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EVALUATION OF POLICIES INFLUENCING ROAD TRANSPORT FUEL CONSUMPTION IN DEVELOPING COUNTRIES

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TABLE OF CONTENTS

	Page
S. SUMMARY AND CONCLUSIONS	S-1
S.1 Major Findings	S-1
S.2 Policy Implications	S-4
1. INTRODUCTION	1-1
1.1 Overview	1-1
1.2 Study Scope	1-2
1.3 Organization of the Report	1-3
2. OVERVIEW OF ROAD TRANSPORT IN DEVELOPING COUNTRIES	2-1
2.1 Introduction	2-1
2.2 Energy Consumption in the Transport Sector	2-1
2.3 Factors Influencing Energy Consumption in Road Transport	2-7
References	2-26
3. REVIEW AND SUMMARY OF VEHICLE AND FUEL TAX POLICIES	3-1
3.1 Overview	3-1
3.2 Acquisition and Ownership Taxes	3-3
3.3 User Fees	3-10
References	3-16
4. AUTOMATION TECHNOLOGY IN DEVELOPING COUNTRIES	4-1
4.1 Overview	4-1
4.2 Country Specific Vehicle Characteristics	4-2
4.3 Fuel Efficiency of Motor Vehicles in Developing Countries	4-13
4.4 Policy Implications	4-19
APPENDIX A: RATES AND BASES OF ASSESSMENT OF ROAD USER TAXES	A-1

LIST OF TABLES

		Page
S-1	Basis of Road User Taxes in AID-Assisted Countries	S-2
2-1	Energy Imports and Exports	2-2
2-2	Trends in Transport Sector Energy Use in AID-Assisted Countries	2-3
2-3	Total Transport Petroleum Use in AID-Assisted Countries	2-5
2-4	Road Transport Petroleum Use in AID-Assisted Countries	2-6
2-5	Motor Fuel Use by Fuel Type	2-8
2-6	Motor Vehicle Registrations in 1982 By Vehicle Type	2-10
2-7	Total Registrations of Passenger Cars and Commercial Vehicles: 1970-1982	2-11
2-8	Motor Vehicle Registrations Per 1,000 Inhabitants	2-13
2-9	Trends in Car Registrations and Gasoline Consumption in AID-Assisted Countries	2-16
2-10	1981 Road Traffic in AID-Assisted Countries	2-17
2-11	1981 Imports and Assemblies of Passenger Cars by Country of Origin: Central/South America	2-19
	1981 Imports and Assemblies of Passenger Cars by Country of Origin: Africa	2-20
	1981 Imports and Assemblies of Passenger Cars by Country of Origin: Asia	2-21
3-1	Basis of Road User Taxes in AID-Assisted Countries	3-2
3-2	Vehicle Ownership Taxes for Selected Models in India	3-5
3-3	Passenger Car Customs Duties in India	3-6
3-4	Motor Vehicle Ownership Taxes in Pakistan	3-7
3-5	Passenger Car Import Duties in Pakistan.	3-8
3-6	Sales Tax on New Cars in Portugal - 1985	3-9

LIST OF TABLES (cont'd)

		Page
3-7	Comparison of Petroleum Product Prices - July 1984	3-11
3-8	Vehicle and Fuel Costs of a Gasoline Vs. Diesel Ford Wagon in Pakistan in 1975	3-15
4-1	Model Specific Sales in 1982 - Mexico	4-4
4-2	Vehicle Sales in 1982 - India	4-6
4-3	1982 Car Sales in Countries with Major Assembly Facilities	4-8
4-4	1982 Commercial Vehicle Sales in Countries with Major Assembly Facilities	4-10
4-5	Proven Reserves of Oil and Gas	4-22

LIST OF FIGURES

		Page
S-1	Relationship Between Gasoline Consumption and Affordability in 1983	S-4
S-2	Relationship Between Diesel Fuel Use and Economic Output in 1983	S-5
2-1	1982 Relationship Between Motor Gasoline Consumption and Passenger Car Usage	2-14
2-2	Relationship Between Gasoline Consumption and Affordability	2-23
2-3	Relationship Between Diesel Fuel Use and Economic Output	2-24
3-1	Components of Fuel Prices in Pakistan	3-12
4-1	Engine Series Which is Provided for Each Representative Car Family in Each Destination	4-16

S. SUMMARY AND CONCLUSIONS

Road transport typically constitutes about 70-80 percent of the total transportation fuel use in developing countries and is almost wholly dependent on petroleum. In an effort to reduce oil imports, many developing countries have promoted alternative sources of energy supplies and they have directly or indirectly encouraged fuel conservation through the use of a range of tax and pricing policies affecting patterns of motor vehicle ownership and use.

This study, sponsored by the U.S. Agency for International Development (AID), attempts to provide a better understanding of the effectiveness of fiscal tax and pricing policies on fuel consumption in the road transport sector of developing countries. The study focuses on two areas: 1) an assessment of the influence of taxation on fuel use, and 2) an examination of the impact of automotive technology on fuel consumption in developing countries. Major findings in each of the two areas are summarized below in Section S.1. Policy implications for AID are outlined in Section S.2.

S.1 MAJOR FINDINGS

S.1.1 Motor Vehicle and Fuel Taxation

Road transport taxes in developing countries fall into three broad categories: motor vehicle acquisition fees, ownership taxes and use (primarily fuel) taxes (see Table S-1). No data are available to quantify the influence of these tax burdens on fuel efficiency and fuel use in developing countries. Nevertheless, qualitative conclusions can be drawn.

TABLE S-1

BASIS OF ROAD USER TAXES IN AID-ASSISTED COUNTRIES

	Acquisition Tax										Ownership Taxes						Use Fees		
	Sales Tax		Resale Tax	Import Duty		Registration Fee													
	Value	CID		Value	Vehicle Type	Flat	Horse Power	Vehicle Type	Value	Weight	CID	Fuel	Horse Power	Age	Weight	Vehicle Type	Fuel	Transport	Tire
AFRICA																			
Kenya	X			X		X											X		X
Niger							X	X					X	X		X	X	X	
Tunisia							X					X	X		X	X	X	X	
Upper Volta		X			X			X					X				X		
SOUTH/CENTRAL AMERICA																			
Colombia				X					X	X							X		
Mexico																	X		
Peru	X		X		X					X							X		
Uruguay															X		X	X	X
ASIA																			
India	X			X	X	X										X	X	X	X
Pakistan				X	X										X	X	X		
Philippines																	X		
Sri Lanka			X	X	X			X						X	X	X	X		X
Thailand					X										X		X	X	
EUROPE																			
Cyprus	X							X		X		X	X	X		X	X		
Portugal	X	X	X							X	X	X		X		X	X	X	

SOURCE: International Road Federation, World Road Statistics 1979-1983, 1984 edition

Motor Vehicle Acquisition and Ownership Taxes

- Vehicle purchase and ownership taxes vary widely among developing countries with respect to rates and bases of assessment. Bases of assessment include value, horsepower, weight, and/or engine displacement.
- In most of the AID-assisted countries, import duty rates on commercial vehicles are lower than those for automobiles -- reflecting the greater value assigned to the importation of goods for economic development than for personal consumption.
- Most countries have highly progressive taxes on the sale and ownership of passenger cars -- taxes which are typically structured to provide an incentive for the purchase of smaller gasoline-fueled vehicles or two-wheelers and a disincentive for diesel car ownership.

Fuel Taxes and Prices

- Diesel fuel is priced and taxed at relatively low levels in comparison to gasoline in many developing countries. This is done for a variety of purposes, including: 1) subsidization of agricultural and construction industries for which diesel fuel costs are a large input, and 2) subsidization of mass transit which serves lower income elements of society. As a result, diesel fuel consumption is typically two to three times greater than gasoline usage in many developing countries.
- Low diesel to gasoline prices result in the disproportionate shortages of diesel fuel and problems for the disposal of surplus gasoline. This is due to the fact that the gasoline to distillate product ratio at the refinery can only be varied within a narrow margin and at a higher cost. Therefore, tax policies which sustain or promote low diesel to gasoline ratios may reap some benefit from encouraging the use of more efficient vehicles, but these benefits are partially negated by the costs of additional refining and the disposal of surplus gasoline.
- Data limitations preclude the establishment of a quantitative relationship between fuel tax burdens and fuel usage levels in developing countries. Nevertheless, there are sufficient data to demonstrate that rising per capita gasoline consumption levels are linearly related to growth in the relative affordability of gasoline (measured by the ratio of per capita income to fuel price) in developing countries (see Figure S-1). In addition, diesel fuel use is directly correlated with growth in economic output (see Figure S-2).

3

FIGURE S-1

Relationship Between Gasoline Consumption And Affordability In 1983

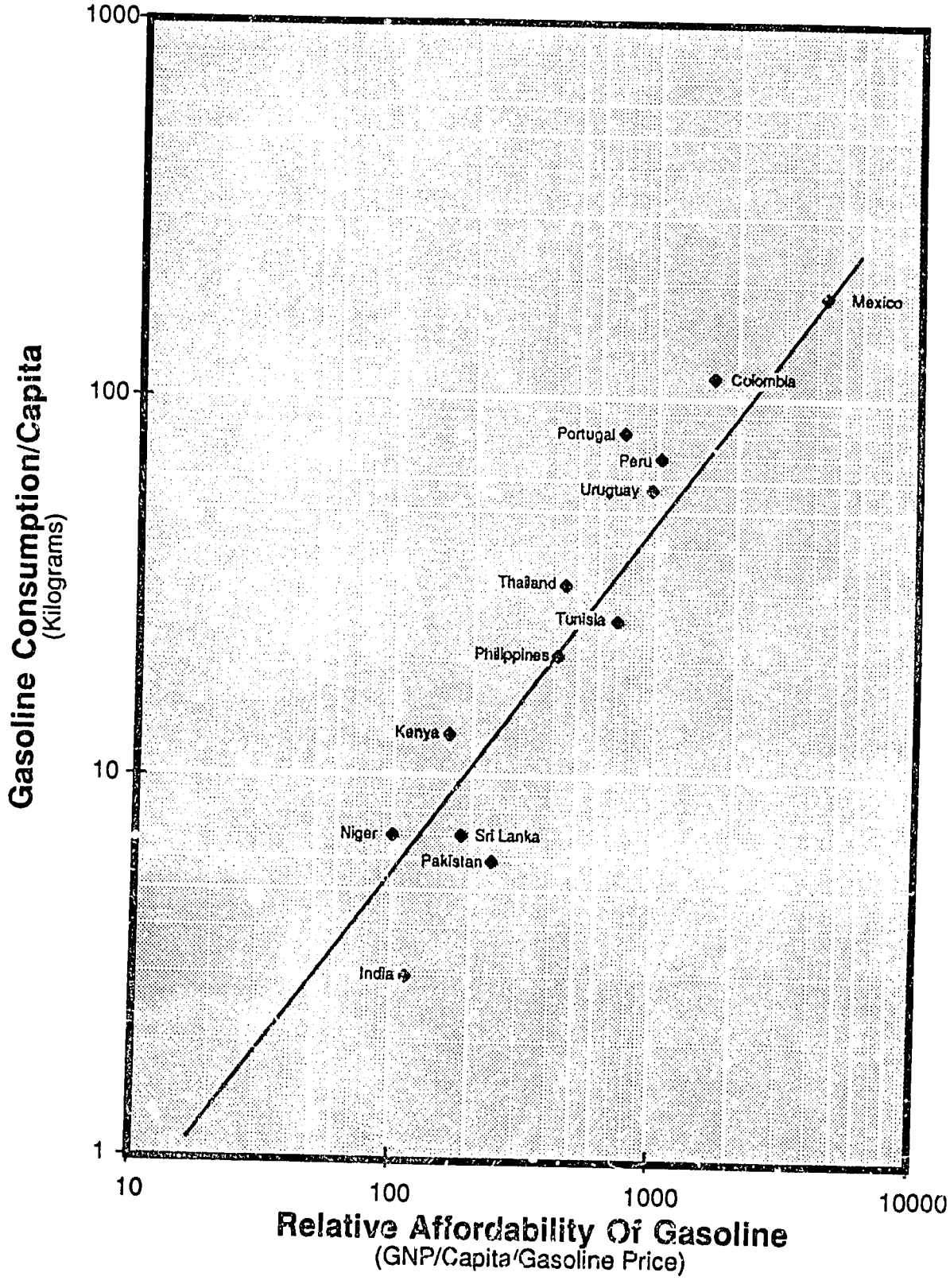
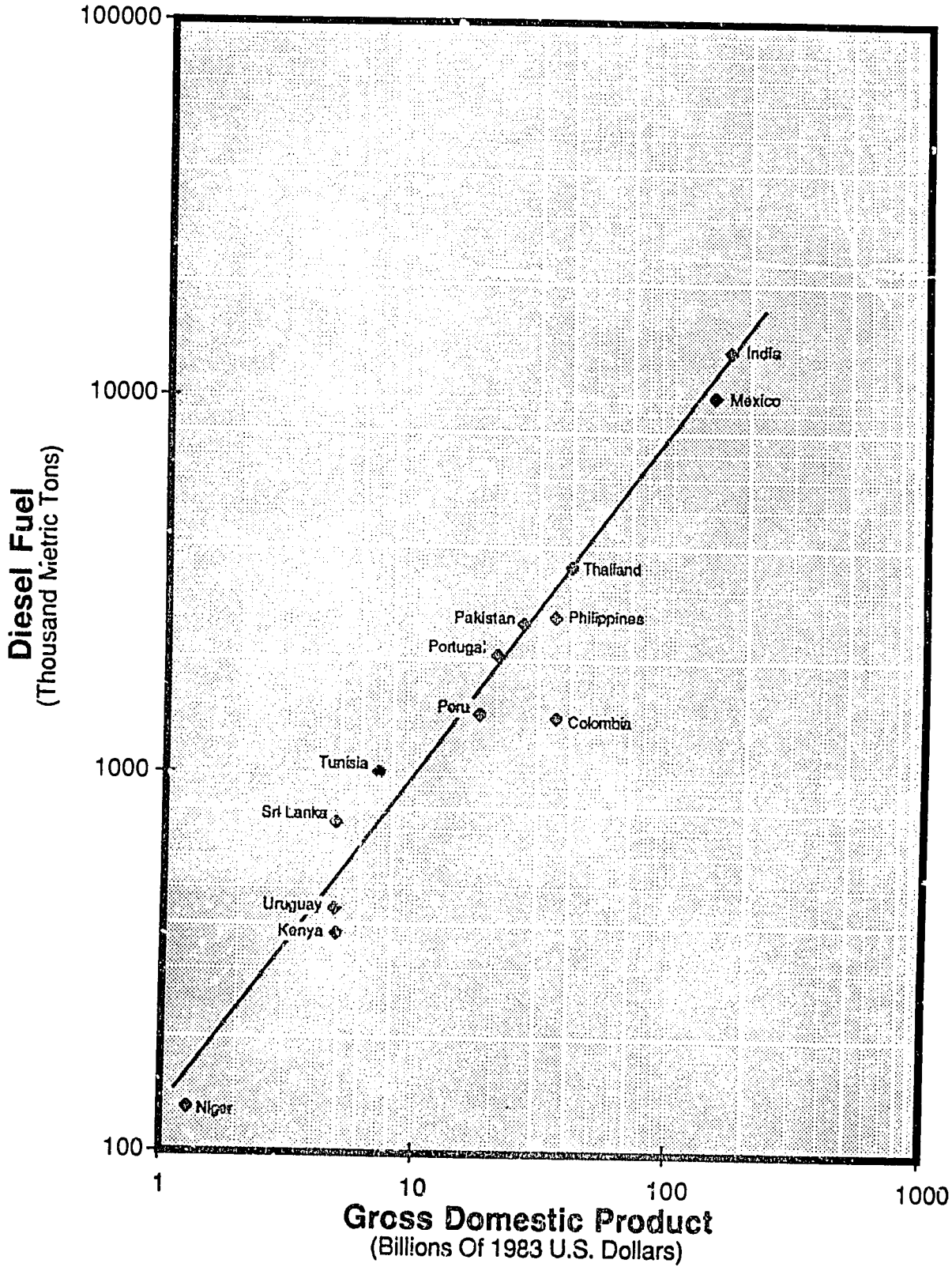


FIGURE S-2

Relationship Between Diesel Fuel Use And Economic Output In 1983



5

S.1.2 Motor Vehicle Technology and Fuel Efficiency

- The conversion of two-wheelers from two-stroke to four-stroke gasoline engines can provide significant fuel efficiency improvements to consumers. The net impact on total fuel consumption is expected to be small as two-wheelers consume only a small fraction of the total fuel.
- The 15 AID-assisted nations vary considerably with respect to the makes of vehicles available and used in road transport. Only two countries -- Mexico and India -- possess extensive manufacturing facilities. The others import most of their vehicles or have facilities for the assembly of vehicles using imported knocked-down kits.
- Japan dominates the car markets of most developing countries outside of a few in Europe/North Africa where France retains a large presence. European manufacturers hold a large share of the heavy truck markets in developing countries but are facing increased Japanese competition. Japanese manufacturers dominate the light truck markets in almost all developing countries.
- Except for Portugal, most of the AID-assisted nations surveyed in this study do not collect and provide information on vehicle fuel economy to consumers.
- The fuel economy characteristics of new models sold for export/use in developing countries are not significantly different from the equivalent models sold in industrialized nations; they do not employ advanced technology but have lower performance. Two technologies which can be used to improve fuel efficiency and may be cost-effective for developing countries include electronic engine controls for gasoline engines and turbochargers for diesels.
- While new vehicle efficiency in most developing countries is approximately on par with the industrialized world, the fuel efficiency of the in-use fleet lags far behind. This is attributed to: 1) very low rates of vehicle scrappage and stock turnover caused by very high rates of inflation which make the purchase of a new vehicle significantly more costly than the repair of an old one and thereby inhibits fuel efficiency improvement through the diffusion of new technology; and 2) poor preventive maintenance and repair practices which significantly reduce on-road fuel economy performance.

6

- The potential savings in foreign exchange from reduced petroleum imports through the substitution of domestically produced alcohol fuels in diesel engines is not being realized in any of the developing countries analyzed.

S.2 POLICY IMPLICATIONS

This assessment of motor vehicle taxation, technology and fuel efficiency characteristics in developing countries indicates a number of areas where AID could initiate new policies. Specifically, AID should encourage developing country governments to:

- Institute programs designed to gather more data on the technological and operating characteristics of their transport fleets. Surveys which are conducted to collect information on vehicular fuel efficiency, travel, fuel use by fuel type (gasoline versus diesel) and the age distribution of the fleet would be especially useful to the design and evaluation of automotive energy conservation policies.
- Establish programs and policies to accelerate the rate of turnover of vehicles, especially commercial vehicles, in the fleet in order to speed the diffusion of fuel efficiency improvements embodied in new vehicles. Such programs may take the form of offering a bounty on the scrappage of old vehicles, tax rebates on the purchase of newer ones, or a stringent inspection program designed to take old, high emitting, low fuel economy vehicles out of service.
- Initiate public information activities designed to increase consumer awareness of fuel economy and the benefits of preventive vehicle maintenance.
- Accelerate the introduction of cost-effective electronic engine controls and turbochargers through policies such as: 1) reduced import duties, 2) mechanics training, 3) mandatory inclusion by local assemblers, and/or 4) tax rebates for the purchase/installation of the electronic spark controls as a retrofit option.
- Actively intervene to mandate technology improvements in countries where the automotive market is highly protected or characterized by limited model choice.
- Alleviate problems of excess demand/consumption of diesel fuel relative to gasoline by providing tax incentives for the use of alcohol in diesel vehicles, particularly in commercial and fleet applications. Such a policy would not only displace

diesel fuel and alleviate potential shortages, it would also produce environmental benefits of reduced vehicle emissions in urban areas. In addition, it would reduce petroleum imports if the alcohol was produced from domestic supplies of natural gas.

1. INTRODUCTION

1.1 OVERVIEW

The transport sector performs an important role in the economies of all developing and industrialized nations. It provides the infrastructure to support continued economic growth and development. However, it also is a very energy-intensive sector which relies almost exclusively on the use of petroleum as the major source of energy. In almost all countries, developing or industrialized -- petroleum provides over 95 percent of the energy requirements for motor transport.

These factors often create a predicament for governments of oil importing developing countries: more transport is needed to support economic development, but more transport requires more petroleum imports which are a burden to the economy and a drain on scarce foreign exchange reserves. Governments typically attempt to resolve this predicament by establishing policies designed to improve transport sector energy efficiency -- an approach which can simultaneously reduce the growth in oil imports while maintaining growth in the transport system infrastructure. Most developing countries have little or no indigenous motor vehicle production capabilities, and therefore cannot increase the energy efficiency of motor transport by setting standards to force changes (improvements) in vehicle design. Nevertheless, developing countries can and do influence vehicle fuel efficiency through the implementation of fiscal tax policies affecting fuel prices and the costs of vehicle ownership and operation.

In order to promote the use of fiscal and pricing measures as a means of encouraging fuel efficiency, it is necessary to understand and evaluate the effectiveness of alternative policy options. A fairly extensive

body of literature exists on the influence of taxation on vehicle purchase and use patterns in industrialized countries. However, there is no centralized source of information concerning the influence of fuel pricing and vehicle taxation policies in developing countries. Therefore, the purpose of this study is to gather data on fiscal policies influencing road transport in selected developing countries (assisted by the U.S. Agency for International Development). Data related to vehicle ownership, consumption and use patterns are collected and organized on a consistent metric basis to support a qualitative evaluation of the influence of alternative policy options on fuel consumption patterns in developing countries.

To properly evaluate the effectiveness of alternative policy options, it is important to have a good understanding of the influence of vehicle technology on fuel efficiency in developing countries. This is particularly important in light of evidence that tax policies can and do introduce distortions in the marketplace which may lead to the use of relatively inefficient vehicle technologies. For example, the maintenance of extremely high duties on imported motor vehicles and parts in India has prevented the widespread use of turbochargers for diesel powered commercial trucks and electronic engine controls for gasoline-fueled vehicles. Yet, these are two fuel efficient technologies, which have been demonstrated to be highly cost-effective in industrialized nations. Hence this study also provides a separate review of the technologies available in vehicles marketed in developing countries which are assisted by the U.S. Agency for International Development (AID).

1.2 STUDY SCOPE

A primary AID directive for this study was to limit the analysis of tax policies in developing countries to those nations currently receiving AID funds. Due to the large number of AID-funded countries, it was necessary to select a more manageable sample representing the full

spectrum of tax policies, economic, transportation and energy characteristics (i.e., automobile production capacity, car registrations, income and fuel consumer per capita) of developing nations. In addition, an important criterion also concerned the availability of data on tax policies and transportation-related characteristics. Using these criteria, the following 15 AID-assisted countries were selected for this study:

Africa	Latin America
Kenya	Colombia
Niger	Mexico
Tunisia	Peru
Upper Volta	Uruguay

Asia	Europe
India	Cyprus
Pakistan	Portugal
Philippines	
Sri Lanka	
Thailand	

1.3 ORGANIZATION OF THE REPORT

Section 2 provides an overview of road transport in the 15 AID-funded countries selected for this study. It presents and reviews available data on the transportation fuel use and the characteristics of the motor vehicle fleet in developing countries. Section 3 reviews and summarizes vehicle and fuel tax-related policies in each of the 15 countries. A detailed characterization of automotive technology in developing countries is presented in Section 4. Appendix A presents details on the motor vehicle tax rates and bases of assessment in selected AID-assisted countries.

2. OVERVIEW OF ROAD TRANSPORT IN DEVELOPING COUNTRIES

2.1 INTRODUCTION

In order to analyze the influence of motor vehicle and fuel tax-related fiscal policies in developing countries, it is important to have a good understanding of the underlying trends in the fuel consumption patterns and motor vehicle fleet physical (technological) and operational characteristics. This section presents and reviews the available data on energy consumption in the transport sectors of 15 AID-funded countries. It also discusses available data on the economic and structural factors influencing road transport fuel use in developing countries (i.e., motor vehicle registrations per capita, distribution of vehicles, by vehicle type, fuel use per vehicle, etc.).

2.2 ENERGY CONSUMPTION IN THE TRANSPORT SECTOR

The role of petroleum both as the primary fuel driving the transport sector and as a major factor in the balance of payments positions of developing countries cannot be ignored in the development of transport fiscal policy. As shown in Table 2-1, fuels and lubricants in 1982 accounted for 2 to 37 percent of the total merchandise imports of the AID-assisted countries examined in this study. Except for Peru (which consumes most of its domestic petroleum production), the cost of petroleum imports ranged from 17 to 48 percent of the total merchandise exports of AID-assisted nations in 1983.

As shown in Table 2-2 the transport share of total energy use in AID-assisted countries spans a relatively wide range of 8 to 38 percent and is almost completely dependent on petroleum. With some exceptions (most notably, Tunisia), the transport share of total energy appears to be

TABLE 2-1

ENERGY IMPORTS AND EXPORTS

	Fuels and Lubricant Share of Total Merchandise Imports - 1982 (Percent)	Energy Imports Share of Total Merchandise Exports - 1983 (Percent)
AFRICA		
Kenya	37	N/A
Niger	15	17
Tunisia	21	31
Upper Volta	16	50
SOUTH/CENTRAL AMERICA		
Colombia	12	21
Mexico	12	N/A
Peru	2	2
Uruguay	32	33
ASIA		
India	35	N/A
Pakistan	31	49
Philippines	26	44
Sri Lanka	31	40
Thailand	31	39
EUROPE		
Cyprus	19	N/A
Portugal	27	48

SOURCE: World Bank, World Development Report 1985

TABLE 2-2

TRENDS IN TRANSPORT SECTOR ENERGY USE
IN AID-ASSISTED COUNTRIES

	Transport Share of Total Energy Use (Percent)				Petroleum Share of Transport Energy (Percent)			
	1979	1980	1981	1982	1979	1980	1981	1982
AFRICA								
Kenya	9.2	9.0	9.1	8.1	98.4	98.3	98.5	98.9
Niger	8.5	9.4	10.0	n/a	100.0	100.0	100.0	100.0
Tunisia	30.0	28.5	32.3	33.1	99.6	99.5	99.5	99.4
Upper Volta	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SOUTH/CENTRAL AMERICA								
Colombia	28.9	27.6	28.1	28.6	100.0	100.0	100.0	100.0
Peru	27.8	29.3	30.6	29.1	100.0	100.0	100.0	100.0
Mexico	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Uruguay	28.3	29.4	31.9	32.6	99.7	99.8	99.8	100.0
ASIA								
India	15.6	15.3	14.7	14.8	59.8	60.3	64.2	67.2
Pakistan	15.3	16.2	19.3	19.7	100.0	100.0	100.0	100.0
Philippines	13.2	11.3	10.3	9.9	100.0	100.0	100.0	100.0
Sri Lanka	18.3	19.8	19.4	19.0	100.0	100.0	100.0	100.0
Thailand	23.7	23.4	23.4	20.8	100.0	100.0	100.0	100.0
EUROPE								
Cyprus	35.7	34.9	36.2	38.4	100.0	100.0	100.0	100.0
Portugal	35.4	33.3	35.4	N/A	99.3	99.2	99.3	99.3

N/A = not available

SOURCE: United Nations, Energy Balances and Electricity Profiles, 1982, published in 1985

lowest in Africa (~8-10 percent) and highest in Europe (~33-38 percent) with that of Asia and South/Central America falling in the middle of the range (~15-24 percent and ~27-33 percent, respectively). While there have been some small changes in the transport share of total energy use over the 1978 to 1982 time period, the trends as shown in Table 2-2, have not been consistent across AID-assisted countries.

In absolute terms, the volume of total transport petroleum usage also has varied widely across AID-assisted countries. Table 2-3 shows that during the period 1979 to 1982, transport sector petroleum usage ranged from about 3,000 terajoules in Niger to 558,000 terajoules in India. In addition, there were major differences in the growth of petroleum usage among AID-assisted countries during the late 1970's and early 1980's. In countries such as Pakistan, Niger, India and Sri Lanka, transport petroleum usage grew in excess of 5 percent per year between 1979 and 1982. In other nations such as the Philippines, Kenya and Thailand, transport petroleum consumption actually declined over the 1979-1982 time period (see Table 2-3).

As illustrated in Table 2-4, road transport accounts for the bulk of total transport petroleum usage in most of the AID-assisted countries. Again, however, this share varies widely from country to country depending upon the composition of the transportation infrastructure. For example, in countries such as Kenya and Peru, railroads are a major energy-user, and road motor vehicles account for only 47 to 50 percent of total transport energy use. In other nations, such as Cyprus, Niger, Tunisia and India, road transport contributes over 85 percent of the total fuel consumed by the transportation sector.

There are little or no data available on the distribution of petroleum fuels by fuel type within road transport. While several sources publish data on the consumption of motor gasoline in road vehicles in developing

TABLE 2-3

TOTAL TRANSPORT PETROLEUM USE IN AID-ASSISTED COUNTRIES
(Terajoules)

	1979	1980	1981	1982	Annual Percent Change 1979-1982
AFRICA					
Kenya	27,080	27,659	28,584	26,098	- 1.2
Niger	3,022	3,453	3,884	N/A	+13.4*
Tunisia	37,668	35,866	38,608	40,704	+ 2.6
Upper Volta	N/A	N/A	N/A	N/A	N/A
SOUTH/CENTRAL AMERICA					
Colombia	169,841	170,153	177,053	182,578	+ 2.4
Mexico	N/A	N/A	N/A	N/A	N/A
Peru	95,029	105,390	112,871	109,168	+ 4.7
Uruguay	23,724	24,884	24,677	23,470	- 0.4
ASIA					
India	470,633	484,063	508,046	557,714	+ 5.8
Pakistan	80,640	90,401	114,498	126,530	+16.2
Philippines	89,408	76,968	68,738	67,140	- 9.1
Sri Lanka	20,786	22,698	22,069	23,307	+ 3.9
Thailand	179,921	172,712	180,498	174,359	- 1.0
EUROPE					
Cyprus	8,353	8,646	8,602	9,077	+ 2.8
Portugal	112,625	108,438	113,881	N/A	+ 0.6*

SOURCE: United Nations, Energy Balances and Electricity Profiles, 1982, 1985

*1979-1981

TABLE 2-4

ROAD TRANSPORT PETROLEUM USE IN AID-ASSISTED COUNTRIES
(Terajoules)

	Road Transport Petroleum Use				Road As a Percent of Total Transport			
	1979	1980	1981	1982	1979	1980	1981	1982
AFRICA								
Kenya	12,677	12,676	14,610	12,477	46.8	45.8	51.1	47.6
Niger	2,891	3,193	3,494	N/A	95.7	92.5	90.0	N/A
Tunisia	30,929	33,188	34,202	35,521	82.1	92.5	88.6	87.3
Upper Volta	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SOUTH/CENTRAL AMERICA								
Colombia	133,071	131,005	136,061	139,138	28.4	77.0	76.9	76.2
Mexico	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Peru	49,764	53,281	55,655	59,392	52.4	50.6	49.3	54.4
Uruguay	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ASIA								
India	390,306	412,231	430,878	461,343	82.9	85.2	84.8	82.7
Pakistan	51,273	57,282	67,906	76,800	63.6	63.4	59.3	60.7
Philippines	67,507	53,779	47,317	45,722	75.5	69.9	68.8	68.1
Sri Lanka	17,167	18,092	17,328	18,356	82.6	79.7	78.5	78.8
Thailand	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EUROPE								
Cyprus	8,353	8,646	8,602	9,077	100.0	100.0	100.0	100.0
Portugal	86,248	82,899	87,085	N/A	79.5	76.4	76.5	N/A

SOURCE: United Nations, Energy Balances and Electricity Profiles, 1982, published in 1985

countries, the availability of diesel fuel consumption data on a similar basis is limited. This is due to the fact that statistics on highway diesel fuel and distillate fuels used in railroad, home heating, marine and agricultural applications are often lumped together. For example, in a country such as India, which relies heavily on railroads for passenger and freight transport, a significant amount of diesel fuel is consumed by locomotives. With this caveat in mind, Table 2-5 shows the relative consumption of total diesel fuel versus total motor gasoline in various AID-funded countries. Diesel fuel ranges widely from 40 percent to seven times the demand for gasoline. As presented in Table 2-5, in most countries (except, perhaps those in Africa), diesel fuel also has either grown faster or fallen more slowly than gasoline consumption over the period 1979-1983. This is directly attributable to the relatively higher growth in the commercial vehicle versus passenger car fleets which has occurred over the past several years (see Section 2.3).

Even if one assumed that 40-50 percent of the total diesel fuel in Table 2-5 was non-highway related, diesel fuel would continue to have a relatively high share of total road transport use in most developing countries. This is attributable to the proportionately large component of diesel powered commercial vehicles (trucks and buses) vis-a-vis gasoline-fueled motor cars in use.

2.3 FACTORS INFLUENCING ENERGY CONSUMPTION IN ROAD TRANSPORT

There are a number of factors which directly affect road transport fuel consumption in developing countries. These include: 1) trends in the size and composition of the motor vehicle fleet, 2) growth in road travel, and 3) technological characteristics influencing motor vehicle fuel efficiency. Changes in each of these factors are brought about by shifts in demographics, macro-economic trends (i.e., fuel prices, income levels) and government intervention (i.e., through the manipulation of fiscal tax policy and regulatory standards). Changes in motor vehicle

18

TABLE 2-5

MOTOR FUEL USE BY FUEL TYPE
(x 1,000 metric tons)

	1979			1983			1979-1983 Annual Growth (percent)	
	Gasoline	Diesel	Diesel/ gas	Gasoline	Diesel	Diesel/ Gas	Gasoline	Diesel
AFRICA								
Kenya	283	417	1.47	240	378	1.58	- 4.0	- 2.4
Niger	31	108	3.48	40	130	3.25	+ 6.6	+ 4.7
Tunisia	148	909	6.14	176	1,001	5.69	+ 4.4	+ 2.4
Upper Volta	44	63	1.43	57	52	0.91	+ 6.7	- 4.7
SOUTH/CENTRAL AMERICA								
Colombia	3,036	1,129	0.37	3,135	1,400	0.45	+ 0.8	+ 5.5
Mexico	11,878	10,556	0.89	14,141	10,074	0.71	+ 4.4	- 1.2
Peru	1,154	1,396	1.21	1,315	1,435	1.09	+ 3.3	+ 0.7
Uruguay	212	494	2.33	171	439	2.57	- 5.2	- 2.9
ASIA								
India	1,569	10,927	6.96	1,928	13,410	6.96	+ 5.3	+ 5.3
Pakistan	538	2,018	3.75	613	2,482	4.05	+ 3.3	+ 5.3
Philippines	1,899	3,760	1.98	1,080	2,611	2.42	-13.2	- 8.7
Sri Lanka	107	352	3.29	114	737	6.46	+ 1.6	+20.3
Thailand	1,711	3,837	2.24	1,588	3,550	2.24	- 1.8	- 1.9
EUROPE								
Cyprus	103	140	1.36	111	182	1.64	+ 1.9	+ 6.8
Portugal	750	1,505	2.01	817	2,055	2.52	+ 2.2	+ 8.1

SOURCE: United Nations, Energy Statistics Yearbook, 1983

technological characteristics and fiscal tax policies are the subjects of Sections 3 and 4. This section focuses on the data available on the "structural" and key macro-economic factors influencing road transport fuel use.

2.3.1 Motor Vehicle Registrations

Table 2-6 presents data on motor vehicle registrations in 1982 by vehicle type for AID-assisted developing countries. Total motor vehicle registrations ranged from about 37,000 in Niger to nearly seven million in Mexico. In most of the AID-assisted countries in Africa, South/Central America and Europe, passenger cars accounted for well over 40 percent of the total motor vehicles in use. The share of commercial vehicles ranged from about ten percent in Uruguay to as high as 46 percent in Tunisia. In several of the lower per capita income developing countries of Asia, two-wheeled vehicles also were a dominant mode of transport. In India, for example, there were three times as many two-wheelers as there were passenger cars.

From 1970 to 1982 the number of passenger cars and commercial vehicles in operation in AID-assisted countries expanded rapidly. As illustrated in Table 2-7, total registrations grew at annual rates ranging from two percent for Kenya to 11.3 percent for Mexico and 14.6 percent for Portugal.* On a regional basis, there were no clear cut differences among the growth rates in total passenger car and commercial vehicle registrations recorded by the AID-assisted countries.

For all countries (except Tunisia and Upper Volta in Africa and Thailand in Asia), passenger automobiles accounted for well over 50 percent of the total cars and commercial vehicles in operation. However, the passenger car share of the total generally declined over the 1970 to 1982 period --

*Table 2-7 excludes two-wheelers as no data were available for 1970.

TABLE 2-6

MOTOR VEHICLE REGISTRATIONS IN 1982
BY VEHICLE TYPE
(in thousands)

	Passenger Cars	Commercial Vehicles	Two-Wheelers	Total
AFRICA				
Kenya	114.7	29.2	16.8	160.7
Niger	16.0	15.0	5.7	36.7
Tunisia	141.2	147.6	29.1	317.9
Upper Volta	12.6	13.4	16.8	42.8
SOUTH/CENTRAL AMERICA				
Colombia	551.8	270.7	463.7	1,286.2
Mexico	4,808.0	1,777.4	371.3	6,956.7
Peru	370.2	194.8	N/A	N/A
Uruguay	281.3	49.8	186.7	517.8
ASIA				
India	907.4	900.7	2,962.7	4,770.8
Pakistan	325.2	123.7	310.3	759.2
Philippines	344.6	524.1	187.0	1,055.7
Sri Lanka	131.7	100.9	96.9	329.5
Thailand	451.0	535.7	1,140.7	2,127.4
EUROPE				
Cyprus	78.0	29.2	39.5	146.7
Portugal	2,881.7	690.3	95.8	3,667.8

SOURCES: United Nations, Statistical Yearbook 1982.

U.S. Motor Vehicle Manufacturers Association, World Motor Vehicle Data, 1984-85 edition.

21

TABLE 2-7

TOTAL REGISTRATIONS OF PASSENGER CARS AND COMMERICALS VEHICLES: 1970-1982
(in thousands)

	1970				1982				1970-1982
	Passenger Cars	Commercial Vehicles	Total	Percent Cars	Passenger Cars	Commercial Vehicles	Total	Percent Cars	Annual Percent Growth in Total Registration
AFRICA									
Kenya	95.9	18.0	113.9	84.2	114.7	29.2	143.9	80.0	+2.0
Niger	5.6	7.0	12.6	44.4	16.0	15.0	31.0	52.8	+7.8
Tunisia	N/A	N/A	N/A	N/A	141.2	147.6	288.8	48.7	N/A
Upper Volta	6.4	6.9	13.3	48.1	12.6	13.4	26.0	48.7	+5.7
SOUTH/CENTRAL AMERICA									
Colombia	238.5	83.5	322.0	74.2	551.8	270.7	822.5	67.2	+8.1
Mexico	1,233.8	588.9	1,822.7	67.7	4,808.0	1,777.4	6,585.4	71.4	+11.3
Peru	230.4	117.5	347.9	66.1	370.2	194.8	565.0	63.9	+4.1
Uruguay	121.0	88.0	209.0	57.9	281.3	49.8	331.1	85.5	+3.9
ASIA									
India	627.2	413.9	1,041.1	57.9	907.4	900.7	1,808.1	52.0	+4.7
Pakistan	154.5	63.6	218.1	70.3	325.2	123.7	448.9	72.9	+6.2
Philippines	279.2	179.4	458.6	60.8	344.6	524.1	868.7	39.6	+5.5
Sri Lanka	87.7	44.9	132.6	66.0	131.7	100.9	232.6	56.9	+4.8
Thailand	184.7	162.8	347.5	53.1	451.0				
EUROPE									
Cyprus	85.1	13.7	68.8	80.1	98.0	29.2	127.2	76.9	+5.3
Portugal	551.0	146.8	697.8	79.0	1,040.0	331.0	3,572.0	75.7	+14.6

SOURCES: United Nations, Statistical Yearbook 1982.

U.S. Motor Vehicle Manufacturers Association, World Motor Vehicle Data, 1984-85 edition.

probably reflecting an accelerated growth in the use of commercial vehicles for freight transport, public transit, etc. (This explains, in large part, the growth in diesel fuel vis-a-vis gasoline consumption which has occurred in many developing countries over the past several years.) In addition, accelerated growth in two-wheeled vehicles made in-roads on passenger cars. In India, for example, the number of passenger cars in-use grew at an annualized rate of 3.1 percent between 1970 and 1982 while two-wheelers grew at 14.6 percent/year.

While Table 2-7 provides a comparative overview of the growth in total motor vehicles in-use, Table 2-8 presents a more accurate comparison of trends in motor vehicle ownership levels. Table 2-8 shows that there is a wide disparity in the number of motor vehicle registrations per 1,000 inhabitants. As might be expected, AID-assisted countries in Europe recorded the highest motor vehicle ownership levels, while the more populated and developing countries of Asia and Africa recorded the lowest motor vehicle ownership rates. In fact, the growth in motor vehicle registration in Kenya during the 1970 to 1982 time period did not keep pace with an exploding birth rate and subsequent population boom -- resulting in an actual decline in motor vehicle ownership levels.

The close correlation between the degree of motorization (number of passenger cars per 1,000 inhabitants) and gasoline consumption per capita in AID-assisted countries is illustrated in Figure 2-1. As expected, countries such as Cyprus, Portugal, Uruguay and Mexico which have relatively high car ownership levels also experience high gasoline consumption. What is interesting in Figure 2-1, however, is the fact that several countries with similar car ownership levels have vastly different per capita gasoline consumption rates. This for example, is true of Tunisia, Peru and Colombia all of which have ownership levels of about 20 cars per thousand inhabitants but gasoline consumption rates

TABLE 2-8

MOTOR VEHICLE REGISTRATIONS PER 1,000 INHABITANTS

	Passenger Cars			Commercial Vehicles			Total		
	1970	1982	% Growth	1970	1982	% Annual Growth	1970	1982	% Annual Growth
AFRICA									
Kenya	8.5	6.4	-2.3	1.6	1.6	0	10.1	8.0	-1.8
Niger	1.4	2.8	5.9	--	2.5	--	--	5.3	--
Tunisia	13.0	21.2	4.2	--	22.3	--	--	43.5	--
Upper Volta	1.3	1.9	3.2	1.4	2.0	3.0	2.7	3.9	+3.1
SOUTH/CENTRAL AMERICA									
Colombia	11.2	21.7	5.7	3.9	10.6	8.7	15.1	32.3	+6.5
Mexico	24.1	71.4	9.5	11.5	28.6	7.9	35.6	100.0	+9.0
Peru	17.9	20.0	0.9	9.2	11.3	1.7	27.1	31.3	+1.2
Uruguay	43.1	100.0	7.3	31.3	16.9	-5.0	74.4	116.9	+3.8
ASIA									
India	1.1	1.3	1.4	0.8	1.2	3.4	1.9	2.5	+2.3
Pakistan	2.6	3.5	2.5	1.1	1.3	1.4	3.7	4.8	+2.2
Philippines	7.6	6.7	-1.0	4.9	10.2	6.3	12.5	16.9	+2.5
Sri Lanka	7.0	8.7	1.8	3.6	6.6	5.2	10.6	15.3	+3.2
Thailand	5.1	9.1	4.9	4.5	10.8	7.6	9.6	19.9	+6.3
EUROPE									
Cyprus	91.2	153.8	4.5	22.6	46.2	6.1	113.8	200.0	+4.8
Portugal	60.9	105.2	4.7	16.2	33.7	6.3	77.1	138.9	+5.0

SOURCES: United Nations Statistical Yearbook, 1982

U.S. Motor Vehicle Manufacturers Association, World Motor Vehicle Data, 1984-85 edition

24

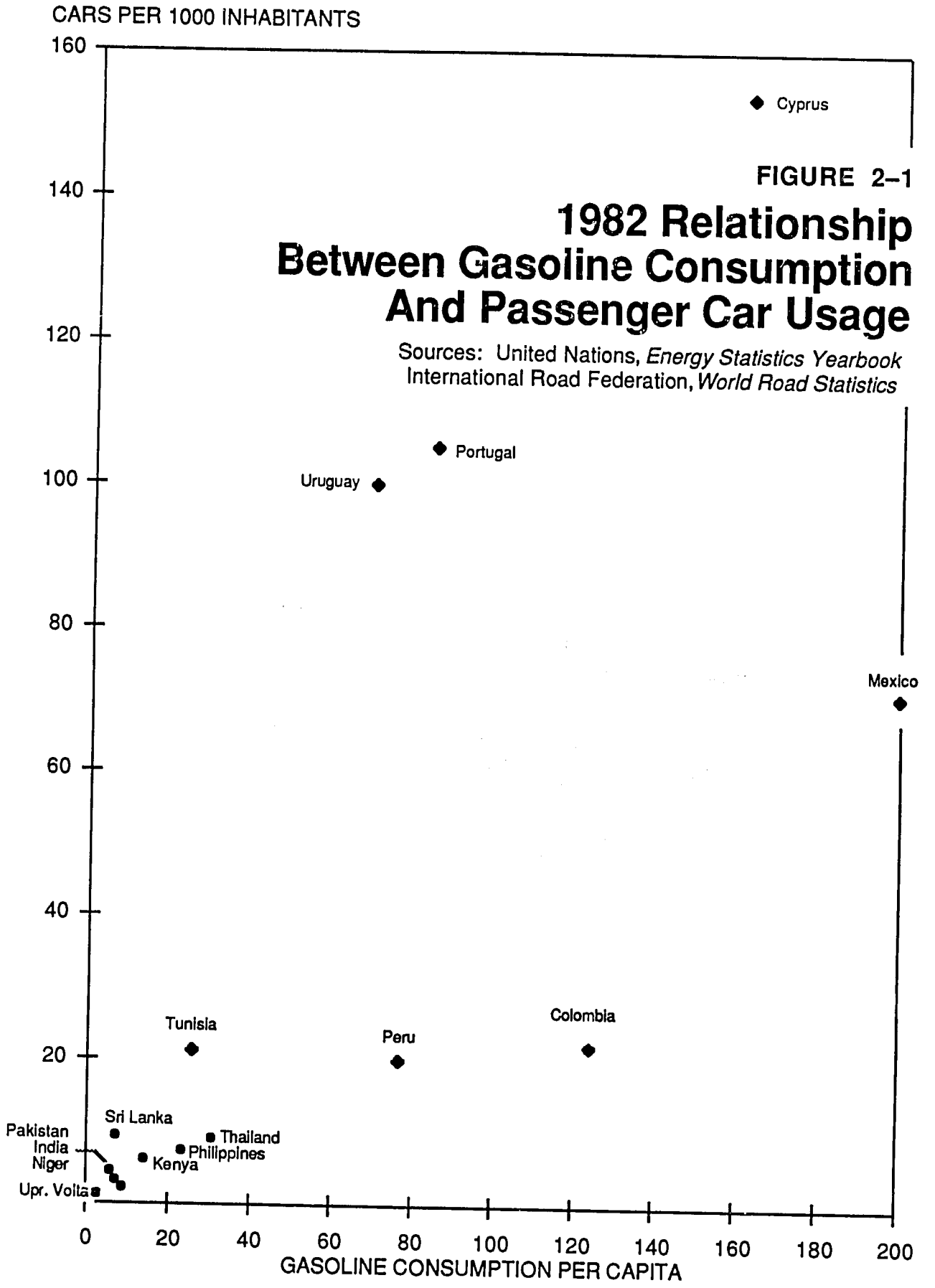


FIGURE 2–1

1982 Relationship Between Gasoline Consumption And Passenger Car Usage

Sources: United Nations, *Energy Statistics Yearbook*
International Road Federation, *World Road Statistics*

25

which vary from 20 to 120 kilograms per capita. This reflects differences in geographic conditions and levels of urbanization among developing countries (which influences driving distances, levels of traffic congestion, etc.). It also would seem to indicate the existence of motor vehicle fleets with vastly different technological and operating characteristics.

On a per vehicle basis there are, in fact, significant differences in gasoline consumption levels across countries. Table 2-9 compares total gasoline consumption per car by country. These figures are admittedly crude in that they include non-passenger car gasoline consumption. Nevertheless, some general conclusions can be drawn. Annual gasoline consumption per car in 1982 varied from 2,152 gallons per car in Colombia to 263 gallons per car in Uruguay. Except for three countries in Africa, Pakistan and Portugal, gasoline consumption per car generally dropped sharply over the 1979 to 1982 time period. As annual gasoline consumption per car is essentially the quotient of annual miles traveled per vehicle and vehicular fuel efficiency, a decline would imply either a reduction in travel or substantial growth in efficiency.

2.3.2 Growth In Road Travel

Unfortunately, there are little or no data on the travel characteristics of motor vehicles in developing countries. While information on fuel consumption can generally be obtained from tax receipts, statistics on road travel and traffic must usually be derived from surveys which are costly to perform. As a result, few developing countries allocate resources to collecting travel data. Table 2-10 shows that of the 15 AID-assisted countries in this study, only five provided some information on road travel.

26

TABLE 2-9

TRENDS IN CAR REGISTRATIONS AND GASOLINE CONSUMPTION IN AID-ASSISTED COUNTRIES

	Car Registrations (thousands)				Gasoline Consumption Per Car (gallons/car)				1978-1982 Annualized Change in	
	1979	1980	1981	1982	1979	1980	1981	1982	Car Registrations	Consumption/Car
AFRICA										
Kenya	110.4	113.6	114.2	114.7	915	984	938	787	+ 1.3	- 4.9
Niger	--	15.8	15.8	16.0	--	792	814	848	+ 0.6	+ 3.5
Tunisia	--	152.7	132.4	141.2	--	360	434	435	- 3.8	+ 9.9
Upper Volta	--	15.5	11.0	12.6	--	1,218	1,817	1,619	- 9.8	+15.2
SOUTH/CENTRAL AMERICA										
Colombia	478.0	522.7	599.3	551.8	2,267	2,148	1,949	2,152	+ 4.9	- 1.7
Mexico	3,762.7	4,254.9	4,746.5	4,808.0	1,127	1,155	1,148	1,099	+ 8.5	- 0.8
Peru	--	318.7	345.2	370.2	--	1,414	1,367	1,359	+ 7.8	- 2.0
Uruguay	219.8	220.4	281.3	281.3	344	358	296	263	+13.1	- 8.6
ASIA										
India	924.9	929.8	1,057.0	1,096.4	606	534	556	586	+ 5.8	- 1.1
Pakistan	303.2	283.0	301.2	325.2	633	729	685	673	+ 2.4	+ 2.1
Philippines	464.1	441.3	505.1	560.5	1,461	1,063	802	751	+ 6.5	-19.9
Sri Lanka	114.5	120.9	126.3	131.7	334	319	308	309	+ 4.8	- 2.6
Thailand	355.8	435.0	348.2	451.0	1,717	1,397	1,586	1,180	+ 8.2	-11.8
EUROPE										
Cyprus	88.1	94.1	97.9	105.9	417	379	361	351	+ 6.3	- 5.6
Portugal	--	941.0	990.0	1,040.0	221	268	276	289	+ 5.1	+ 9.4

SOURCES: United Nations, Energy Statistics Yearbook 1982
United Nations, Statistical Yearbook 1982

TABLE 2-10

1981 ROAD TRAFFIC IN AID-ASSISTED COUNTRIES

	Traffic Volume (million of vehicle kilometers)				Average Annual Kilometers Traveled		
	Cars	Buses	Goods Vehicles	Two-Wheelers	Cars	Buses	Goods Vehicle
AFRICA							
Kenya	--	--	--	--	--	--	--
Niger	--	--	--	--	--	--	--
Tunisia	3,533	125	967	452	3,110	--	--
Upper Volta	--	--	--	--	--	--	--
CENTRAL/SOUTH AMERICA							
Colombia	3,680	912	2,413	--	26,000	86,000	57,000
Mexico	--	--	--	--	--	--	--
Peru	--	--	--	--	--	--	--
Uruguay	2,805	311	1,195	--	10,000	83,000	27,600
ASIA							
India	--	--	--	--	--	--	--
Pakistan	--	--	--	--	--	--	--
Philippines	--	--	--	--	--	--	--
Sri Lanka	--	--	--	--	--	--	--
Thailand	5,547	4,411	8,939	--	--	--	--
EUROPE							
Cyprus	--	--	--	--	--	--	--
Portugal	--	279,100	--	--	--	66,064	--

SOURCE: International Road Federation, World Road Statistics: 1979-1983, 1984 edition.

Travel data are nevertheless essential to obtain an accurate understanding of fuel consumption trends in developing countries. A recent study of Tunisia, finds, for example, that diesel-fueled automobiles are used almost 85 percent more than gasoline cars (on an annual VMT per vehicle basis). This is attributed to the fact that diesel fuel prices in Tunisia are nearly one-half those of gasoline.[1/]

There also is very little information available on the fuel efficiency characteristics of automobiles in AID-assisted nations. One can, however, perform an assessment of fuel efficiency based on knowledge of the types of passenger cars produced and/or imported into AID-assisted countries particularly since automotive technology does not vary significantly world wide.

2.3.3 Characteristics of New Vehicle Registrations

Data limitations and resource constraints prevent the detailed analysis of motor vehicle fleet characteristics for each of 15 developing countries. It is, nevertheless, useful to analyze trends in the composition of new vehicle sales in these countries. As shown in Table 2-11, India is the only one of the 15 countries selected for this study which has a indigenous automobile production. Each of the other countries rely exclusively on imports of passenger cars or the assembly of foreign cars locally to satisfy their transportation needs. In Central/South America, French manufacturers dominated the 1981 passenger car market in Colombia, the U.S. and Japan shared the majority of the Mexican market while the Japanese dominated the markets in Peru and Uruguay. In Africa, the Japanese held significant shares of the markets in Kenya and Niger while the French dominated automobile sales in Tunisia and Upper Volta. In Asia, high tariff barriers have protected the domestic automobile in India and restricted imports. In other Asian countries,

TABLE 2-11

1981 IMPORTS AND ASSEMBLIES OF PASSENGER CARS
BY COUNTRY OF ORIGIN
CENTRAL/SOUTH AMERICA

	Colombia	Mexico	Peru	Uruguay
USA				
Imports	1,538	3,585	4,735	7
Assemblies	4,472	163,965		--
SPAIN				
FRANCE				
Imports	10,176	23,417	734	1,928
Assemblies	14,806	22,204	--	--
W. GERMANY				
Imports	917	197	991	1,323
Assemblies	--	121,879	5,174	--
JAPAN				
Imports	3,762	5	16,271	4,394
Assemblies	--	47,449	7,922	--
UNITED KINGDOM	13	--	3	3,753
MEXICO	2	--	63	--
CANADA	12	570	110	3
YUGOSLAVIA	500	--	--	--
SWEDEN				
Imports	56	2	118	15
Assemblies	--	--		--
ITALY				
Imports	2,052	7	217	181
TOTAL				
Imports	24,996	27,776	23,242	11,603
Assemblies	26,515	355,597	13,096	--
TOTAL	51,511	383,273	36,338	11,603
Percent of New Car Sales	100	100	100	100

TABLE 2-11 (cont'd)

1981 IMPORTS AND ASSEMBLIES OF PASSENGER CARS BY COUNTRY OF ORIGIN*
AFRICA

	Kenya	Niger	Tunisia	Upper Volta
USA	--	385	124	--
FRANCE	324	739	4,819	428
W. GERMANY	421	43	1,380	17
JAPAN	542	638	4	200
UNITED KINGDOM	33	--	5	--
CANADA	3	--	--	--
SWEDEN	54	--	8	--
ITALY	--	--	979	--
TOTAL	1,377	1,805	7,319	645
Percent of New Car Sales	100	100	100	100

*All vehicles are imports.

31

TABLE 2-11 (cont'd)

1981 IMPORTS AND ASSEMBLIES OF PASSENGER CARS BY COUNTRY OF ORIGIN
ASIA

	India	Pakistan	Philippines	Sri Lanka	Thailand
USA					
Imports	6	11	125	9	12
Assembly	--	--	18,683	--	--
CANADA	3	1	1	--	--
FRANCE	65	17	87	111	1,257
ITALY	--	--	--	--	240
W. GERMANY	243	249	368	88	1,015
SWEDEN	17	6	4	2	410
JAPAN					
Imports	278	7,588	23,609	1,143	22,884
Assembly	--	--	9,079	--	--
UNITED KINGDOM	2	4	1	3	1
TOTAL					
Imports	615	7,876	24,195	1,356	25,819
Assembly	--	--	27,762	--	--
TOTAL	615	7,876	51,957	1,356	25,819
Percent of New Car Sales	-1	100	100	100	100

SOURCES: Society of Motor Vehicle Manufacturers and Traders Ltd. The Motor Industry of Great Britain, 1982

Motor Vehicle Manufacturers Association, World Motor Vehicle Data Book, 1984-85 ed.

32

however, Japanese makes have held dominant shares of the markets. For instance, Japanese automobiles accounted for 96 percent of new cars sold in Pakistan in 1981.

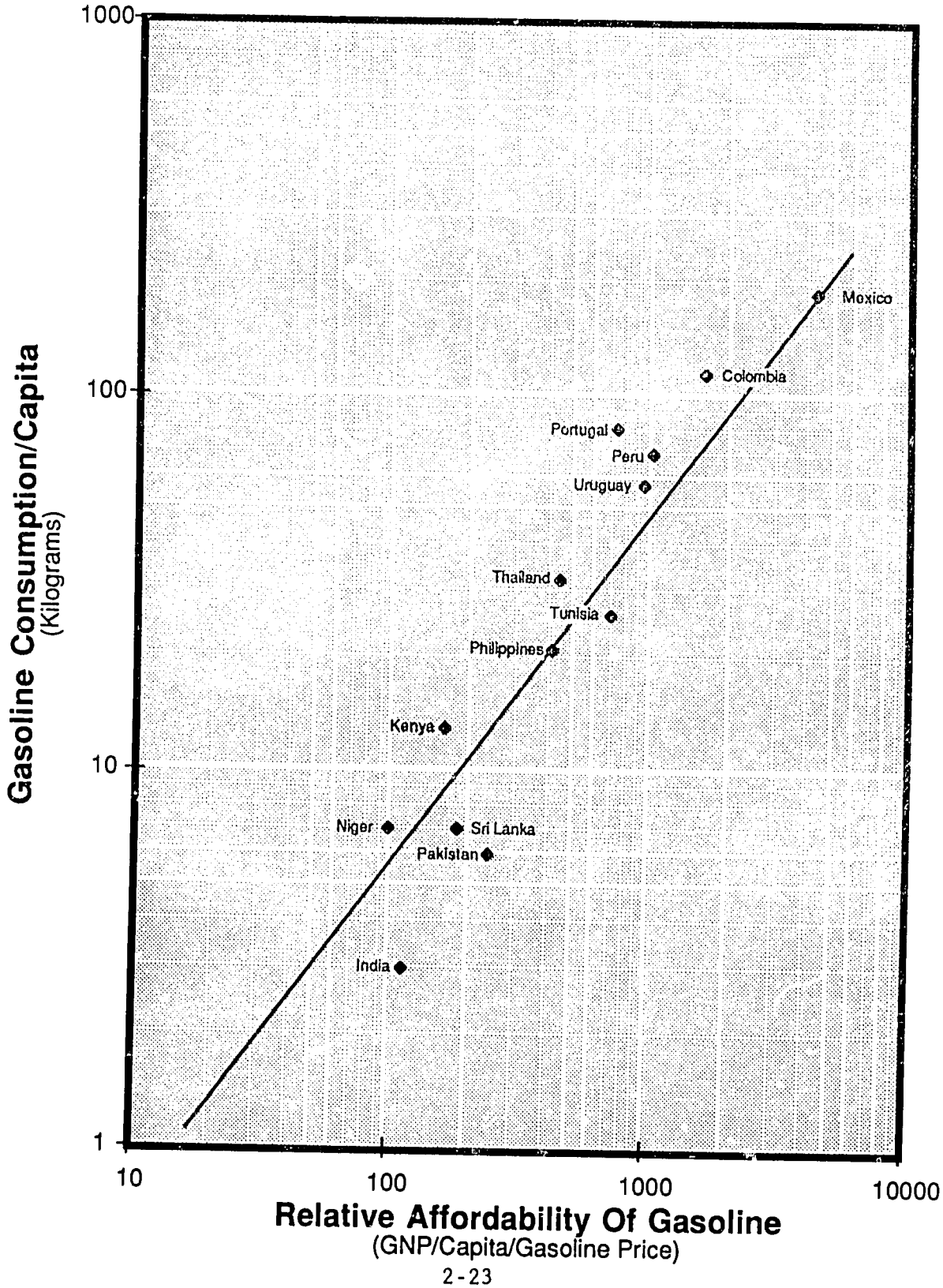
Section 4 will present additional detail on the technological characteristics of motor vehicles in selected countries.

2.3.4 Economic Factors

Fuel use in developing countries is significantly influenced by trends in overall macroeconomic conditions. Gasoline is typically viewed as a luxury consumer good in most developing countries. Therefore, the consumption of gasoline can be directly related to its affordability to consumers. One way of measuring the affordability of gasoline is to examine the ratio of income per capita to the price of gasoline. As shown in Figure 2-2, there is almost a direct relationship between the affordability of gasoline and gasoline consumption per capita in the sample of developing countries examined for this study. As the affordability of gasoline increases due either to rising per capita income or lower fuel prices, gasoline consumption per capita also increases. Thus, for example, the affordability of gasoline in Peru is higher than in Thailand by a factor of two and gasoline consumption per capita is more than twice that of Thailand. Of course, differences in demographics, geography and transportation structure explain some of the scatter of the points in Figure 2-2. India, for instance, has a very low per capita gasoline consumption even though the relative affordability of gasoline is about the same as in Niger. This is attributable not just to the effect of the vast population in India, but also the fact that much of the transportation system infrastructure is oriented towards railroads for passenger transport and trucking for commercial/freight movements. Both of these modes are largely diesel-fueled.

FIGURE 2–2

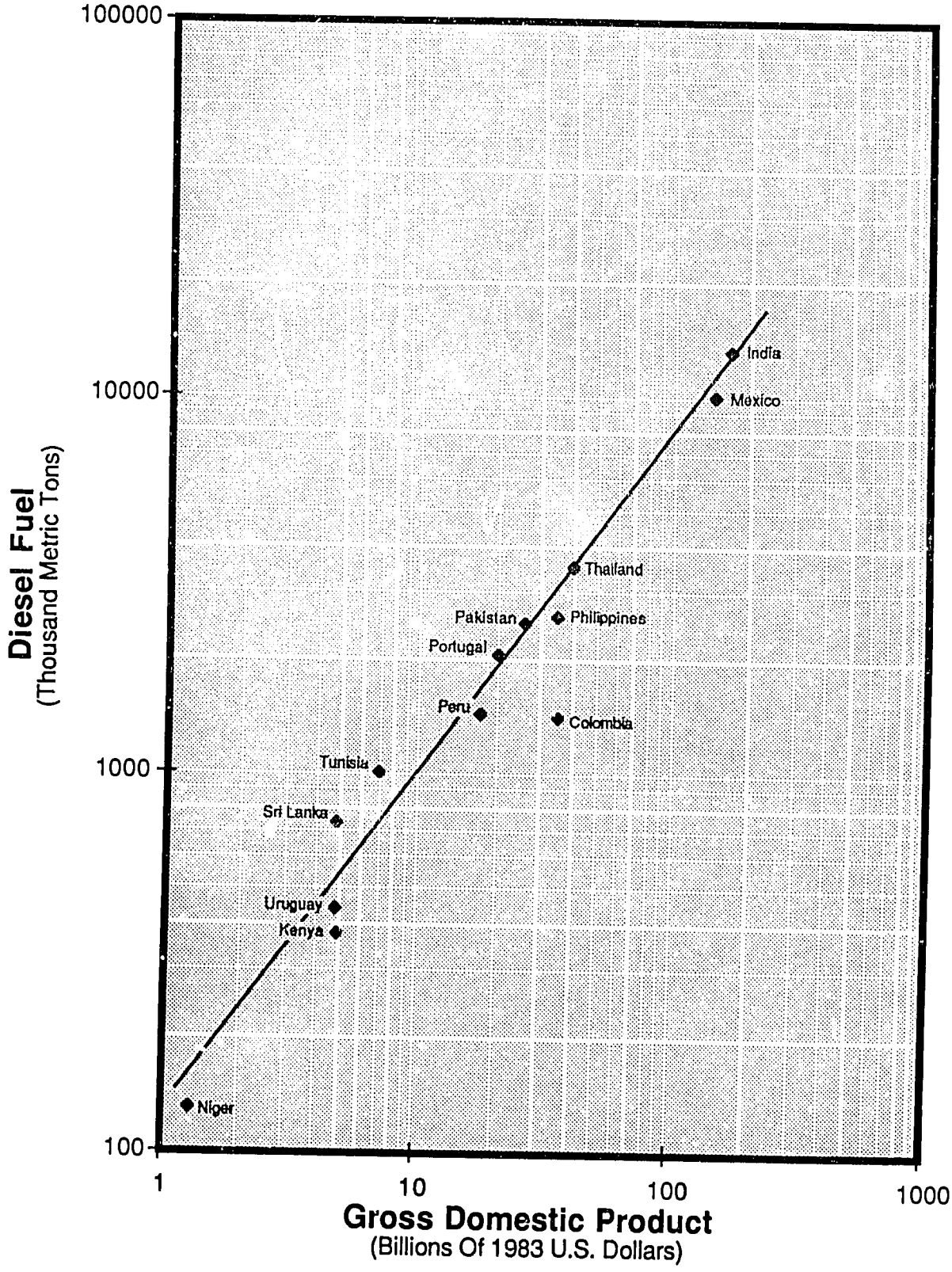
Relationship Between Gasoline Consumption And Affordability In 1983



34

FIGURE 2–3

Relationship Between Diesel Fuel Use And Economic Output In 1983



35

Diesel fuel forms a significant economic input to agriculture and construction-related industries in developing countries. Unlike gasoline, diesel fuel is far more sensitive to trends in economic output than to swings in fuel prices. This relationship between diesel fuel use and economic output in developing countries is shown in Figure 2-3. The figure shows that increasing diesel fuel use is directly correlated with rising economic output (as measured by gross domestic product). Differences in the industrial economic structures among developing countries do, however, introduce some distortion in the relationship between diesel fuel use and GDP. In the oil producing countries of Mexico, Colombia, and Peru, for example, the relationship between economic output and diesel fuel use is somewhat inflated by the large contribution of the oil industry to GDP.

REFERENCES

1. D.L. Greene, et al, Oak Ridge National Laboratory, "Transportation Energy Use and Efficiency in Tunisia," August 1984.

3. REVIEW AND SUMMARY OF VEHICLE AND FUEL TAX POLICIES

3.1 OVERVIEW

Governments of developing (and industrialized) nations establish taxes in the transport sector for a variety of purposes. These include but are not necessarily limited to: 1) revenue to finance road construction, transportation infrastructure development; 2) protection and promotion of domestic industries; 3) discouragement of consumption of "luxury" goods; and 4) energy conservation. Generally speaking, road transport taxes fall into three broad categories:

- Acquisition taxes
- Ownership taxes
- Use taxes

Acquisition taxes include taxes imposed on the sale and/or resale of a vehicle. They also include duties on imported vehicles, and fees for the first-time registration of a vehicle.

Ownership taxes are typically imposed annually for the re-registration of a vehicle.

Use taxes include taxes on fuels, tires, and the transport of passengers and/or freight.

Table 3-1 classifies the types of taxes imposed by AID-assisted countries. (A detailed summary of tax rates and bases of assessment by country is presented in Appendix A.) While all nations impose some combination of vehicle acquisition, ownership and use taxes, the basis of assessment varies significantly. For example, Niger uses horsepower and vehicle type (passenger car or goods vehicle) as the basis for setting

TABLE 3-1

BASIS OF ROAD USER TAXES IN AID-ASSISTED COUNTRIES

	Acquisition Tax										Ownership Taxes						Use Fees		
	Sales Tax		Resale Tax	Import Duty		Registration Fee													
	Value	CID		Value	Vehicle Type	Flat	Horse Power	Vehicle Type	Value	Weight	CID	Fuel	Horse Power	Age	Weight	Vehicle Type	Fuel	Transport	Tire
AFRICA																			
Kenya	X			X		X											X		X
Niger							X	X					X	X		X	X	X	
Tunisia							X					X	X		X	X	X	X	
Upper Volta		X			X			X					X				X	X	
SOUTH/CENTRAL AMERICA																			
Colombia				X					X	X							X		
Mexico	X		X		X					X							X		
Peru																	X		
Uruguay															X		X	X	X
ASIA																			
India	X			X	X	X										X	X	X	X
Pakistan				X	X										X	X	X		
Philippines																	X		
Sri Lanka			X	X	X			X						X	X	X	X		X
Thailand					X										X		X	X	
EUROPE																			
Cyprus	X							X		X		X	X	X		X	X		
Portugal	X	X	X							X	X	X		X		X	X	X	

SOURCE: International Road Federation, World Road Statistics 1979-1983, 1984 edition

first-time registration fees or acquisition taxes whereas Colombia, Peru, Cyprus and Portugal assess these fees on the basis of vehicle weight. Almost all of the countries have some type of vehicle import duty, but the basis of the tax (vehicle value, vehicle type or both) ranges widely. With respect to ownership taxes or annual registration fees, the bases of assessment include engine CID, fuel type, horsepower, vehicle age, vehicle weight and/or vehicle type. Many countries (i.e., Cyprus, Upper Volta, Tunisia, Niger) use a combination of horsepower and vehicle or fuel type to determine annual ownership fees. Others, such as Uruguay, Pakistan, Sri Lanka and Thailand, rely primarily on weight as the basis of assessment.

With regard to use taxes, all of the AID-assisted countries reviewed in this study implement a tax on fuel. In addition some countries assess a fee based on the transport of passengers and goods. Several nations such as Kenya, Uruguay, India and Sri Lanka, also tax the purchase of tires.

3.2 ACQUISITION AND OWNERSHIP TAXES

In an effort to obtain specific information detailing vehicle ownership and acquisition taxes schedules by basis of assessment (i.e., value of tax by CID, weight, fuel type, etc.) in AID-assisted countries, EEA contacted all of the relevant foreign embassies in Washington, D.C. as well as numerous international organizations (i.e., the United Nations, World Bank, International Road Federation). In addition, EEA conducted an extensive letter-writing campaign to request information directly from the petroleum, transportation, and tax government ministries of the selected AID-assisted countries. Despite these efforts, only minimal response and/or cooperation was obtained from the various government agencies. Given the lack of data, it was virtually impossible to perform a comparative evaluation of the influence of taxation on fuel use in AID-assisted countries.

Some observations on individual countries may nevertheless be made. As shown in Table 3-2, the level of ownership tax in India (as a percent of vehicle price) varies significantly by type and size of motor vehicle. For example, ownership taxes on 3-wheeler vehicles are 36-39 percent while taxes on standard (domestic) vehicles are on the order of 40.1 to 46.3 percent.

Import duties on cars in India are established on the basis of fuel type and engine CID. Table 3-3 shows that the duties are: a) set high to protect domestic manufacturers, b) skewed to discourage the importation of passenger cars with large engines, and c) set to tax the importation of small diesel vis-a-vis gasoline fueled passenger cars.

Table 3-4 shows ownership taxes for various categories of vehicles in Pakistan. While it is difficult to draw any substantive conclusions from this table, it would appear that (on the basis of vehicle weight) taxes are the lowest for owners of motor cars and motor cycles and highest for operators of commercial vehicles (i.e., rickshaw, pick-up, bus, truck).

Import duties and sales taxes in Pakistan are designed to discourage the purchase of large cars. In addition, they are lower for commercial vehicles than for automobiles. Unlike India, however, Pakistan does not differentiate on the basis of fuel type (see Table 3-5).

Information from Portugal indicates that the acquisition tax on new cars is highly progressive and is based on engine size (Table 3-6). As illustrated in Table 3-6, sales taxes on new cars increase from 4 percent on vehicles up to 1,400 cc. to 160 percent of the sales price for vehicles with engines over 2000 cc. Annual car ownership taxes vary

TABLE 3-2

VEHICLE OWNERSHIP TAXES FOR SELECTED MODELS IN INDIA
(AS OF 3-12-1981)

Model	Type	Weight (kg)	Fuel Type	Engine cc	Consumer Tax* (% of sales price)
Ashok Leyland Comet	Truck	15,244	Diesel	6,075	40.1
Ashok Leyland Viking	Bus	15,660	Diesel	6,075	40.2
Bajaj Tempo	Mini Bus	4,650	Diesel	2,399	37.4
API 3-Wheeler	Rickshaw	800	Gas	175	38.9
Premier Automobile	Car	1,295	Gas	1,089	46.3
Hindustan Motors	Car	1,528	Gas	1,489	40.1
API	Scooter	298	Gas	150	38.0
Kinetic Engg.	Moped	183	Gas	497	28.8

SOURCE: Association of Indian Automobile Manufacturers, Automan India 1984

*Covers excise, sales tax, central sales tax and interstate tax.

TABLE 3-3

PASSENGER CAR CUSTOMS DUTIES IN INDIA
(as of 1/3/1984)

	Total Cumulative Customs Duties
Gasoline	
0 - 1200cc	152.6% + Rs 9975
1201 - 1500cc	152.6% + Rs 11025
1501 - 1600cc	152.6% + Rs 16800
1601 - 2500cc	205.2% + Rs 16800
+2500cc	265.6%
Diesel	
0 - 1500cc	152.6% + Rs 14700
1501 - 1600cc	152.6% + Rs 16800
1601 - 2500cc	205.2% + Rs 16800
+2500cc	265.6%

SOURCE: Government of India, Central Board of Excise and Customs

TABLE 3-4

MOTOR VEHICLE OWNERSHIP TAXES IN PAKISTAN

Type of Vehicle	Motor Vehicles Ownership Taxes	# of Engine Cylinders	Engine Capacity	Vehicle Weight
1. Motor Car	Rs.384 Per Annum	4	1600 c.c	915 Kg
2. Bus	Rs.168 Per Seat Per Annum	6	107 H.P.	5600 Kg
3. Truck	Rs.2828 Per Annum	6	107 H.P.	5600 Kg
4. Mini Bus	Rs.42 Per Seat Per Annum	4	24 H.P.	1700 Kg
5. Wagon	Rs.42 Per Seat Per Annum	4	24 H.P.	1550 Kg
6. Pick-up (Suzuki)	Rs.376 Per Annum	3	539 c.c	600 Kg
7. Rickshaw	Rs.392 Per Annum	1	150 c.c	279 Kg
8. Motor Cycle	Rs.62 Per Annum	1	100 c.c	98 Kg

SOURCE: Government of Pakistan, Public Service Vehicles and Motor Vehicle Utilization Studies.

TABLE 3-5

MOTOR VEHICLE IMPORT DUTIES AND SALES TAX RATES IN PAKISTAN

Motor Vehicle Type	Rate of Duty	Rate of Sales Tax
Passenger Cars		
0 - 1000cc	70%	30%
1001 - 1300cc	120%	30%
1301 - 1600cc	175%	30%
1601 - 2000cc	350%	30%
+2000cc	350%	30%
Buses	60%	Free
Truck	60%	Free

SOURCE: Pakistan Customs Tariff by Central Board of Revenue, November 1983

45

TABLE 3-6

SALES TAX ON NEW CARS
IN PORTUGAL - 1985

Engine Size	Percentage of Sale Price
0 - 1400cc	0.04 x cylinder capacity (c.c.)
1401 - 1700cc	70
1701 - 2000cc	110
+2001cc	160

SOURCE: Government of Portugal

according to cylinder capacity, age of vehicle and fuel used. Private diesel passenger cars are taxed as a luxury item at a rate 186 percent of the maximum tax for gasoline-fueled private cars.

3.3 USER FEES

As indicated earlier in Table 3-1, road user fees include fuel taxes, taxes on commercial truck tires, license fees, etc. The most common road transport user fee assessed by developing countries is a tax on motor fuels. Table 3-7, compares motor fuel prices among AID-assisted countries and indicates the percentage of total fuel prices which is tax. For comparison purposes, prices and taxes on motor fuels in the U.S. also are presented.

Table 3-7 shows that the price and tax on motor gasoline in most developing countries is well above that of industrialized nations such as the U.S. The exceptions are the oil producing countries of Central/South America (Mexico, Colombia and Peru) which maintain relatively low retail gasoline prices (with nevertheless high tax rates). Table 3-7 also indicates that the price of diesel fuel is maintained 28 to 50 percent below that of motor gasoline in most of the AID-assisted countries (except Colombia) included in this study. Furthermore, the tax rate on diesel fuel --while high in relation to an industrialized nation such as the U.S. --is generally substantially below the equivalent tax rate on gasoline in the AID-assisted countries. This is particularly true of AID-assisted countries in Africa and Asia. For example, in Thailand, the tax rate on diesel is 23 percent while the tax rate on gasoline is 69 percent.

Very little information is available on trends in fuel prices and fuel taxes over time for all fifteen countries included in this study. One country which does have historical data on the components of gasoline and diesel retail fuel prices is Pakistan. Figure 3-1 shows the trend in the

TABLE 3-7

COMPARISON OF PETROLEUM PRODUCT PRICES - JULY 1984
(U.S. $)

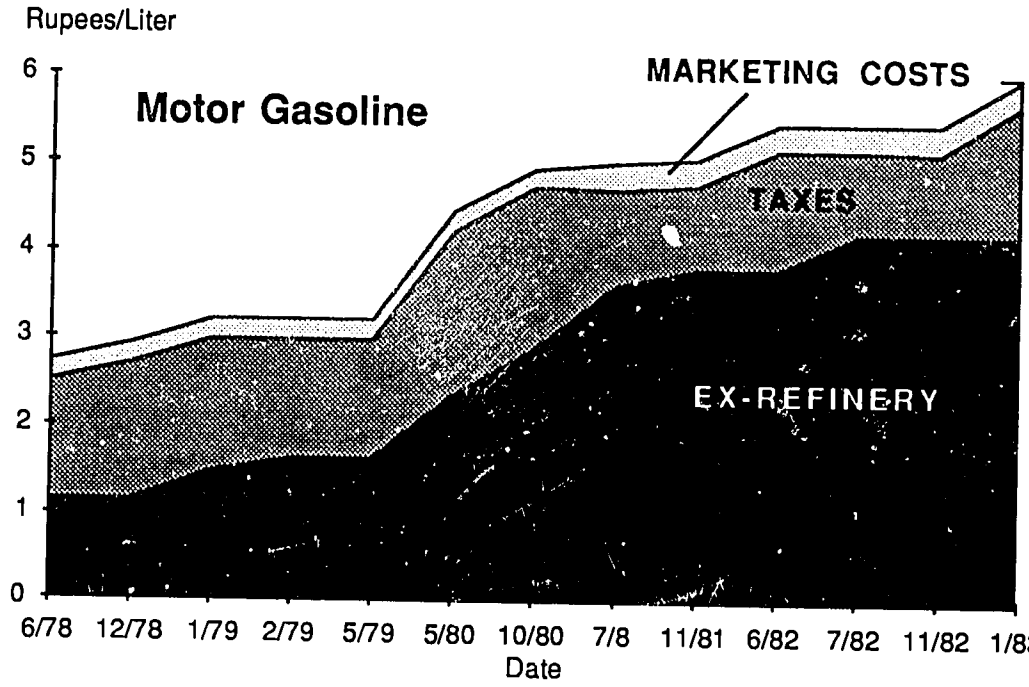
	Regular Leaded Gasoline		Auto Diesel		Diesel as A Percent Of Gasoline
	Fuel Price	Percent Tax	Fuel Price	Percent Tax	
AFRICA					
Kenya, Nairobi	2.10	37.1	1.30	26.2	61.9
Tunisia, Tunis	1.67	53.3	N/A	N/A	N/A
CENTRAL/SOUTH AMERICA					
Colombia, Bogota	0.84	27.4	0.84	22.6	100.0
Mexico, Mexico City	0.89	58.4	0.49	59.2	55.0
Peru, Lima	1.03	63.1	0.76	63.1	73.8
Uruguay, Montevideo	2.15	39.5	1.42	26.1	66.0
ASIA					
Pakistan, Islamabad	1.75	26.3	0.97	6.2	55.4
Philippines, Manila	1.69	30.2	1.10	10.9	65.1
Sri Lanka, Columbo	2.03*	3.9	1.03	3.9	50.7
Thailand, Bangkok	1.78	69.1	0.93	22.6	52.2
EUROPE					
Portugal, Lisbon	2.47	58.7	1.30	35.4	52.6
UNITED STATES	1.21	17.4	1.14	19.3	94.2

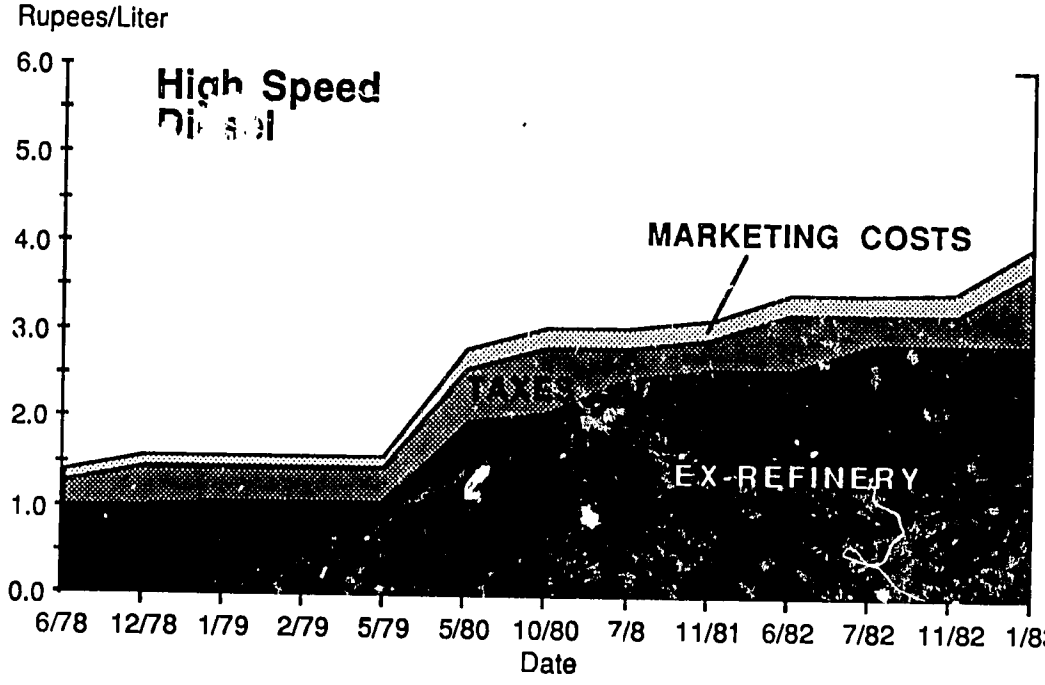
SOURCE: U.S. Energy Information Administration, International Energy Annual 1984, October 1985.

*Premium leaded.

FIGURE 3-1

Components Of Retail Fuel Prices In Pakistan





retail prices of motor gasoline and diesel fuel in Pakistan between the middle of 1978 and the beginning of 1983. Retail prices in Pakistan are fixed by the government which determines the allowable wholesale/retail mark-ups, customs duties and taxes for diesel fuel and gasoline. As shown in Figure 3-1, marketing margins for diesel fuel are about one-half those for gasoline and taxes are about one-third those for gasoline. In addition, the price of diesel ex-refinery is about two-thirds that of gasoline. Although the prices of both fuels rose substantially during the 1979/1980 oil crisis, taxes on gasoline rose faster than taxes on diesel.

The policy of taxing gasoline at levels substantially above that for diesel is generally directly related to the revenue-raising and economic development objectives of developing country governments. Users of gasoline are mostly automobile owners who, as a class, fall into higher income groups in developing countries. The automobile is viewed as a luxury and status symbol especially in poorer developing countries which depend on imports and, consequently, its use is not encouraged due to the need to conserve scarce foreign exchange reserves. Governments also tax gasoline with the intention of raising revenue to pay for road network maintenance and/or to reduce urban traffic congestion and pollution. High tax rates on gasoline and cars and import restrictions on cars are a consequence of this logic. Diesel fuel on the other hand, is taxed at low rates, largely for reasons of public utility and social considerations. It is used in public service transport vehicles which primarily serve the less affluent elements of society and it also is used in agriculture and industry where there are alternative sources of energy as well. In addition, the maintenance of relatively low diesel fuel prices in developing countries is generally done out of a concern for the effects of price increases on the final prices of food and other basic commodities and to promote greater agricultural mechanization.

The practice of indirectly subsidizing diesel fuel can, however, produce distortions in economic efficiency. For example, to the extent that diesel fuel also is used in marine applications, diesel price subsidies can lead to the indirect subsidization of foreign shipping. This occurred in Tunisia in the late seventies with the pricing of diesel fuel substantially below gasoline and world price levels.[1/] Recent research on transportation energy use in Tunisia also concluded that the wide diesel/gasoline fuel price differential was the primary factor behind rapid growth in the stock and utilization level of diesel-powered light commercial vehicles in that country.[2/]

Substantial subsidies for diesel fuel also can lead to excessive investments in imported diesel passenger cars which are considerably more expensive than gasoline vehicles and thereby create a drain on foreign exchange reserves. For example, a study by the Government of Pakistan demonstrated that lower diesel fuel prices resulted in a net economic loss to the country.[3/] Table 3-8, drawn from that study, shows the relative costs of owning and operating a diesel vs. gasoline-fueled Ford Station Wagon in Pakistan in 1975. Excluding taxes, the overall costs of diesel wagons were 11 percent higher than gasoline wagons. However, the effects of taxes were to lower the costs of diesels 7 percent below that of gasoline wagons. In absolute terms, the Pakistan economy spent an additional Rs. 7,370 per vehicle that would not have had to have been paid had the relative costs of diesel vs. gasoline vehicles not been distorted by taxes. The study concluded that this distortion in relative costs was the cause of a substantial increase in the proportion of light diesel vehicles in operation.

TABLE 3-8

VEHICLE AND FUEL COSTS OF A GASOLINE VS. DIESEL FORD WAGON IN PAKISTAN IN 1975

Item	Excluding Taxes		Including Taxes	
	Gasoline	Diesel	Gasoline	Diesel
Per Mile Costs (Paisa)				
Vehicle Costs	19.40	28.77	33.02	.17
Fuel Costs	25.00	20.45	47.73	25.00
TOTAL:	44.40	49.22	80.75	75.17
Net Present Value (Rs.)				
Capital Costs	29,082	43,112	49,489	75,184
Fuel Costs Discounted	36,630	29,970	69,930	36,630
TOTAL:	65,712	73,082	119,419	111,814

SOURCE: A Majeed, Government of Pakistan, National Transport Research Carter, Planning Commission, "A Note on Petrol Versus Diesel," August 1977

REFERENCES

1. D.L. Green et al, Oak Ridge National Laboratory, "Transportation Energy Use and Efficiency in Tunisia," August 1984.

2. Ibid.

3. A. Majeed, Government of Pakistan, National Transport Research Center Planning Commission, "A Note on Petrol Versus Diesel," August 1977.

4. AUTOMOTIVE TECHNOLOGY IN DEVELOPING COUNTRIES

4.1 OVERVIEW

The data presented in Section 2 of this report indicate that there are substantial differences in per capita use of gasoline and diesel in the 15 AID-assisted nations, and these differences are caused not only by economic factors such as the income, GNP and fuel price, but also the alternatives available such as rail transportation as well as the usage and fuel efficiency of the fleet. The usage and fuel efficiency factors are examined in this section of this report. A preliminary examination revealed that these factors varied considerably across the 15 countries. For the purposes of technology analysis these countries can be subdivided into those with:

- Vehicle manufacturing capability
- Vehicle assembly capability
- Capability for some domestic manufacture, usually in combination with imports
- No capabilities for domestic manufacture or assembly.

Manufacturing capabilities or assembly capabilities do not necessarily imply that no vehicles are imported into the country. In this section of the report, a country-by-country analysis of technology status is performed to the extent allowed by the data. Countries with little or no manufacturing capabilities are grouped together since they rely primarily on developed nation manufacturers for their supply of motor vehicles. Following this, the possible reasons for poor fuel economy in developing countries is discussed in Section 4.3. Potential policy implications for developing nations based on this analysis are presented in Section 4.4.

Prior to the discussion of technology, it must be noted that each individual country's policy is also tailored to its access to crude oil. None of these 15 countries analyzed show any significant penetration of alternative fuel vehicles -- i.e. vehicles that can run on alcohols, vegetable oils or natural gas. The potential for alternative fuel use is considered in Section 4.4 of this report.

4.2 COUNTRY SPECIFIC VEHICLE CHARACTERISTICS

Mexico and India are unique among all AID nations in possessing extensive capabilities for the manufacture of motor vehicle. All of the four nations in Africa considered in this analysis import 100 percent of their automobiles and trucks. In Asia, countries other than India analyzed have assembly facilities which produce a few models from "knock-down" kits and import the rest. Sri Lanka, with its small sales base, however imports 100 percent of its fleet. Cyprus, with a relatively small sales base also does not manufacture or assemble cars. Portugal assembles about two-thirds of all cars sold domestically, while over 90 percent of all trucks sold are locally assembled. In South America, Colombia and Peru have several domestic units that assemble vehicles, but imports are a very significant share of total sales of cars and light trucks. Little data are available on Uruguay, which has some domestic assembly capability like other South American nations. It is of interest to examine the type and technology capability of the vehicles produced in each country.

4.2.1 Vehicle Manufacturers

Mexico, with its advanced production capability has an auto industry that is allied with U.S. corporations to a large extent. This is unusual, as most U.S. manufacturers build vehicles that are not generally suitable for developing nations in that they are large (by developing nation standards), powerful and relatively fuel inefficient. Similar trends are evident in the light truck fleet, as Mexico manufactures and/or assembles a number of large relatively payload inefficient U.S. models powered by

55

gasoline engines. Typically, in commercial applications, diesel engines are favored due to their very high fuel efficiency -- 50 percent higher than gasoline engine efficiency. Table 4-1 shows the distribution of vehicle sales by model for both cars and light trucks in 1982 in Mexico. More recently, the severe downturn in the economy has caused vehicle sales to decline considerably from their 1982 trends, although the mix of vehicles sold has not changed significantly.

As can be seen from Table 4-1, a significant part of total car sales is in the compact category, including the Datsun 1600, the VW "Beetle" and the Renault 12 and 18. These three vehicles are 1970's vintage models that have been phased out from production in the parent countries, but are still being manufactured in Mexico. The larger car classes are dominated by U.S. companies, and in these classes, the vehicles sold are identical to those in the U.S. in most respects. EEA has contacted the domestic manufacturers, who have confirmed that the principal differences between U.S. and Mexican vehicles of the same model type are in their calibration and emission control system. Typically, the spark calibration is retarded from U.S. levels to allow use of lower octane gasoline in Mexico, which results in lower fuel economy. However, the absence of the complex emission control system and the changed air/fuel ratio calibration provide some gains in fuel economy to offset the loss due to spark retard. As a result, U.S. and Mexican models of the same type have similar fuel economy. The fuel economy of most light trucks are also nearly equal to similar models sold in the U.S. Engines for heavy-duty diesels are directly imported from the U.S.

The other major manufacturer in the group of countries analyzed is India. The Indian market is completely protected and the net import penetration is less than one percent of the market. In 1982, two passenger car models -- the Premier Padmini and the HM Ambassador -- accounted for nearly all of the domestic passenger cars sold. As shown

TABLE 4-1

MODEL SPECIFIC SALES IN 1982
MEXICO

Cars			
	Compact	Datsun 1600	47828
		VW	110052
		Renault 12/18	22048
			179929
	Intermediate	Chrysler "K-car"	36551
		Ford Fairmont	16107
		GM Malibu	17845
		AMC	8126
			78669
	Large/Luxury	Chrysler	2128
		Ford	13355
		GM	4605
			20080
	Sports	Ford Mustang	8076
			286761
Trucks			
	Light (gasoline)	Chrysler 100/150	30111
		Ford F 100/150	43126
		GM C 10/20	28973
		Nissan (compact)	18573
		VW (compact)	17273
			150838
	Heavy Diesel Truck		24023
	Diesel Bus		1430

57

in Table 4-2, five manufacturers compete in the light commercial segment with Bajaj having the largest share. In the heavy truck segment, two manufacturers account for 97 percent of all vehicles sold. The status of technology on these vehicles is, however, quite different from Mexico. Both the Premier and the Ambassador cars are of ancient designs from the late 1950's of popular European cars (the Fiat and the Vauxhall, respectively). Both cars feature small engines with very low compression ratio (7.3:1), little control of spark timing or combustion and relatively low fuel economy. Although no standard fuel economy information is available, anecdotal evidence suggests that Premier Padmini has a fuel economy of approximately 11km/litre and the and Ambassador 9/km litre. Modern vehicles with equivalent engine displacement can provide up to 50 percent improvement in fuel economy from these values. Light commercial vehicles are almost completely dieselized, but even these models feature relatively old design engines with low power to weight ratios. One exception is the Mahindra NC 665 which features a modern Peugeot diesel tnat is both more powerful and more fuel efficient than others in the market. Heavy trucks manufactured by Tata and Leyland are almost exclusively in the 15,000-17,000kg GVW class with payloads of ten to 12 tons. Engines are also of relatively older designs from Mercedes and British Leyland, respectively, although modest improvements have been made to these vehicles.

More recently, India has changed its automotive policy of restricted licensing for manufacture and allowed a host of joint ventures, most of which are with Japanese companies. Importantly, passenger car production will double from 1982 levels in 1986, and similar trends are expected in light commercial vehicles. The Japanese collaborations have introduced new vehicles, such as the Suzuki 800 (known as Maruti in India) and the Toyota Dyna. Existing manufacturers of cars and light trucks have also set up collaborations to improve vehicle technology, and as a result, the

TABLE 4-2

VEHICLE SALES IN 1982
INDIA

Cars	HM Ambassador	22804
	Premier	20842
	Other	123
		43769
Utility	Jeep	20259
Light Truck	Bajaj	11670
	Premier	1207
	Mahindra	8474
	HM	2016
	Standard	4751
		28118
Heavy Trucks and Bus	Tata	42965
	Leyland	15028
	Premier	1549
	HM	849
		60931

entire market has been upgraded. However, the total market is still relatively small and it is not clear if such a large number of manufacturers can survive in the newly competitive environment.

4.2.2 Countries Importing Vehicles (Knock-Down and Built-up Units)

The term "vehicle assembly" is rather general and can include a range of activities so that anywhere between 10 to 70 percent of the vehicles manufacturing costs are incurred by the assemblers. In general, most AID countries that have assembly facilities contribute less than 50 percent of the total end product value indigenously. Typically the assembly labor costs are the primary value added component, but glass parts, tires, batteries and electrical components are sourced locally. Four countries of the 15 examined in this study have extensive assembly facilities -- Portugal, Colombia, Philippines and Peru. Four other countries have more limited assembly capability -- Thailand, Pakistan, Kenya and Uruguay.

Portugal, due to its close proximity to developed European nations, has an assembly industry that is largely dominated by European manufacturers, and in particular, by French manufacturers. Portugal is also unique since it reexports nearly 25 percent of cars assembled back to other European nations, but imports nearly 35 percent of all cars sold domestically. Both light and heavy trucks are also assembled domestically, and 90 percent of light trucks and all heavy trucks sold in Portugal are domestically assembled. Because of the close association with European manufacturers, the technology of the vehicles sold in Portugal is generally on par with the developed nations of Europe. Tables 4-3 and 4-4 show the distribution of vehicle sales by engine size or weight category for cars and commercial vehicles, respectively.

60

TABLE 4-3

1982 CAR SALES IN COUNTRIES
WITH MAJOR ASSEMBLY FACILITIES

Portugal

By Manufacturer		
Renault	24435	(22896)
Citroen/Peugeot	16332	(5080)
Fiat	9867	(9479)
Opel	6171	(4199)
Ford	5855	(4271)
BL	3878	(1714)
VW	2297	(485)
Toyota	3529	
Datsun	2013	
Mercedes	3633	
Other	10684	
Total (domestic and import)	85154	

By Engine Size	
Under 1050c.c.	16657
1,051-1250c.c.	28499
1251-1550c.c.	18154
Over 1550c.c.	10440
Diesel	(5491)
Total domestic	73752

Colombia

Assembled Domestically	
Renault 4/6	5648
Renault 18	8092
Chevrolet Chevette	2948
Chevrolet Celebrity	680
Fiat 147	4017
Fiat 131	2400
Total	24001

Imported	
Japan	1513
France	5122
Italy	2261
Germany	1543
U.S.	1417
Total	12113

61

TABLE 4-3 (cont'd)

1982 CAR SALES IN COUNTRIES
WITH MAJOR ASSEMBLY FACILITIES

Peru

Assembled Domestically	
Nissan Stanza	3684
Sunny	794
Toyota Corona	4948
VW 1300	5113
Total	14539

Imported	
Japan	12437
Italy	321
France	346
Germany	1964
U.S.	1271
Other	1383
Total	17722

Philippines

Assembled Domestically	
Mitsubishi Colt	10318
Toyota Corolla	9602
Mazda 323	5780
Isuzu Rekord	3064
Nissan	282
Total	29046

Imported	
U.S.	111
Germany	418
U.K.	509
Other	8
Total	1046

62

TABLE 4-4

1982 COMMERCIAL VEHICLE SALES IN
COUNTRIES WITH MAJOR ASSEMBLY FACILITIES

Portugal
(all domestically assembled)

	Light Trucks	Heavy Trucks
Toyota	11083	1131
Nissan	8287	36
Mitsubishi	1392	1734
Other Japanese	2145	119
Ford (U.K.)	7883 (2649)	1153
Bedford	5356 (1152)	705
Other U.K.	1496	--
Opel	1973 (482)	--
Mercedes	1354	428
MAN	--	339
Other German	194	118
Pugeot	2397	--
Renault	356	775
Volvo	--	1010
Other European	1944 (159)	982
Total	45860 (4442)*	8287

*Exported.

TABLE 4-4 (cont'd)

1982 COMMERCIAL VEHICLE SALES IN
COUNTRIES WITH MAJOR ASSEMBLY FACILITIES

COLOMBIA

	Light Trucks	Heavy-Duty Trucks
Isuzu LUV	4069	--
GM	2563	2420
Imports - Japan	15490	9086
Imports - U.S.	1185	--
Imports - Other	266	--
	22573	11506

PERU

Chrysler	836	563
Nissan	4164	--
Volvo	--	310
Imports - Japan	5849	193
Imports - U.S.	1197	497
Imports - Germany	749	1347
Imports - Sweden	--	418
Imports - Other	347	311
	13141	2639

PHILIPPINES

Chrysler/Mitsubishi	443	660
Toyota	4208	3771
Ford/Mazda	5163	1133
GM/Isuzu	5867	--
Other	970	710
	17251	6274

64

Colombia and Peru assembled 16 and 45 percent of total cars sold in 1982, and only 25 and 37 percent of trucks respectively. In Colombia, Renault dominates the car market, while Japanese light trucks -- Datsun, Toyota and Isuzu -- dominate line truck markets. In Peru, Japanese manufacturers -- principally Toyota and Datsun dominate both car and light truck markets. Information on the extent of dieselization of the light truck markets is not available, but informal evidence suggests that it is small. Tables 4-3 and 4-4 also show the types of vehicles sold in Peru and Colombia for cars and trucks, respectively.

The situation in ten other countries with more limited assembly capability is less clear as sales by model type and model specifications are not available. Available information on Pakistan, Thailand and Kenya, did not allow us to determine sales by model in these countries, and the extent of domestic assembly versus imports of fully built-up units. However a review of imports (knock down kits and built-up units) data shows that Japan and France are the principal suppliers of these nations. In Thailand, 80 percent of all car imports and are nearly 100 percent of truck imports are of Japanese models, and almost all Japanese manufacturers are represented. In Pakistan, over 90 percent of both car and light truck suggests are from Japan, with Suzuki 800 car and the micro-truck the most popular models by a wide margin. In the heavy truck end, domestically assembled Bedford truck (from the U.K.) hold one-third of the market with Japanese models holding the rest. There is some evidence to suggest that only 30 to 50 percent of cars and trucks are assembled locally. Kenya has some assembly capability for commercial vehicles, but all cars are imported. In Kenya, Japanese and British cars account for 35 percent of the market each, but over 80 percent of trucks sold are of Japanese origin.

A few countries have no assembly facilities at all. These include Niger, Cyprus, Tunisia, Upper Volta and Sri Lanka, and vehicles sales in these countries are too low to support even an assembly industry. For example, in Niger and Sri Lanka, car and truck sales are approximately 1,000-1,500 per annum. As a result these countries simply import fully built-up vehicles. Sales in Sri Lanka and Cyprus are dominated by Japanese imports, but in Niger and Upper Volta, French makes are dominant. In Tunisia, French, German and Italian makes are dominant in the car market, but the Japanese manufacturers have a 25 percent share of the market.

The above discussion illustrates that Japanese manufacturers are usually dominant in car markets excepts for a few nations of Europe/North Africa where French vehicles have a significant market share. In the heavy truck markets, a significant share of the market in developing countries is still held by European manufacturers notably Mercedes, Volvo and Bedford (U.K.), although Japanese manufacturers are expanding market share in this size class as well. In light truck markets, Japanese manufacturers are, by a wide margin, dominant in virtually all developing countries. U.S. manufacturers have virtually no sales in developing countries outside of relatively small market shares in oil producing nations of South America.

4.3 FUEL EFFICIENCY OF MOTOR VEHICLES IN DEVELOPING COUNTRIES

Since road transport accounts for the bulk of petroleum usage in most AID-assisted countries, energy conservation in this sector is of critical importance. Yet, one obvious area of investigation has not, by and large, been pursued in developing nations examined in this study. Little information exists in actual (or on-road) fuel economy of the vehicles, and most nations surveyed, with the exception of Portugal, do not collect or provide fuel economy information to consumers in these countries. Limited research information is available on tests of a few in-use vehicles conducted in Pakistan, India and Kenya. The test

results show considerable variability in fuel economy even for the same vehicle model type, and the measurement methods and test cycle used are not reliable. Accordingly, EEA met with representatives of major auto manufacturers to obtain comments on the relative fuel efficiency of vehicles in developing countries.

EEA met with representatives of Ford of Europe, Volkswagen, Mercedes-Benz and GM (U.S.A), and corresponded with responsible staff in Toyota and Nissan. Their comments can be summarized in five areas:

- Technology of new vehicles
- Availability of technologies to improve fuel economy
- Fuel economy of the fleet of vehicles
- Maintenance practices
- Alternate fuel technologies.

The manufacturers believed that for the most part, the fuel economy of new vehicles sold in the developing nations that are principally assemblers or importers are not significantly different than those sold in developed nations, although the reasons are not directly linked to technology. Most manufacturers do not produce specific models for sale in individual developing countries; rather, some models are developed as "general export models" and sold in virtually all developing countries that the manufacturer has a sales network in. EEA obtained details of general export model specifications from both Nissan and Toyota as these two companies have nearly half the market for cars and light trucks in developing countries as a whole. In general, the models sold in developing countries tend to have the smaller engines as well as lower axle ratios that reduce performance in comparison to vehicles sold in developed nations. Typically, the engines sold in these general export models have lower compression ratios for the low octane gasoline sold in the countries, and do not employ any sophisticated fuel or spark management systems such as fuel injection or computer spark control. In addition, some special engine combinations are specially provided to

take advantage of tax laws based on engine size. Figure 4-1 shows the types of vehicles and engines sold by Nissan in developing nations; note that Nissan offers a 1 litre engine for their "general export" model Sentra to take advantage of tax laws reducing duties for vehicles with engine sizes of 1 litre or less.

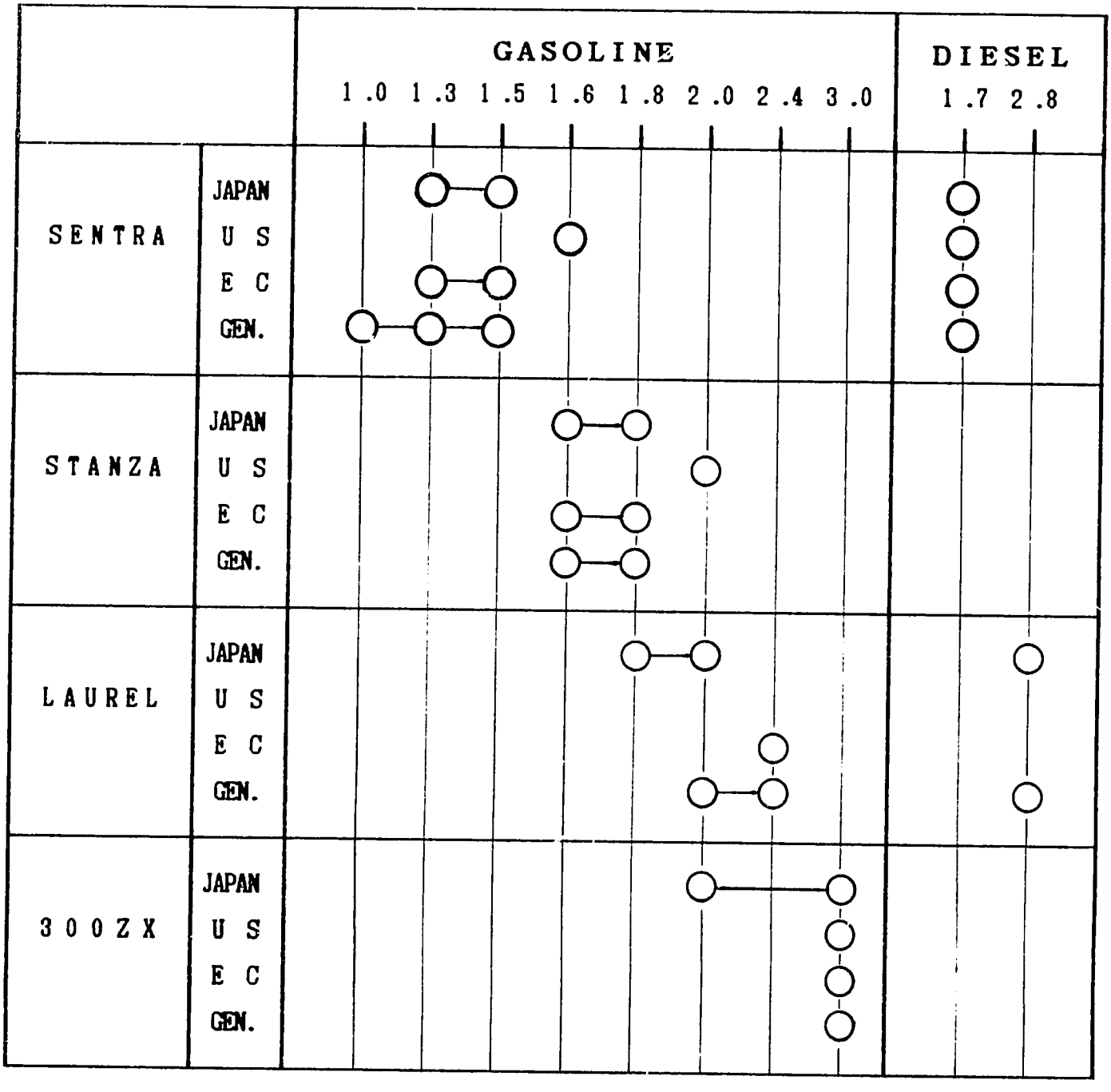
Auto manufacturers suggested that the fuel economy of the general export model was potentially higher than that of the same model as sold in developed nations, because the effect of lower technology and reduced compression ratio were offset by engine size and performance reductions, as well as by reductions in accessory loads (such as air conditioning or power steering) and lack of emission controls. Manufacturers were of the opinion that similar trends were essentially true in the diesel heavy-duty market, although most trucks sold in developing countries were typically naturally aspirated compared to turbocharged trucks sold in developed nations. In addition, the size and weight limitations in most developing countries were such that the heaviest truck sold would fall into the "medium-duty" class in developed nations. Such vehicles are inherently less efficient per unit payload than the larger vehicles used for long distance transport in developed nations.

Thus, manufacturers were of the general opinion that the technology level of new vehicles were generally on par with those of developed nations as far as fuel efficiency. Although there were individual cases of the two vehicle manufacturers in the group of countries analyzed, manufacturers noted that both Mexico and India have recently set new policies to enhance the technology status of new vehicle manufactured indigenously. This is expected to result in significant fuel economy improvements to new vehicles manufactured in those countries and, in particular, in India.

62

FIGURE 4-1

ENGINE SERIES WHICH IS PROVIDED FOR EACH REPRESENTATIVE CAR FAMILY IN EACH DESTINATION



69

At the same time, manufactures conceded that a range of technologies available could be used to enhance fuel economy in developing nations. Two, in particular, were suggested as cost-effective. They are electronic engine controls for gasoline engines and turbochargers for diesels. Electronic control of spark timing and idle speed could provide four to five percent improvement in fuel efficiency, while turbocharging of diesels could provide a ten to 15 percent benefit in fuel efficiency. Typically, the adoption of electronic spark control results in a price increase of $75-100 (retail equivalent price) in cars; turbocharged truck engines can cost over $1,000 more than their naturally aspirated counterparts, but such engines can be used on larger trucks because of the 40 to 50 percent increase in power output. For both technologies, manufacturers claimed that the very high sensitivity of customers in developing nations to increased first cost prevents marketing of these technologies to any great degree. The infrastructure in developing nations for vehicle maintenance is very poor, further eroding customer preference for new technology. The technologies described, however, are not more maintenance intensive although they will be new to mechanics in developing countries.

A separate topic that is somewhat outside the scope of this report is the technology level of two-wheeled vehicles, a very popular mode of personal transportation in most developing nations. For low first cost, most of these vehicles are powered by two-stroke engines which are 25 to 50 percent less efficient than four stroke engines. This very large fuel efficiency gain, especially in comparison to the moderate first cost increase, can be of considerable benefit to consumers. However, fuel consumption by two-wheelers is not a significant factor of total consumption.

All manufacturers suggested that any significant problems in fuel economy were not related to the technology of new vehicles but of the existing fleet of vehicles. As shown in Table 2-8, most developing nations have very high growth rates in total vehicle registrations. A comparison of annual sales to growth rates shows that vehicle scrappage is very low in most developing countries. For example, in India few vehicles ever reach the stage (other than through an accident) where repair is not a less costly option than new vehicle purchase. This is partly because of the low labor cost for mechanics' time in these countries, but also because of relatively high rates of inflation which make new vehicle prices in absolute terms, very much higher than the original price for an older vehicle. As a result, the vehicle fleet in developing nations consists of a large number of fuel inefficient old technology vehicles, where poor fuel economy is a result of both poor maintenance and outdated designs. It should be noted that electronic spark control can be retrofitted to many existing gasoline engine vehicles, making this technology a viable option for improving fleet fuel economy in comparison to affecting only new vehicle fuel economy. Electronic spark control also has the advantage of not requiring adjustment (although it can fail), reducing fuel wastage as a result of the engine being out of tune.

Another significant factor influencing fuel efficiency in developing countries is the maintenance practices. All manufacturers interviewed, and especially truck manufacturers, claimed that preventive maintenance was rarely performed in developing countries. Commercial vehicle owners were generally unsure of the benefits of such maintenance and valued the lost "downtime" more highly. Lack of access to spare parts, or the general problem of high inflation pricing spare parts out of reach also contributed to the poor maintenance problem. Manufacturers suggested that the combination of low scrappage and poor maintenance practices led to very low fuel economy levels for the fleet. A study of vehicle fuel

71

economy conducted in Pakistan found that several poorly maintained trucks had fuel economy levels 25 to 40 percent below the fuel economy of well maintained trucks of the same model and vintage.

Finally, the potential savings of foreign exchange from reduced petroleum imports through the use of alternate fuel is not being realized in any of the countries analyzed. Part of the reason is that the focus of alternate fuel research in most developed countries has been on fuels to replace gasoline. In developing nations, diesel fuel is far more critical, especially since it propels industrial activity as shown in Section 2. Most of the AID-assisted nations in this study use over three times the amount of diesel fuel as gasoline fuel (see Table 2-5), and are typically faced with the problem of excess gasoline from their refineries. Unfortunately, little technology is commercially available to change the mix of fuels that the diesel engine can operate on. Truck manufacturers noted that the commercialization of technology to use alcohol fuels in diesel engines would be valuable to most developing nations.

4.4 POLICY IMPLICATIONS

The analysis of the current trends in automotive technology and fuel efficiency in developing countries suggest a number of areas where new policy initiatives can be directed.

First, AID-assisted nations can take steps to popularize the two high payoff motor car technologies identified in this report, namely electronic spark control for gasoline engines and turbochargers for truck diesel engines. This can be done in a variety of ways:

- Reducing import duties for electronic controls and turbochargers
- Providing training to mechanics to replace and/or repair these items

72

- Imposing mandatory requirements for local vehicle assemblers or manufacturers to incorporate such technologies in their models
- Offering electronic spark control as a retrofit item for the existing fleet.

Second, it is noted that in potential markets such as Mexico and India, and other countries where few models are offered, the technology availability lags the availability in developed nations. However, the small total sales volume in most developing countries makes it difficult to foster a competitive environment. Even a small assembly plant for motor vehicles must produce 5,000 to 10,000 units per year to be economical. Most developing nations with assembly plants face the problem of restricting model availability with possible monopilistic effects or else fragmenting the market so that manufacture becomes uneconomical. Policies directed at this problem must rely on government intervention, if only a monopoly is possible, to force technology improvements. Such policies are not required in developing countries currently importing their motor vehicles.

Third, the low scrappage rates in developing countries has the net effect of lowering fuel economy and increasing emissions. As noted previously, the low scrappage is related to the low cost of repair and the very high cost of replacement due to inflation. Policies aimed at this problem require some economic distortion of the marketplace. For example, a bounty can be offered to scrap very old fuel inefficient vehicles to compensate the owner of inflationary losses. Another possibility is a stringent inspection program to take old, high emitting, low fuel economy vehicles out of service by refusing registration. Any of these initiatives could, however, result in increased import costs for new vehicles to replace old vehicles. Thus, in the short-term, the balance of payments picture may worsen with this initiative although the long-term fuel conservation benefits are cost-effective. For example, on a motor car that is rated at 30 mpg, the incorporation of electronic spark

control would raise the fuel economy to 33 mpg. At gasoline prices of $2.00/gallon typical in developing countries, the increased first cost is recovered in 15,000 miles of driving.

Fourth, the lack of consumer awareness of maintenance benefits and lack of information on fuel economy is an area that policies could address at low cost to the government. Outside of Portugal and Cyprus (which use EC information) we found little evidence of any program providing information on fuel economy of available models under typical driving conditions. In several countries, manufacturers advertise fuel efficiency based on misleading constant speed tests that serve to divert attention from true fuel efficiency. In a manner similar to developed countries, fuel economy information based on a government approved test cycles should be a priority. In addition, governmental bodies can disseminate information on the benefits of periodic preventive maintenance and even provide an incentive by setting up an inspection program for common fuel wasting malperformances such as excessive smoke from diesels or high carbon monoxide in the exhaust of gasoline engines.

Finally, AID and developed nations can alleviate the problem of high diesel consumption relative to gasoline by providing incentives for substitution of diesel fuel with methanol fuels, derived from natural gas. Natural gas reserves are far more plentiful in most AID-assisted nations than oil reserves; Table 4-5 shows that proven gas reserves are fairly substantial in several of the AID-assisted countries in comparison to oil reserves. In addition, there are many developing countries with small, or as yet, undetermined, resources of natural gas that might have the potential for methanol production. Little work has been done to commercialize modifications to diesel engines to enable them to burn methanol. EEA is aware of considerable research in progress in developed and developing nations, and believes that this is an area where AID can provide critical support in technology transfer to developing nations.

TABLE 4-5

PROVEN RESERVES OF OIL AND GAS (1984)

	Oil Reserves (million bbl)	Gas Reserves (BCF)	Reserves/Annual Consumption	
			Oil	Gas
Tunisia	1,815	3,953	80.2	N/A
Colombia	1,200	4,134	18.7	41.3
Mexico	49,260	76,702	103.9	71.1
Peru	670	992	13.2	N/A
India	3,760	16,870	13.3	159.0
Pakistan	102	15,384	2.3	44.0
Philippines	31	34	0.4	0.8
Thailand	58	3,484	0.7	N/A

75

APPENDIX A

RATES AND BASES OF ASSESSMENT OF ROAD USER TAXES

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World Road Statistics: 1979-1983
1984 Edition

76

KENYA Shilling	*Acquisition* Import duty	Varies from 40 % to 200 % ad valorem according to engine capacity.
KENYA Shilling	Transfer fee	400 Sh - 800 Sh payable on transfer of ownership.
KENIA Schilling (31-12-1983)	Registration fee	100 Sh. for new vehicle.
	Ownership •Vehicle tax	Varies from 250 Sh to 4 000 Sh according to weight. Higher rates for diesel vehicles, min. 400 Sh. Motorcycle 80 Sh; 3 wheeler 100 Sh. Trailer 60 Sh up to 500 kgs; 120 Sh up to 750 kgs; 200 Sh. up to 1 000 kgs.
	Use •Fuel tax	Petrol 2,04 Sh per litre ; diesel fuel 0,75 Sh.
	Transport tax	Road Service Licence, Passenger vehicles 30 Sh; Goods vehicles, for hire 30 Sh; own account 10 Sh.
	Vehicle Spares	25% duty on all spares.
	Tyres and tubes	30% duty and 10% sales tax is imposed.
	Sales tax	25 % imposed on all vehicles (CIF + duty). 15 % on goods vehicles (CIF + duty).
	Driving licence fee	500 Sh for an engine size of 1500-1750 cm³, 200 Sh on goods vehicles.

NIGER Franc CFA		
NIGER Franc CFA	*Ownership* •Registration tax	Varies from 3 000 to 25 000 Fr. CFA according to H.P., — half rates for goods vehicles. Initial fee : 2 000 Fr. CFA.
NIGER Franc CFA (31-12-1983)	•Vehicle tax	Trailers and semi-trailers : 10 000 Fr. CFA. Varies from 6 000 to 60 000 Fr. CFA according to H.P., half rates for vehicles over 5 years old ; vehicles over 8 years old exempt.

TUNISIA Dinar	*Ownership* Vehicle tax	Motorcycles: 10.0 D. Cars: varies from 20.0 D to 500 D according to HP. Goods vehicles, varies from 10.4 D to 41.6 D per metric ton of pay load.
TUNISIE Dinar		Diesel vehicles : varies from 100 D to 150 D according to HP.
TUNESIEN Dinar (31-12-1983)	*Use* Transport tax	Tax levied on passenger vehicles on seat/km basis. Fees for temporary permits varying from 1.9 D to 45.7 D according to area concerned. Temporary tax on transport of goods varying from 6.7 D to 13.3 D according to distance travelled. Rental cars : 3,18 D per month. Public transport of goods : 11,44 D per ton chargeable weight per year.

77

UPPER VOLTA - Franc CFA		
HAUTE-VOLTA Franc CFA	*Acquisition* Immatriculation tax	1 200 F CFA for motorcycles. 4 200 F CFA for private cars 7 200 F CFA for trucks.
OBER VOLTA Franc CFA (31-12-1979)	Driving licence fee	From 1 000-4 000 F CFA, depending on the category.
	Import tax	From 36 % to 56 % according to type of vehicle + 15 % on every vehicle + 0,5 % of the price of the tax.
	Use Yearly tax	From 1 000 to 25 000 F CFA, according to HP.
	Technical inspection and public transport cards	From 1 700 to 4 600 F CFA for the first inspection. From 800 to 2 800 F CFA for renewals. 4 800 F CFA + 300 F CFA per passenger.
	Transporter's licence	4 800 F CFA + 1 000 F CFA per ton.
	Fuel tax	34,40 F CFA per liter on petrol. 16 F CFA per liter on Diesel.

78

COLOMBIA Peso COLOMBIE Peso KOLUMBIEN Peso (31-12-1981)	*Acquisition* Acquisition tax Customs duty *Ownership* Vehicle tax	Private cars 150 %, trucks 65 %, busses 40 % of CIF value. Varies according to value, weight and model of vehicle.
MEXICO Peso MEXIQUE Peso MEXIKO Peso (31-12-1981)	*Use* Fuel tax	Federal tax 0.93 peso/litre ; (Super 1.33 peso/litre)
PERU Sol Oro PÉROU Sol Oro PERU Sol Oro (31-12-1978)	*Acquisition* Sales tax Transfer tax Import tax *Ownership* Vehicle tax *Use* Fuel tax	5% of value. 4% of sales value. Varies according to the type of vehicle. 10 to 50$ according to dimensions. Petrol: 0.0275$ per litre.
URUGUAY Peso URUGUAY Peso URUGUAY Peso (31-12-1982)	*Acquisition* *Ownership* Tire tax Interdepartemental transport tax *Use* Municipal taxes Fuel tax	On vehicles over 2 T charging capacity, in 1981 amounted to 100 Pesos per tire. 5 % on turnover of bus transport companies which are active in interdepartemental transport. Vehicle transfer, registration numberplate, driving licence are all taxed by municipalities. Petrol : ordinary 56,3 % super 61,2 % Diesel : 30,7 % of the sales price.

19

INDIA Rupee (= 100 paise) **INDE** Roupie (= 100 paise) **INDIEN** Rupie (= 100 Paise) (31-12-1978)	*Acquisition* Excise duty	"Ad valorem" tax on motor vehicles at rates varying between 10% and 15% subject to minimum amounts.
	Import duty	At rate of 150% "ad valorem", 20% if from Burma (less for buses and goods vehicles).
	Sales tax	Varies between 6% and 15% of the sale price.
	Ownership *Motor vehicle tax	Varies from state to state. The tax varies between Rs 8 and Rs 150 for motorcycles and cars, Rs 80 and Rs 1 800 for taxis and buses and Rs 380 and 4 300 for trucks, trailers and heavy articulated vehicles.
	Use Excise duty on fuel	On motor spirit Rs 950.02 per 1 000 litres—on high speed diesel oil Rs 478.92 per 1 000 litres.
	Sales tax on fuel	Motor spirit—ranging from 6 paise per l. to 27.2 paise per litre. High speed diesel oil—ranging from 5 paise per litre to 15.8 paise per litre.
	Excise duty on tyres	50 per cent ad valorem.
	Import duty on tyres	60 per cent ad valorem (10% if produced in Burma).
	Sales tax on tyres	From 6 to 11 per cent.
	Excise duty on spares	From 25% to 50% ad valorem.
	Import duty on spares	60% ad valorem.
	Sales tax on spares	From 6 to 13 per cent.
	General *Passenger tax	Varies from one state to another. Ranges from 10% to 25% of the fare.
	*Goods tax	Varies from one state to another. Ranges from 3% to 25% of the freight.
PAKISTAN Rupee **PAKISTAN** Roupie **PAKISTAN** Rupien (31-12-1980)	*Acquisition* Customs duty	Motor cars landed cost not exceeding Rs 5 500, 40% ad valorem (35% if CKD), landed cost between Rs 5 500 and Rs 11 000, 100% ad valorem, between Rs 11 000 and Rs 15 000, 300% ad valorem Microbuses, Jeeps, Land Rovers, etc., 30% ad valorem. Scooters, motorcycles, etc., 40% ad valorem (35% if CKD). Buses and trucks, 35% ad valorem.
	Ownership Annual vehicle tax	Cars: Rs 200 (light cars Rs 25). Goods vehicles: varying from Rs 144 to Rs 1440 according to weight. Buses: Rs 360 plus Rs 50 for every seat over six (Rs 88 for vehicles operating outside local areas).

80

SRI LANKA (CEYLON) Rupee SRI LANKA (CEYLAN) Roupie SRI LANKA (CEYLON) Rupie (31-12-1979)	Import Duty	Unassembled vehicles : 40 %. Cars up to CIF value of Rs 40 000 : 50 % or minimum duty of Rs 10 000. CIF value up to Rs 60 000 : 50 % of first 40 000 and 100% on balance. CIF value over Rs 60 000: 50 % on first 40 000, 100 % on next 20 000, 200 % on balance. Jeeps : 50 % ; Passenger coaches : 12 % Lorries and vans : 5 % - 50 %, depending on weight ; chassis parts and motorcycles : 50 % ; Tires : 75 %.
	Registration fee	Varies according to registration series (from Rs 100 to Rs 600).
	Ownership Licence fee	Based on age and weight of vehicle, payable annually ; varies from Rs 56,25 to Rs 1950 for motor cars and from Rs 75 to Rs 525 for goods vehicles, plus a surchage, varying from 25 % to 50 %, according to age of vehicle ; for coaches, varies from Rs 12,50 to Rs 30 per seat according to age of vehicle.
	Driving licence	Rs 25 per person.
	Transfer fees	Rs 100 to Rs 300 per vehicle according to interval since previous registration.
	Use Fuel tax	Since Aug. 1969 all motor fuel is produced by the Petroleum Corporation which pays tax in the form of turnover tax and income tax.
	Customs duty on tyres	Approximately 72%, based on the wholesale value.
	General Re-sale tax on cars	Levied on all cars purchased after 1.1.63 and all cars imported duty free, at rate of 80% of profit on re-sale.

THAILAND Baht THAILANDE Baht THAILAND Baht (31-12-1982)	*Acquisition* Import duty	Varies from 60 % on 2 and 3 wheeled vehicles to 80 % on passenger car, 30 % on buses and trucks. 25 % on crude oil.
	Ownership Annual tax	0 — 500 kg = 1 B per kg. 500 — 1 000 kg : 2 B per kg. Over 1000 kg : 4 B per kg.
	Business tax	41 % for passenger cars, 7-12 % on other vehicles.
	Fuel tax	33,8 % on petrol. 13,3 % on diesel.
	Licence fee	0,50-4 B depending on cc.

81

CYPRUS Cyprus Pound	*Acquisition* Excise duty	As from 1-7-1978 : is applied to Motor vehicles. There is also a part of 40 % VAT (only 25 % for EEC countries).
CHYPRE Livre cypriote	•Registration fee	Varies from £15 to £55, according to the weight of the vehicle, for goods vehicles, and from £20 to £400 for private cars.
	Luxury tax	Varies from 0 % - 40 % according to cc.
ZYPERN Zyp. Pfund (31-12-1979)	*Ownership* •Road tax	Annual rates vary between £6 25 and £41.25 (£150 and £216 for diesel vehicles) for private cars and between £2.35 and £13.10 (£90.1 and £216.0 for diesel vehicles) for public vehicles. (Private vehicles in use for more than 5 years receive a 25% discount.) £2.35 for motor cycles.
	Use •Fuel tax	£0.113 per Imperial gallon on petrol only.
	•Driving licence	£2 per annum.
	Other	4% on lubricating oil.

PORTUGAL Escudo	*Acquisition* Sales tax	All cars until 1400 cm³ : 4 % × cylinder capacity in cm³ of sales price. Above :
PORTUGAL Escudo		*cm³* — *% on sales price* 1401 - 1700 — 70 1701 - 2000 — 110 over 2000 — 160
PORTUGAL Escudo (31-12-1983)	Special tax	Sale of secind hand cars (up to 5 years old) : 40 000 - 60 000 Escudos.
	Ownershin Annual tax	Varies according to age of vehicle, the cylinder capacity and the fuel used, from 240 - 22 500 Escudos for cars and 150 - 6 360 Escudos for motorcycles.
	Use Compensation tax	Passenger cars and mixed use vehicles up to 2,5 T : 42 000 Escudos. Others : 12 000 Escudos.
	Road transport tax	On bus and trucklines competing with the railway ; it is calculated according to a formula using the number of km, of persons transported, of tons transported and a tarrif per ton-km or person-km.
	Circulation tax	Vehicles below 3500 kg : from 60 - 1 350 Escudos according to the permitted range of action. Vehicles above 3500 kg : 108 - 2 430 Escudos according to permitted range of action.
	Petrol tax	Petrol : 4 700 Escudos per liter.

82