	2622	1911					564	114	49[illegible]	8059
1978		648		231	334	114	2929	1953					601	115	[illegible]218	8467
1979		661		214	379	116	3261	2039					630	116	5425	8869
1980		675		224	432	118	3654	2150					634	117	5416	9173
1981	542	690	785	232	450	121	3735	2027	53	39	1368	1576		118		9361
1982																

Notes: (1) Chinese Statistical Yearbook,1981,p.273. Figures represent total passenger traffic.
(2) (6) (10) (14) (18) (22) (26) -- all population figures were from EPD Data Bank,mid-year population (in mil.).
(3) (7) (11) (15) (19) (23) (27) -- Traffic/population
(4) (8) (12) (16) (20) (24) (28) -- GNP per capita for all countries except USSR was taken from EPD Data Bank-Atlas GNP per capita at constant US dollars (using the domestic GNP deflator for the base period 1979-1981). GNP per capita for USSR was at 1980 US dollars taken from the USSR Facts & Figures Annual.
(5) Transportation in America, July 1983, p.13.
(9) Soviet Economy in the 1980's: Problems & Prospects, Part I, Joint Economic Committee Congress of the US, Dec. 1982,p.224.
(13) SAR-India-Railway Modernization & Maintenance Project II, October 26,1982 provided the rail passenger non-suburban traffic(p.50); Report of the National Transport Policy Committee (May 1980) provided the percentage share of rail in total passenger traffic (p.18).
(17) 1960-1965, Transport Sector of Brazil, Dec. 20, 1974.
1970-1981, GEIPOT,1979(p.445) & 1981(p.643), total passenger traffic less city passenger traffic.
(21) SAR-Korea-Provincial and County Roads Project, November 23,1982, p.32. Urban passenger traffic is excluded from total passenger traffic. The first three figures are for the years 1961, 1966 and 1971.
(25) Japan Statistical Yearbook and Nippon, a charted survey of Japan, various issues. Rail commuters were excluded from the total passenger traffic. No information available on road commuters.

Table B.22: USA - HOUSEHOLD TRIPS BY MAIN PURPOSE, 1977
(in thousands)

		Visit Relatives	Recreation	Business	Others
Total Household Trips	312532	136639	72718	86689	16486
Percentage share of total	100%	44	23	28	5
Round Trip Distance (percentage share in total household trips)					
200 to 299 miles		33	35	32	37
300 to 399 miles		16	17	15	19
400 to 599 miles		18	17	16	15
600 to 799 miles		8	7	8	6
800 miles and over and outside US		25	25	29	22

Source: 1977 Census of Transportation - National Travel Survey.
Department of Commerce, USA

1/10/84

Table B.23 : CHINA - PASSENGER TRAFFIC BY MODE OF TRANSPORT

	Billion Pass-km					Percentage Share				
YEARS	Rail	Road	Water	Air	Total	Rail	Road	Water	Air	Total
1950	21	1	1	0.01	24	88.48	5.34	6.14	0.04	100.00
1955	27	5	4	0.06	35	75.62	14.25	9.97	0.17	100.00
1960	67	15	6	0.16	88	76.29	16.53	7.01	0.18	100.00
1965	48	17	5	0.25	70	68.71	24.13	6.80	0.36	100.00
1970	72	24	7	0.18	103	69.65	23.29	6.89	0.17	100.00
1975	96	37	9	1.54	144	66.53	26.09	6.31	1.07	100.00
1976	96	40	9	1.60	147	65.10	27.41	6.39	1.09	100.00
1977	102	45	10	1.80	159	64.46	28.23	6.18	1.13	100.00
1978	109	52	10	2.80	174	62.71	29.89	5.79	1.61	100.00
1979	122	60	11	3.50	197	61.79	30.64	5.79	1.78	100.00
1980	138	73	13	4.00	228	60.63	31.96	5.66	1.75	100.00
1981	147	84	14	5.00	250	58.92	33.56	5.52	2.00	100.00
1982	158	96	15	6.00	274	57.40	35.13	5.28	2.19	100.00

Source: Chinese Statistical Yearbook, 1981 (p.273).

Table B.24 : USA - PASSENGER TRAFFIC BY MODE OF TRANSPORT

	Billion Pass-km				Percentage Share			
YEARS	Rail	Road	Air	Total	Rail	Road	Air	Total
1940	40	487	2	529	7.54	92.07	0.39	100.00
1945	150	399	7	556	27.06	71.70	1.24	100.00
1950	52	742	16	810	6.45	91.54	2.01	100.00
1955	46	1061	37	1144	4.04	92.75	3.21	100.00
1960	35	1167	55	1257	2.77	92.88	4.35	100.00
1965	28	1354	93	1476	1.92	91.75	6.33	100.00
1970	18	1692	191	1900	0.92	89.03	10.04	100.00
1975	16	1925	239	2179	0.75	88.31	10.95	100.00
1976	17	2067	265	2348	0.72	88.02	11.26	100.00
1977	17	2159	285	2461	0.68	87.75	11.57	100.00
1978	17	2233	327	2577	0.66	86.66	12.69	100.00
1979	19	2172	367	2558	0.73	84.92	14.35	100.00
1980	18	2136	353	2507	0.73	85.21	14.06	100.00
1981	19	2206	348	2572	0.74	85.75	13.51	100.00
1982	18	2251	366	2635	0.67	85.44	13.89	100.00

Source: Transportation in America, July 1983, p.13.

11/8/83

Table B.25 : USSR - PASSENGER TRAFFIC BY MODE OF TRANSPORT

YEARS	Billion Pass=km Rail	Road	Water	Air	Total	Percentage Share Rail	Road	Water	Air	Total
1965	202	121	6	38	367	54.99	32.87	1.75	10.39	100.00
1970	265	203	7	78	553	47.98	36.61	1.27	14.14	100.00
1975	313	304	8	123	747	41.83	40.64	1.12	16.41	100.00
1976	315	325	9	131	780	40.41	41.72	1.09	16.78	100.00
1977	322	345	8	128	803	40.15	42.93	1.03	15.89	100.00
1978	332	362	8	140	842	39.45	42.94	0.96	16.64	100.00
1979	335	376	8	151	871	38.51	43.19	0.95	17.34	100.00
1980	332	390	9	161	891	37.27	43.74	0.97	18.02	100.00

Source: Soviet Economy in the 1980's: Problems & Prospects , Part I, Joint Economic Committee Congress of the US,Dec. 1982, p.225.

Table B.26 : BRAZIL - PASSENGER TRAFFIC BY MODE OF TRANSPORT

YEARS	Billion Pass-km Rail	Road	Water	Air	Total	Percentage share Rail	Road	Water	Air	Total
1960	8	30	0.03	2	39	19.02	75.07	0.00	5.83	99.92
1965	8	56	0.03	2	66	12.61	84.92	0.00	2.43	99.95
1970	5	109	0.05	2	116	4.65	93.58	0.00	1.72	99.96
1975	5	211	0.01	5	221	2.21	95.48	0.00	2.31	100.00
1976	5	241	-	6	252	1.94	95.67	0.00	2.39	100.00
1977	12	275	-	7	294	3.98	93.77	0.00	2.24	100.00
1978	12	315	0.02	8	334	3.56	94.14	0.00	2.29	99.99
1979	11	359	0.03	9	380	3.00	94.67	0.00	2.32	99.99
1980	12	410	-	10	432	2.86	94.92	0.00	2.21	100.00
1981	13	427	0.21	10	450	2.92	94.82	0.00	2.22	99.95

Sources: (1) 1960-1965, The Transport Sector of Brazil, Dec. 20, 1974.
(2) 1970-1976, GEIPOT, 1979, p.643.
(3) 1977-1982, GEIPOT, 1982, p.445.

11/8/83

Table B.27 : INDIA - PASSENGER TRAFFIC BY MODE OF TRANSPORT

	Billion Pass-km				Percentage Share			
YEARS	Rail	Road	Air	Total	Rail	Road	Air	Total
1950	66	23	-	89.00	74.16	25.84	0.00	100.00
1955	62	31	0.30	93.30	66.45	33.23	0.32	100.00
1960	78	57	0.60	135.60	57.52	42.04	0.44	100.00
1965	96	95	1.00	192.00	50.00	49.48	0.52	100.00
1970	118	169	-	287.00	41.11	58.89	0.00	100.00
1975	149	225	2.60	376.60	39.56	59.75	0.69	100.00
1976	164	235	2.90	401.90	40.81	58.47	0.72	100.00
1977	177	250	3.40	430.40	41.12	58.09	0.79	100.00
1978	192			192.00				
1979								
1980	229	331	2.00	562.00	40.75	58.90	0.36	100.00
1981								

Source: (1) SAR-India-Railway Modernization & Maintenance Project II, Oct.26,1982
(2) National Transport Policy Committee (May 1980).

Table B.28 : JAPAN - PASSENGER TRAFFIC BY MODE OF TRANSPORT

	Billion Pass-km					Percentage Share				
YEARS	Rail	Road	Water	Air	Total	Rail	Road	Water	Air	Total
1955	72	28	2.00	0.20	102	70.83	27.01	1.96	0.20	100.00
1960	98	56	2.70	0.70	157	62.40	35.43	1.72	0.45	100.00
1965	135	121	3.10	2.90	262	51.65	46.06	1.18	1.11	100.00
1970	153	284	4.80	9.40	451	33.90	62.95	1.06	2.08	100.00
1975	172	361	6.60	19.10	558	30.74	64.65	1.18	3.42	100.00
1976	169	363	6.50	20.10	559	30.29	64.96	1.16	3.59	100.00
1977	166	369	6.30	23.60	564	29.35	65.35	1.12	4.18	100.00
1978	165	403	6.20	26.90	601	27.44	67.06	1.03	4.48	100.00
1979	166	428	6.40	30.20	630	26.27	67.92	1.02	4.79	100.00
1980	167	432	6.10	29.70	634	26.28	68.07	0.96	4.68	100.00

Source: Japan Statistical Yearbook, various issues.

Table B.29 : RAILWAY AND ROAD NETWORK - DENSITY IN SELECTED COUNTRIES

COUNTRY	YEAR	POPULATION (mil.)	AREA ('000 sq.km)	RAIL LENGTH ('000 km.)	RAIL DENSITY (KM/'000 pop)	RAIL DENSITY (km/'000 sq.km.)	ROAD LENGTH ('000 KM)	ROAD DENSITY (km/'000 pop)	ROAD DENSITY (km/'000 sq.km)
China	1981	991	9600	53.91	0.05	5.62	897	0.91	93.49
Brazil	1980	118	8512	29.66	0.25	3.48	1395	11.82	163.85
India	1979	661	3285	60.78	0.09	18.50	1604	2.43	488.31
Japan	1980	117	378	24.00	0.21	63.55	1113	9.52	2947.95
Korea	1980	38	98	3.16	0.08	32.07	47	1.24	476.77
USA	1979	225	9363	358.90	1.60	38.33	6304	28.02	673.24
USSR	1979	264	22400	141.10	0.53	6.30	1427	5.41	63.71

Sources: 1. World Road Statistics 1976-1980.
2. Indian Railways Yearbook 1978-1979.
3. China Statistical Yearbook, p.269.
4. Transport Policy for Brazil 1979/85, preliminary draft, by Cloraldino Severo, June, 1983.
5. Korea - Staff Appraisal Report of Seventh Railway Project, April 1, 1980.
6. USSR - Une Crise Durable des Transports Interieurs de l'URSS. Herve Gicquiau in "Le Courrier des Pays de l'est no 251 Mai 1981.

1/23/84

Table B.30: RAIL DENSITY BY PROVINCE

OBS	PROVINCE	RAIL LENGTH (KM)	AREA ('000 SQ.KM)	RAIL DENSITY (KM/'000 SQ. KM)	POPULATION (10,000)	RAIL DENSITY (KM/10,000)
1	TOTAL	53906.0	9600	5.6152	99622	0.54111
2	BEIJING	858.5	17	50.5000	902	0.95177
3	TIANJIN	459.9	11	41.8091	763	0.60275
4	HEBEI	3201.1	190	16.8479	5256	0.60904
5	SHANXI	2074.3	150	13.8287	2509	0.82674
6	INNER MON	4408.1	1100	4.0074	1903	2.31640
7	LIAONING	3775.9	150	25.1727	3535	1.06815
8	JILIN	3470.3	180	19.2794	2231	1.55549
9	HEILONGJ	4987.7	460	10.8428	3239	1.53989
10	SHANGHAI	244.7	6	40.7833	1163	0.21040
11	JIANGSU	713.6	100	7.1360	6010	0.11874
12	ZHEJIANG	830.8	100	8.3080	3871	0.21462
13	ANHUI	1296.2	130	9.9708	4956	0.26154
14	FUJIAN	1027.9	120	8.5658	2557	0.40199
15	JIANGXI	1375.7	160	8.5981	3304	0.41637
16	SHANDONG	1749.7	150	11.6647	7395	0.23661
17	HENAN	3602.5	160	22.5156	7397	0.48702
18	HUBEI	1601.0	180	8.8944	4740	0.33776
19	HUNAN	2560.9	210	12.1948	5360	0.47778
20	GUANGDONG	1149.6	220	5.2255	5884	0.19538
21	GUANGXI	2044.7	230	8.8900	3613	0.56593
22	SICHUAN	2919.1	560	5.2127	9924	0.29415
23	GUIZHOU	1373.3	170	8.0782	2827	0.48578
24	YUNNAN	1629.6	380	4.2884	3223	0.50562
25	TIBET	.	1200	.	186	.
26	SHAANXI	1858.4	190	9.7811	2865	0.64866
27	GANSU	2244.4	390	5.7549	1941	1.15631
28	QINGHAI	1027.2	720	1.4267	382	2.68901
29	NINGXIA	439.1	66	6.6530	383	1.14648
30	XINJIANG	982.3	1600	0.6139	1303	0.75388

Table B.31: INVESTMENT IN THE TRANSPORT SECTOR
(Including Post & Telecommunication)
(Bil.Yuan)

	1st.FYP 1953-57	2nd.FYP 1958-62	1963-65	3rd.FYP 1966-70	4th.FYP 1971-75	5th.FYP 1975-80	1978	1979	1980	6th.FYP 1981-85	1981	1982	1983	1984
Railway	5.916	10.416	3.395	11.25	17.308	14.047			3.044	17.29	1.445	2.459	4.3	6.4
Highway									1.086		.799			
Waterway									1.391		1.295			
Aviation									.275		.07			
Pipeline									.054		0.02			
Subtotal									5.85		3.627			
Post & Tele-communications									.384		.42			
Total	9.015	16.33	5.378	15.001	31.759	30.245	6.804	6.409	6.234		4.047	5.721		
Total capital Investment	58.847	120.609	42.189	97.603	176.395	234.217	50.099	52.348	55.889		44.291	55.553		
Transport in % of total investment	15.32	13.54	12.75	15.37	18.00	12.91	13.58	12.24	11.15		9.14	10.30		

Sources: 1. China Statistical Abstract, JPRS84111, 12 August 1983, p.119.
2. Railway Knowledge, 7/28/1983, p.2.
3. Ta Kung Pao, December 2, 1983.

1/6/84

Table B.32: FREIGHT TRAFFIC

QUADRUPLE: Case 1 - Low Road Share

	Annual Growth Rates	
	1980-90	1990-2000
GVIAO	7.20%	7.20%
Elasticity	1.0	0.9
Freight Transport	7.20%	6.48%

	Modal Split in Percentage		
	1980	1990	2000
Modes:			
Rail	67.37%	63.00%	59.00%
Road	8.95%	14.00%	17.00%
Water	17.90%	19.00%	21.00%
Pipeline	5.77%	4.00%	3.00%
Total	99.99%	100.00%	100.00%

	Traffic in Billion Tkm		
	1980	1900	2000
Modes:			
Rail	572	1072	1881
Road	76	238	542
Water	152	323	669
Pipeline	49	68	96
Total	849	1701	3188

	Annual Growth Rate	
	1980-90	1990-2000
Modes:		
Rail	6.48%	5.78%
Road	12.11%	8.57%
Water	7.84%	7.55%
Pipeline	3.34%	3.46%
Total	7.20%	6.48%

Table B.33: FREIGHT TRAFFIC

QUADRUPLE: Case 2 - Low Road Share

	Annual Growth Rates	
	1980-90	1990-2000
GVIAO	7.20%	7.20%
Elasticity	0.9	0.8
Freight Transport	6.48%	5.76%

	Modal Split in Percentage		
	1980	1990	2000
Modes:			
Rail	67.37%	63.00%	59.00%
Road	8.95%	14.00%	17.00%
Water	17.90%	19.00%	21.00%
Pipeline	5.77%	4.00%	3.00%
Total	99.99%	100.00%	100.00%

	Traffic in Billion Tkm		
	1980	1900	2000
Modes:			
Rail	572	1002	1643
Road	76	223	473
Water	152	302	585
Pipeline	49	64	84
Total	849	1591	2785

	Annual Growth Rate	
	1980-90	1990-2000
Modes:		
Rail	5.77%	5.07%
Road	11.35%	7.83%
Water	7.12%	6.82%
Pipeline	2.65%	2.76%
Total	6.48%	5.76%

Table B.34: FREIGHT TRAFFIC

BALANCE: Case 3 - High Road Share

	Annual Growth Rates	
	1980-90	1990-2000
GVIAO	6.40%	6.40%
Elasticity	1.0	0.9
Freight Transport	6.40%	5.76%

	Modal Split in Percentage		
	1980	1990	2000
Modes:			
Rail	67.37%	63.00%	56.00%
Road	8.95%	14.00%	20.00%
Water	17.90%	19.00%	21.00%
Pipeline	5.77%	4.00%	3.00%
Total	99.99%	100.00%	100.00%

	Traffic in Billion Tkm		
	1980	1900	2000
Modes:			
Rail	572	995	1548
Road	76	221	553
Water	152	300	580
Pipeline	49	63	83
Total	849	1579	2764

	Annual Growth Rate	
	1980-90	1990-2000
Modes:		
Rail	5.69%	4.52%
Road	11.27%	9.60%
Water	7.04%	6.82%
Pipeline	2.57%	2.76%
Total	6.40%	5.76%

Table B.35: FREIGHT TRAFFIC

BALANCE: Case 4 - High Road Share

	Annual Growth Rates	
	1980-90	1990-2000
GVIAO	6.40%	6.40%
Elasticity	0.9	0.8
Freight Transport	5.76%	5.12%

	Modal Split in Percentage		
	1980	1990	2000
Modes:			
Rail	67.37%	63.00%	56.00%
Road	8.95%	14.00%	20.00%
Water	17.90%	19.00%	21.00%
Pipeline	5.77%	4.00%	3.00%
Total	99.99%	100.00%	100.00%

	Traffic in Billion Tkm		
	1980	1900	2000
Modes:			
Rail	572	936	1371
Road	76	208	490
Water	152	282	514
Pipeline	49	59	73
Total	849	1486	2449

	Annual Growth Rate	
	1980-90	1990-2000
Modes:		
Rail	5.05%	3.89%
Road	10.60%	8.94%
Water	6.39%	6.18%
Pipeline	1.96%	2.14%
Total	5.76%	5.12%

Table B.36: CHINA ROAD NETWORK
('000 km)

Surface type		1975	1976	1977	1978	1979 /a	1980	1981	1982
Paved		92	108	126	143	151	158	165	170
Improved		405	424	435	456	496	504	511	518
Of which:	Medium quality					241	245	247	252
	Low quality					255	259	264	267
Unimproved (earth)		287	292	294	290	229	227	221	215
Total		784	824	855	889	876	889	897	904

/a A 1979 road survey indicated that the 1978 estimates of road length were too high.

Notes: (1) Paved includes: asphaltic concrete, cement concrete, hot-mix macadam, penetration surface macadam, cold-mix macadam, bituminous-coated macadam.

(2) Medium quality includes: bituminous-lime treatment, graded aggregates, gravel surface.

(3) Low quality includes: improved earth surface.

Table B.37: PASSENGER TRAFFIC

Case 1 - High Road Share

	Annual Growth Rates		
	1980-90	1990-2000	1980-2000
GDP/capita	6.20%	6.20%	6.20%
Pass-km Elasticity	1.7	1.5	1.6
Pass. Transport	10.54%	9.30%	9.92%

	Percentage of Total Pass-km				
	1973	1980	1982	1990	2000
Modes:					
Rail	62.70%	60.60%	57.40%	52.00%	46.00%
Road	29.90%	32.00%	35.10%	40.00%	46.00%
Water	5.80%	5.70%	5.30%	5.00%	4.00%
Air	1.60%	1.80%	2.20%	3.00%	4.00%
Total	100.00%	100.10%	100.00%	100.00%	100.00%

	Billion Pass-km				
	1978	1980	1982	1990	2000
Modes:					
Rail	109	138	158	323	695
Road	52	73	97	248	695
Water	10	13	15	31	60
Air	3	4	6	19	60
Total	174	228	275	621	1511

	Pass-km Annual Growth		
	1980-90	1990-2000	1980-2000
Modes:			
Rail	8.86%	7.97%	8.41%
Road	13.03%	10.84%	11.93%
Water	9.10%	6.89%	7.99%
Air	16.33%	12.49%	14.40%
Total	10.54%	9.30%	9.92%

Table B.38: PASSENGER TRAFFIC

Case 1 - Low Road Share

		Annual Growth Rates	
	1980-90	1990-2000	1980-2000
GDP/capita	6.20%	6.20%	6.20%
Pass-km Elasticity	1.7	1.5	1.6
Pass. Transport	10.54%	9.30%	9.92%

			Percentage of Total Pass-km		
	1973	1980	1982	1990	2000
Modes:					
Rail	62.70%	60.60%	57.40%	55.00%	50.00%
Road	29.90%	32.00%	35.10%	37.00%	42.00%
Water	5.80%	5.70%	5.30%	5.00%	4.00%
Air	1.60%	1.80%	2.20%	3.00%	4.00%
Total	100.00%	100.10%	100.00%	100.00%	100.00%

			Billion Pass-km		
	1978	1980	1982	1990	2000
Modes:					
Rail	109	138	158	342	756
Road	52	73	97	230	635
Water	10	13	15	31	60
Air	3	4	6	19	60
Total	174	228	275	621	1511

		Pass-km Annual Growth	
	1980-90	1990-2000	1980-2000
Modes:			
Rail	9.47%	8.26%	8.87%
Road	12.16%	10.69%	11.42%
Water	9.10%	6.89%	7.99%
Air	16.33%	12.49%	14.40%
Total	10.54%	9.30%	9.92%

Table B.39: PASSENGER TRAFFIC

Case 2 - High Road Share

	Annual Growth Rates		
	1980-90	1990-2000	1980-2000
GDP/capita	6.20%	6.20%	6.20%
Pass-km Elasticity	1.5	1.2	1.6
Pass. Transport	9.30%	7.44%	9.92%

	Percentage of Total Pass-km				
	1973	1980	1982	1990	2000
Modes:					
Rail	62.70%	60.60%	57.40%	52.00%	46.00%
Road	29.90%	32.00%	35.10%	40.00%	46.00%
Water	5.80%	5.70%	5.30%	5.00%	4.00%
Air	1.60%	1.80%	2.20%	3.00%	4.00%
Total	100.00%	100.10%	100.00%	100.00%	100.00%

	Billion Pass-km				
	1978	1980	1982	1990	2000
Modes:					
Rail	109	138	158	288	523
Road	52	73	97	222	523
Water	10	13	15	28	45
Air	3	4	6	17	45
Total	174	228	275	555	1137

	Pass-km Annual Growth		
	1980-90	1990-2000	1980-2000
Modes:			
Rail	7.64%	6.13%	6.88%
Road	11.77%	8.95%	10.35%
Water	7.88%	5.07%	6.46%
Air	15.03%	10.58%	12.78%
Total	9.30%	7.44%	8.37%

Table B.40: PASSENGER TRAFFIC

Case 2 - Low Road Share

	Annual Growth Rates		
	1980-90	1990-2000	1980-2000
GDP/capita	6.20%	6.20%	6.20%
Pass-km Elasticity	1.5	1.2	1.6
Pass. Transport	9.30%	7.44%	9.92%

	Percentage of Total Pass-km				
	1973	1980	1982	1990	2000
Modes:					
Rail	62.70%	60.60%	57.40%	55.00%	50.00%
Road	29.90%	32.00%	35.10%	37.00%	42.00%
Water	5.80%	5.70%	5.30%	5.00%	4.00%
Air	1.60%	1.80%	2.20%	3.00%	4.00%
Total	100.00%	100.10%	100.00%	100.00%	100.00%

	Billion Pass-km				
	1978	1980	1982	1990	2000
Modes:					
Rail	109	138	158	305	569
Road	52	73	97	205	478
Water	10	13	15	28	45
Air	3	4	6	17	45
Total	174	228	275	555	1137

	Pass-km Annual Growth		
	1980-90	1990-2000	1980-2000
Modes:			
Rail	8.25%	6.42%	7.33%
Road	10.90%	8.81%	9.85%
Water	7.88%	5.07%	6.46%
Air	15.03%	10.58%	12.78%
Total	9.30%	7.44%	8.37%

Table B.41: COAL PRODUCTION, TRANSPORTATION AND CONSUMPTION SUMMARY BY PROVINCE, 1980
(Unit: MT)

	Production	Railway transport loading volume	Railway transport unloading volume	Consumption
North	204.6	154.0	111.8	154.0
Beijing	7.9	6.5	18.2	19.7
Tianjin	-	-	9.3	9.3
Hebei	53.5	40.5	51.8	56.4
Nei Monggol	22.1	14.8	12.5	19.9
Shanxi	121.0	92.2	19.9	48.7
Northeast	97.8	74.2	90.5	114.0
Liaoning	37.3	24.5	43.8	56.5
Jilin	18.1	14.1	20.0	23.9
Heilongjiang	42.5	35.6	26.7	33.6
East	106.1	70.8	90.1	136.9
Shanghai	-	1.2	1.8	11.8
Jiangsu	18.1	11.8	28.3	35.7
Zhejiang	1.4	0.8	5.3	12.1
Anhui	24.1	22.0	18.0	18.4
Jiangxi	14.9	7.0	7.8	15.4
Fujian	4.6	2.6	4.7	6.7
Shandong	42.9	24.9	24.3	36.9
South Central	98.0	57.8	71.6	109.2
Henan	56.2	40.2	26.2	42.2
Hubei	3.8	0.2	17.7	18.5
Hunan	24.0	10.4	13.8	27.4
Guangdong	8.0	4.3	8.9	12.8
Guangxi	5.9	2.6	5.1	8.3
Southwest	64.7	25.9	23.6	62.2
Sichuan	39.0	13.5	14.5	39.8
Yunnan	11.7	5.0	5.4	12.1
Guizhou	14.0	7.3	3.7	10.3
Northwest	48.8	32.2	27.0	43.6
Shaanxi	17.9	12.9	10.3	15.3
Gansu	7.7	5.0	8.7	11.4
Qinghai	2.2	1.0	2.1	3.2
Xinjiang	11.4	2.5	1.3	10.1
Ningxia	9.7	10.7	4.6	3.6
Total	620.1	414.8	414.7	620.0

Table B.42: RAILWAY ENERGY CONSUMPTION PLAN
(Data for analysis)

	Petroleum	Coal	Electricity
1980			
Consumption quantity (kg/10,000 gross tkm or kWh/10,000 gross tkm)	35	216	130
Percentage of traffic carried by type of locomotive	18	80	2
Railway transport consumption (mt or billion kWh)	0.7	18.5	0.3
Energy equivalent to standard coal of 7,000 kcal/kg (mt)	1.1	14.8	0.1
1990			
Consumption quantity (kg/10,000 gross tkm or kWh/10,000 gtkm)	32	244	120
Percentage of traffic carried by type of locomotive	41	38	21
Railway transport consumption (mt or billion kWh)	2.8	19.6	5.3
Energy equivalent to standard coal of 7,000 kcal/kg (mt)	4.4	15.7	2.1
2000			
Consumption quantity (kg/10,000 gross tkm or kWh/10,000 gtkm)	32	284	110
Percentage of traffic carried by type of locomotive	39.3	18	42.7
Railway transport consumption (mt or billion kWh)	4.9	19.8	18.2
Energy equivalent to standard coal of 7,000 kcal/kg (mt)	7.7	15.8	7.4

Notes: (1) Railway steam locomotive coal equivalent 11,360 kcal/kg or 162% of SCE. Railway steam locomotive on industrial energy coal 5,600 kcal/kg. Railway coal equivalent equals 203% of industrial energy coal caloric value. Therefore, the unit consumption given in the Statistical Yearbook of 106.4 kg/10,000 tkm should be 173 kg/10,000 tkm of SCE at 7,000 kcal/kg. This is the consumption per 10,000 gross tkm which includes passenger traffic (gross trailing weight excludes the weight of locomotive). There are two ways to convert passenger traffic into tkm, both giving almost same result. The first method uses a standard 800 t for a 13-coach train, the second uses 1 pkm = 1 tkm with average 600 passengers per train; i.e., 600 t plus weight of cars 240 t so total 840 t per train.

(2) Total rail consumption of energy (SCE): 1980 = 16.0 million tons; 1990 = 22.2 million tons; 2000 = 30.9 million tons.

(3) Locomotive oil consumption is calculated based on 11,000 kcal equivalent/kg.

(4) Railway energy consumption other than for transport for 1980: petroleum = 0.5 mt, coal 5.2 mt, electricity 1.8 billion kWh. This is used by stations, factories, housing and construction (petroleum).

(5) In the percentage of traffic carried by type of locomotive, the traffic includes both freight and passengers, where 1 pkm = 1 tkm.

(6) To achieve the amount of electric traction given in the table, they would need to electrify 1,000 km of line per year from now to the year 2000.

Source: Ministry of Railways

Table B.43: PRODUCTION AND RAIL FREIGHT DESTINATION (1982)

				DESTINATION					
	PRODUCTION	RAIL LOADINGS		PROVINCE		REGION		OTHER	
PROVINCE	mil.tons	mil.tons	% of (1)	mil.tons	% of (2)	mil.tons	% of (2)	mil.tons	% of (2)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Heilongjiang	3.21	1.40	43.61	1.34	95.71	0.02	1.43	0.04	2.86
Jilin	2.03	0.90	44.33	0.77	85.56	0.12	13.33	0.01	1.11
Liaoning	8.13	3.99	49.08	2.09	52.38	0.84	21.05	1.06	26.57
Northeast region	13.37	6.29	47.05	4.20	66.77	0.98	15.58	1.11	17.65
Beijing	2.49	1.12	44.98	1.11	99.11	0.01	0.89		
Tianjin	0.82	0.03	3.66	0.01	33.33	0.02	66.67		
Nei Monggol	1.24	0.58	46.77	0.40	68.97	0.08	13.79	0.10	17.24
Hebei	5.87	1.95	33.22	1.03	52.82	0.73	37.44	0.19	9.74
Shanxi	3.12	0.67	21.47	0.39	58.21	0.27	40.30	0.01	1.49
Northern region	13.54	4.35	32.13	2.94	67.59	1.11	25.52	0.30	6.90
Shanghai	2.13								
Jiangsu	7.49	0.91	12.15	0.50	54.95	0.33	36.26	0.08	8.79
Shandong	6.89	0.67	9.72	0.45	67.16	0.19	28.36	0.03	4.48
Anhui	2.90	0.88	30.34	0.62	70.45	0.26	29.55		
Zhejiang	3.97	0.72	18.14	0.67	93.06	0.04	5.56	0.01	1.39
Jiangxi	2.48	0.69	27.82	0.46	66.67	0.19	27.54	0.04	5.80
Fujian	1.64	0.51	31.10	0.51	100.00				
Eastern region	27.50	4.38	15.93	3.21	73.29	1.01	23.06	0.16	3.65
Henan	4.84	1.23	25.41	0.76	61.79	0.11	8.94	0.36	29.27
Hubei	4.90	1.21	24.69	0.91	75.21	0.16	13.22	0.14	11.57
Hunan	5.79	2.21	38.17	0.95	42.99	1.14	51.58	0.12	5.43
Guangdong	6.17	0.32	5.19	0.31	96.88			0.01	3.13
Guangxi	2.74	0.79	28.83	0.58	73.42	0.20	25.32	0.01	1.27
South central	24.44	5.76	23.57	3.51	60.94	1.61	27.95	0.64	11.11
Sichuan	6.41	1.59	24.80	1.21	76.10	0.02	1.26	0.36	22.64
Guizhou	1.61	0.40	24.84	0.17	42.50	0.01	2.50	0.22	55.00
Yunnan	1.94	0.21	10.82	0.18	85.71	0.01	4.76	0.02	9.52
Xizhang	0.06								
Southwest region	10.02	2.20	21.96	1.56	70.91	0.04	1.82	0.60	27.27
Shaanxi	2.58	0.89	34.50	0.74	83.15	0.07	7.87	0.08	8.99
Gansu	2.05	1.05	51.22	0.56	53.33	0.49	46.67		
Qinghai	0.28	0.01	3.57	0.01	100.00				
Xinjiang	1.10	0.02	1.82	0.02	100.00				
Ningxia	0.30	0.05	16.67	0.03	60.00	0.01	20.00	0.01	20.00
Northwest region	6.31	2.02	32.01	1.36	67.33	0.57	28.22	0.09	4.46
Total	95.18	25.00	26.27	16.78	67.12	5.32	21.28	2.90	11.60

Table B.44: IRON & STEEL PRODUCTS - PRODUCTION & RAIL FREIGHT DESTINATION (1982)

PROVINCE	PRODUCTION mil.tons	RAIL LOADINGS mil.tons	RAIL LOADINGS % of (1)	DESTINATION: PROVINCE mil.tons	DESTINATION: PROVINCE % of (2)	DESTINATION: REGION mil.tons	DESTINATION: REGION % of (2)	DESTINATION: OTHER mil.tons	DESTINATION: OTHER % of (2)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Heilongjiang	0.62	1.46	235.48	0.70	47.95	0.54	36.99	0.22	15.07
Jilin	0.64	1.43	223.44	0.54	37.76	0.60	41.96	0.29	20.28
Liaoning	15.63	13.34	85.35	7.01	52.55	2.32	17.39	4.01	30.06
Northeast region	16.89	16.23	96.09	8.25	50.83	3.46	21.32	4.52	27.85
Beijing	4.51	4.18	92.68	1.44	34.45	1.54	36.84		
Tianjin	1.90	2.78	146.32	0.65	23.38	1.09	39.21		
Nei Monggol	1.92	1.71	89.06	0.31	18.13	0.61	35.67	0.79	46.20
Hebei	3.59	4.79	133.43	1.69	35.28	1.54	32.15	1.56	32.57
Shanxi	2.44	2.17	88.93	0.60	27.65	0.67	30.88	0.90	41.47
Northern region	14.36	15.63	108.84	4.69	30.01	5.45	34.87	5.49	35.12
Shanghai	5.91	2.30	38.92	0.03	1.30	1.24	53.91		
Jiangsu	1.79	2.05	114.53	0.53	25.85	1.00	48.78	0.52	25.37
Shandong	1.97	2.08	105.58	1.52	73.08	0.40	19.23	0.16	7.69
Anhui	3.11	1.90	61.09	0.37	19.47	1.20	63.16	0.33	17.37
Zhejiang	0.83	0.67	80.72	0.34	50.75	0.25	37.31	0.08	11.94
Jiangxi	0.75	0.97	129.33	0.38	39.18	0.33	34.02	0.26	26.80
Fujian	0.51	0.40	78.43	0.29	72.50	0.09	22.50		
Eastern region	14.87	10.37	69.74	3.46	33.37	4.51	43.49	2.40	23.14
Henan	1.41	2.11	149.65	0.91	43.13	0.28	13.27	0.92	43.60
Hubei	6.40	4.87	76.09	2.48	50.92	0.89	18.28	1.50	30.80
Hunan	1.72	1.62	94.19	0.98	60.49	0.37	22.84	0.27	16.67
Guangdong	0.92	0.80	86.96	0.34	42.50	0.29	36.25	0.17	21.25
Guangxi	0.46	0.52	113.04	0.31	59.62	0.13	25.00	0.08	15.38
South central	10.91	9.92	90.93	5.02	50.60	1.96	19.76	2.94	29.64
Sichuan	4.91	3.72	75.76	2.11	56.72	0.31	8.33	1.30	34.95
Guizhou	0.53	0.65	122.64	0.11	16.92	0.30	46.15	0.24	36.92
Yunnan	0.90	0.42	46.67	0.19	45.24	0.08	19.05	0.15	35.71
Xizhang	0.00								
Southwest region	6.34	4.79	75.55	2.41	50.31	0.69	14.41	1.69	35.28
Shaanxi	0.22	0.66	300.00	0.14	21.21	0.08	12.12	0.44	66.67
Gansu	0.48	0.79	164.58	0.25	31.65	0.16	20.25	0.38	48.10
Qinghai	0.15	0.14	93.33	0.01	7.14	0.07	50.00		
Xinjiang	0.25	0.09	36.00	0.05	55.56	0.01	11.11		
Ningxia	0.06	0.14	233.33	0.02	14.29	0.05	35.71	0.07	50.00
Northwest region	1.16	1.82	156.90	0.47	25.82	0.37	20.33	0.98	53.85
Total	64.53	58.76	91.06	24.30	41.35	16.44	27.98	18.02	30.67

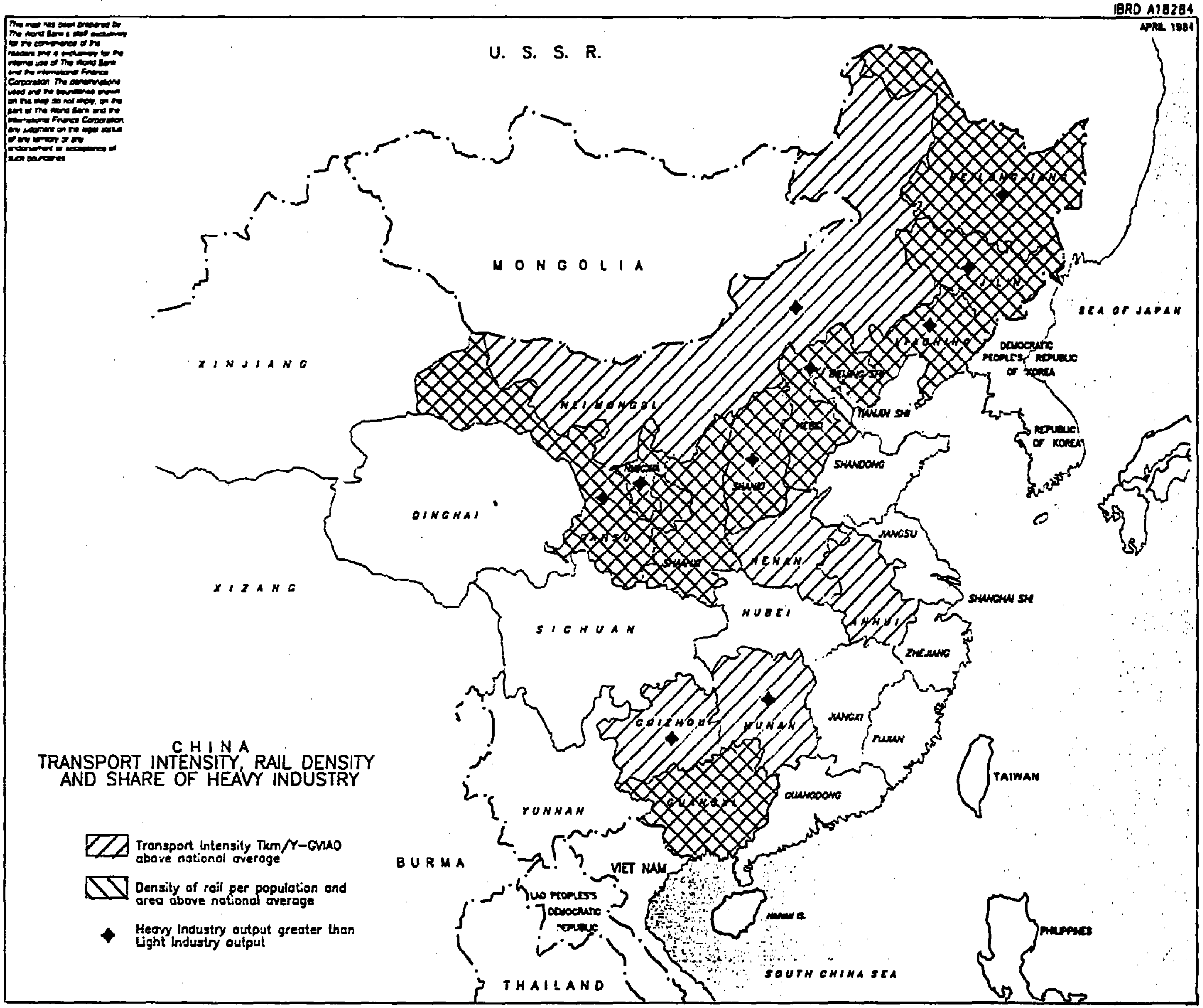
Table B.45: GRAIN - PRODUCTION & RAIL FREIGHT DESTINATION (1982)

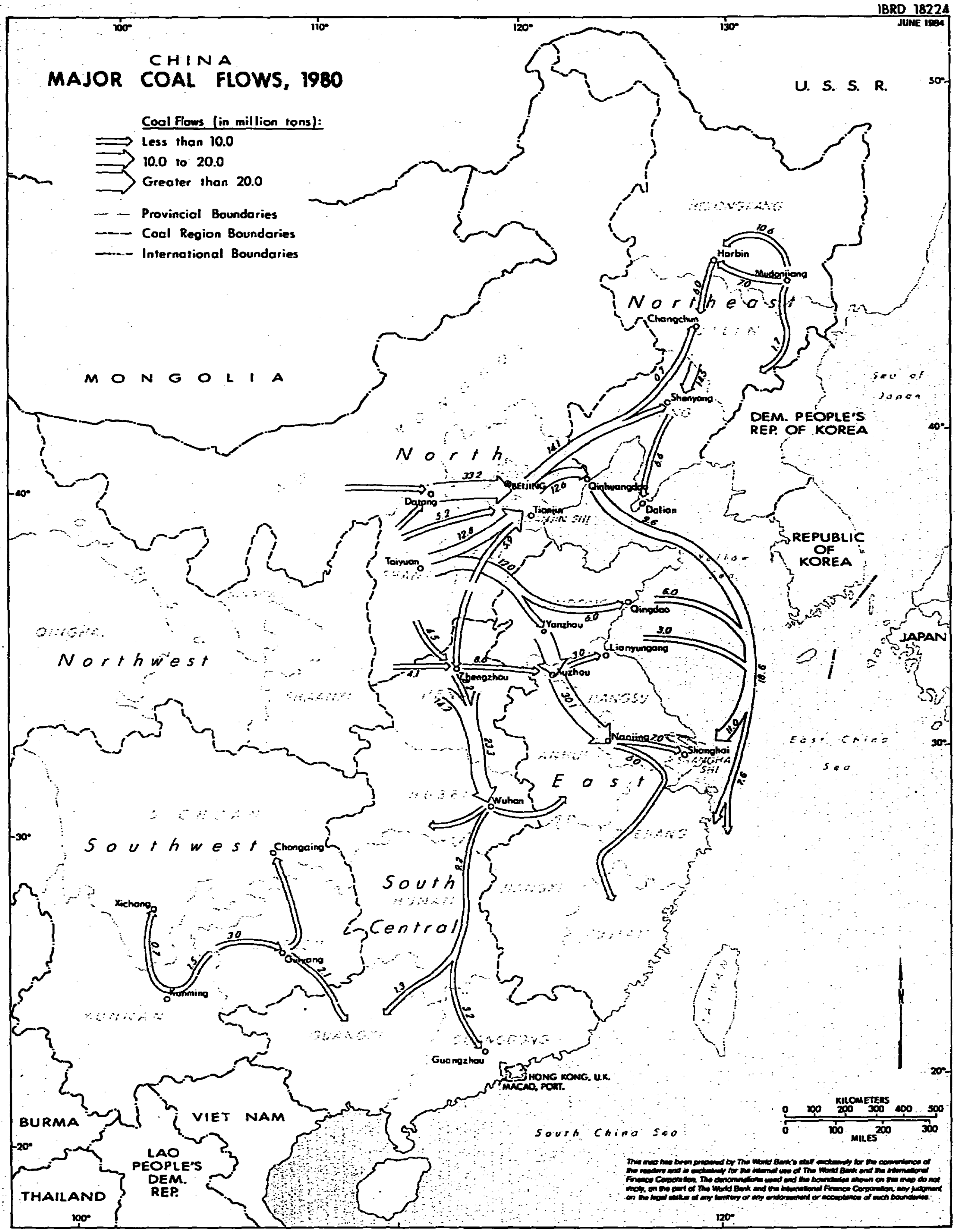
PROVINCE	PRODUCTION	RAIL LOADINGS		DESTINATION: PROVINCE		DESTINATION: REGION		DESTINATION: OTHER	
	mil.tons	mil.tons	% of (1)	mil.tons	% of (2)	mil.tons	% of (2)	mil.tons	% of (2)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Heilongjiang	11.50	3.35	29.13	2.94	87.76	0.22	6.57	0.19	5.67
Jilin	10.00	2.89	28.90	1.47	50.87	0.33	11.42	1.09	37.72
Liaoning	11.52	6.27	54.43	3.92	62.52	1.99	31.74	0.36	5.74
Northeast region	33.02	12.51	37.89	8.33	66.59	2.54	20.30	1.64	13.11
Beijing	1.86	0.16	8.60	0.10	62.50	0.04	25.00	0.02	12.50
Tianjin	1.23	2.62	213.01	1.01	38.55	1.59	60.69	0.02	0.76
Nei Monggol	5.30	0.68	12.83	0.48	70.59	0.09	13.24	0.11	16.18
Hebei	17.52	2.83	16.15	1.09	38.52	0.49	17.31	1.25	44.17
Shanxi	8.25	0.64	7.76	0.34	53.13	0.08	12.50	0.22	34.38
Northern region	34.16	6.93	20.29	3.02	43.58	2.29	33.04	1.62	23.38
Shanghai	2.16	0.62	28.70	0.00	0.00	0.35	56.45	0.27	43.55
Jiangsu	23.56	1.89	6.62	0.31	16.40	0.30	15.87	1.28	67.72
Shandong	23.75	1.72	7.24	1.10	63.95	0.02	1.16	0.60	34.88
Anhui	19.33	1.47	7.60	0.52	35.37	0.49	33.33	0.46	31.29
Zhejiang	17.13	0.37	2.16	0.24	64.86	0.05	13.51	0.08	21.62
Jiangxi	14.09	1.00	7.10	0.22	22.00	0.60	60.00	0.18	18.00
Fujian	8.48	0.59	6.96	0.59	100.00	0.00	0.00		
Eastern region	113.50	7.66	6.75	2.93	38.90	1.81	23.63	2.87	37.47
Henan	22.17	1.66	7.49	0.95	57.23	0.25	15.06	0.46	27.71
Hubei	19.96	1.01	5.06	0.43	42.57	0.26	25.74	0.32	31.68
Hunan	23.75	1.60	6.74	0.38	23.75	0.38	23.75	0.84	52.50
Guangdong	19.43	0.96	4.94	0.14	14.58	0.40	41.67	0.42	43.75
Guangxi	13.53	0.39	2.88	0.32	82.05	0.05	12.82	0.02	5.13
South central	98.84	5.62	5.69	2.22	39.50	1.34	23.84	2.06	36.65
Sichuan	37.35	0.83	2.22	0.63	75.90	0.09	10.84	0.11	13.25
Guizhou	6.54	0.05	0.76	0.03	60.00	0.01	20.00	0.01	20.00
Yunnan	9.46	0.18	1.90	0.15	83.33	0.00	0.00	0.03	16.67
Xizang	0.45								
Southwest region	53.80	1.06	1.97	0.81	76.42	0.10	9.43	0.15	14.15
Shaanxi	9.25	0.27	2.92	0.23	85.19	0.01	3.70	0.03	11.11
Gansu	4.69	0.39	8.32	0.34	87.18	0.00	0.00	0.05	12.82
Qinghai	0.93	0.03	3.23	0.02	66.67	0.00	0.00	0.01	33.33
Xinjiang	4.08	0.04	0.98	0.02	50.00	0.01	25.00	0.01	25.00
Ningxia	1.20	0.14	11.67	0.05	35.71	0.05	35.71	0.04	28.57
Northwest region	20.15	0.87	4.32	0.66	75.86	0.07	8.05	0.14	16.09
Total	353.47	34.65	9.80	18.02	52.01	8.15	23.52	8.48	24.47

6/13/84

Table B.46: FERTILIZER -- RAIL FREIGHT DESTINATION (1982)

PROVINCE	PRODUCTION mil.tons (1)	RAIL LOADINGS mil.tons (2)	RAIL LOADINGS % of (1) (3)	DESTINATION: PROVINCE mil.tons (4)	DESTINATION: PROVINCE % of (2) (5)	DESTINATION: REGION mil.tons (6)	DESTINATION: REGION % of (2) (7)	DESTINATION: OTHER mil.tons (8)	DESTINATION: OTHER % of (2) (9)
Heilongjiang		0.91		0.57	62.64	0.05	5.49	0.29	31.87
Jilin		1.05		0.73	69.52	0.06	5.71	0.26	24.76
Liaoning		2.40		1.23	51.25	0.64	26.67	0.53	22.08
Northeast region		4.36		2.53	58.03	0.75	17.20	1.08	24.77
Beijing		0.28		0.14	50.00	0.04	14.29	0.10	35.71
Tianjin		0.79		0.07	8.86	0.24	30.38	0.48	60.76
Nei Monggol		0.36		0.10	27.78	0.07	19.44	0.19	52.78
Hebei		1.81		0.52	28.73	0.13	7.18	1.16	64.09
Shanxi		1.49		0.30	20.13	0.05	3.35	1.14	76.51
Northern region		4.73		1.13	23.89	0.53	11.21	3.07	64.90
Shanghai		0.59		0.00	0.00	0.53	89.83	0.06	10.17
Jiangsu		1.02		0.27	26.47	0.23	22.55	0.52	50.98
Shandong		1.52		1.25	82.24	0.20	13.16	0.07	4.61
Anhui		1.00		0.96	96.00	0.02	2.00	0.02	2.00
Zhejiang		0.67		0.57	85.07	0.06	8.96	0.04	5.97
Jiangxi		0.69		0.51	73.91	0.13	18.84	0.05	7.25
Fujian		0.67		0.57	85.07	0.10	14.93		
Eastern region		6.16		4.13	67.05	1.27	20.62	0.76	12.34
Henan		1.07		0.77	71.96	0.22	20.56	0.08	7.48
Hubei		0.91		0.31	34.07	0.25	27.47	0.35	38.46
Hunan		1.51		0.79	52.32	0.42	27.81	0.30	19.87
Guangdong		1.22		0.23	18.85	0.82	67.21	0.17	13.93
Guangxi		0.33		0.29	87.88	0.02	6.06	0.02	6.06
South central		5.04		2.39	47.42	1.73	34.33	0.92	18.25
Sichuan		2.47		1.19	48.18	0.39	15.79	0.89	36.03
Guizhou		0.18		0.10	55.56	0.00	0.00	0.08	44.44
Yunnan		0.67		0.30	44.78	0.04	5.97	0.33	49.25
Xizang									
Southwest region		3.32		1.59	47.89	0.43	12.95	1.30	39.16
Shaanxi		0.55		0.44	80.00	0.00	0.00	0.11	20.00
Gansu		0.68		0.42	61.76	0.16	23.53	0.10	14.71
Qinghai		0.08		0.00	0.00	0.03	37.50	0.05	62.50
Xinjiang		0.01		0.01	100.00	0.00	0.00	0.00	0.00
Ningxia		0.08		0.03	37.50	0.03	37.50	0.02	25.00
Northwest region		1.40		0.90	64.29	0.22	15.71	0.28	20.00
Total		25.01		12.67	50.66	4.93	19.71	7.41	29.63


IBRD A18284
APRIL 1984
U. S. S. R.
MONGOLIA
XINJIANG
XIZANG
QINGHAI
NEI MONGOL
HEILONGJIANG
JILIN
LIAONING
BEIJING SHI
TIANJIN SHI
HEBEI
SHANXI
NINGXIA
GANSU
SHAANXI
SHANDONG
HENAN
JIANGSU
SHANGHAI SHI
ANHUI
HUBEI
SICHUAN
ZHEJIANG
GUIZHOU
HUNAN
JIANGXI
FUJIAN
GUANGXI
GUANGDONG
YUNNAN
TAIWAN
SEA OF JAPAN
DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA
REPUBLIC OF KOREA
BURMA
VIET NAM
LAO PEOPLE'S DEMOCRATIC REPUBLIC
THAILAND
HAINAN IS.
SOUTH CHINA SEA
PHILIPPINES
CHINA
TRANSPORT INTENSITY, RAIL DENSITY AND SHARE OF HEAVY INDUSTRY
Transport Intensity Tkm/Y-GVIAO above national average
Density of rail per population and area above national average
Heavy Industry output greater than Light Industry output


IBRD 18224
JUNE 1984
CHINA
MAJOR COAL FLOWS, 1980
Coal Flows (in million tons):
Less than 10.0
10.0 to 20.0
Greater than 20.0
Provincial Boundaries
Coal Region Boundaries
International Boundaries
U. S. S. R.
MONGOLIA
DEM. PEOPLE'S REP. OF KOREA
REPUBLIC OF KOREA
JAPAN
Sea of Japan
East China Sea
South China Sea
BURMA
VIET NAM
LAO PEOPLE'S DEM. REP.
THAILAND
HONG KONG, U.K.
MACAO, PORT.
Northeast
North
Northwest
Southwest
East
South Central
Harbin
Mudanjiang
Changchun
Shenyang
Dalian
BEIJING
Tianjin
Qinhuangdao
Datong
Taiyuan
Qingdao
Yanzhou
Lianyungang
Zhengzhou
Xuzhou
Nanjing
Shanghai
Wuhan
Chongqing
Xichang
Guiyang
Kunming
Guangzhou
KILOMETERS
0 100 200 300 400 500
0 100 200 300
MILES
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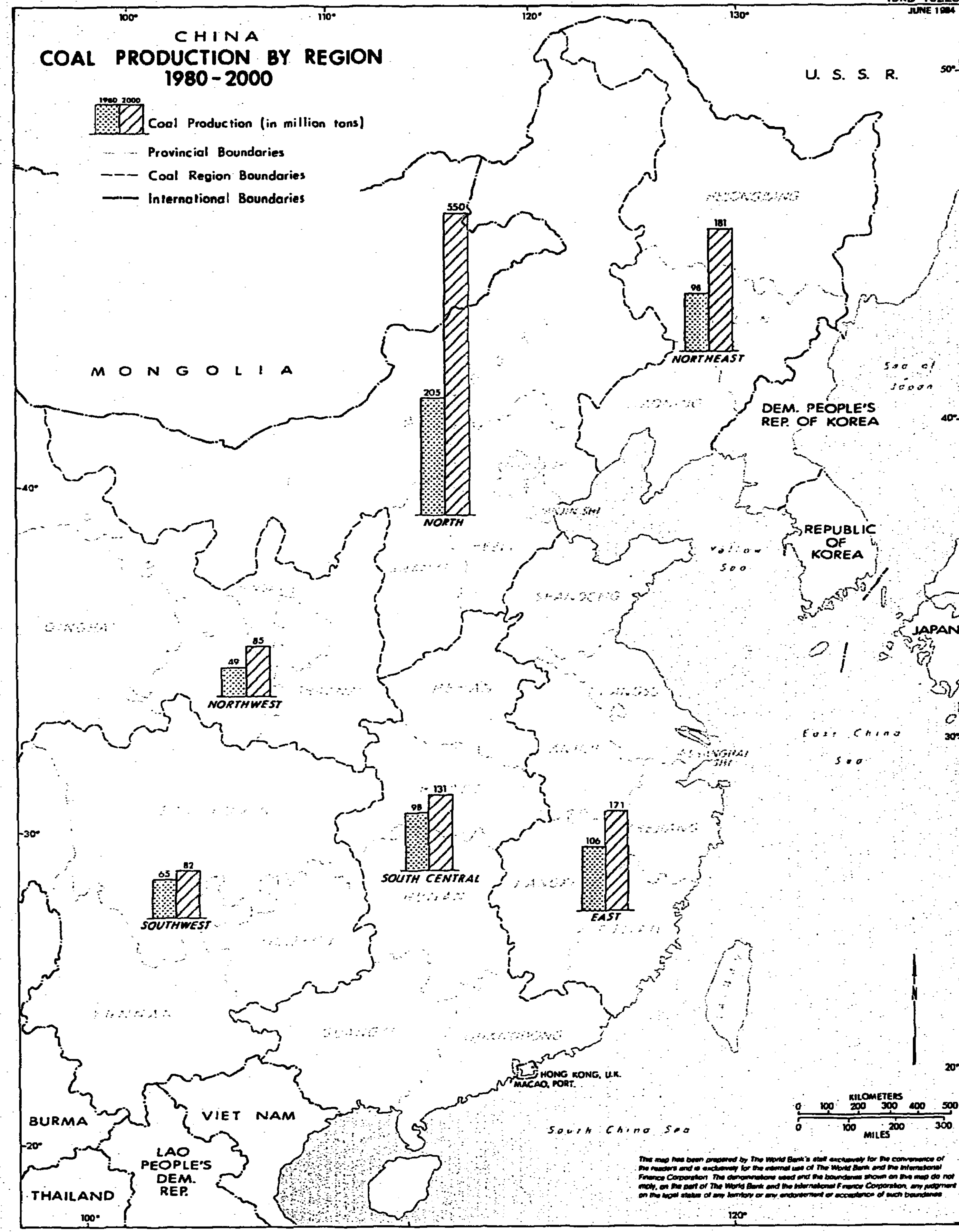
IBRD 18225



JUNE 1984
CHINA
COAL PRODUCTION BY REGION
1980 - 2000
1980 2000
Coal Production (in million tons)
Provincial Boundaries
Coal Region Boundaries
International Boundaries
U. S. S. R.
MONGOLIA
550
205
NORTH
181
98
NORTHEAST
85
49
NORTHWEST
131
98
SOUTH CENTRAL
171
106
EAST
82
65
SOUTHWEST
DEM. PEOPLE'S REP. OF KOREA
REPUBLIC OF KOREA
JAPAN
Sea of Japan
Yellow Sea
East China Sea
South China Sea
HONG KONG, U.K.
MACAO, PORT.
BURMA
VIET NAM
LAO PEOPLE'S DEM. REP.
THAILAND
KILOMETERS
0 100 200 300 400 500
0 100 200 300
MILES
100°
110°
120°
130°
50°
40°
30°
20°
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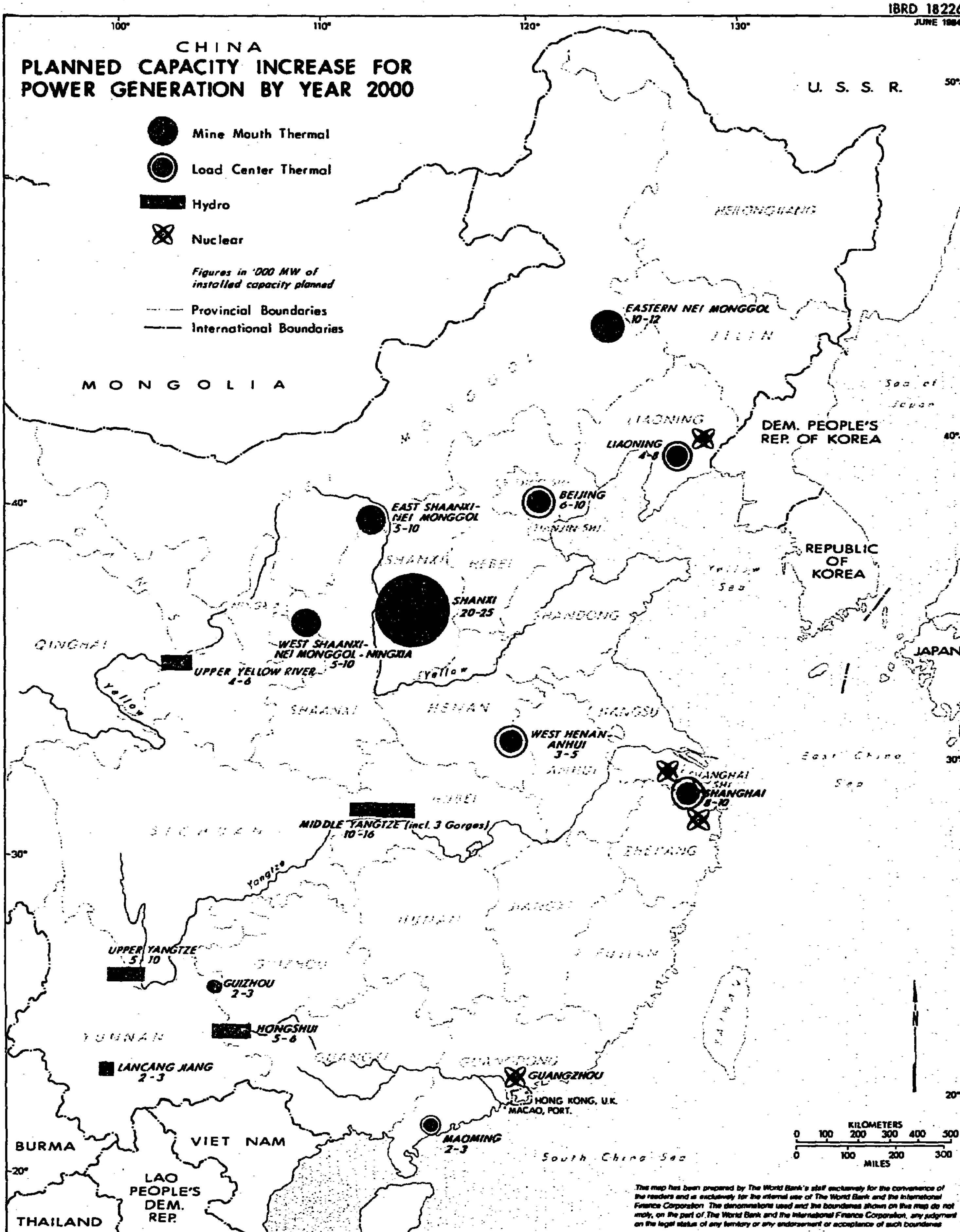
IBRD 18226


JUNE 1984
CHINA
PLANNED CAPACITY INCREASE FOR POWER GENERATION BY YEAR 2000
Mine Mouth Thermal
Load Center Thermal
Hydro
Nuclear
Figures in '000 MW of installed capacity planned
Provincial Boundaries
International Boundaries
U. S. S. R.
MONGOLIA
HEILONGJIANG
JILIN
LIAONING
DEM. PEOPLE'S REP. OF KOREA
REPUBLIC OF KOREA
JAPAN
EASTERN NEI MONGGOL 10-12
LIAONING 4-8
BEIJING 6-10
EAST SHAANXI-NEI MONGGOL 5-10
SHANXI 20-25
WEST SHAANXI-NEI MONGGOL - NINGXIA 5-10
UPPER YELLOW RIVER 4-6
QINGHAI
SHANXI
HEBEI
SHANDONG
SHAANXI
HENAN
JIANGSU
WEST HENAN-ANHUI 3-5
ANHUI
SHANGHAI 6-10
HUBEI
MIDDLE YANGTZE (incl. 3 Gorges) 10-16
SICHUAN
ZHEJIANG
HUNAN
JIANGXI
FUJIAN
Yangtze
Yellow
UPPER YANGTZE 5-10
GUIZHOU 2-3
HONGSHUI 5-6
YUNNAN
LANCANG JIANG 2-3
GUANGXI
GUANGDONG
GUANGZHOU
HONG KONG, U.K.
MACAO, PORT.
MAOMING 2-3
BURMA
VIET NAM
LAO PEOPLE'S DEM. REP.
THAILAND
South China Sea
KILOMETERS
MILES
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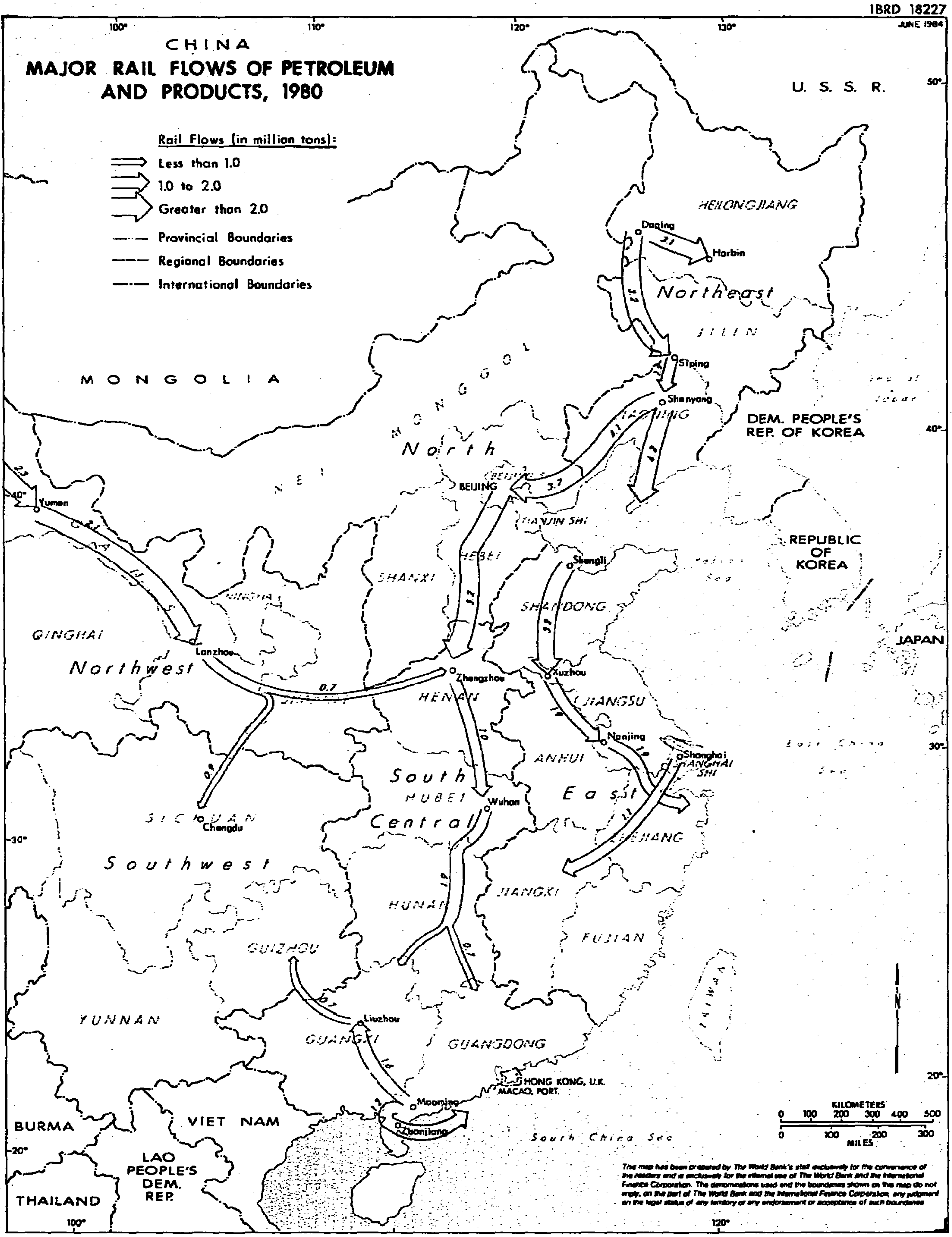
IBRD 18227


JUNE 1984
CHINA
MAJOR RAIL FLOWS OF PETROLEUM AND PRODUCTS, 1980
Rail Flows (in million tons):
Less than 1.0
1.0 to 2.0
Greater than 2.0
Provincial Boundaries
Regional Boundaries
International Boundaries
U. S. S. R.
MONGOLIA
DEM. PEOPLE'S REP. OF KOREA
REPUBLIC OF KOREA
JAPAN
BURMA
VIET NAM
LAO PEOPLE'S DEM. REP.
THAILAND
HONG KONG, U.K.
MACAO, PORT.
South China Sea
East China Sea
HEILONGJIANG
JILIN
NEI MONGGOL
SHANXI
HEBEI
TIANJIN SHI
SHANDONG
JIANGSU
ANHUI
SHANGHAI SHI
HENAN
HUBEI
HUNAN
JIANGXI
ZHEJIANG
FUJIAN
TAIWAN
GUANGDONG
GUANGXI
GUIZHOU
YUNNAN
SICHUAN
QINGHAI
NINGXIA
Northeast
North
Northwest
South Central
East
Southwest
Daqing
Harbin
Siping
Shenyang
Beijing
Shengli
Xuzhou
Nanjing
Shanghai
Yumen
Lanzhou
Zhengzhou
Wuhan
Chengdu
Liuzhou
Maoming
Zhanjiang
3.7
0.7
KILOMETERS
0 100 200 300 400 500
0 100 200 300
MILES
100°
110°
120°
130°
50°
40°
30°
20°
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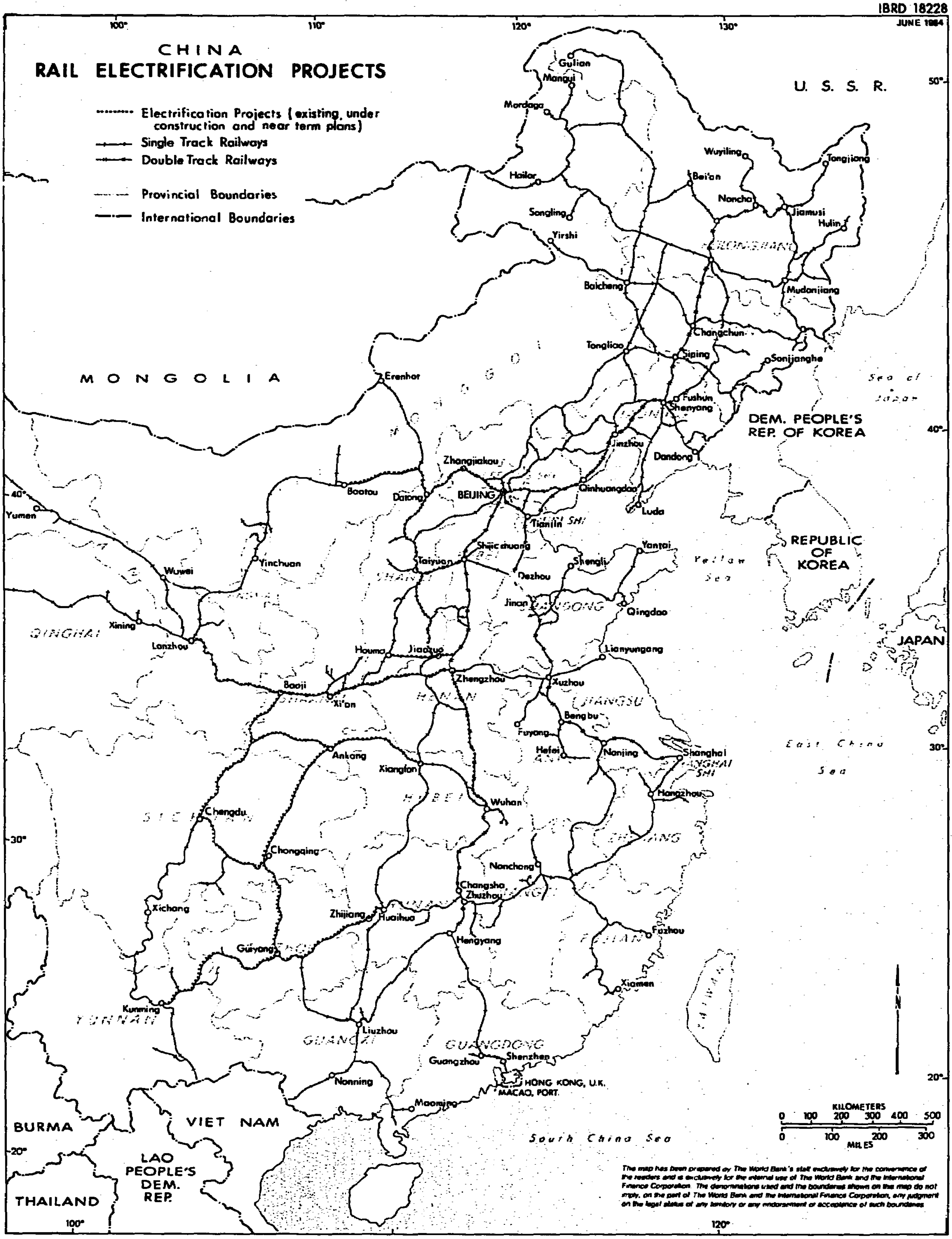
IBRD 18228


JUNE 1984
CHINA
RAIL ELECTRIFICATION PROJECTS
Electrification Projects (existing, under construction and near term plans)
Single Track Railways
Double Track Railways
Provincial Boundaries
International Boundaries
U. S. S. R.
MONGOLIA
DEM. PEOPLE'S REP. OF KOREA
REPUBLIC OF KOREA
JAPAN
BURMA
VIET NAM
LAO PEOPLE'S DEM. REP.
THAILAND
HONG KONG, U.K.
MACAO, PORT.
Sea of Japan
Yellow Sea
East China Sea
South China Sea
QINGHAI
YUNNAN
GUANGXI
GUANGDONG
HEILONGJIANG
TIANJIN SHI
SHANDONG
JIANGSU
SHANGHAI SHI
HUBEI
Gulian
Mangui
Mordaga
Hailar
Songling
Yirshi
Wuyiling
Tongjiang
Bei'an
Nancha
Jiamusi
Hulin
Baicheng
Mudanjiang
Changchun
Tongliao
Siping
Sanjianghe
Erenhot
Fushun
Shenyang
Jinzhou
Dandong
Zhangjiakou
Baotou
Datong
BEIJING
Qinhuangdao
Luda
Tianjin
Yumen
Yinchuan
Wuwei
Taiyuan
Shijiazhuang
Dezhou
Shengli
Yantai
Xining
Lanzhou
Jinan
Qingdao
Houma
Jiaozuo
Lianyungang
Baoji
Xi'an
Zhengzhou
Xuzhou
Bengbu
Fuyang
Hefei
Nanjing
Shanghai
Ankang
Xiangfan
Hangzhou
Chengdu
Wuhan
Chongqing
Nanchang
Changsha
Zhuzhou
Xichang
Zhijiang
Huaihua
Hengyang
Fuzhou
Guiyang
Xiamen
Kunming
Liuzhou
Guangzhou
Shenzhen
Nanning
Maoming
KILOMETERS
0 100 200 300 400 500
0 100 200 300
MILES
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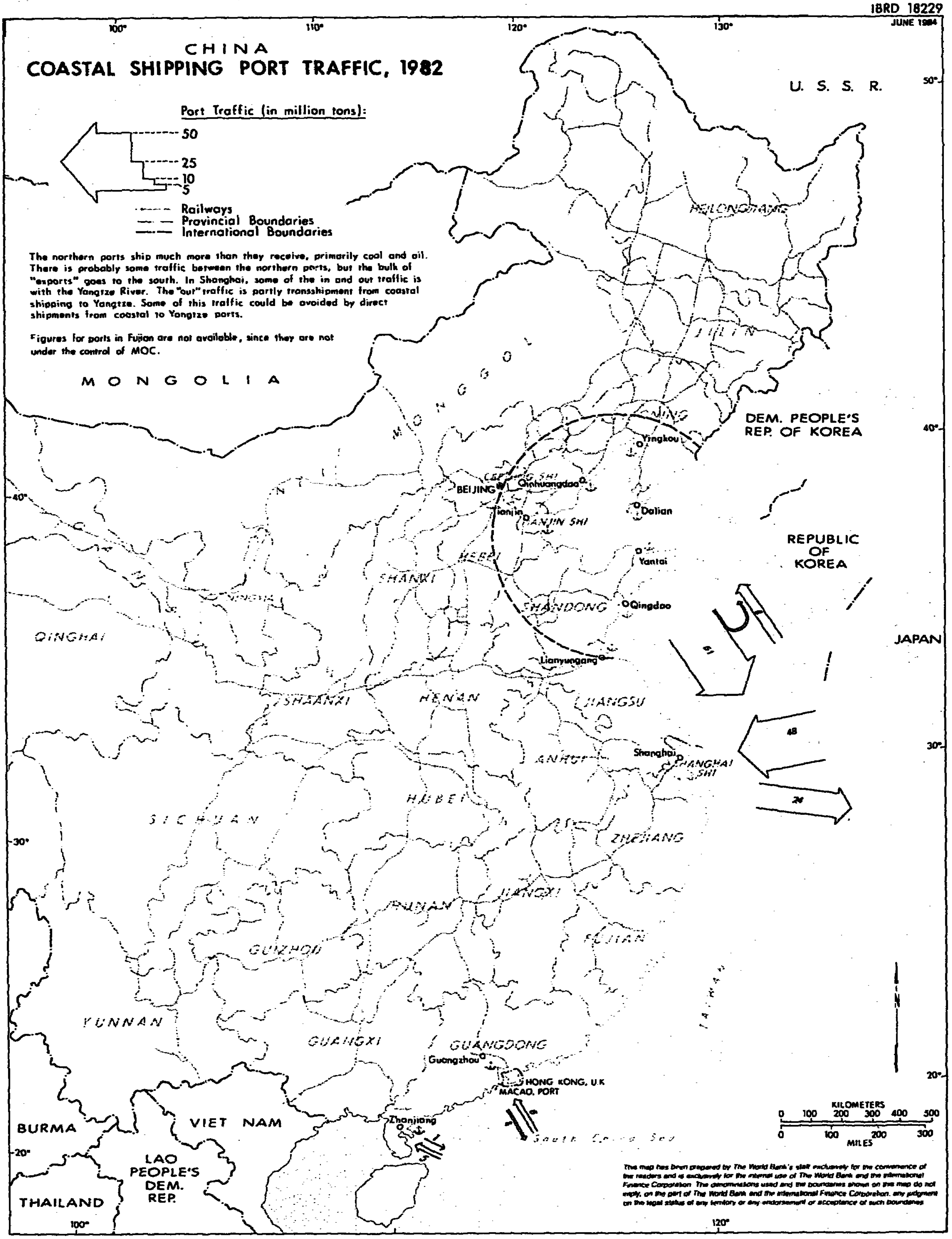
100°
110°
120°
130°
50°
40°
30°
20°

IBRD 18229


JUNE 1984
CHINA
COASTAL SHIPPING PORT TRAFFIC, 1982
Port Traffic (in million tons):
50
25
10
5
Railways
Provincial Boundaries
International Boundaries
The northern ports ship much more than they receive, primarily coal and oil. There is probably some traffic between the northern ports, but the bulk of "exports" goes to the south. In Shanghai, some of the in and out traffic is with the Yangtze River. The "out" traffic is partly transshipment from coastal shipping to Yangtze. Some of this traffic could be avoided by direct shipments from coastal to Yangtze ports.
Figures for ports in Fujian are not available, since they are not under the control of MOC.
U. S. S. R.
MONGOLIA
HEILONGJIANG
JILIN
DEM. PEOPLE'S REP. OF KOREA
REPUBLIC OF KOREA
JAPAN
Yingkou
BEIJING
Qinhuangdao
Dalian
Tianjin
TIANJIN SHI
Yantai
HEBEI
SHANXI
SHANDONG
Qingdao
QINGHAI
Lianyungang
SHAANXI
HENAN
JIANGSU
ANHUI
Shanghai
SHANGHAI SHI
48
24
HUBEI
SICHUAN
ZHEJIANG
JIANGXI
HUNAN
GUIZHOU
FUJIAN
YUNNAN
GUANGXI
GUANGDONG
Guangzhou
HONG KONG, U.K.
MACAO, PORT
Zhanjiang
BURMA
VIET NAM
LAO PEOPLE'S DEM. REP.
THAILAND
KILOMETERS
0 100 200 300 400 500
0 100 200 300
MILES
100°
110°
120°
130°
50°
40°
30°
20°
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