TEXTO PARA DISCUSSÃO

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"THE ROAD TRANSPORTATION INDUSTRY IN BRAZIL: MARKET STRUCTURE, PERFORMANCE AND GOVERNMENT REGULATION"

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THE ROAD TRANSPORTATION INDUSTRY IN BRAZIL:

Market Structure, Performance and Government Regulation

Newton de Castro*

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ABSTRACT

This study summarizes some of the most important characteristics of the road transportation industry, and presents a discussion of its performance. The main objective is identifying areas where government action may be needed in order to correct market failures or to remove inadequate regulation. In the first part, the structure, size and economic relevance of the industry are presented. There is also a brief review of government regulation. The second part is dedicated to analyzing the industry performance, including: investment levels; fleet renewal and adequacy; energy consumption and conservation possibilities; cost structures and freight rates; the impact of government regulation; and factors concerning efficiency and growth. Suggestions for further studies are also outlined.

INTRODUCTION

In spite of the significant role of the road transportation industry to the Brazilian economy, only a few studies have been made so far about its evolution, structure and performance.[1] Even simple aggregates such as the size of the fleet, fuel consumption, or the output produced are not measured with the desirable accuracy. Notwithstanding, government influence in the industry has been pervasive: input price setting (e.g., fuels, equipment); equipment financing; standards for equipment use; economic regulation (entry, routes, schedules and pricing); and so forth.

This regulatory thrust — pervasive in the Brazilian economy in the seventies and eighties — are now becoming a deregulatory one, as proposed by the new elected government. This tendency, however, may become legislation and policies without the necessary knowledge to assess their impacts and, therefore, may lead to unwanted situations which eventually decrease service levels and consumers' welfare. For instance, deregulating a sector such as the intercity passenger road transportation, believed to be characterized by economies of network configuration and scale, may induce mergers and market concentration, allowing higher tariffs and/or lower service levels provided.

It is our premise that economic analysis should be used to evaluate the impact of government interventions in the industry. In this direction, this paper summarizes the most important characteristics of the road transportation industry and presents a discussion of its performance. The main objective is identifying areas where government action may be needed in order to correct market failures or to remove inadequate regulation. In the first part, there is a brief review of some figures about the structure, size and economic

1. Some of the few examples are Wright (1982), Rezende (1984), Faria (1986), Swait (1986) and Castro (1988-B).

relevance of the industry, and a summary of the basic elements of government regulation. The second part concentrates on performance, including: investment levels; fleet renewal and adequacy; energy consumption and conservation possibilities; cost structures and freight rates; the impact of government regulation; and factors concerning efficiency and growth. Suggestions for further studies are also outlined.

I. CHARACTERISTICS OF THE ROAD TRANSPORTATION INDUSTRY

I.1 Size and Economic Relevance of the Industry

Transportation has shown a stable share in Brazilian GDP of 3.7%. The road sector alone accounts for 2.5 to 3% of this value. In contrast with the rail and water transportation sectors, for which one can find adequate data, there is no sistematic information for the road sector, especially for the services provided both by independent truck owners and by firms not engaged in commercial trucking. Automobile use by firms and households is also a neglected issue.

A more revealing picture of the global characteristics of the industry and of the relative importance of the road sector can be built from the bills paid for commercial transportation services, and from investment and operational expenditures of public and private interests. Tables I.1 to I.3 summarize the estimate of the operational bill by mode and type of service. The total bill reaches 22% of GDP, divided into 10.8 and 11.5% for the cargo and passenger transportation, respectively. The road sector is responsible for 86% of the grand total, consisting of US$ 20 billion spent in cargo and US$ 25 billion spent in passenger transportation.

Table I.1- Transportation Bill by Mode in 1985 (in % of GDP)

PASSENGER		CARGO	
AIR	0.82	AIR	0.24
AIRPORTS	0.04	RAIL	0.38
RAIL	0.04	ROAD	8.65
ROAD	10.62	PORT	0.14
		WATER	1.34
TOTAL	11.53	TOTAL	10.76

Table I.2 - Transportation Bill by Mode in 1985 (US$ Million)

PASSENGER		CARGO	
AIR	1927	AIR	572
- Domestic	706	- Domestic	173
regular	665	regular	165
regional	41	regional	8
- International	1221	- International	399
AIRPORTS	104	RAIL	888
		- RFFSA	573
RAIL	99	- FEPASA	151
- Interurban	25	- EFVM	164
- Suburban	32		
- Metro	42	ROAD	20215
		- Truck	20215
ROAD	24816	urban	7982
- Bus	3543	intermunicipal	6378
urban	1868	interstate+international	5855
intermunicipal	1213		
interstate+international	461		
- Auto	21273	PORT (Portobras)	338
		WATER	3142
		- inland	81
		- coastwise	306
		- international	2756
TOTAL	26946	TOTAL	25156

Sources : Anuario Estatistico dos Transportes - GEIPOT
Perfil das Empresas Estatais - SEST/SEPLAN 1985
Empresas de Transp. Rodoviario - FIBGE 1984
Estudo sobre o Transp. Rodoviario de Carga - GEIPOT 1985

Table I.3 - Distribution of Transportation Bill by Mode in 1985 (%)

PASSENGER		CARGO	
AIR	7.15	AIR	2.27
- Domestic	2.62	- Domestic	0.69
regular	2.47	regular	0.66
regional	0.15	regional	0.03
- International	4.53	- International	1.59
AIRPORTS	0.39	RAIL	3.53
		- RFFSA	2.28
RAIL	0.37	- FEPASA	0.60
- Interurban	0.09	- EFVM	
- Suburban	0.12		
- Metro	0.16	ROAD	80.36
		- Truck	80.36
ROAD	92.09	urban	31.73
- Bus	13.15	intermunicipal	25.35
urban	6.93	interstate+international	23.27
intermunicipal	4.50		
interstate+international	1.71		
- Auto	78.95	PORT (Portobras)	1.34
		WATER	12.49
		- inland	0.32
		- coastwise	1.22
		- international	10.96
TOTAL	100.00	TOTAL	100.00

In the sixties, investments of government agencies and public companies in transportation were responsible for more than 40% of total public capital formation. In absolute value, the peak was reached in 1975, when capital expenditures amounted to 3.3% of GDP. Since that year investment figures decreased drastically both in absolute and in relative terms, remaining below 1% of GDP after 1981 (Castro, 1987-B).

Up to 1975, the road sector received the largest share of public investments in transportation. Road building, repair and maintenance expenditures reached its peak in 1974 when US$ 2.3 billion were spent at the federal, state and municipal levels. The sharp decline that happened since that year is made clear by contrasting the US$ 267 million figure spent in 1985, at the federal level, with the corresponding amount of US$ 1.2 billion invested in 1974. This trend, however, was reversed in 1986 after the recreation of the Fundo Rodoviário Nacional. In that year and in 1987, the amount invested was boosted to US$ 548 and 651 million, respectively.[2]

In the mid-seventies, rail and water investments increased rapidly. Rail investments were kept above the US$ 1 billion mark between 1975 and 1977. Nevertheless, those rail figures stayed above federal investments in highways until 1985. It must be remembered, however, that investments in rail include expenditures in vehicles, terminals and ancillary facilities, whereas investments in road include only building and maintaining the highways, as vehicles, terminals and other facilities are privately owned.

Growth in the industry has systematically exceeded growth of other industries and of GDP. Evidence for this performance can be drawn both from GDP accounts and from indirect measures such as diesel fuel consumption (Table I.4). From 1970 to 1988 GDP, the industrial and agricultural outputs have grown at 5.7, 4.0 and 5.6 per year, respectively. In the same period, the cargo transportation output, measured in ton-kilometers, has grown at an annual rate of 8.2%, while value added in transportation expanded at 7.6% per year. It should be noted, however, that there has been a substitution of gasoline for diesel trucks during that period. As diesel consumption is used as the main indicator in obtaining estimates of the evolution of both GEIPOT's aggregate ton-kilometers produced

2. All values in 1985 US dollars, unless noted otherwise. For further discussion on transportation investments see Castro (1987-B).

(8.2%) and, in particular, IBGE's estimates of the value added in transportation, there may be biases in the figures shown.

Table I.4- Evolution of National and Transportation Aggregates

		GROSS PRODUCT					
	GDP				DIESEL	TKM	PASS.KM
YEAR	INDEX	AGRICULT.	INDUSTRY	TRANSPORT	CONSUMP.	(GEIPOT)	(GEIPOT)
1970	100	100	100	100	100	100	100
1971	111	110	112	115	110	109	113
1972	125	114	126	124	126	116	129
1973	142	115	149	149	149	133	147
1974	154	116	162	170	165	159	167
1975	162	124	169	187	184	174	190
1976	178	127	189	212	212	189	217
1977	187	142	195	224	227	208	253
1978	196	138	208	243	248	226	289
1979	209	144	222	267	270	247	328
1980	229	159	243	287	290	269	374
1981	219	171	221	282	281	259	389
1982	220	171	221	287	287	267	405
1983	213	169	208	281	283	268	421
1984	223	173	221	293	292	296	438
1985	242	192	241	313	304	327	456
1986	260	176	269	347	342	355	476
	1987	270	203	272	363	362	
	1988	270	205	265	378	375	
RATE :		5.67	4.07	5.56	7.67	7.62	8.23	10.24
VALUE		US$ mill	US$ mill	US$ mill	US$ mill	1000 M3	10E9 TKM	10E9 PKM
LAST YEAR		253,268	20,196	91,468	9,363	24,424	468,722	552,821

Sources : Anuario Estatistico do Brasil - FIBGE
Anuario Estatistico dos Transportes - GEIPOT
Anuario Estatistico do CNP

I.2 Fleet: Composition and Evolution

1985 is the last year for which data is available for the composition of the Brazilian cargo and passenger fleet. This data comes from SERPRO/Ministério da Fazenda data files of the unified tax system for road use (Taxa Rodoviária Única) in effect until 1985. After that year the collection of road taxes was delegated to the states.

Table I.5 shows the composition of the fleet from 1981 to 1985, according to GEIPOT (1986). It should be noted that SERPRO has adjusted the data for those years, eliminating vehicles whose owners had not paid the federal road tax for two or more years. Therefore, comparisons with fleet data before 1981 should be regarded with caution.

Comparing with total GDP growth in the 1981-85 period (10.5%), we note the fleet grew at faster rates in almost all classes of vehicles. Classes more closely related to urban activities, however, appear with much higher rates (cars, pickups, small trucks and buses). Medium and heavy truck fleet lagged behind GDP, although superheavy truck growth compensated at the end of the scale. This evidence supports a general belief that the use of semi-heavy trucks in medium and long distance hauls is increasing, while adapted (3rd axle) medium size trucks are loosing ground in this type of service. On the other hand, the demand for heavy trucks has remained below expectations. In fact, after the energy crisis of the seventies, it was expected that the market for heavy trucks would expand rapidly due to the lower unit costs and energy consumption of larger vehicles. This happens, however, only if the utilization rate and the load factor are kept high enough, which may not be possible in most low density origin/destination markets.

Table I.5 - Fleet by Vehicle Class

(units)

CLASS	1981	1982	1983	1984	1985
AUTO	7.685.210	8.207.437	8.761.457	9.198.447	9.527.296
BUS	112.062	120.237	126.501	129.947	130.719
PICKUP	702.058	759.690	812.861	861.372	905.200
TRUCK	864.958	901.753	929.712	959.714	979.096
- Domestic	857.786	894.572	922.530	952.530	972.961
- Small	156.894	167.789	177.328	188.232	201.836
- Medium	474.462	486.469	493.942	501.615	495.108
- Semi-Heavy	140.401	150.629	158.822	167.254	178.840
- Heavy	69.797	71.541	72.545	73.408	72.362
- Super-Heavy	12.015	13.908	15.641	17.751	20.671
- Non-specified	4.217	4.236	4.252	4.270	4.144
- Imported	7.172	7.181	7.182	7.184	6.135

Source : Anuario Estatistico dos Transportes, GEIPOT 1986

I.3 Structure of the Industry

Trucking

Estimates based on a sample of 120.000 trucks raised by GEIPOT in 1982 indicated the predominance of private and independent truck ownership, as shown in Table I.6.

Table I.6- Structure of Fleet Ownership (%)

Independent trucker (no attachments)	16.1
Independent trucker (attached to trucking firms)	6.2
Independent trucker (attached to non-trucking firms)	4.6
Individual ownership (private use)	9.2
Non commercial trucking firms (private use)	37.8
Commercial trucking firms	17.6
Others	8.5

Source: GEIPOT, 1985

The GEIPOT (1985) study also confirmed that the fleet owned by independent truckers is older, consisting predominantly of adapted medium size trucks with conventional open bodies. They concentrate their operations in medium and long distance hauls, especially when serving commmercial trucking firms. On the other hand, non commercial trucking owners which hold half the number of vehicles appear more frequently in urban distribution and in the intercity hauls that require specialized equipment.[3]

Commercial trucking firms mount to 11.000 to 15.000 in number. In 1982, 10.971 firms answered a questionary raised yearly since 1968 by the IBGE Foundation. That year those firms employed 220.000 and had operational revenues of US$ 6 billion hauling 277 million tons. Their market is usually segmented according to the type of itinerary — fixed or variable — and the type of product carried. Up to the point that the data allowed investigation, commercial trucking firms appeared highly specialized with respect to the type of market served (Castro, 1988).

Shipment size and the quality of service demanded determine how investments should be allocated between vehicles and fixed facilities, as well as the location of the latter. Investments in vehicles vary from 90 to 40% of total productive assets depending whether the firm operates bulk or break-bulk cargoes.

The density of the market is also a major determinant of market structure. Larger firms concentrate their services on denser O/D pairs while smaller firms appear more frequently in less dense links or in more specialized services. Although there may be hundreds of firms operating in a particular segment of the market, concentration indexes indicate that the four largest firms may hold a significant share (10 to 60%) of

3. See Rezende (1984) and Castro (1988-B) for additional evidence on this point.

that market. The size of the market leaders seems to be determined by the size of the specific market served. Regional comparisons show, on one hand, that the average size of firms do not vary much. On the other hand, large firms can be 10 or 20 times greater in the wealthier Southeast region than they are in the Northeast (Castro, 1988-B).

Age of the firm is also an important factor determining market structure. In 1982, the average revenue of the oldest firms (founded before 1967) was 30 times that of firms founded that year. The 867 oldest firms were only 8% of the total number of firms investigated but answered for 35% of gross receipts of commercial trucking.

Passenger Transportation

In Brazil, passenger transportation is considered a public service. Entry in the sector is restricted by government permissions or concessions. Therefore, the structure of this market is given basically by government regulation. Municipal, state and federal goverments set rates, routes, frequencies, safety and quality standards in practically all market segments.

Private enterprises are predominant in number and hold the largest share of the market. The majority of these firms are small to medium in size, controlled by one entrepreneur or by a family group. In the interstate segment and in dense intermunicipal connections, however, there are a few firms providing services in huge and complex networks, operating fleets of more than a thousand buses. This market concentration is in part the outcome of a process of mergers and take-overs that began in the seventies, and was fostered by authorities under the conviction that there were significant economies of scale in production. As a result, the intercity market leaders grew into large and dynamic enterprises; large enough to accommodate investments in the

development of bus technologies (e.g., aluminum bodies, buses with third axle). In the eighties, these firms have entered vigorously in the small shipments and parcel service markets.

In the urban segment, however, large firms are scarce. In the metropolitan centers, firms usually serve a strictly defined geogrphical area, operating, from a single garage, a fleet of two or three hundred buses at most. Unlike the trucking market, in the passenger sector there are no owner-operators, but in very small towns. In medium and small towns a monopolistic regime prevails. Its is also worth noting that in the large metropolis there are publicly owned and operated firms. These firms are usually bigger than private firms in the area. Their existence is justified by authorities on the basis of: a) guaranteeing services in areas apparently unattractive to private interests; b) reducing the clout of private firms when negotiating for tariffs and service standards; and c) acquiring a better knowledge of the cost structures of passenger transportation.

I.4 The Role of Government

Until 1983 the truck market was unregulated. Government provided and maintained the infrastructure and influenced operations only indirectly through pricing and taxation of inputs, license fees and financing (both the regulation of private agents and direct financing through BNDES), and by the introduction of entry barriers to foreign firms since 1980.

In 1983, trucking economic regulation brought two new important restrictions, along with a taxonomy for the classes of truck operators presented in section I.3. First, non commercial trucking firms were forbidden to sell trucking services to third parties. Second, the Ministry of Transport — MT was invested with mandate to impose restrictive measures to entry of new trucking firms. In 1987, additional restrictions were imposed by MT which, surprisingly, extended

the scope of the law, establishing minimum capacity levels for commmercial trucking firms and geographical limits to operations as well as to the type of commodity carried. In practice, problems with the implementation of the operator's mandatory register and/or insufficient political support or means to enforce legislation have made the impact of these restrictions negligible so far.

In passenger transportation, the presence of government is widespread, as has already been noted. In addition to the provision of infrastructure public companies operate buses, suburban and intercity trains, subways, passenger water transport systems, airports and a domestic airline. The permission or concession regime that prevails in all these segments makes entry of new firms quite difficult and rare.

II. PERFORMANCE OF THE ROAD TRANSPORTATION INDUSTRY

II.1 Investment, Fleet and Adequacy of Capacity

Although investment in vehicles represents only a fraction of total operational capital employed in the industry, the availability of data on vehicle production and sales makes it the only consistent indicator of the evolution of the industry capacity. Data on the fleet stock is restricted by compatibility reasons for the period before 1981. After 1985 the compiling of fleet data have been discontinued.

Tables II.1 to II. 2 show estimates of the evolution of vehicle sales, from 1957 to 1988, by type and fuel used, compiled from various sources. Fleet data covering the period from 1981 to 1985 comes from GEIPOT (1986) and estimates for 1980 and 1986 to 1988, shown in Table II.3, were constructed using sales data and scrappage parameters obtained from the 1981/85 period.

Figures II.1 to II.6 (in Appendix) show the evolution of sales to GDP ratios. Fleet to GDP ratios are also shown; the fleet being expressed in terms of the number of vehicles in each class and of total static capacity.

Table II.1- Estimates of Auto, Bus and Pickup Sales

	AUTO			BUS			PICKUP			
FUEL / YEAR	GASOLINE	ALCOHOL	TOTAL	GASOLI	DIESEL	TOTAL	GASOLINE	DIESEL	ALCOHOL	TOTAL
1957	13565	0	13565	247	345	592	10818	-	-	10818
1958	42564	0	42564	166	592	758	19322	-	-	19322
1959	68338	0	68338	436	1302	1738	26101	-	-	26101
1960	69471	0	69471	574	1399	1973	29600	-	-	29600
1961	85850	0	85850	160	1291	1451	29948	-	-	29948
1962	110314	0	110314	119	569	688	41154	-	-	41154
1963	123056	0	123056	126	967	1093	27476	-	-	27476
1964	133057	0	133057	67	2161	2228	26485	-	-	26485
1965	138792	0	138792	28	2152	2180	21519	-	-	21519
1966	158530	0	158530	41	2507	2548	31374	-	-	31374
1967	172102	0	172102	22	3188	3210	28077	-	-	28077
1968	205893	0	205893	6	5684	5690	28949	292	-	29241
1969	280986	0	280986	6	5662	5668	26335	842	-	27177
1970	343852	0	343852	24	3924	3948	29594	573	-	30167
1971	438393	0	438393	13	4183	4196	34651	492	-	35143
1972	509602	0	509602	30	4269	4299	45059	547	-	45606
1973	599370	0	599370	55	6110	6165	57455	639	-	58094
1974	697130	0	697130	96	7257	7353	65835	597	-	66432
1975	713817	0	713817	114	8679	8793	64374	781	-	65155
1976	760094	0	760094	11	11035	11046	58851	1323	-	60174
1977	712998	0	712998	0	12117	12117	30402	2394	-	32796
1978	837260	0	837260	0	12710	12710	36990	4432	-	41422
1979	871340	4465	875805	11	10804	10815	41332	15287	149	56768
1980	581427	241712	823139	0	12705	12705	33235	19589	13273	66097
1981	519676	122099	641775	0	11179	11179	17870	30260	5617	53747
1982	369106	215646	584752	0	8549	8549	15117	32744	20633	68494
1983	79659	551094	630753	0	6228	6228	10904	24939	39685	75528
1984	60114	497915	558029	0	5798	5798	3365	28099	59972	91436
1985	42465	573383	615848	0	6651	6651	6690	29395	66856	102941
1986	77969	609227	687196	0	8049	8049	5553	36025	77877	119455
1987	48110	375916	424026	0	9605	9605	7372	27629	49751	84752
1988	77463	396435	473898	0	12314	12314	11761	37687	44301	93749

Sources : ANFAVEA
Anuario Estatistico dos Transportes - GEIPOT
Transporte Moderno

Table II.2- Estimates of Truck Sales

TYPE / FUEL / YEAR	SMALL DIESEL	SMALL GASOLIN	SMALL ALCOHOL	MEDIUM DIESEL	MEDIUM GASOLIN	MEDIUM ALCOHOL	S-HEAVY DIESEL	S-HEAVY GASOLIN	S-HEAVY ALCOHOL	HEAVY DIESEL	TOTAL
1957	0	849	0	4012	10392	0	0	0	0	4094	19347
1958	0	31	0	7130	16260	0	0	0	0	4183	27604
1959	0	1619	0	6644	25387	0	0	106	0	3456	37212
1960	0	3862	0	5608	24163	0	0	381	0	4114	38128
1961	0	2165	0	3763	18022	0	0	285	0	2134	26369
1962	0	3453	0	6501	23458	0	0	550	0	2228	36190
1963	0	1510	0	4657	12792	0	0	127	0	2448	21534
1964	0	1847	0	4467	12820	0	7	269	0	1727	21137
1965	0	2008	0	5154	12565	0	37	274	0	2539	22577
1966	0	2728	0	8573	16363	0	0	0	0	2798	30462
1967	0	2724	0	9091	14017	0	0	0	0	1828	27660
1968	0	4311	0	14980	18965	0	0	0	0	2232	40488
1969	0	4346	0	16444	16147	0	0	0	0	2483	39420
1970	0	3917	0	16145	13029	0	2539	20	0	2448	38098
1971	0	4084	0	14538	11776	0	4364	18	0	2929	37709
1972	2644	5105	0	19792	14674	0	4871	45	0	3156	50287
1973	4276	5396	0	25046	20317	0	5371	29	0	4376	64811
1974	4871	5685	0	23750	23591	0	7290	37	0	6233	71457
1975	7222	3037	0	26616	13657	0	11700	64	0	8094	70390
1976	9954	2490	0	33910	5603	0	14033	10	0	9595	75595
1977	16365	947	0	45635	957	0	17664	1	0	8746	90315
1978	18319	244	0	36347	675	0	16778	3	0	6578	78944
1979	19687	180	0	34378	1578	0	16928	33	0	5922	78706
1980	20165	412	0	32013	1796	13	18572	2	0	7041	80014
1981	11847	392	0	18129	1245	692	15387	51	1465	5520	54728
1982	11687	64	0	12337	222	314	10699	5	590	4633	40551
1983	11581	213	1	8885	204	444	9899	0	1624	5237	38088
1984	15424	126	12	9379	84	848	11980	0	1679	5755	45287
1985	18403	53	345	10891	15	639	15912	0	905	7465	54628
1986	26198	70	140	9743	121	608	32345	0	704	9978	79907
1987	19915			8760			19949			8523	57147
1988	18695			8491			18481			10114	55781

Sources : ANFAVEA
Anuario Estatistico dos Transportes - GEIPOT
Transporte Moderno

Table II.3- Estimates of Fleet and Scrappage Coefficients

CLASS	1980	1981	1982	1983	1984	1985	1986	1987	1988
FLEET									
AUTO	7155236	7685210	8207437	8761457	9198447	9527296	10065628	10332379	10644833
BUS	103194	112062	120237	126501	129947	130719	135841	142404	151530
PICKUP	676439	702058	759690	812861	861372	905200	987014	1030723	1081612
TRUCK	826753	864958	901753	929712	959714	979096	1038969	1074618	1108012
- Domestic	819583	857786	894572	922530	952530	972961	1032834	1068483	1101877
- Small	147976	156894	167789	177328	188232	201836	223715	238610	251950
- Medium	461403	474462	486469	493942	501615	495108	498061	499257	500166
- Semi-Heavy	126466	140401	150629	158822	167254	178840	207691	222766	236018
- Heavy	79530	81812	85449	88186	91159	93033	99223	103707	109599
- Non-specif.	4208	4217	4236	4252	4270	4144	4144	4144	4144
- Imported	7170	7172	7181	7182	7184	6135	6135	6135	6135
SALES									
AUTO	823139	641775	584752	630753	558029	615848	687196	424026	473898
BUS	12705	11179	8549	6228	5798	6651	8049	9605	12314
PICKUP	66097	53747	68494	75528	91436	102941	119455	84752	93749
TRUCK	80014	54728	40551	38088	45287	54628	79907	57147	55781
- Small	20577	12239	11751	11795	15562	18801	26408	19915	18695
- Medium	33822	20066	12873	9533	10311	11545	10472	8760	8491
- Semi-Heavy	18574	16903	11294	11523	13659	16817	33049	19949	18481
- Heavy	7041	5520	4633	5237	5755	7465	9978	8523	10114
SCRAPPAGE COEF.							Coefficients used for Fleet Estimates		
AUTO			0,0081	0,0093	0,0138	0,0312	0,015625		
BUS			0,0033	-0,0003	0,0186	0,0452	0,022391		
PICKUP			0,0155	0,0294	0,0528	0,0686	0,041583		
TRUCK									
- Small			0,0055	0,0134	0,0263	0,0276	0,022440		
- Medium			0,0018	0,0042	0,0053	0,0360	0,015187		
- Semi-Heavy			0,0076	0,0221	0,0329	0,0313	0,023471		
- Heavy			0,0122	0,0293	0,0315	0,0613	0,040712		

Note : 1981 to 1985 data from CVP/TRU , GEIPOT (1986)
1980 , 1986 to 1988 estimates.

Sales to GDP ratio for trucks (Figure II.1) has shown an overall declining tendency since the 1960's. From 1963 to 1980

it has oscillated around 100 points, falling in the 1980's to 60 points. That is 40% below the relative fleet renewal and expansion rate found in the seventies. The ratio for pickups has fallen sharply in 1977, but sales recovered since then showing an ascendent trajectory that reached a peak in 1986. Ratios of auto and bus sales to GDP show smoother trajectories (Figure II.2). After the upward movement since the start off of Brazilian auto industry in 1959, it has followed a continuous decline into the eighties. The bus/GDP ratio shows a more cyclical pattern and a smaller amplitude of variation, with sales recovering after 1985.

Sales to GDP ratios by truck class reveal an interesting situation. As shown in Figure II.3, the ratio for overall truck sales has declined significantly in the eighties. Nevertheless, Figure II.3 shows that all truck classes but medium trucks have ratios equal or above that found in 1970 (=100). In fact, sales data presented in Table II.2 have already indicated the substitution phenomenon of medium trucks for small and semi-heavy trucks in the urban and intercity markets, respectively.

The cycles and uncertainties of the eighties have interrupted sales growth. Grossly, the level of investment in recent years (excluding 1986) is similar to that found in the mid-seventies, in spite of the level of activity being around 50% higher (see Table I.4). The fleet, however, has grown faster than GDP in all classes of vehicles between 1981 and 1985. Figure II.4 shows that the fleet to GDP ratio for trucks has increased from 1980 to 1983, falling afterwards until 1986. The values of this ratio for 1981 to 1983 reflect more the poor performance of GDP and the low scrappage rates of the fleet. Conversely, when GDP starts growing the ratio falls; it increases again in 1988 when growth was close to zero.

These results indicate that scrappage rates have remained on the lower side during the eighties, causing the average age

of the fleet to increase. This process of extending the use of existing capital, however, has limits and may eventually trigger a cycle of scarce capacity and higher freight rates, which in turn may attract investment to the road transportation industry.

II.2 Fleet Renewal and Adjustment to New Technologies

Evidence shown above indicates that the fleet is not being renewed as rapidly as GDP and that the average age of the fleet may be increasing. On the other hand, a significant improvement in the truck technology has been noted in the eighties. Mercedes-Benz, the market leader, has now strong competition in the small, medium and semi-heavy size trucks coming especially from Volkswagen and Ford. Mercedes itself and Volvo — an entrant of the eighties — are also challenging the comfortable position enjoyed by Saab-Scania, the market leader in the heavy truck segment. With competition came investments to produce more efficient engines and modern trucks and buses. The industry of parts and components has its evolution determined by the auto makers and therefore has improved the quality and expanded the variety of its products.

Contrasting with the performance of the supply side, the demand seems to be lagging behind. Fleet upgrading and renewal has been a phenomenon concentrated in the segments of capitalized non commercial trucking and in the large commercial trucking firms. Owner-operators seem to be decreasing in number and their fleet to be aging. Numbers for the utilization of owner-operators by commercial trucking firms have decreased 30% in real terms from 1974 to 1983 in a gradual and monotonic way, while other input utilization indicators have remained almost constant (Castro, 1988-B). Preliminary evidence obtained from the 1985 vehicle registration data indicates that 65% of the cargo fleet six or more years old was owned by owner-operators. This percentage

falls to 51, 45, 36, 40, 41, and 38% for trucks of 5 to less than one year of age.

II.3 Energy Consumption and Conservation

Transportation is responsible for approximately 1/4 of total energy consumption in Brazil. In terms of oil products consumption the share of transportation reaches 50%, notwithstanding the increase in alcohol use in automobiles. Gasoline, diesel and querosene are the products consumed mostly by the industry. Following a tendency found in many other countries, the share of middle destillates (diesel and querosene) in total oil products consumption has increased from 40 to 55% in the last decade. In the Brazilian case, this tendency has been reinforced by: a) the price differential of gasoline to diesel (see Figure II.7) that accelerated the dieselization of the truck and pickup fleets since 1974 (see also Tables II.1 and 2); b) the substitution of gasoline for alcohol mentioned above; and c) the substitution of fuel oil for electricity and coal in industrial processes.

Trucking

Trucking is responsible for 50% of the consumption of diesel oil. The sensitivity of this demand to economic variables is shown in Table II.4.

Table II.4- Diesel oil consumption in trucking: Sensitivity to selected variables

Variable (1% change)	Diesel consumption (% change)
Family income	0.85
(population constant)	-
Average family income	0.39
Total income and population	0.46
Agricultural production	0.26
Industrial production	0.10

Source: Castro, 1986.

Distribution of goods for final consumption, as revealed by family income is the most influential factor, followed by agricultural and industrial outputs. It should be noted that these elasticities are the result of the product of the share of each of these variables in total trucking consumption and the elasticity of the specific demand for diesel of each variable. Assuming this specific elasticity is equal to one, the figures shown above would represent the shares of each variable in diesel oil used in trucking.[4]

The importance of average family income in trucking can be explained in part by a tendency to diversify the consumption of goods with income — in particular, increasing imports from

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4. Formally, this interpretation is given as:
$E = (dQ/dX)(X/Q) = (dQ_X/dX + dQ_o/dX)(X/Q_X)(Q_X/Q)$,
where
E = total elasticity estimated
Q = total consumption
X = a variable that determines consumption
Q_X= consumption of Q determined by X
Q_O= consumption of Q not determined by X (i.e. $Q-Q_X$).
Assuming that the impact of X on Q_o is negligible ($dQo/dX=0$) we get:
$E = (dQ_X/dX)(X/Q_X)(Q_X/Q) = E_X(Q_X/Q)$
where
E_X= elasticity of Q_X with respect to X
Q_X/Q= share X in the consumption of Q.
In cases where E_X is equal or close to 1, the estimated total elasticity (E) can be interpreted as the share of variable X in total consumption.

other regions. Low income groups would have a consumption pattern more concentrated on locally produced goods.

These results can be used to shed some light on the evolution of diesel demand that for 30 years until 1984 have grown faster than GDP, in spite of real price increases observed in that period. Particularly in 1984/85, GDP growth was pushed by exports (in contrast to internal consumption in 1986). In those two years, for the first time, diesel demand expanded at a rate below GDP's, as shown below.

Table II.5- Annual Growth Rate of Diesel Oil, GDP, and Diesel Real Price Index

Period	Diesel Price Index	Average Annual Growth Rate (%)		
		Diesel Consumption (A)	GDP (B)	A/B
1954/58	100	12.8	6.5	2.0
1958/63	122	10.2	6.4	1.6
1963/68	143	7.5	5.0	1.5
1968/73	172	11.9	11.1	1.1
1973/78	238	10.1	6.7	1.5
1978/83	320	14.2	1.6	8.9
1984	324	3.0	5.1	0.6
1985	298	4.2	8.3	0.5
1986	212	12.7	7.6	1.7
1987	184	5.7	3.6	1.6
1988	184	3.5	-0.3	-

Sources: Conselho Nacional do Petróleo - CNP and Fundação IBGE

At the level of the firm that produces transportation services there is little room for substitution of energy for other inputs of production. In the short run, price increases are expected to be passed on to rates. Therefore, the possibilities for energy substitution lie mainly in technological innovations and in changes of the operational aspects of the service demanded and produced.[5]

5. On this point see Faria (1986), for passenger transportation; and Swait (1986), and Rezende e Silva (1987), for trucking.

Unitary energy consumption by different modes and submodes show a wide amplitude of values. In Brazilian rail, one finds figures that range from 4 litres of diesel for 1,000 ton-kilometers, in Estrada de Ferro Vitória-Minas, to 27 litres/1,000 tkm in certain divisions of RFFSA. Trucking firms carrying liquid or dry bulk commodities in long distance hauls, on the other hand, compare favourably with the upper limits for rail showing unitary consumptions of 20 to 25 litres/1,000 tkm. In short hauls and in the distribution of perishable goods, however, numbers of 100 to 300 litres/1,000 tkm are not uncommon.

It should be noted, however, that average consumption by mode is seldom a good starting point for making comparisons and exploring energy conservation possibilities: one cannot disregard the attributes of each type of service. The impact of the operational characteristics of transportation services in diesel consumption are shown in Table II.6. Significant economies with respect to the volume carried (measured in tons) can be found in the average firm, although constant unitary consumption begins to appear in the largest firms carrying liquid bulk cargoes. Given two firms of the average size of the industry, if the first hauls 10% more tons it would have a consumption of diesel only 7.4% higher. Following the same rationale, if the number of lines increases, ceteris paribus (i.e., total tons and other variables constant), the network served becomes less dense and, therefore, fuel consumption increases. Conversely, the negative sign of the effect for the variable representing the total extension of lines can be understood by remembering that an increase in this variable reduces the dispersion of the network. It should also be noted the positive relationship between quality of service, represented by the unit value of goods, and energy consumption.

Table II.6- Impact on diesel oil consumption caused by trucking service characteristics

Service Characteristic (1% variation)	Impact (%)
Tons hauled	0.74
Total extension of lines	-0.27
Total number of lines	0.45
Unit value of goods hauled (proxy for service quality)	0.19

Source: Castro, 1988.

These results can be used to guide policies oriented towards energy conservation and towards fostering the industry overall efficiency. Specifically, measures can be devised to stimulate concentration of cargoes, rationalization of networks and of scheduling and routeing of flows. As trucking has the largest share in domestic transportation, one can expect a reasonable potential for conservation through these measures within the trucking industry itself. Conservation through mode choice is also likely to produce some impact, especially in inter-regional traffic, where the rail share is negligible. The reductions in energy consumption, however, are more likely to be achieved through small incremental gains within each mode. As explained, global averages for entire modal systems can not be compared naïvely.

Passenger Transportation

Brazil has experienced an intense process of urbanization, in the last decades, followed by the diffusion of ownership and utilization of automobiles. In fact, the urban population share which was only 26% in 1940 jumped to 65% in 1980. Auto fleet exploded from 3.7 million in 1974 to more than 10 million in 1980.

Productive activities answer for approximately 25 to 30% of the energy consumed in autos (gasohol and alcohol). Commercial and service sectors demand a larger share than

agricultural and industrial activities. Families in journey-to-work or leisure trips consume 3/4 of energy used in autos (Castro, 1989).

Energy spent in individual passenger transportation by income group is shown below. Note that low income groups show a small unitary consumption: a person with an average income of one minimum wage in 1980 spent approximately 1.3% of his income (in this case mostly indirectly) in automotive fuels. Nevertheless, the large number of people in these lower income brackets makes their global consumption significant (Table II.7). Other evidence from census data indicates the relative importance of the demand for individual transportation by low income groups. According to those numbers, 30% of the auto fleet, in 1980, was owned by households with income below the 5-minimum-wage line (see Table II.8).

This evidence points in the direction of a demand for quality of service in passenger transportation which may be severely restricted by lack of alternatives: the expensive auto or the bus (usually providing poor service levels). Considering that unitary energy consumption of buses, in Brazil, stays around 1/12 of the auto's, one may conclude that there may be room for conservation through an expansion of service options of intermediate quality.[6]

6. For more discussion on this topic see Castro (1986-B).

Table II.8- Energy Consumption in Individual Passenger Transportation by Income Group

Income Group (in min.wage)	Unit Consumption (litre/yr.)	Total Consumption (1000 M3)*	Share in Total Consumption
less than 1	30	750	5.56
1 - 2	42	717	5.31
2 - 5	147	1978	14.67
5 - 10	448	1862	13.80
10 - 20	1167	2118	15.70
more than 20	3033	2619	19.42
Total		10044	74.46 %

*Gasohol plus hidrated alcohol, adjusted for unitary energy content

Source: Castro, 1989.

Table II.8- Distribution of Auto Ownership According to Household Income

Income Group (in minimum wages)	Number of Households (000)	% with auto	Cummulative Autos (000)	Cummulative Share (%)
less than 1/2	257	1.4	3.6	0.06
1/4 - 1/2	1295	1.1	17.8	0.31
1/2 - 1	3179	2.1	84.6	1.49
1 - 2	5446	5.3	373.2	6.58
2 - 5	7889	17.6	1761.7	31.06
5 - 10	3862	44.3	3472.6	61.23
10 - 20	1874	73.5	4850.0	85.51
more than 20	912	90.1	5671.7	100.00
Total	24714	23.0	-	-

Source: Fundação IBGE

II.4 Operating Costs and Freight Rates

The cost structure of trucking, estimated for a sample of 1,500 firms, shows consistent economies of density which vary with the amount and type of cargo carried. Cost elasticities with respect to the volume carried (measured in tons) ranged from 0.36 for the smaller firm in the sample (6,700 tkm

produced) to 0.85 for the largest one (1.2 billion tkm produced), being 0.63 for the average firm. Futhermore, firms that operate in bulk cargo markets present cost structures with less intense economies of density. Constant returns to density can be found in liquid bulk cargo firms around 2 billion tkm level of production, while firms operating in general cargo segments would enjoy economies of density until 14 billion tkm (Castro, 1988-B).[7]

Economies of scale were found in passenger transportation both in the urban and intercity markets. In the first, constant returns would be reached for a firm with a fleet of approximately 170 buses, while in the latter the fleet size would be 600 buses (Faria, 1986). It should be noted, however, that the concept of economies of scale adopted in that study did not distinguish between economies of density and economies of size. Moreover, the data did not allow to take into consideration the structure of the network served in the specification of the cost model.

In the short run, the cost structure for trucking reveals a significant share of fixed costs; short run marginal costs and consequently tariffs can be set up to 40% below long run marginal costs. The ratio of operational expenses to revenues varies from 50 to 70%, the upper bound found in firms that operate with bulk cargoes. Total expenses to revenues are around 91% (Castro, 1988-B).

Analysis of the impact of market structure and size on profits of commercial trucking firms shows that the more concentrated the market and the greater the share held by the firm, the larger its profits. On the other hand, no correlation was found between firm size and profits. Sales margins for liquid bulk carriers are consistently above the industry average and above every other class of carrier. This

7. These limits, however, are only indicative as they fall outside the sample used for estimation.

result is most likely influenced by the structure of the market for transportation of oil products. There, rates are set by a government agency (CNP) and covered by charges built into consumer price of oil products — there is no price competition and entry is restricted in this trucking market. In other segments of the market, there appears to be no indication of above normal profits (Castro, 1988-B).

Truck rates estimated for 1982 reveal a competitive position of this mode in relation to rail. In fact, rates charged that year by interstate trucking firms were similar to the average trucking rate charged by FEPASA and RFFSA railroads (excluding iron ore rates), around 2.8 cents/tkm. It should be noted, however, that these rates are for long distance trucking while the average rail distance in Brazil is shorter. Favouring truck rates, we also find the widespread practice of non-compliance to regulation of weight per axle and total weight of trucks, as well as a low level of road user charges. Rail firms, on the other hand, have to build and maintain their infrastructure and ancillary facilities (Castro, 1986-B).

II.5 Impact of Government Regulation

The average commercial trucking firm operating with fixed itinerary, in 1983, would have invested in fixed facilities US$ 38,000 plus US$ 19,000 in equipment. These values do not represent by any means barriers to entry in the industry (Castro, 1988-B). These values raise questions related to the desirability of the minimum capacity restrictions imposed by the Ministry of Transportation in 1987, as they would be insufficient to acquire a new fleet of 48 tons of net capacity as required by Portaria 216/87 imposed by the Ministry of Transportation. On the other hand, the largest firms of this sector showed fixed assets in excess of US$ 10 million, the largest number observed being US$ 21 million (Castro, 1988-B).

It is generally accepted that new commercial trucking firms are formed mainly by successful owner-operators. Entry and exit in this sector appear to be intensive. According to IBGE Foundation data, in the period 1980-82 there were 2,435 new entries. Meanwhile, only 298 firms were added to the total number of firms interviewed. The conclusion is that apparently 2,137 firms exited the industry. These calculations do not take into account other factors that may have influenced the results, especially problems related to the aplication of the questionary itself. Nevertheless, factors such as the economic recession of 1981; the low barriers to entry; and the high factor mobility found in trucking, certainly contributed to what appears to be a high rate of turn-over in that period.

Trucking costs exhibit strong evidences of economies of density. In this respect, the traditional point of view of the theory of economic regulation is that industries characterized by economies of scale should be imposed entry restrictions in order to take full advantage of cost economies; tariff regulation would be imposed, on the other hand, in order to protect social interests. More recently the theory of market contestability argues that industries with declining costs but not regulated may turn out a performance desirable from the social standpoint. Baumol, Panzar and Willig (1982) show that perfectly contestable markets (whose caracteristics can be approximated in reality) with fixed cost structures are compatible with equilibrium results found for competitive market structures. The basic conditions for such result are that fixed costs should not be sunk and that they also stay above a minimum level.

Trucking has low entry and exit costs in many segments which turns it into a highly contestable market. Not only the investment requirements to operate the average trucking firm are small when compared to other industries, but they also have great mobility. In the case of vehicles this mobility is

above any doubt. In the case of fixed facilities (warehouse, terminals, garages, etc.) they are usually flexible enough to provide many different services with minimum adaptation. The question, however, of whether fixed costs are high enough so as to guarantee that prices are sustainable remains unanswered.

Market structure of commercial trucking is heterogeneous, showing segments with high concentration indexes. Moreover, the largest firms in each market segment seem to be limited in size by the extent of each market. Contrasting cost and market structures, one could argue that a policy that affected indistinctively all segments of the trucking market would be bound to lead to economic distortions. Imposing limits to entry may restrict undesirably the supply of services in less dense markets, unattractive to larger existing firms. Measures that foster growth of trucking firms so as to take advantage of economies of scale may not be effective because growth may be in fact limited by the extent of each market, as empirical evidence suggests. It may be true, however, that a competitive environment in times of economic recession may stimulate the practice of predatory pricing, inhibiting investment and growth. The declining supply of capacity by owner-operators — more likely to be vulnerable to economic fluctuations — supports this argument.

II.6 Issues and Factors Concerning Efficiency and Growth

In the 1974-83 period, the commercial trucking sector has shown an inverse relationship between financial expenditures and investment per ton hauled. In fixed itinerary firms, while financial costs grew from Cz$ 7 to Cz 14 per ton, unit investment fell from Cz$ 50 to Cz$ 16. In variable itinerary firms, investment per ton carried were nine times unit financial expenditures in 1974. In 1983, this ratio was only

1.5. During this period labor costs per ton have remained around Cz$ 27 (Castro, 1988-B).

The impact of the increase in financial cost may particularly hurt owner-operators and smaller trucking firms. These do not have access to privileged financing terms (e.g., through FINAME) and have to bear with higher interest rates and shorter financing periods.

Entry restrictions in passenger transportation and potentially in trucking are also aspects that may be lead to economic inefficiencies.

II.7 Summing-up and Suggestions for Additional Studies

After three decades of continuous and stable growth, the road transportation industry has experienced, in the eighties, a period of substantial changes. The macroeconomic cycles and uncertanties have kept investments at the same level they were in the middle seventies, in spite of the level of activity being 50% higher. The effects in terms of an older and less productive fleet, however, were unevenly distributed, being concentrated on the segment of independent owner-operators. The full consequences of these transformations to the market structure of the industry are still unknown, but may potentially include higher entry barriers and more concentration, as firms become less able rely on borrowed capacity form the independent operators to complement their service needs.

Policies to counteract these tendencies, however, should be preceded by deeper investigation, as the universe of both owner-operators and non commercial trucking firms is poorly known. In fact, the decline of the former and the expansion of the latter in recent times indicate that important changes are

taking place in those segments. To act upon these trends, however, requires deeper understanding of issues concerning investment and growth of the trucking industry and, in particular, of the impact of interest rates and financing terms on independent operators. It must be stressed that, in Brazil, the owner-operator performs a major role in providing services during seasonal peaks, due to his greater geographical mobility and his ability to quickly adapt his operational patterns to demand requirements. This ability is of great importance to a country of the size of Brazil, where agricultural production is spreading to new areas each time farther from the major consumption centers.

The issue of the desirability of some sort of economic regulation in trucking is far from settled. The existing regulation treats indistinctively all market segments and thus may lead to economic distortions. On one hand, the entry barriers imposed may be restricting supply in less dense markets. On the other hand, potential gains from existing economies of density may not be achieved because the growth of firms may be limited in fact by the extent of each market.

Specific aspects included in the Portaria MT 216/87 should be assessed in more detail. The process of birth and growth of trucking firms can be examined in order to determine the potential effects of restrictions to entry. The choices of network structures and service standards by firms may provide important information with regard to the evaluation of the desirability of both geographical area and type of cargo regulatory restrictions. Further evidence and analysis can also be developed with respect to the determinants of firm size and costs structures.

Turning to energy conservation, it should be emphasized that, in the past, the discussion in transportation has been focused on the truck versus rail or water transportation, as the most promising way to improve energy efficiency. Results,

however, showed that truck can be as efficient as rail depending on the service characteristics, and that it is unlikely that change of mode per se (i.e., service characteristics constant) would produce any significant improvement in energy consumption. Therefore, studies and policies, in Brazil, should be aimed more at intramodal conservation possibilities.

In passenger transportation, studies revealed the importance of private automobile use by low income families, as well as by the productive sectors. These results raise interesting questions about the distributive impact of automotive fuels pricing and the demand for quality of service in urban transportation. On this issue, one could speculate that there is room for energy conservation policies through the provision of services with an intermediate level of service, positioned between the private auto and the crowded bus, particularly in metropolitan centers.

Passenger transportation cost studies should be extended in order to take into consideration network structure and alternative measures of output. A solid knowledge of cost structures is a precondition for the assessment of the impact of economic deregulation of this industry. A more general study following the industrial organization methodology can also be of great value.

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APPENDIX

Figure II.1 – Sales / GDP Ratio

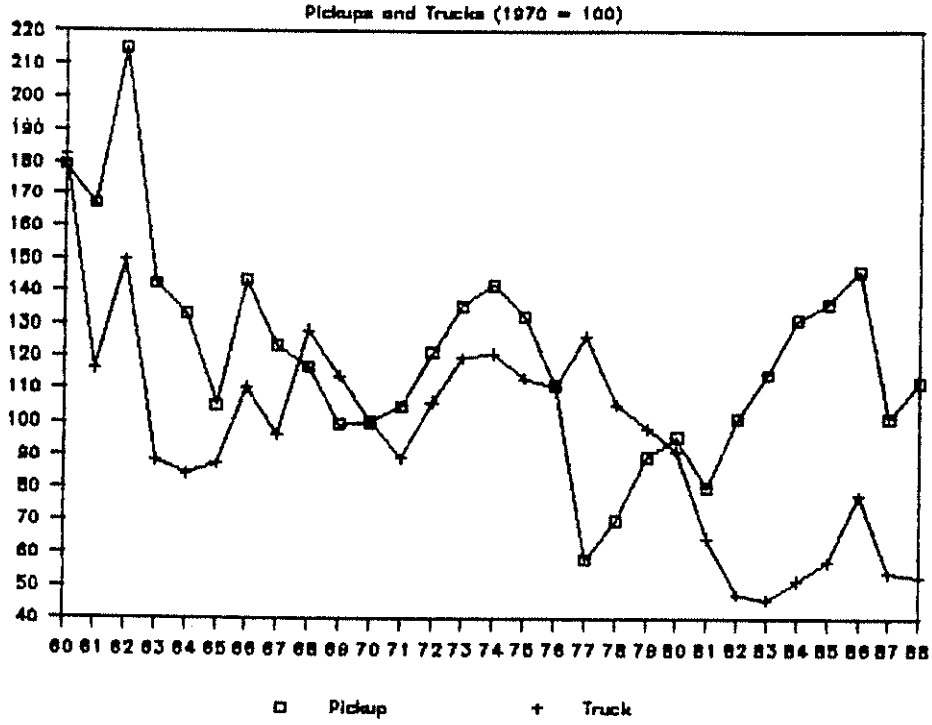

Figure II.2 – Sales / GDP Ratio

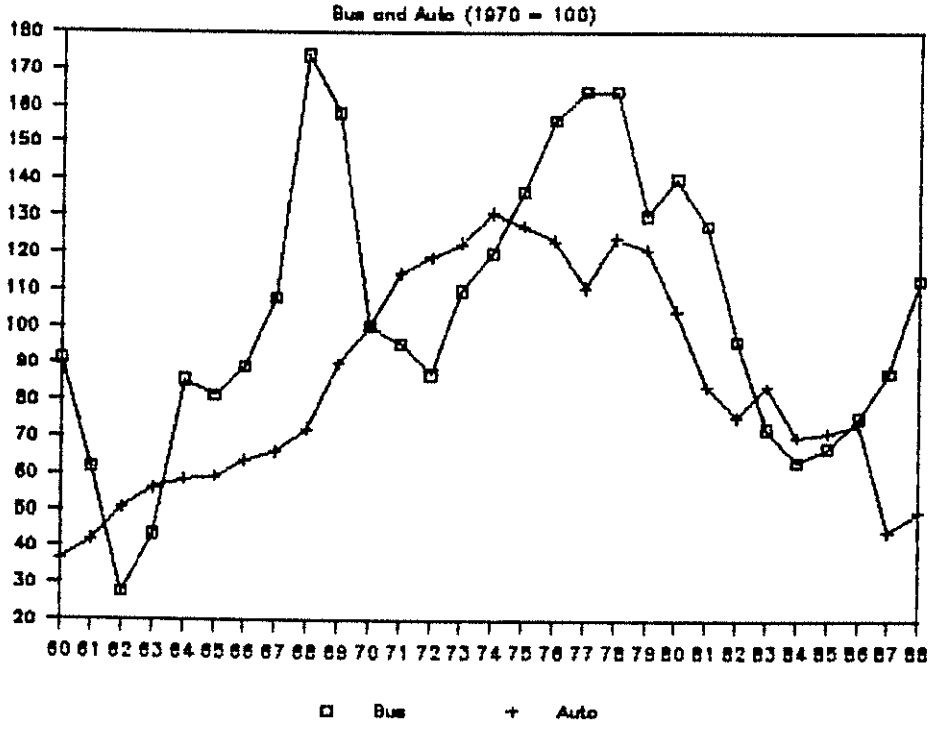

Figure II.3 – Sales / GDP Ratio

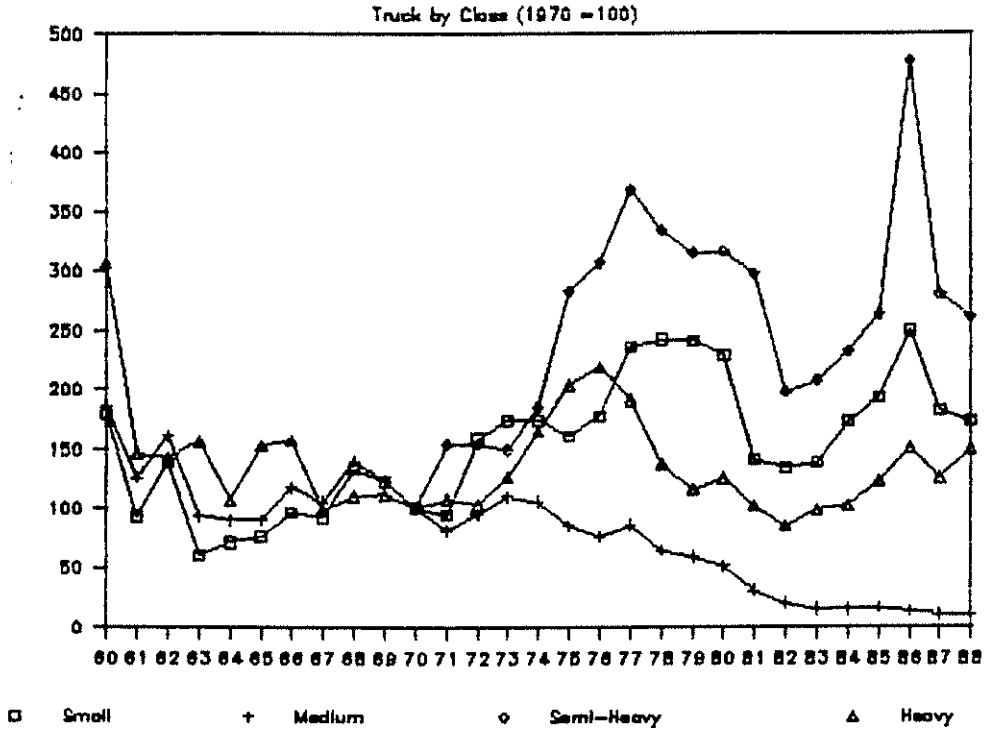

Figure II.4 – Fleet / GDP Ratio

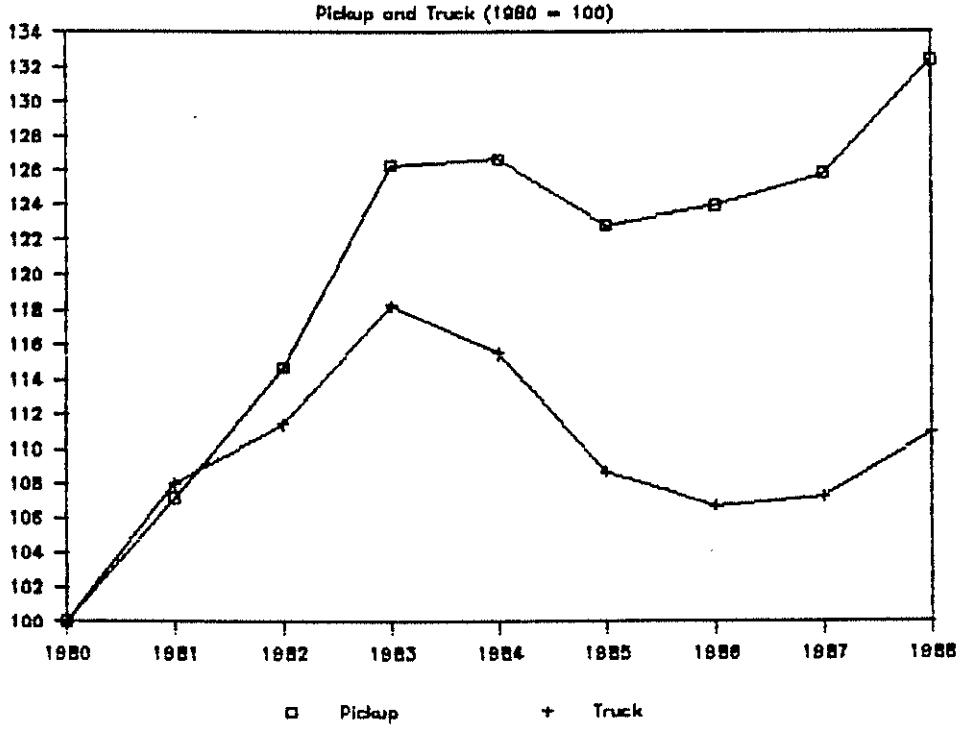

Figure II.5 – Truck Fleet / GDP Ratio

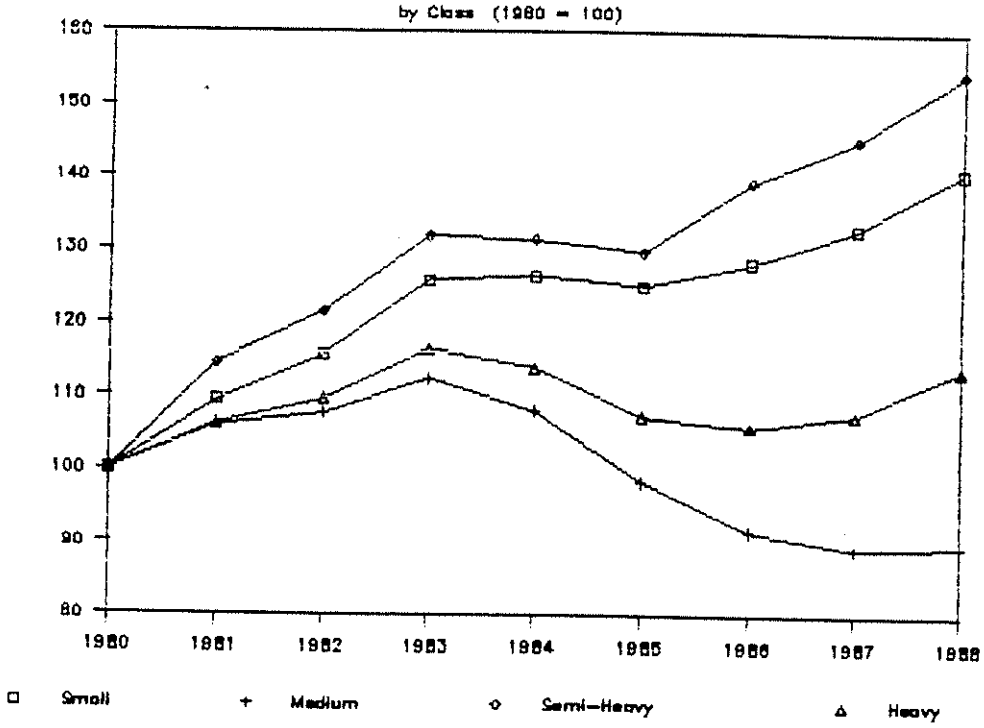

Figure II.6 – Fleet / GDP Ratio

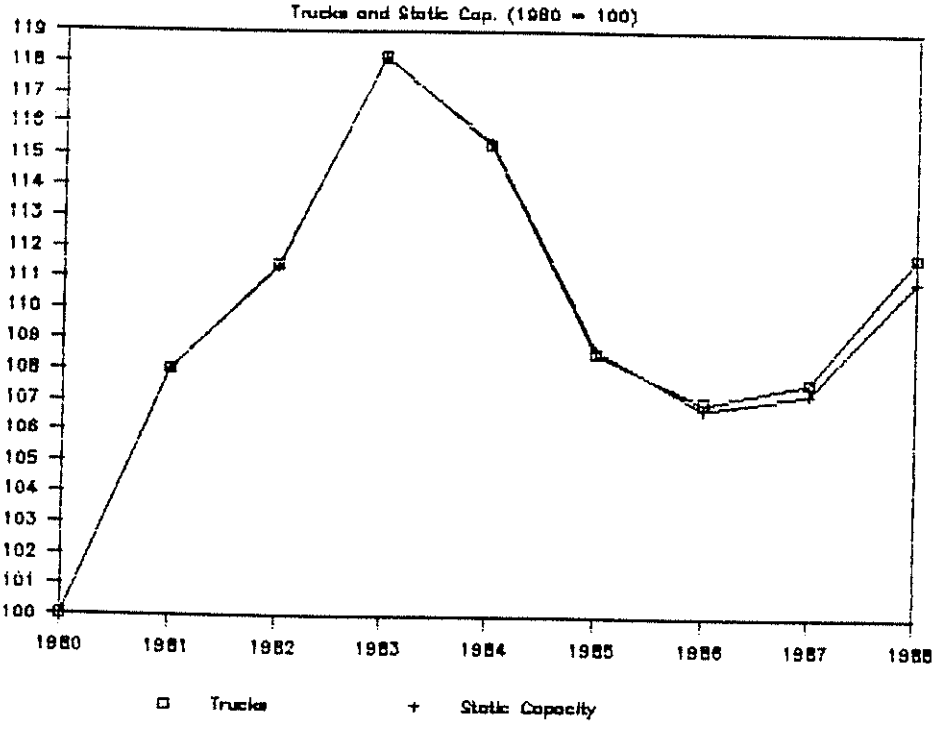

Figure II.7- Diesel and Gasoline Prices