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Meyers, S.

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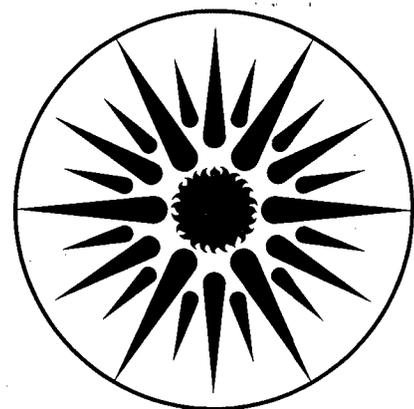
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**Transportation in the LDCs:
A Major Area of Growth in World Oil Demand**

S. Meyers

March 1988



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**TRANSPORTATION IN THE LDCs:
A MAJOR AREA OF GROWTH IN WORLD OIL DEMAND**

Stephen Meyers

International Energy Studies Group

Applied Science Division

Lawrence Berkeley Laboratory

University of California

Berkeley, CA 94720

March 1988

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TRANSPORTATION IS THE BIGGEST AREA OF GROWTH IN LDC OIL USE

Growth in oil use in the LDCs (including OPEC and China) has been the most important source of increase in world oil consumption since the first oil price shock in 1973. While OECD oil consumption in 1986 was 13% below its 1973 level, LDC oil use in 1986 was 60% greater than in 1973. As a result, the LDC share of world oil consumption grew from 14% in 1970 to 23% in 1986. In 1986, LDC oil demand grew to about 14 million barrels per day after having been relatively stagnant for two years. This amount was more than Western Europe and nearly as much as North America. Between 1976 and 1986, the LDCs accounted for nearly all of the growth in Non-Communist World gasoline consumption.

Many LDCs have been successful in substituting coal, natural gas, and other energy sources for oil in industry and electricity generation. With the exception of Brazil's ethanol program, which has substantially reduced gasoline use, there has been little substitution in the transportation sector. As a result, it has been the largest source of growth in LDC oil use since the mid-1970s. For 15 major LDCs -- Argentina, Brazil, Chile, Colombia, India, Indonesia, South Korea, Malaysia, Mexico, Pakistan, Philippines, Taiwan, Thailand, and Venezuela -- transportation accounted for half of the total increase in oil use between 1970 and 1984.¹

Combined oil use in transportation for the 15 LDCs increased at an average rate of 5.8% per year between 1970 and 1985 (and would have been about 6% if not for Brazil's ethanol program). GDP growth averaged

¹ Most of the country-level energy consumption data are from the LBL Developing Country Energy Data Series. Data for Chile and Colombia are from OLADE.

4.9% per year. In the OECD in the same period, oil use in transportation grew at an average rate of 2.2% per year, slightly less than GDP growth. Very high growth occurred in some LDCs. In a few countries -- Nigeria, South Korea, and Taiwan -- the annual increase averaged over 10%.

Growth in oil demand in the 15 LDCs through 1982, which was supported by the economic boom in the oil-exporting countries, averaged 7.1%. In the 1982-85 period, however, average growth was only 0.7% per year. This reflects the effect of lower economic activity and higher fuel prices. Oil use resumed growth in 1985 and 1986 following a period of stagnation in 1983 and 1984.

Oil-exporting countries accounted for much of the total growth between 1970 and 1985. Increase in oil use was substantial after 1975 in Mexico, Venezuela, Indonesia, and Nigeria, as well as in Saudi Arabia. Next to Mexico, Brazil is the largest consumer of oil in transportation. Transport oil use in Brazil would have been 25% higher had it not been for displacement of nearly 6 million TOE of gasoline by locally-produced ethanol.

The growth in LDC transportation oil demand reflects the fact that population growth, industrialization, and modernization result in more people and goods in transit. The greater degrees of national and regional integration and specialization of economic production that generally come with the development process add to transportation needs, and also increase the distance that people and goods travel. Thus, at least until a country reaches a rather mature stage of development, economic growth tends to be accompanied by a more-than-proportional growth in the physical amount of transportation demand.

As development proceeds, the growing demand for more efficient transportation is increasingly met by modern motorized forms of transport. These forms not only increase the speed of travel (and thus allow greater distances to be covered); they also allow more weight (people or goods) to be carried. Although the traditional human and animal-powered means of transport are still quite important in rural and some urban areas of LDCs, their share of overall passenger and freight transportation has been giving way to oil-powered transport modes.

Road Transportation is the Main Area of Growth

Most of the oil use in LDC transportation, and most of the growth, is in road transportation. In 1984, the estimated share of road transport was over 90% in the majority of the 15 countries. In contrast to the industrialized countries, most LDCs have not developed extensive rail networks, and thus the competition between rail and road for passenger and freight transportation that was (and to some extent still is) so important in the industrial countries has been much less significant in the LDCs. Rail transportation is very significant for passenger transport only in India, and for freight transport in India, China, and Korea. Trains mainly use coal in China, and coal is still heavily used in India.

Combined gasoline use in the 15 LDCs grew at an average rate of 4.1% per year between 1970 and 1985. Excluding Brazil, the average growth was 5.2% a year. Combined diesel fuel use in transportation increased much faster at an average rate of 7.6% per year. The combined effects of higher gasoline prices and slowed economic activity are evident in the decline in gasoline consumption in 1975 and 1983-84. Growth in diesel fuel use was more continuous, in part because consumer prices rose less than was the case for gasoline (many governments

continued to subsidize the diesel fuel price), and in part because there is less discretionary diesel fuel use and it is therefore less price-responsive. The slowing of growth in 1983-84 was related to reduced economic activity.

Absolute growth in gasoline use was greatest in Mexico, Saudi Arabia, Venezuela, and Nigeria, all major oil producers with low domestic gasoline prices. These four countries accounted for three-fourths of the total increase in combined gasoline use for the major LDCs. Extremely high growth occurred in Saudi Arabia (18% per year), Nigeria (16% per year), and Taiwan (14% per year).

The strong growth in the oil-producing countries after 1973 reflects the huge increase in the number of motor vehicles in use. Growth in Mexico alone after 1978 was a major contributor to total growth in LDC gasoline demand. Growth in demand slowed or was negative after 1982 or 1983 in all of these countries except Saudi Arabia (and probably slowed there in 1985). Gasoline use was lower in 1985 than in 1970 in Brazil because of substitution by ethanol.

For diesel fuel, the largest absolute growth was in Brazil, Mexico, and India. The fastest growth was in Taiwan (15% per year) and Nigeria (14% per year), but growth averaged 7% per year or higher for most of the 15 countries. This more consistent growth (relative to gasoline) reflects the fact that most LDCs did not allow the price of diesel to rise as much as that of gasoline. Brazil, Mexico, and India all had strong and steady growth in the 1970s, but growth slowed in Brazil and was negative in Mexico (in part because the growth in 1979-81 was so rapid) in the early 1980s. In Asia, South Korea and Thailand as well as India have experienced considerable growth in demand for diesel fuel.

**Average Annual Growth in Gasoline
and Diesel Consumption, 1970-1985 (%)**

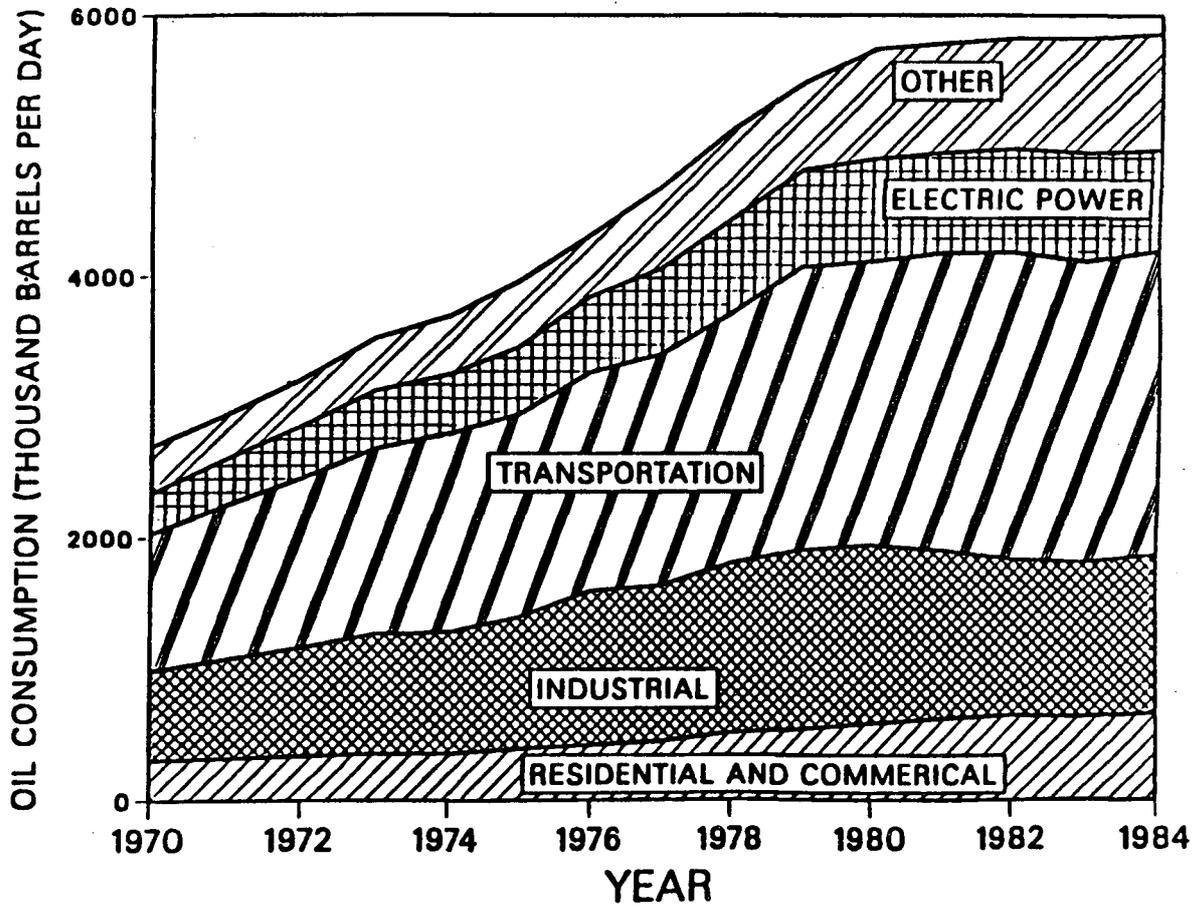
	Gasoline	Diesel
Argentina	1.8	3.7
Brazil	neg.	7.1
Chile	neg.	6.7
Colombia	4.0	11
India	2.6	8.5
Indonesia	7.9	11
Malaysia	9.6	6.4
Mexico	5.9	8.0
Nigeria	16	14
Pakistan	7.0	10
Philippines	neg.	3.3
South Korea	6.2	11
Taiwan	13	15
Thailand	4.1	6.6
Venezuela	6.4	7.4

Jet Fuel Use Has Also Grown Rapidly

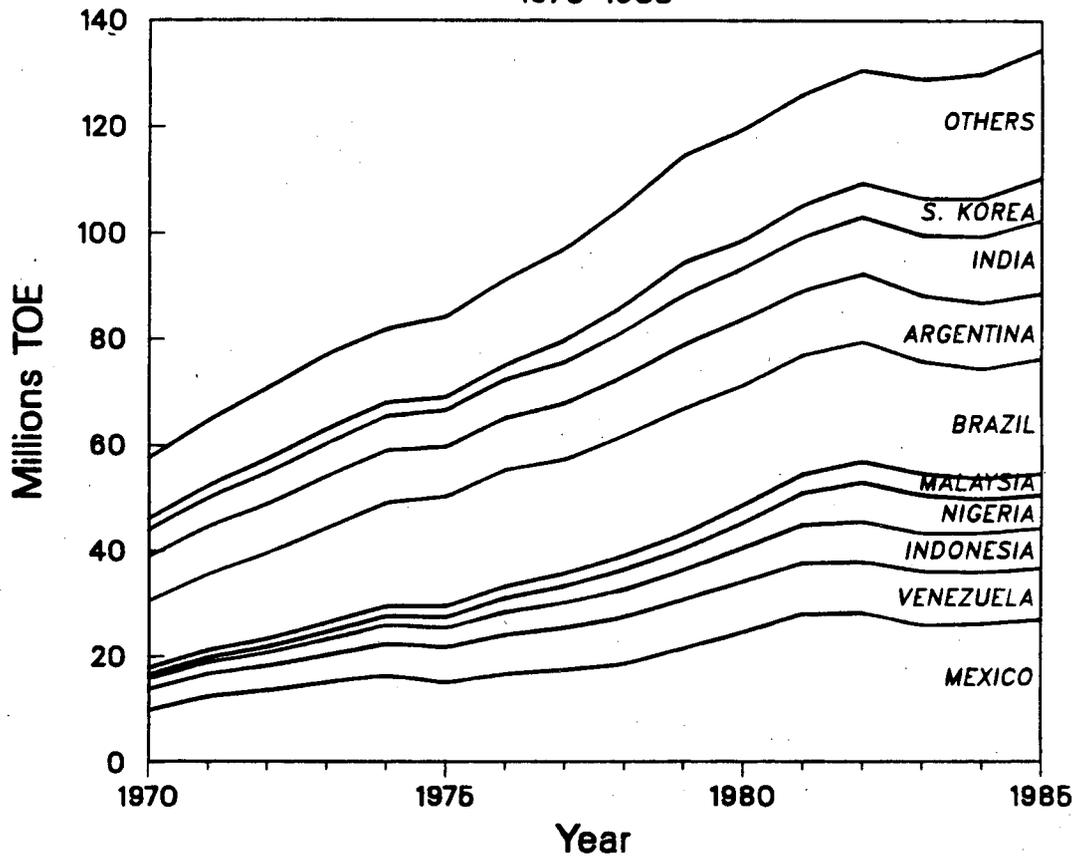
Air transportation has also seen substantial growth in many LDCs, though it is still in a rather early stage of development. Combined jet fuel use in the 15 major LDCs grew at an average rate of 6.2% per year between 1970 and 1985. Growth has been fairly continuous, with some slowing in the 1980s due to economic stagnation, particularly in Latin America. The absolute growth was greatest in Saudi Arabia, Brazil, and Mexico. The fastest growth was in Saudi Arabia (18% per year), Nigeria (12% per year, from a quite low base), and Malaysia (9% per year).

The largest consuming region is Latin America, but the fastest growth has been in Southeast Asia. There was decline in demand in 1984 in the Middle East and Africa, and no recovery thereafter. In Latin America, demand picked up again in 1985 following stagnation in the 1982-84 period.

Oil Consumption by Sector in Major LDCs



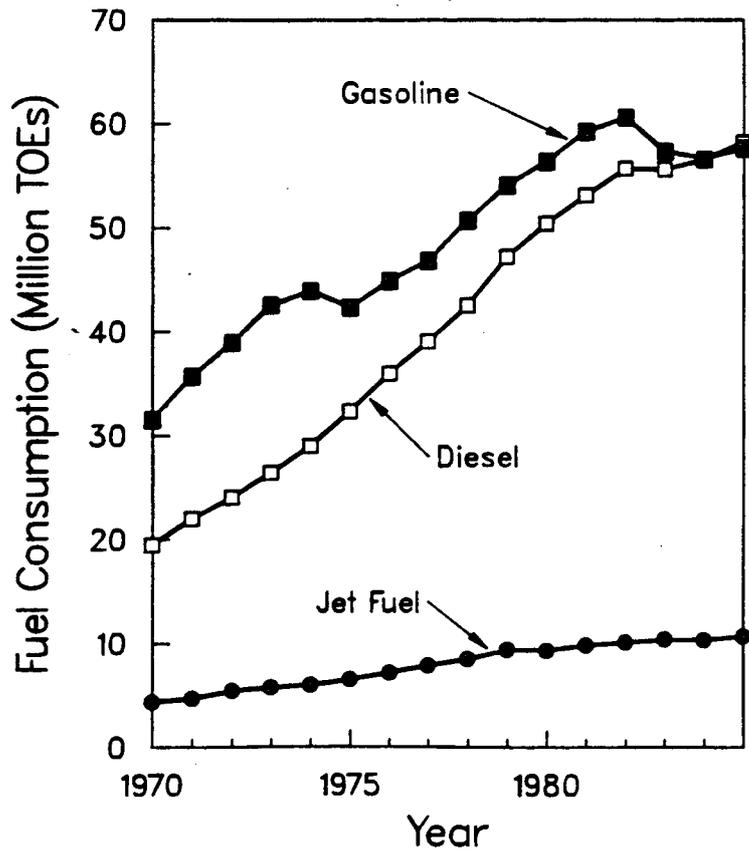
Transportation Oil Use in 15 LDCs 1970-1985



OTHERS = CHILE, COLOMBIA, TAIWAN, THAILAND, PAKISTAN, PHILIPPINES

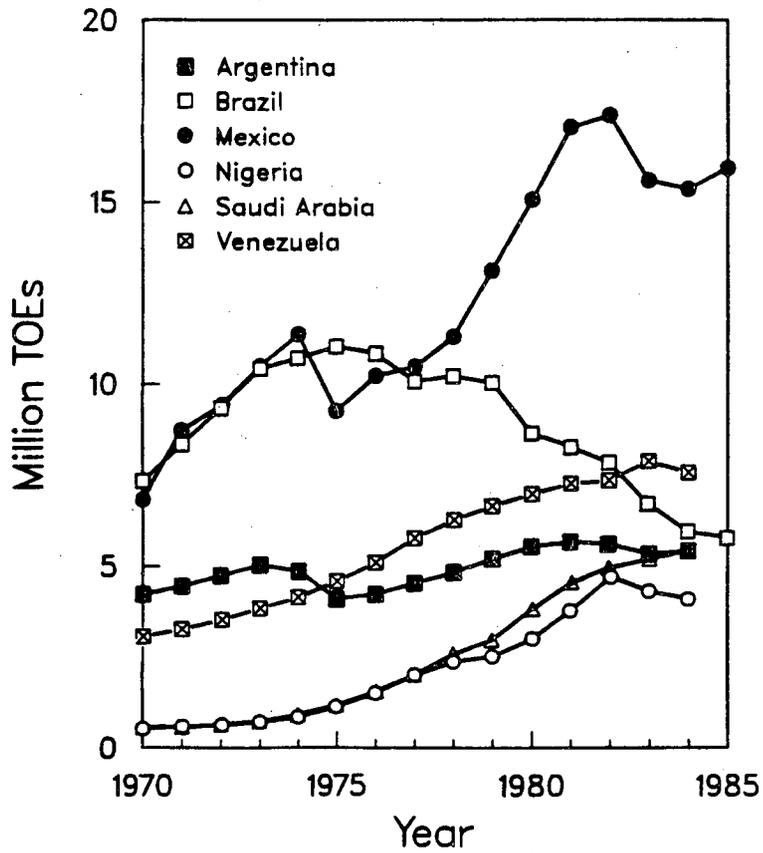
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Transportation Fuel Use in 15 Major LDCs



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Gasoline Use in Six Largest LDC Consumers*



*Excluding China

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GROWTH IN VEHICLE NUMBERS HAS DRIVEN LDC TRANSPORTATION OIL DEMAND

The number of motor vehicles in use in the LDCs is not well-determined, but it is clear that the total has grown rapidly.¹ In most cases, growth has occurred from a low level, so the LDCs still account for a relatively modest share of the world total: around 10% of passenger cars and around 20% of trucks and buses. But as with oil demand, the LDCs are collectively beginning to claim a significant share of the growth at the margin. With relatively low motor vehicle ownership levels in many countries, the potential exists for substantial increase.

The Saturation of Passenger Cars Varies Widely Among the LDCs

Most LDCs have less than 1 car (including taxis) per 100 persons. Only the Middle Eastern high-income oil-exporting countries and Argentina have more than 10 cars per 100 persons. A handful of countries have between 5 and 10 cars per 100 persons: Venezuela, Brazil, Mexico, Malaysia, and Taiwan. In Europe, Greece and Portugal have 12-13 cars per 100 persons, while the wealthier countries have around 30-35 cars per 100 persons. Japan has about 22 cars per 100 persons, while the U.S. has the highest saturation at more than 50 cars per 100 persons.

The LDCs with higher car saturation tend to have higher levels of per capita income, but other factors also play a role. These include taxation on new cars, registration fees and other operating expenses, and the status of domestic car manufacturing.

¹ See "Note on Motor Vehicle Data in LDCs" at the end of this section.

Latin America has historically had much higher car saturation than Asia, though Malaysia and, more recently, Taiwan, are now at a comparable level. The Middle Eastern oil-producers also have relatively high saturation. Car saturation in sub-Saharan Africa is very low (except in South Africa).

Because of the higher car saturation, Latin America has far more passenger cars than Asia, the Middle East, or Africa. Brazil has nearly 10 million cars, followed by Mexico with 4.5 million and Argentina with around 3.2 million. The countries in Asia with the most cars are Malaysia, India, and Taiwan, each with around 1 million. In the Middle East, Saudi Arabia and Iran each have around 1.5 million cars. In Africa, only Nigeria (and South Africa) has over 0.5 million cars.

Growth in Car Saturation Has Been Fastest in the Newly-Industrialized Countries and Some Oil-Exporters

Although the saturation of cars in the LDCs is still quite low relative to the OECD countries, it has been growing considerably in a number of countries. Between 1965 and 1985, car saturation increased five-fold or more in the newly-industrialized countries -- Brazil, Taiwan, South Korea, and Malaysia -- and in oil-exporters such as Saudi Arabia and Nigeria. In Taiwan, South Korea, and Nigeria, saturation was very low in 1965. Despite the high growth, it is still relatively low in South Korea and Nigeria, both of which have less than 1.5 cars per 100 persons. In South Korea, however, saturation is growing fairly rapidly, while it is stagnant in Nigeria. The most marked increase in car saturation has been in Taiwan, where it grew from around 0.1 cars per 100 persons

in 1965 to about 5 cars per 100 persons in 1985.

Although the growth in the above countries has been high, it is generally less than occurred in the lower-income OECD countries in the 1955-1975 period. In this period, car saturation increased by 7-fold in Portugal, 15-fold in Italy, 20-fold in Greece, 25-fold in Spain, and by around 90-fold in Japan.

Despite the high rate of growth in the OECD countries, their car saturation in 1965 in most cases was lower than in LDCs at similar income levels in 1986. This may be due to technological and industrial change. The LDCs have grown to their current level of economic development during a period of rapid transfer of car manufacturing, aggressive marketing, and generally declining real prices for cars. For the OECD countries, the period after 1965 was one of high economic growth.²

² Unless specified otherwise, the values for GDP per capita used in this analysis are based on purchasing power parity (PPP) methods, not exchange rates. This results in better comparability among countries, particularly when comparing countries at different ends of the income spectrum. The data come from the United Nations-sponsored International Comparison Project (Summers and Heston, 1984). GDP values were calculated using a system of international prices calculated for 1975 for domestic "absorption", and current-year export and import prices in valuing the net foreign balance portion of GDP. The international price system uses the U.S. dollar as numeraire, but the values are not in U.S. dollars *per se*, but rather are an international unit (akin to the Special Drawing Rights used by the IMF).

<u>Car Ownership and GDP per Capita</u>		
	Cars/100	GDP per Capita (1975 \$)
OECD -- 1965		
Italy	10	2900
Japan	2	2630
Spain	2-3	2580
Greece	1	1970
Portugal	3	1500
LDCs -- 1986		
Taiwan	5	3170
Venezuela	9-10	2970
S. Korea	2	2670
Malaysia	6-8	2650
Argentina	9-11	2640
Iran	3-4	2530
Chile	3-4	2335
Mexico	5-6	2120
Colombia	1.5-2	2100
Brazil	7	2025

The Status of Domestic Car Manufacturing is an Important Determinant of Growth in Saturation

Japan in 1955 had similar car saturation and per capita income as Taiwan in 1965. Japan's growth in car saturation over the next 20 years was much larger than Taiwan's between 1965 and 1985: about 90-fold versus about 40-fold in Taiwan. Japan's average income increased a little over four-fold, while Taiwan's increased a little over three-fold. Why was there much higher growth in car saturation in Japan? A likely explanation is the role of car manufacturing as an engine for economic growth in Japan, and the larger size of the Japanese market, which encouraged the growth of the domestic industry. In Taiwan, locally-assembled cars have had a relatively high imported content until fairly recently, and the government thus did not pursue policies that encouraged car ownership. The smaller size of the market also made the development of a full-scale car manufacturing industry less attractive.

The role of the domestic car industry as an engine for economic growth has also been important in Brazil. Like most Latin American countries, car saturation in Brazil in 1965 was much higher than in Asia. But it increased strongly, about five-fold, between 1965 and 1980. With the economic difficulties of the 1980s, however, growth has been much slower.

Like Taiwan and Japan, the situation of Brazil in 1965 with respect to car saturation and average income was similar to that of Portugal in 1955. In this case, however, the magnitude of growth over the next 20 years in both car saturation and average income was roughly the same for Brazil and Portugal. Portugal went from having around 1 car per 100 persons in 1955 to 7-8 cars in 1975, and Brazil did about the same between 1965 and 1985. In contrast to Japan, Portugal did not develop a major car industry, and had to rely on local assembly of imported components and import of complete cars. Spain, with a much larger domestic market, did develop a major industry and went from having a car saturation about half that of Portugal in 1955 to having one 50% greater by 1975.

Among both LDCs and OECD countries, countries with a large-enough market to support a mature car industry have had greater growth in car saturation than countries reliant on imports. When car purchase supports local industry and employment, government policy tends to be liberal. When car purchase places high demands on foreign exchange, government policy tends to be discouraging of car ownership. In many LDCs, cars are regarded as luxuries and are heavily taxed. Domestic car assembly now exists in many LDCs, but the amount of locally-manufactured content is generally not high, and such assembly thus requires considerable foreign exchange. Imported components are heavily taxed in many countries. In Thailand, kits for local assembly are subject to import duties of 120-160%. Vehicles are taxed at various stages of pro-

duction, and there is a business tax on the finished item.

Even where most or all of the car is manufactured locally, government policy may discourage ownership. In South Korea, car production has been mainly targeted for export. An array of taxes pushes the retail price of a car up 40-80% higher than ex-factory prices. On a Hyundai Pony Excel, one of the most common cars sold, taxes push prices up 54% from US \$4175 to US \$6430. In addition to value-added, sales, and registration taxes, the Korean car buyer must pay a special consumption tax, a defense tax, and a tax for the Seoul subway fund. Annual registration fees are also very high. As a result of these factors, the domestic market has developed relatively slowly despite considerable income growth. Per capita GDP in South Korea is only around 15% less than in Taiwan, but the car saturation is over three times lower.

In many LDCs, the domestic market is not large enough to support an efficient assembly industry, much less full-scale manufacturing. Too many assemblers competing for pieces of a small pie leads to inefficient use of capacity. In Thailand, for example, annual production of all motor vehicles is less than 10% of capacity.

Countries with assembly industries tend to push for greater use of indigenous components. Efforts to increase local content of cars may lead to use of more expensive components, however. A study for Thailand estimated that increasing local content from 30% to 45% could involve increasing costs per car starting at US \$20 for each percentage point, with the final one-point increase costing US \$99. In some countries, estimates show that it is less costly to import completely-built units than to buy cars from locally-assembled kits. But the existence of the car assembly industry and its employment presents a strong argument for kit assembly, thus helping to keep car prices high.

In India, the potential market is large, and local car manufacturing has existed since the 1960s. Until the 1980s, production of passenger cars was limited primarily to three firms that produced high-cost, out-dated, fuel-inefficient models, and there were restrictions on production. Demand was further discouraged by high taxation, which nearly doubled the cost of the car to the consumer. Despite the high cost, there was a long waiting list for new cars. Policy liberalization in the early 1980s, including lower tariffs and easier licensing of new production, and the entry of a new, low-priced "people's car" (a collaboration with Suzuki), resulted in a doubling of passenger car sales by 1985. The sudden rise in car sales brought political and foreign exchange problems, as the imported content of the newer models was high. Policy changes, including increased taxation of imported components, were implemented that resulted in lower car sales in 1986.

The Oil Boom Brought Rapid Increase in Car Saturation for Some Oil-Exporters, but the Decline in Oil Prices Has Greatly Slowed Growth

Car saturation increased very rapidly between 1973 and the early 1980s in the Middle Eastern oil exporters and in Nigeria. In the major Latin American oil exporters, Mexico and Venezuela, car saturation was already relatively advanced in the mid-1970s (around 4 and 7 cars per 100 persons, respectively). The oil boom had a stronger effect on car saturation in Mexico, which has a more developed car industry (and larger market) than Venezuela. In Indonesia, high taxation limited growth in car saturation, which is still quite low (around 0.5 cars per 100 persons).

In Nigeria, vehicle sales were heavily dependent on oil revenues, which also resulted in development of substantial motor vehicle assembly capacity. The deterioration of the economic situation, which was already

underway before the recent oil price collapse, has resulted in near-total collapse of the car market. In Saudi Arabia, car sales declined from a peak of around 200,000 in 1982 to only 50,000 in 1986. In Indonesia and Malaysia, lower prices for oil (and other commodities) exports have also resulted in slower growth in car saturation.

Economic Stagnation Has Slowed Growth in Car Saturation in Latin America

In Argentina and Venezuela, car saturation was relatively high by the mid-1970s. Both countries already had relatively high per capita income in the 1960s, and Argentina had developed a major car industry. Since the mid-1970s, the increase has been slow, as real per capita income has declined considerably in both countries in the 1980s.

Economic difficulties have slowed growth in saturation in other countries, as well, particularly those dependent on imported cars and components.

The Degree of Car Penetration Into the LDC Middle Class is Important But Not Well-Determined

At early stages of economic development, car purchases are made by the very affluent, large business enterprises, and government agencies. Large cars tend to be purchased, and saturation in these groups of consumers is very high. Taxis may comprise a high share of total cars: their share was over 40% in Taiwan and South Korea in 1965. As cars become more familiar and road networks improve, new, larger purchasing groups enter the market: business owners acting in their personal or business capacity, high ranking government officials and business executives, and professionals. Gradually, cars penetrate into the middle class. If economic conditions are right, rapid growth can occur in this stage. At this stage, car prices become more important.

The share of business/government cars and taxis is still quite high in many LDCs. In India, it is estimated that 70% of new car purchases in 1985 was by corporations, 10% was by government, 5% was taxis, and only 15% was by private households.

Car Saturation Among Households Increases Rapidly Past a Certain Income Level

Survey results from Singapore and Malaysia, two of the wealthiest Asian LDCs, show how car ownership rises rapidly from the lower income groups to the middle class. In Singapore in 1983, household car saturation increased from 17% among households in the S \$1000-1999 (US \$450-900) monthly income range to 43% among households in the S \$2000-3999 (US \$900-1800) and to 81% among the upper-income group.

In Malaysia's major cities in 1980, the use of cars for commuting to work showed a similar trend as car ownership in Singapore. There was almost no use of cars until the M \$1000-1999 (US \$400-800) group, in which about half used a car. This is a lower income level than the group in which about half of the households owned a car in Singapore. This may reflect the greater opportunity to use a car in Malaysia (for intercity travel and touring) than in the city-state Singapore, and the lower need for a car in Singapore. Among the upper 20% of households, cars were used by nearly 80% of the households.

These results and anecdotal evidence from other countries suggest that a car is a high priority consumer good in LDCs, as it has been in the OECD countries. Purchase by households depends mainly on their income and the price of a car, which is higher than OECD levels for comparable models in many LDCs. The ratio of the price of a basic car to annual household income is an important determinant of growth in a country's car market. Most of the change in the ratio is

due to growth in income. But car prices also decline as the market matures. Gradually, the relationship becomes a positive feedback loop: as incomes increase due to economic growth, the demand for cars goes up. This contributes to maturation of the industry (greater economies of scale, more competition), which leads to lower car prices. In turn, the growing automobile industry can be an important engine of overall economic growth.

In Japan, the ratio of the price of a basic car to average annual household income declined almost three-fold between 1959 and 1967 (Tomisawa, 1987). Sales of new cars started to accelerate rapidly around 1964 (the time of the Tokyo Summer Olympics), when the ratio was in the range of 0.7-0.8. In South Korea, the ratio of car price (for a Hyundai Pony Excel) to annual household income in 1985 was 0.86, about where Japan was in 1963. (This is despite the high rate of taxation on cars.) New car sales have been increasing at a fairly rapid rate since the slump of 1980-81, though not as fast as in Japan in the mid-1960s. South Korea still has a relatively undeveloped sales-and-servicing structure. There are no independent car dealers, and the number of company-owned outlets is not large.

In some countries, the middle class has grown, but most households do not yet have sufficient income for car purchase. In India, sources estimate that the average annual middle class household income ranges from Rs 24,000 (~US \$2,000) to Rs 60,000 (~US \$5,000). The price of a Hindustan Ambassador, a standard model, was Rs 78,000 in early 1986, well above the annual income of the wealthiest middle-class households. The new Maruti/Suzuki 800, which entered the market in 1984, was at Rs 55,000 for a basic model in 1986 the first car whose price falls within the range of annual middle-class income. The quick growth in sales of the Maruti (the company claimed 47% of the car market in 1985) reflects the pent-up demand by households who had been just below the

income threshold for car purchase.

The degree to which car ownership is considered a status symbol influences the extent to which people will purchase cars at the expense of other goods, or purchase cars rather than save. As car ownership becomes more common, social factors become important. Households without cars may feel left out. A Hyundai salesman in South Korea said recently, "We are seeing more and more middle-income people in our showrooms who would not have considered buying two years back. They seem to be following their neighbors. It is a matter of maintaining status."

Road Development Has Evolved With Growth in Car Saturation, But Poor Roads Do Not Seem to Be a Strong Deterrent to Car Purchase

The existence of a network of good-quality roads probably acts as a positive reinforcement to other incentives to car ownership. The extent to which the lack of good roads in most LDCs acts as a disincentive is difficult to assess, however. Among LDCs, there is no clear relationship between car saturation and the density of paved roads (km of roads per thousand square km of land area). Most of the countries have less than 100 km of paved roads per '000 km² of area, but car ownership ranges over a factor of 20. In part this reflects national geography: Saudi Arabia, Brazil, and Venezuela, for example, have large sparsely settled areas.

Road density also does not capture the amenity of travel offered. Most of the heavily-travelled roads in many LDCs are too narrow for the traffic and not well-maintained. Car drivers must often share the road with animal-drawn vehicles, bicycles, and pedestrians. India has a very high paved road density (equal to South Korea), but the heavily-travelled roads are poorly maintained and in need of widening. In South Korea, on the other hand, the road system includes modern freeways linking

Seoul to the south, but car saturation is much lower than in many other LDCs.

Traffic Congestion Could Be a Deterrent in Some LDC Cities

Urban traffic congestion, due mainly to the low ratio of street area to land area that prevails in most LDC cities, may act as a disincentive to car purchase, though it probably affects car usage more than ownership. In Lagos, Nigeria, and Bangkok, for example, studies show that the average vehicle travels at only about half the speed of its counterpart in London or Frankfurt (World Bank, 1986). The fact that the street-to-land ratio is lower in Asian than in Latin American cities may be partly responsible for the higher growth in motorcycle ownership in Asia. Traffic congestion in Bangkok may partly explain why car sales have not risen very much despite rising GDP per capita. The fact that Kuala Lumpur, the capital of Malaysia, is more spacious than most Asian cities may be one reason for the higher car saturation in Malaysia.

Traffic congestion may be more of an inhibiting factor where there is also relatively well-developed mass transit. This combination exists in Seoul, capital of South Korea, and may partly explain why new car sales have not taken off as rapidly as some have expected.

The Effect of Mass Transit on Car Saturation is Unclear

A well-developed system of trains and buses for urban and inter-urban transport may act as a disincentive to car ownership, especially for people just at the income threshold for car purchase. But as with traffic congestion, the effect is probably stronger for car usage than for ownership. The quality of urban mass transit varies among LDCs. Buses are often very overcrowded. A few cities such as Buenos Aires, Rio de Janeiro, Sao Paulo,

Mexico City, Bombay, and Seoul have had extensive rapid rail transit systems for many years. Heavy rail and light rail systems of varying degree of development also exist or are under construction in many other cities.

Use of trains or, more likely, buses for inter-city passenger transport is common in all LDCs, but they are generally crowded and slow. They thus do not offer much of a disincentive to car ownership for people with sufficient income. Countries with the economic resources to provide reasonably good public transit also tend to have higher per capita incomes. Income growth seems to lead to car ownership regardless of the state of public transport, though the latter could be a reinforcing factor in cases where other factors also tend to discourage car ownership (as in South Korea).

Gasoline Prices May Play a Minor Role in Affecting Car Purchase

In countries where gasoline prices have historically been very high or very low, they have probably had some effect on the passenger car market. Not surprisingly, oil-exporting countries have considerably lower prices than oil-importers. Along with the low price level, the relative lack of increase may be a factor contributing to the high rate of growth in car ownership in many of the oil-exporting countries. South Korea has very high taxes on gasoline, and this could be part of the reason why car sales have not taken off as much as the income growth would lead one to expect. Fuel prices have a more clear effect on vehicle usage and the type of vehicle purchased (both in terms of type of fuel used and fuel economy).

Government Policy Influences Growth in Car Saturation in Most LDCs

Although growing income is the most important factor, rise in car saturation depends on other factors, many of which are shaped by

government policy. Governments affect the supply and price of cars by controlling or influencing domestic production and/or by placing restrictions or disincentives (high import duties and/or taxes) on imported and domestic cars. In some cases, governments have an explicit policy that seeks to limit private motorization. China, which has far lower car saturation than any other country, is the best example of this, but India, Taiwan, South Korea, and other countries have discouraged car ownership in the past through high taxes, limiting licensing of production, and other regulation of the market. Domestic assemblers are often protected from external competition by import restrictions, but prices are high due to high taxation of imported components, taxes on completed vehicles, and in some cases, low production efficiency.

Growth in Trucks and Buses Has Been More Evenly Distributed Among Countries Than Growth in Cars

Whereas passenger cars are seen as a luxury in many countries, and their ownership has been discouraged, use of trucks and buses (including vans and miscellaneous commercial vehicles) is more closely tied to economic activity or provision of mass transportation. Consequently, in many countries taxation is much higher on cars than on trucks and buses. In some countries, particularly in Asia, more trucks and buses have entered the vehicle stock since the mid-1970s than cars.

Light trucks ("pickups") have become very popular in many LDCs. Hauling of small quantities of goods is important in both urban and rural areas, and the greater durability of light trucks favors them over cars where road conditions are poor. In Taiwan, the number of light trucks rose from only 20,000 in 1970 to 325,000 in 1985. In 1970, there were as many heavy trucks as light trucks, but by 1985 there was four times as many light trucks. The number of light

trucks has also grown substantially in countries such as Indonesia and Thailand, where they are assembled locally.

The situation is different in India, where light commercial vehicles (LCV) accounted for only 25% of truck sales in the 1974-84 period. LCVs have not carved out a niche for themselves between three-wheelers and medium-duty commercial vehicles, in part due to bad roads and the lack of service points in rural areas. Medium-duty vehicles (above 6 tons, 2 axles) accounted for 72% of truck sales.

Small three-wheeled vehicles are commonly used for small-scale freight transport in many Asian cities. In higher-income countries, they have been displaced by light trucks and vans. In Japan, the number of three-wheelers declined from 900,000 in 1962 to less than 100,000 in 1975. In Taiwan, there has also been decline in the number of three-wheelers, but they remain important in most countries.

Compared to Passenger Cars, Growth in the Number of Trucks and Buses Generally Occurs More Gradually Relative to Growth in GDP

During periods of economic boom, the number of trucks and buses (mainly trucks) has grown much faster than GDP, but not as fast as passenger cars. In Taiwan between 1965 and 1985, the number of trucks and buses grew at an average rate of 16% per year, twice as fast as GDP. But average growth for cars was three times as fast as GDP. (Taiwan had low numbers of in both categories in 1965.) The growth in Taiwan was slightly lower than that experienced in Japan in the 1955-75 period, though the average GDP growth rate was about the same.

With slower economic growth, the elasticity between GDP growth and growth in trucks

and buses appears to be less. In India between 1965 and 1985, economic growth was less than half as fast as in Taiwan. The number of trucks and buses grew only about 1.4 times as fast as GDP.

The Number of Motorcycles Has Risen Very Rapidly in Asia

Motorcycles (including scooters and mopeds) are a relatively inexpensive form of motorized transport, have advantages over cars in congested cities, and are also useful in rural areas for travel between towns and villages. Over the past 10 years their numbers have increased considerably, especially in Asia. Average growth between 1979 and 1984 was 11-15% per year for most Asian LDCs, and was even higher in South Korea. There has also been considerable growth in Egypt, Iran, and other countries as well. With the exception of Brazil, there has been relatively slow growth in Latin America.

Although they may consume three to four times less gasoline per mile driven than a typical car, because of their numbers motorcycles have become significant in some countries. In Taiwan, which has the highest number of motorcycles per capita among LDCs (and probably in the world), estimated gasoline use by motorcycles in 1984 was 36% of total consumption (cars accounted for 50%).

Growth in motorcycle ownership may signal the motorization of a segment of the population that previously used mass transit or bicycles. The two-seater scooter has been the "peoples car" in India: annual sales grew from 85,000 in 1975 to over 200,000 in 1982. As incomes allow or as people begin families, motorcycle owners may "graduate" to cars. Alternately, motorcycles may be a more acceptable substitute for a car than is the case in the OECD countries. There are between three and five times as many motorcycles as cars in most Asian LDCs.

Motorcycles per 100 Persons

	1975	1985
Taiwan	11	34
Malaysia	6	15
Thailand	1	4
Indonesia	1	3
South Korea	<1	2
Argentina	2	2
Brazil	<1	1
India	<1	<1

Note on Motor Vehicle Data in LDCs

The number of motor vehicles in use (known as the "park") is not well-defined for most LDCs. The data commonly used are the statistics on vehicle registration distributed by national statistical agencies. Careful examination of these statistics (in particular, comparison with data on new vehicle sales) suggests that they overstate the actual vehicle park (and its growth) in many LDCs. In many cases, the overstatement appears to be large (over 20%). Compounding the problem is the fact that vehicle categories used in registration accounting may change over time, or the statistics may exhibit suspiciously large or small changes from year to year.

It is often difficult to make a definitive statement regarding the inaccuracy of registration statistics, however, due to uncertainty about vehicle scrappage and as to whether annual data on new vehicle sales or shipments are an accurate reflection of the actual number of vehicles entering the stock in a given year. In addition to the uncertainty surrounding vehicle registration statistics, some countries either do not have annual registration or do not make statistics on vehicle registrations publicly available (e.g., Nigeria, Saudi Arabia).

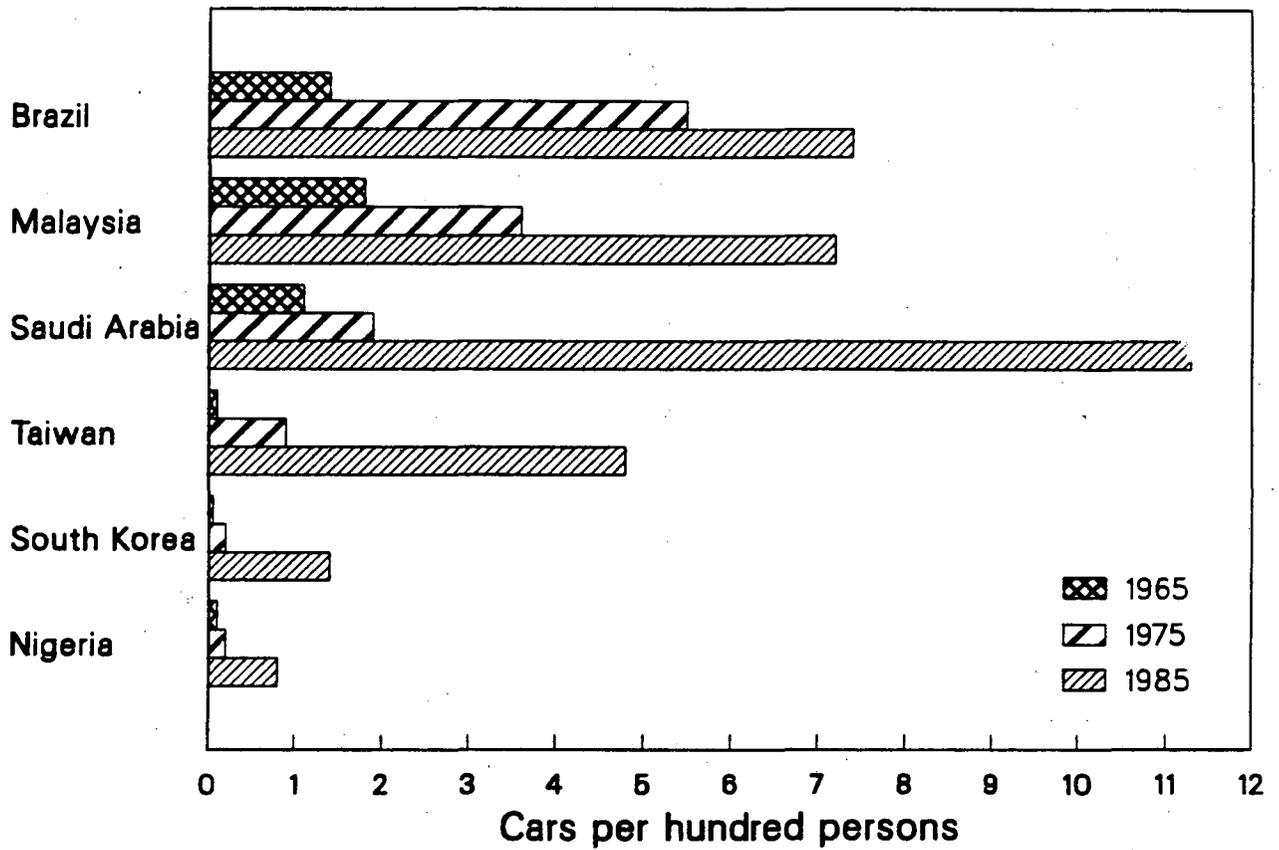
Other sources of statistics on the motor vehicle park are the annual *World Road Statistics* published by the International Road Federation, *World Motor Vehicle Data*, published by the Motor Vehicle Manufacturers Association of the U.S., and *World Automotive Market*, published annually by *Automobile International*. The former two sources for the most part reproduce country registration statistics. The latter makes use of a variety of sources, but less effort goes into assuring accuracy for the LDCs, and estimates from year to year are often marked by large discontinuities. (This is also true of *World Road Statistics*.)

The values used in this report for vehicle numbers come from country registration statistics in cases where they appear to be fairly accurate (Taiwan, Republic of Korea). In most cases, however, they were estimated based on country registration statistics and data assembled for this study on annual shipments of vehicles from overseas vehicle suppliers, annual local production/assembly of cars and commercial vehicles, and where available,³ annual sales of vehicles, as reported by national vehicle manufacturer associations. In most cases, these data provided what we judge to be a fairly accurate portrait of the number of new vehicles introduced into the motor vehicle park in each year. We have not attempted to account for used cars brought in from abroad.

One important conclusion from this study is that statistics on motor vehicles is an area calling for further research in most LDCs.

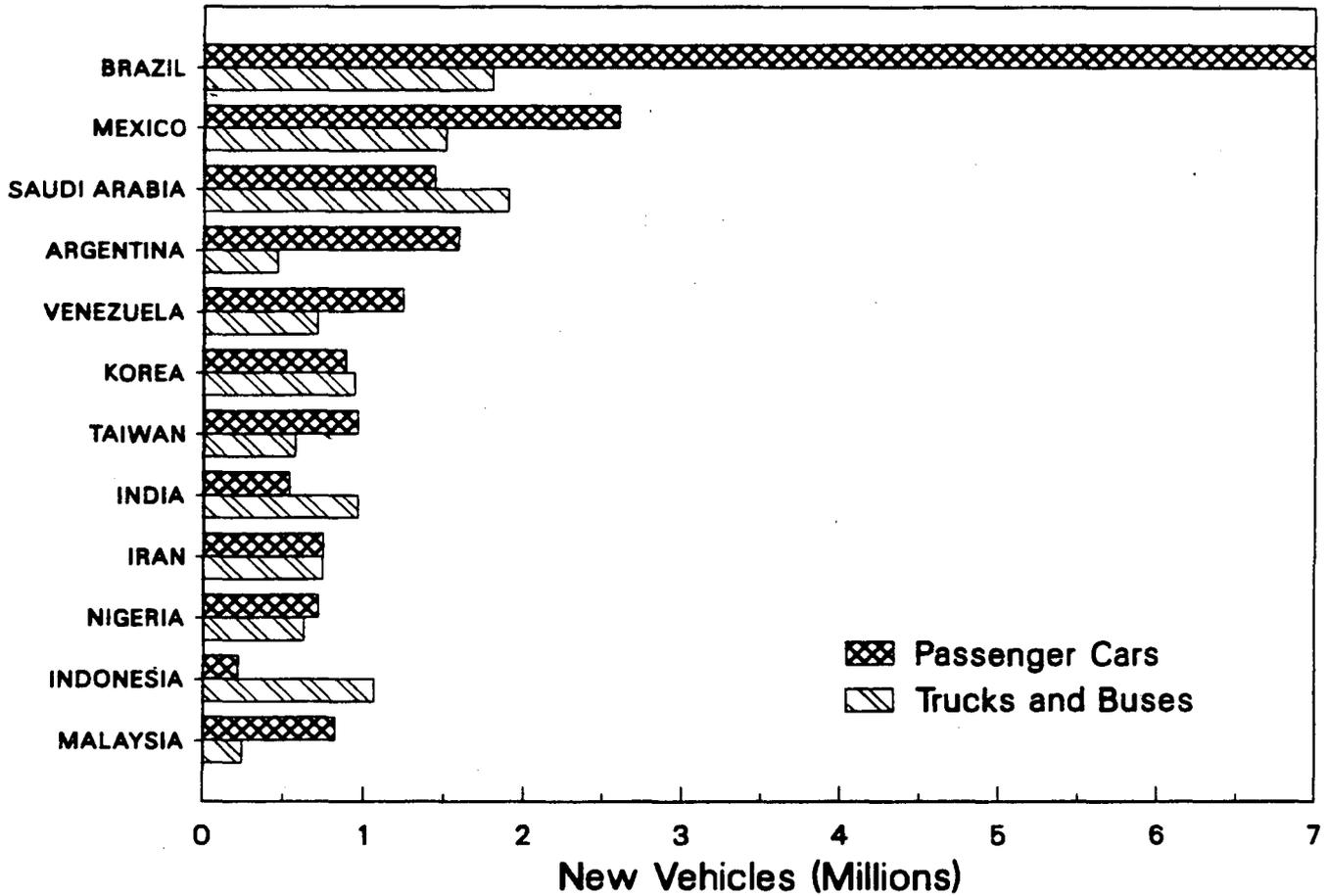
³ Argentina, Brazil, India, Mexico, and South Korea.

LDCs with Fast-growing Car Saturation, 1965-1985



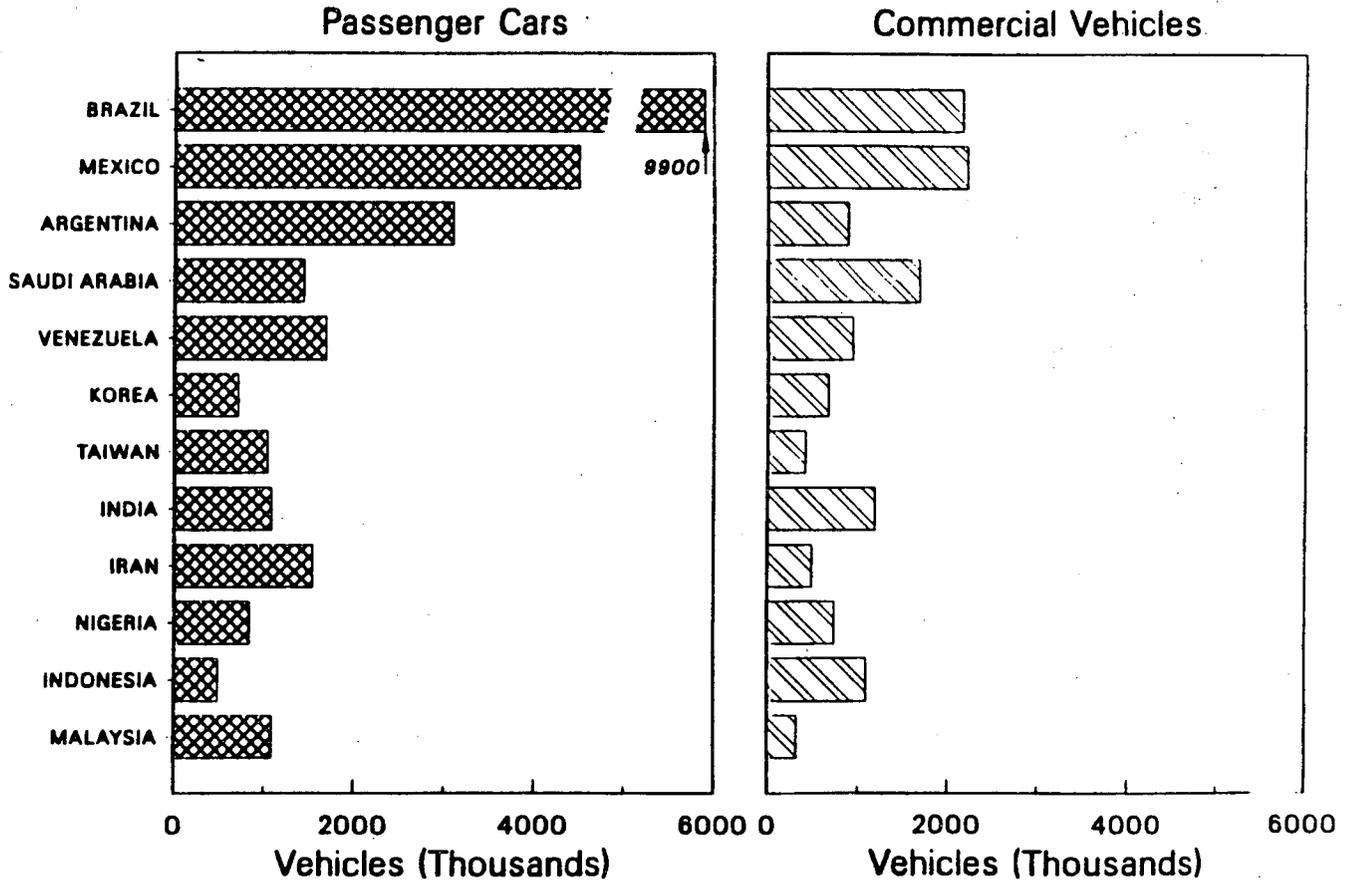
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Cumulative New Vehicles, 1976-1986



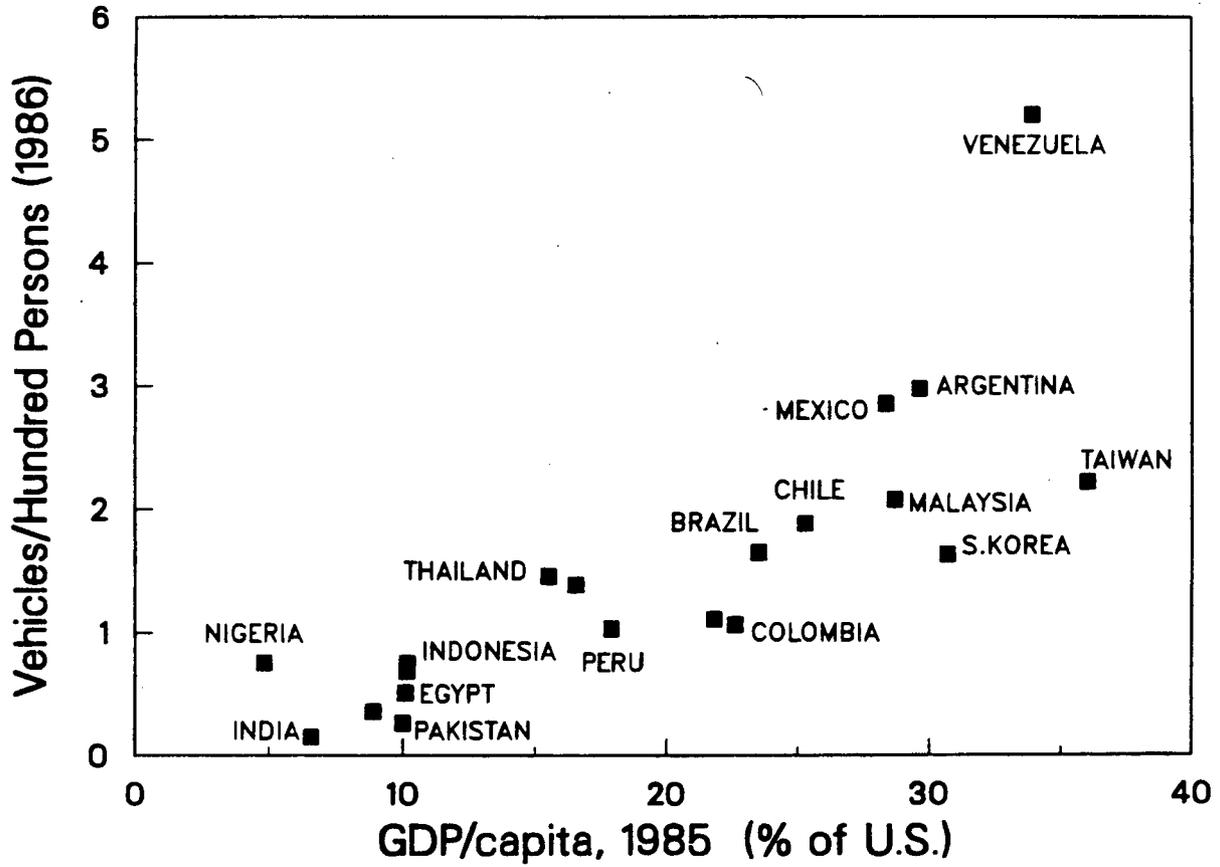
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Motor Vehicles in Use in 12 LDCs (Year-end 1986)



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Saturation of Trucks and Buses Grows with GDP



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CHANGE IN VEHICLE CHARACTERISTICS IS AFFECTING LDC OIL DEMAND

Growing Middle Class Car Purchase Brings More Small Cars

In the early stages of the car market in LDCs, when luxury cars, company-owned cars, and taxis dominated, large cars made up a substantial portion of the stock. As middle class car purchase has grown, smaller cars have taken a greater share. In Mexico, for example, the market share of new cars of larger models declined from 27% to 10% between 1970 and 1982, and the share of subcompacts increased from 44% to 63%.

As incomes grow, very small cars may give way to larger (though still small) cars. In Taiwan, a country with rapid growth in cars, the market share of very small (600-1200 cc) cars increased in the 1977-80 period, but then gave way considerably to cars of 1201-1600 cc size after 1980. This may reflect change in vehicle manufacturer offerings as well as higher incomes and preference for larger cars. Even with the loss in market share, however, very small cars comprised 25% of Taiwan's car stock in 1984.

The rise in gasoline prices of the early 1980s appears to have enhanced the movement to smaller cars. In Argentina, the market share of cars with engine size between 851-1400 cc grew from 29% to 38% of car production in the 1979-83 period. (The market share of light trucks also increased.) In Mexico, where gasoline prices did increase despite the domestic oil production, the share of subcompacts grew from 53% to 63% of sales between 1980 and 1982.

Purchase of smaller cars is encouraged in many LDCs by import duties and taxes that increase progressively with engine size. In Pakistan, most cars are imported, and

import duty and sales tax (as of Nov. 1983) went from 150% for cars in the 1001-1300 cc range up to 380% for cars over 1600 cc. In India, customs duty (as of Jan. 1984) increased from 153% plus Rs 9975 (about \$830) for cars less than 1200 cc up to 266% for cars over 2500 cc. Components for fuel-efficient vehicles had enjoyed considerable customs and excise duty concessions. In late 1986 the concessions were withdrawn for all cars except those with engines smaller than 1000 cc.

The move to small cars is less the case in some of the oil-exporting countries, where increase in income and the availability of foreign exchange has allowed import (or production, as in Nigeria) of larger cars. And in many countries, greater status is associated with larger cars. The prevalence of large extended families in LDCs favors large cars for weekend outings and the like. In South Korea, subcompact cars dominate the market, but dealers say there is an underlying preference for bigger cars.

Vehicle Fuel Economy is Probably Increasing, But Data Are Lacking

Little information exists on actual fuel economy of motor vehicles in LDCs. For passenger cars, which turn over more rapidly than trucks and buses, the vehicle stock in most LDCs has built up during a period when car manufacturers were making considerable improvement in fuel efficiency. Thus, the passenger car stock in many LDCs has a large share of relatively fuel-efficient vehicles. On the other hand, vehicles leave the stock at a much slower rate in LDCs than in the OECD countries because of the much lower cost of maintenance relative to new car purchase. As a result, many LDCs have a large share of fuel-inefficient, old-

technology vehicles. Even new trucks in China are mostly of old design and are very energy-inefficient (Mao and Hu, 1986).

Mexico and India have recently set new policies to enhance the technology status of indigenously produced vehicles. The effect will be particularly strong in India, where the main car models sold until recently employed very old technology with low compression ratio and little control of spark timing or combustion. Joint ventures and collaborations between Indian and Japanese companies are resulting in modernization of new car offerings. In South Korea also, the government is requiring automobile manufacturers to increase the efficiency of car engines.

The fuel economy of cars exported to the LDCs is potentially higher than that of the similar models sold in OECD countries (En. and Env. Analysis, 1986). The models sold in LDCs tend to have smaller engines and lower axle ratios that reduce performance relative to vehicles sold in OECD countries. The engines typically have lower compression ratios for the low octane gasoline sold in LDCs, and do not employ sophisticated fuel or spark management systems. The negative effect of lower technology and reduced compression ratio on fuel economy is offset by the smaller engine size, lack of accessory loads, and lack of emission controls. Similar features probably hold for diesel heavy-duty trucks, although most trucks sold in LDCs are naturally aspirated rather than turbo-charged as in OECD countries.

Fuel economy in actual operation may be reduced in many LDCs due to poor road conditions, traffic congestion, overloading, and lack of vehicle maintenance. Truck manufacturers report that preventive maintenance is rarely performed in many LDCs. Commercial vehicle owners are said to be unsure of the benefits of such maintenance and value the lost downtime more highly. Lack of access to and/or the high price of spare parts contribute to the prob-

lem. A study in Pakistan found that several poorly maintained trucks had fuel economy levels 25-40% below that of well maintained trucks of the same model and vintage. Trucks manufactured in India are typically heavy for their engine size because of road conditions and the fact that they are often overloaded.

Survey results from Taiwan provide evidence that newer cars actually do get better gasoline mileage (Chang, *et al.*, 1986). Subcompacts built in the 1977-80 period averaged 25 miles per gallon, while those built in the 1981-83 period averaged 28 miles per gallon.

**Passenger Car Fuel Economy
in Taiwan, 1984
(km/liter)**

Vintage	Engine size (cc)		
	600-1200	1201-1800	1801-2400
Pre-1977	12.9	10.6	9.2
1977-80	13.1	10.7	9.5
Post-1980	13.1	12.1	9.4
Total	13.1	11.7	9.4

Source: Tzeng, *et al.*, 1986.

Diesel Engines Are Coming Into Greater Use

A higher percentage of trucks and buses run on gasoline in LDCs than in OECD countries, despite the subsidized price of diesel fuel in most LDCs. This is gradually changing, however, and in some LDCs (such as India) the majority of trucks and buses already use diesel. In Brazil, the diesel share of freight transport vehicles increased from around 65% in 1975 to 85% in 1984. In many LDCs, however, this share is still small.

The number of diesel-fueled light trucks has increased substantially in countries where diesel prices are much lower than gasoline (due to high taxes on gasoline and/or subsidization of diesel). In Morocco, the percen-

tage of trucks and buses running on diesel increased from 55% in 1977 to 63% in 1984. In Tunisia, gasoline has been a little over twice as expensive as subsidized diesel fuel since before 1970. The diesel light truck stock grew from around 13,000 in 1972 to 42,000 in 1982 (Greene, *et al.*, 1984). By 1984 in Thailand, 59% of light trucks ran on diesel. In Brazil, the diesel share of the light truck stock grew from 1% in 1975 to 18% in 1984. In Argentina, on the other hand, most new light trucks run on gasoline.

LDC AIR TRAVEL HAS GROWN AT A HIGH RATE

Air travel to and from and within LDCs has increased dramatically over the past 15 years. Between 1970 and 1985 the total number of air passenger-trips (for all scheduled airlines) to and from and within LDCs increased over three-fold. Domestic travel within LDCs registered the highest growth, averaging 9.2% per year, while international travel between LDCs and international travel between LDCs and the OECD averaged growth of 7% to 8% per year.¹

Airlines registered in LDCs have greatly expanded their service, both domestic and international, and airport construction or expansion has occurred or is underway in many countries. Judging from the historic trend, LDC air travel could be a significant area of growth in world oil demand in the 1990s.

The air travel generating jet fuel consumption in LDCs includes travel by local residents, visitors, and transiting passengers. In contrast to the U.S., most of the jet fuel "consumed" (i.e., loaded) in LDCs is not used within the country, but is used for international flights. A large share of the passengers on such flights are not local citizens. In some LDCs, this is also the case on domestic flights. The share attributable to foreigners can be expected to decline as a country's per capita GNP increases, but it is still high for many LDCs.

Air travel in most LDCs is still in an early stage of development where growth has been quite rapid. In contrast to the OECD countries, most air travel by LDC citizens is accounted for by the wealthy and by higher-

rank business, government, and professional people. Although statistics are not available, it is safe to say that the percentage of all persons who have ever flown (which in the U.S. grew from 49% in 1971 to 70% in 1984) is still quite small even in the advanced LDCs. As incomes have grown, however, and air travel become more available and affordable, penetration into the middle class has begun to take place.

Air trips by LDC citizens mostly fall into one of five categories: (1) Work-related, (2) Sightseeing/shopping, (3) Visits to relatives, (4) Religious, and (5) Home visits by citizens living abroad. Relevant statistics are not available, but it is likely that work-related travel accounts for the bulk of both domestic and international air travel, and especially domestic. LDCs at higher income levels (or with a sizable upper class) likely have a higher proportion of sightseeing and shopping and relative-visiting trips. Religious trips are especially important in the Islamic countries.

International air travel by LDC citizens is probably less dominated by work-related travel than is domestic air travel. Travel to OECD countries is affected by the extent to which the national economy interacts with OECD economies. The number of citizens living abroad (and their financial resources) is also a factor. These people generate visits from relatives as well as trips home. International travel is also affected by exchange rates and currency devaluation and restrictions.

¹ Data on air travel are from the International Civil Aviation Organization (ICAO), as reported in the United Nations Statistical Yearbooks, and from Boeing Aircraft Company.

Travel on LDC Airlines Has Risen Considerably Since the Mid-1970s

National statistics on air travel only include travel on airlines registered in the country. For most LDCs, national citizens account for most of the travel on their country's airlines. The share of passenger-trips accounted for by foreigners varies among countries, as does the amount of travel by local citizens on airlines registered in other countries.

Total passenger-km on LDC airlines in 1984 was about 10 times higher than in 1965. Three-fourths of the absolute growth took place after 1974. The fastest and most growth has occurred in Asia (including most of the Middle East). There was steady growth in Latin America until the 1980s, when travel flattened out. There was also some leveling off in Africa. There was no flattening out in Asia for either international or domestic travel. In Latin America, international travel flattened out in the 1980s, but domestic travel was less affected. In Africa, the trend was about the same for each mode.

Mexico, Brazil, and Saudi Arabia had the most total passenger-trips in 1984, followed by India and Indonesia. The highest absolute growth between 1976 and 1984 was in Saudi Arabia and Mexico, followed by India and Brazil. The fastest growth rates were in Nigeria (starting from a low base) and Saudi Arabia. Egypt, South Korea, Algeria, and Thailand all averaged growth in excess of 10% per year.

For international travel, Mexico and Saudi Arabia had the most passenger-trips in 1984. The highest growth rates were recorded in Nigeria, Saudi Arabia, and the Philippines. For domestic travel, Brazil and Mexico had the most passenger-trips in 1984. The fastest growth was in Nigeria (from a low base), South Korea, Saudi Arabia, and Thailand.

The relative shares of domestic and international air travel in terms of total passenger-trips vary considerably among the countries. International trips accounted for over two-thirds of all passenger-trips in Thailand and Egypt in 1984, but for less than 20% in Brazil, Indonesia, Colombia, Argentina, and Venezuela. The high values for Thailand and Egypt may reflect travel by tourists on the national airlines, as well as the limited possibilities for domestic air travel. In some countries, the share of domestic passenger-trips increased between 1973 and 1984 (esp. Saudi Arabia, Argentina, and Venezuela), while in others it decreased.

Over time the average international trip has increased in length. In several cases -- Argentina, Indonesia, South Korea, Thailand, and Saudi Arabia -- the increase has been considerable. This reflects increasing travel to and from OECD countries.

Passenger-Trips on LDC Airlines
(Domestic and international)

	1984 (millions)	1976-84 Growth (%)
Mexico	14567	8.3
Brazil	12948	4.9
Saudi Arabia	11366	16.9
India	9363	9.2
Indonesia	6494	9.7
Colombia	5770	5.6
Malaysia	5685	9.9
Argentina	5139	5.7
Korea (S)	5097	11.9
China	5000	14.7 ^a
Venezuela	4523	6.6
Philippines	4394	5.3
Algeria	3781	10.7
Thailand	3671	10.6
Pakistan	3642	8.1
Egypt	2786	12.2
Nigeria	2375	22.0
Kuwait	1498	9.3

Source: ICAO

Values refer to travel on airlines registered in the country.

^a 1979-84

Outbound Travel by Citizens Has Increased Rapidly in Southeast Asia

Air travel out of the country by local citizens increased at a high rate after 1975 in Southeast Asia. Outbound travelers (citizens) as a percentage of the total population had by 1983 increased to 1.2% in South Korea, 1.3% in the Philippines, 1.5% in Thailand, and 3.6% in Taiwan. The percentage for Taiwan was equivalent to that of Japan. The major area of growth (and normally always the largest volume of travellers) is transborder or nearby-country travel. The reasons for this growth are similar interests for either business or visiting friends and relatives, custom/language familiarity, transportation ease, and low travel cost.

Higher Incomes Allow Growing Air Travel in LDCs, But Other Factors Play a Role

Growth in household and business income is the most important factor shaping growth in LDC air travel, but not the only one. Other factors include the price and availability of flights, trip costs, and availability of leisure time. For domestic air travel, physical and economic geography (diffusion of the industrial economy among cities) are important, as is the availability and attractiveness of alternative transport modes. For international air travel, significant influences include geographic location, the extent of international economic links, exchange rates and currency restrictions, cultural ties with nearby countries, and the number of citizens living abroad. For international travel not for work or study purposes, the development of a tourist mentality (the desire to "get away," to experience other places and people) is a factor, though probably no LDCs are at a stage where this kind of travel accounts for very much of total international travel.

Comparison of Per Capita Air Travel and GDP Shows That Country-Specific Factors Are at Work

International comparison of per capita air travel and per capita GDP confirms that higher-GDP countries generally have more air travel, but it also shows that particular factors play a role, as some countries with similar GDP per capita have very different levels of per capita air travel. The correlation with GDP is stronger for domestic travel, though for domestic and international travel there is a fair amount of scatter.

At the low end of the GDP spectrum, the Philippines has more domestic air travel per capita than other countries, reflecting the growth of inter-island air travel. At the upper end of the spectrum, Malaysia is much higher than South Korea, and Venezuela is higher than Argentina. Geography plays a role in the case of the Asian countries. The distance between peninsular Malaysia and the island provinces is great, while South Korea is relatively compact and has good highways linking major cities.

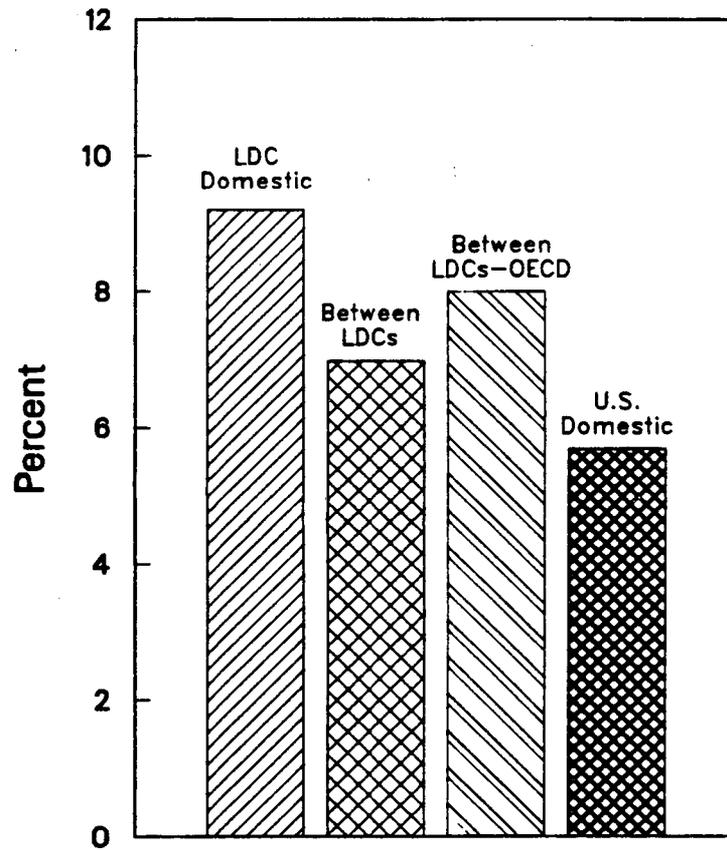
For international air travel, countries at different ends of the GDP spectrum have similar levels of air travel per capita. Pakistan and the Philippines, both with very low GDP per capita, are at roughly the same level of air travel per capita as Colombia, and are higher than Brazil. Part of the explanation for this could be that the statistics used here do not capture significant amounts of citizen travel for the upper-income countries (because people fly on airlines registered in other countries). Pakistan had many workers travelling to and from the Mideast (with travel costs often included in work contracts), and the Philippines has many people with personal and business links to Hawaii and the mainland U.S.

The ratio of average growth in passenger-trips to growth in GDP over the 1970-84

period was between 2 and 3 for a number of countries, and was higher for some with oil-related travel (Nigeria, India, Pakistan). For some countries -- South Korea, Colombia, China, the Philippines, Pakistan -- the elasticity for international travel was greater than for domestic travel. For Malaysia, Mexico, Thailand, Indonesia, India, and Saudi Arabia, the two values were about the same. For Algeria, Brazil, Egypt, and Nigeria, the elasticity for domestic travel was greater.

Scheduled Air Travel

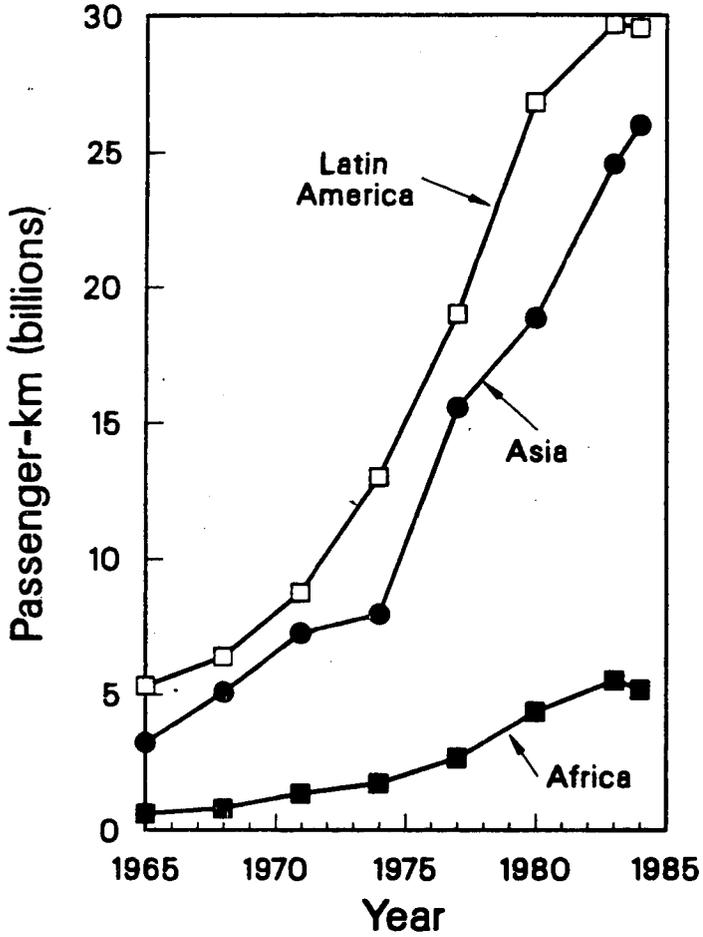
Average Annual Growth in Passengers, 1970-1985



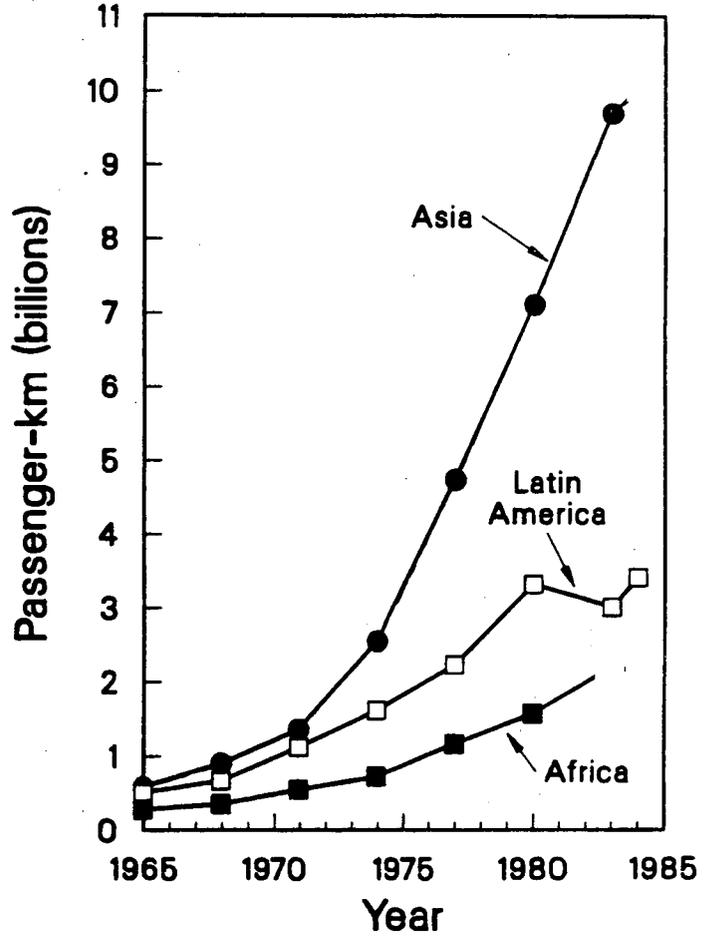
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Air Travel on LDC Airlines

Domestic



International



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THE ROLE OF TRANSPORTATION IN LDC OIL DEMAND IS INCREASING, BUT GROWTH PROSPECTS VARY AMONG COUNTRIES

The decline in oil prices has slowed LDC efforts to displace oil with other (mostly indigenous) fuels, but has not changed the general direction. Although alternative fuels for transportation are receiving attention in a number of countries, the main penetration of new non-oil energy sources will be in industry and electricity generation. As economic development increases demands for motorized freight and passenger transport, the share of oil going to transportation is bound to grow.

The Main Areas of Growth, Road and Air Transport, Are Oil-Intensive

In the OECD countries (especially in Europe and Japan), there has historically been strong competition between rail and road for both passenger and freight transport. Rail networks were extensive before the introduction of motor vehicles. This was not the case in most LDCs. Only India and China and, to a much lesser extent, South Korea, Pakistan, Brazil, and Argentina have built rail systems that carry a significant percentage of passengers or freight. But between the late 1950s and end of the 1970s, the rail share of total land freight ton-km declined from 94% to 65% in India, from 90% to 60% in South Korea, and from 29% to 19% in Brazil. It maintained a high share only in China. For many LDCs, rail has never been very significant.

For the most part, investment in rail systems in LDCs in the past decade has been modest. In general, the high capital cost of rail systems, diversification of industrial production, and the flexibility of trucks for freight transport make it likely that freight movement in the LDCs will increasingly rely on trucks.

For long-distance passenger transportation (and transport of high-value-per-weight commodities), it is quite possible that air transport will grow at the expense of road and rail transport. The main reasons are the poor quality of roads in most LDCs (and resulting long travel time) and the rather low air fares in many countries. Buses will remain important as a means of public transport, with little serious competition from rail in most LDCs.

For urban passenger transportation, improved bus service and rail transit systems are receiving attention in many LDCs. A handful of cities have had fairly extensive rapid transit rail systems for a number of years, and systems of varying degree of development also exist or are under construction (slowly, in most cases) in many other cities. The extent to which these systems will cut into passenger car use remains to be seen.

The Rate of Growth in Motor Vehicles Will be Greatest in Asia

Future increase in motor vehicles will depend mostly on economic growth and the rise of a middle class in the LDCs. In the long run, the current low levels of motorization and large population imply considerable room for growth, particularly in Asia. Government policy, influenced by foreign exchange constraints, and the ability of the local motor vehicle industry to produce good-quality, low-priced cars will have significant effects on growth.

The largest source of growth in motor vehicles over the next decade will be Brazil, but a large share of the new vehicles (especially cars) will use ethanol rather than oil. Brazil

has a large population (135 million), an established motor vehicle industry with government support, and relatively good prospects for economic growth if the debt burden can be managed. The other large Latin American countries -- Argentina, Mexico, and Venezuela -- are in a less robust situation, but motor vehicle ownership levels are expected to rise gradually. If oil prices recover faster than seems likely at present, demand for motor vehicles in Mexico and Venezuela will rise more quickly.

Oil revenues are also a key factor in some of the other major LDCs. Saudi Arabia, Nigeria, Iran, and Indonesia will have very much slower increase in motor vehicles than occurred in the 1974-82 period.

Considerable growth in motor vehicles is likely to occur in Asia's newly-industrialized countries -- Taiwan, South Korea, and, to a lesser extent, Malaysia. A recent study of Taiwan estimated the number of cars would grow about twice as fast as GNP (Kleinbaum, 1985). If GNP grows at 6% a year, the saturation of cars would be about 9 per 100 persons, somewhat below where Argentina is today. In South Korea, where passenger car ownership is less than 2 per 100 persons, the degree of expansion will depend on whether the government eases taxation on cars, but considerable growth is very likely by the 1990s.

Economic difficulties seem likely to limit growth in many of the poorer LDCs, especially in Africa. In many countries, constraints on foreign exchange (to import complete vehicles or components) and local refinery capacity are likely to cause governments to restrain growth in passenger cars. In India, for example, the Finance Ministry in late 1986 suddenly withdrew the three-year-old customs and excise duty concessions for many fuel-efficient cars. Many of the policies that allowed easier licensing of new production capacity have been rescinded, and decisions about licensing additional foreign ventures have been deferred

indefinitely.

In China, the government has focused resources on production of trucks. The opening of the economy resulted in a surge in imports of cars by local cadres in 1985, but the resulting drain on foreign exchange reserves caused the government to shut the door to imports. Although joint ventures with foreign automakers will result in some increase in car production, sizable growth is unlikely, as resources for vehicle production are needed to modernize the outmoded truck fleet. Somewhat like the Koreans, the Chinese are interested in developing an export-based car industry. But unlike Korea, the development of the domestic market appears to be far off in the future.

Lower Oil Prices Have a Mixed Effect on LDC Transportation Oil Demand

The decline in world oil prices is likely in the near-term to result in slower growth in LDC transportation oil demand than occurred in the 1970s and early 1980s. The reason for this seemingly paradoxical result is that much of the growth in LDC demand was in the oil-exporting countries, and decline in their oil revenues has resulted in much slower growth in motor vehicles and air travel. Even though oil prices may slowly recover, the boom that boosted motor vehicle sales and air travel is very unlikely to recur.

The oil-importing countries are benefiting from lower oil prices, but in many countries shortage of foreign exchange and concerns about rising oil demand may cause continued restraint of passenger car sales. Demand for diesel fuel is likely to grow faster than gasoline, as diesel vehicles are seen as more necessary for development. Pricing reform could reduce the popularity of diesel in the light truck market, but modernization of the truck and bus fleet will result in greater diesel use in many countries.

Demand for jet fuel could rise fastest of all, in part because the present level of air travel by LDC citizens is fairly low, and in part because of growing travel to the LDCs by OECD citizens. Foreign exchange constraints play less of a role for jet fuel, because some of the demand is by overseas airlines and national airlines earn hard currency.

Looking regionally, the focus of growth in transportation oil demand will probably shift more strongly from Latin America and the Middle East to Asia. Continuing debt problems and lower oil revenues will restrain growth in Latin America and the Middle East. Taiwan and South Korea have considerable room for growth in demand and the ability to pay for it. Malaysia, Thailand, and Indonesia are more sensitive to changes in oil and other commodity prices, but prospects for economic growth and the accompanying increase in transportation are reasonably good. Perhaps the biggest uncertainty is India, where the potential for growth is substantial because of the large population and the low level of motorization, but growth in motor vehicles is strongly influenced by government policy. Similar conditions, with a stronger government role, prevail in China. In these and other countries, the capacity of the economy to absorb more motorized transport may be greater than their ability to afford it.

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*LAWRENCE BERKELEY LABORATORY
TECHNICAL INFORMATION DEPARTMENT
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720*