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POTENTIAL BARGE TRANSPORTATION FOR INBOUND CORN AND GRAIN

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This research develops a model for estimating future barge and rail rates for decision making. The Box-Jenkins and the Regression Analysis with ARIMA errors forecasting methods were used to develop appropriate models for determining future rates. A software tool was developed based on the model which allows the user to input minimal data and be presented with future barge and rail rates upon which shipping costs can be projected.

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POTENTIAL BARGE TRANSPORTATION FOR INBOUND CORN AND GRAINS

Final Report on MTBC Project #1063

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I. STATEMENT OF PROBLEM

Transportation involves the movement of commodities and humans from one point to another. With the world's population increasing, and therefore the number of goods to be consumed by the population increasing, transportation has become vitally important. Increased consumption results in increased transportation needs for industries and therefore increased transportation costs. Thus, to reduce operating costs, companies require transportation services that are timely and cost effective.

There are various primary modes of transportation: air, rail, truck, and water. The focus of this project is to compare the costs of transporting bulk materials via rail and barge along the Mississippi River. Specifically, the purpose is to study these transportation modes, look at the pros and cons of employing them, and compare the financial cost of using them for transporting goods.

Rail transportation is quite common and available throughout the entire U.S. It is widely used by industries for transporting goods because of its availability and delivery time. However, the inland waterways, augmented by intelligent canalization and navigation improvements, also offer a system of waterways unequaled anywhere in the world where barges are used. The use of this combination of natural resources and engineering achievement has stimulated economic growth in areas contiguous to the inland waterways, especially between the years 1930-1960. Barge usage dropped in the following years of this period, but the rail mergers that occurred during the last couple of years has forced some companies to consider transporting their materials by barge.

A barge is a large boat, usually flat bottomed, designed for carrying heavy freight on rivers, canals, etc. Barge transportation is considered to be one of the oldest and most energy-efficient forms of transportation and is also much faster than what most people think. It has been used in the U.S. to transport goods for a considerable amount of time. Barge transportation has experienced some hard times because of the development of other transportation modes that are faster, but judging from most indicators it is bouncing back. If the origin and/or destination points are on or near the waterway, barge transportation may have a considerable advantage over other transportation modes.

This project will: (a) determine the feasibility of using barge and rail transportation to move corn and other feed grains along the Mississippi River, (b) compare the economics of barge transportation to rail transportation in the transport of grain, and (c) develop software which utilizes the developed cost model in determining the barge and rail cost of transporting corn and feed grains along the Mississippi River.

An extensive literature search was conducted for this project. The results of this search are summarized in the following chapter.

II. REVIEW OF RELEVANT LITERATURE

1. BARGE TRANSPORTATION:

This section summarizes the literature that was found related to barge transportation and its different aspects primarily as they relate to the objectives of this project. The literature includes freight capacity comparisons of different transportation modes, rate structure for barge operations, Merchant's Exchange of St. Louis, cost analysis, carrier selection rules, productivity dimensions, and environmental and safety issues relating to barge transportation.

Little prior work has focused only on barge transportation costs with a quantitative approach, most prior research focused on comparisons between certain transportation mode(s) and several combinations of transportation modes, including barge transportation. The lack of research in analyzing barge transportation costs makes this project a needed endeavor. However, it also makes it challenging, since short-term developments can change the whole demand-and-supply equation overnight, just as it does in the commodities markets [60].

The service area where barges operate in the United States is a river system more than 8,500 miles long, mainly in the eastern half of the country, and includes about 60 barge companies operating some 23,000 barges. In the last quarter century, commercial barge traffic has increased six-fold to an annual level now approaching 300 billion ton-miles [60]. Because of barge transportation's advantage over other transportation modes in freight capacity per unit measures (see Section A), waterway transportation provides the most efficient means of moving bulk and semi-bulk commodities. Barges move 15%

of the U.S. inter-city freight but accounts for only 2% of the freight bill. Waterway transportation contributes to a relatively small portion of the freight transportation expenditures taken as a percentage of the GNP. In 1991, $358 billion was spent for freight transportation, with waterway transportation making up about 5.7 percent (see Table 2.1).

Highway	1970	1975	1980	1985	1989	1990	1991
Truck-intercity							
ICC-authorized	14585	22000	43000	54200	70500	75500	78300
Non-ICC auth.	18968	25400	51551	69000	80800	86800	89100
Truck-local	28819	37287	60545	82200	10240	108350	110500
Bus-intercity	122	156	235	245	166	126	131
Total	62494	84843	15531	20565	25396	270776	278031
Railroad	11869	16509	27858	29150	29922	30403	29852
Water							
International	3187	4928	8279	10745	12267	13118	2705
Intercoastal	834	1136	3155	3605	3049	3008	2925
Inland waterway	621	1283	2395	2448	2791	2852	2956
Great Lakes	239	348	513	461	570	586	541
Locks, channels	376	526	1156	1189	1134	1303	1540
Totals	5257	8221	15498	18449	19811	20868	20667
Oil Pipeline							
Regulated	1188	1874	6340	7484	6579	7045	6802
Non-regulated	208	346	1208	1426	1253	1342	1296
Totals	1396	2220	7548	8910	7832	8387	8096
Air							
Domestic	720	1073	2802	5498	8940	10100	10291
International	451	764	1211	1319	2913	3606	3979
Totals	1171	1838	4013	6817	11853	13706	14270
Other Carriers	358	418	1056	1675	2169	4041	4267
Other Shipper Cost							
Load/unload freight car	1059	1279	1676	1917	2321	2406	2416
Operation traffic departments	374	511	756	1050	1269	1327	1388
Totals	1433	1790	2432	2967	3590	3733	3804
Grand Total	83978	11589	21376	27363	32903	351915	35899
GNP(Billion)	10155	1598.4	27421	4053.6	5248.2	5542.9	5694.5
Grand Total % of GNP	8.27%	7.25%	7.79%	6.75%	6.27%	6.35%	6.30%

Table 2.1 -- Nation's Estimated Freight Bill [54]

More and more companies in the past few years have considered using water transportation as an alternative to their current mode(s) of transportation. Water transportation, as is outlined in a later section, results in lower transportation costs, fewer accidents, less environmental damage, and higher productivity levels.

A. Freight Capacity Comparisons:

Barge transportation involves a number of barges, with a minimum of 15, being pushed by a towboat down or up the river. The amount of cargo that can be carried by a single barge and other types of transportation modes is shown in Table 2.2 [57].

BARGE	15 BARGE TOW	JUMBO HOPPER CAR	100 CAR UNIT TRAIN	LARGE SEMI
1,500 tons	22,500 tons	100 tons	10,000 tons	26 tons
52,500 bushels	757,500 bushels	3,500 bushels	350,000 bushels	910 bushels
452,400 gallons	6,504,000 gallons	30,240 gallons	3,024,000 gallons	7,365 gallons
	1 barge =	15 jumbo hoppers	= 58 large semis	
	1 tow =	2.25 unit trains	= 870 large semis	

Table 2.2 -- Freight Capacity Comparisons [57]

The number of barges that can be pushed by a towboat depends on the river and weather conditions. Given nice weather conditions, no locks on the route, and decent water levels, tows can include more that 32 barges. Clearly, barges have an advantage over land based transportation options in regard to carrying more amounts per unit. However, the primary trade off is with delivery times; for example a barge departing

Pittsburgh will arrive in Cincinnati in one week, St. Louis in two weeks, and Chicago in almost 3 weeks. The same aforementioned routes could be covered in hours by air or in a matter of days by land-based transportation. Therefore, using barge transportation in a JIT environment is practically impossible; but it could be used, in terms of freight capacity, when the transportation of high volumes of commodities is involved [48]. Whether something can be considered a candidate for barge transportation has generally been determined by the volume of the commodity rather than the nature of the product [48]. Also, the long delivery times, which are heavily dependent on river and weather conditions, requires operations using barge to be accurate in scheduling delivery orders and should be suited to the chance of late delivery .

B. Rate Structure for Barge Operations:

Barge rates are heavily dependent on many factors. There is no such thing as a set rate, rather many of the rates are negotiated between carriers and shippers through the St. Louis Merchants Exchange (which is addressed in the next section). From the carrier's standpoint, the factors that determine the requested rate are:

- Availability of equipment
- Opportunity cost
- Competitors
- Shortage/excess of barge capacity
- River and weather conditions
- Time between destination and nose points
- Corporate guidelines

- Imports/exports

Each of these factors are discussed in detail below:

Availability of equipment: Barge rates heavily depend on how many barges the carrier has available for new operations. If there are a large number of barges that are not booked, the carrier would like to book them as soon as possible in an effort to minimize loss. Therefore, the carrier would be more willing to book barges at lower prices. When most of the barges are booked, the opposite scenario happens.

Opportunity cost: Opportunity cost is defined as the cost of producing a particular product. It considers the value of the product that could have been produced using the same resources [51]. In barge transportation, for example, soybeans are more expensive than corn and therefore can afford a higher transportation cost than corn. Most carriers would like to carry soybeans but could be losing money while waiting for soybeans and rejecting corn. Thus, opportunity cost is a factor in barge rate determination, since carriers generally want to maximize their profit.

Competitors: Much like any other industry, the competitors rates play an important role in how much a carrier can charge a prospective customer and not lose them to their competitors. This competition is not only within barge companies but also between the barge companies and other modes of transportation. As a result, the freight rates including barge rates have been relatively stable except in times of extreme conditions. Table 2.3 presents rates of various transportation modes for different years.

	Rail	Truck	Air Cargo	Barge
1981	11.24	10.85	11.58	10.31
1982	1.91	3.43	-5.02	-1.86
1983	-1.63	6.10	-5.78	-3.04
1984	-1.97	-3.37	6.68	0.45
1985	-1.49	1.38	4.28	-2.66
1986	-3.46	-0.25	-7.20	1.84
1987	-5.89	0.05	2.46	-1.28
1988	-6.17	-0.29	4.69	-0.60
1989	3.65	4.56	5.80	-5.59
Forecast				
1990	2.20	0.88	3.87	2.77
1991	3.11	1.93	2.95	2.40
1992	4.02	4.20	4.39	3.87

Table 2.3 – Freight Rates [6]
(annual % change by mode)

Shortage/excess of barge capacity: Much like the supply and demand curve, barge rates tend to decline when there is a decrease in the demand for barge service or an increased supply of barges.

River and weather conditions: This is probably the most important factor that determines the rate structure. Barge transportation is heavily dependent on the conditions of the rivers and the weather. Low water levels mean slower transit times, less loads, and less profit for the carrier. The summer drought of 1988 resulted in the cargo taking more than twice its usual time to reach its destination, which not only increased operating costs but also caused barges to miss out on subsequent loads, thus resulting in lost business [69]. When the number of barges per tow were limited to 16 and a draft restriction of 8.5 feet (100 tons less cargo per barge) was imposed, the barge industry responded with a freight rate increase.

High water levels usually allow for larger loads and quicker transit times but it also has its disadvantages. Flooding causes higher water levels in the rivers and also silting problems on the river floor. This results in a slow down of barge shipments and possible accelerated aging of barges due to of muddy conditions.

In addition to high and low water levels, several acts of mother nature: fog, snow, heavy rain, etc. can have an impact. They do not affect the barge rates as long as they are short lived. But, continuous fog, snow, and rain can slow down the operation of barge tows and may cause movement problems on the river.

Time between destination and nose points: Barge companies have to know how many days of travel there is between the nose and the destination points. Rates tend to go up as the time of travel increases between the points. Examples are presented in Section C (St. Louis Merchants Exchange).

Corporate Guidelines: Corporate guidelines usually define the minimum margin of profit that the company should be getting when providing service for a shipper. These guidelines affect the barge rate to be charged to the shipper.

Imports/exports: Imports and exports also tend to be a strong factor in determining barge rates. In November of 1989, the Soviets made heavy purchases of grain which was to be delivered by April 1990. As a result, rates soared, hitting peaks of 300 percent of benchmarks on the St. Louis Merchant's Exchange [59]. More recently in 1994, record corn harvests combined with an increase in the domestic demand for coal, strong steel imports, and healthy northbound movements of fertilizer and cement resulted in much higher barge rates. Table 2.4 shows the increase from 1993 to 1994 in spot barge rates.

TWC		MM		ILL	
93	94	93	94	93	94
201	246	205	264	205	264
202	275	210	288	210	288
208	344	228	355	228	355
201	243	183	202	183	202
159	272	138	224	138	224
129	246	116	192	116	192

TWC: Upper Mississippi, MM: Mid- Mississippi, ILL: Illinois River
* Rates quoted as a % of 1976 Benchmark

Table 2.4 -- Spot Barge Rates: 1993-1994* [43]
Weekly average over a 6-week period

Imports and exports are transported in high volumes and they keep the barge lines busy for a certain amount of time. When the import/export levels are low, barge rates tend to go down to attract customers. When the import/export levels are high the opposite scenario takes place.

C. Merchants Exchange of St. Louis:

The Merchants Exchange of St. Louis has served as a central marketplace for commodity trading longer than any established grain exchange in America [70]. The heart of the activity centers around the cash Call Sessions which are simply open auctions designed to provide members with a free market in which to trade commodities and services [71]. The majority of cash Call Session trading today is barge transported grain which is bound for New Orleans [71]. In order to conduct business on the Exchange, companies need to issue performance bonds, buy a membership to the exchange, and have a net worth of $500,000.

In the cash Call Sessions, the rates are offered as a percentage of benchmarks which were established in 1976. A few examples of these benchmarks are shown in Table 2.5 below [71].

SOUTHBOUND FROM:	TO: LOUISIANA (Baton Rouge, Destrehan, Myrtle Grove, New Orleans, & Reserve)
INDIANA	
Evansville	399 cents/ton
Mount Vernon	399 cents/ton
KENTUCKY	
Louisville	446 cents/ton
Owensboro	380 cents/ton
OHIO	
Cincinnati	469 cents/ton
OKLAHOMA	
Catoosa	564 cents/ton

Table 2.5 -- Various Southbound Barge Freight Trading Benchmarks [71]

Most companies prefer to deal with their prospective carriers or their prospective shippers through the Merchants Exchange of St. Louis. In return, the Exchange protects the contract agreements between carriers and shippers when one party does not perform.

D. Cost Analysis for Barge Transportation:

The most important decision to be made by the shipper in buying barge transportation is the type of rate to be picked. The two options are dollars-per-ton rate and dollars-per-bargeload rate. The dollars-per-ton method often carries a minimum tonnage requirement of between 1,450 and 1,600 tons, depending on the type of barge. The shipper is responsible for paying that base amount even if the tonnage falls short of the minimum [47]. Dollars-per-bargeload rate, on the other hand, does not have a minimum tonnage requirement and it is a flat rate for use of the barge.

Because of the unpredictability of weather and river conditions, and thus barge operations, it is hard to pick a rate format with complete certainty of maximum profitability. If the shipper knows they will be able to load cargo in excess of the tonnage requirements, dollars-per-bargeload is the best selection. With this format, any cargo in excess of the tonnage minimum is transported at no cost. But, the maximum load a barge can carry is determined by water levels. When water levels are low, the shipper pays the same flat rate but the barge will not hold the full amount of cargo. The second type of rate is dollars-per-ton. This rate could be less profitable when water levels are high and the barge can hold more than the minimum tonnage requirement. In this case, dollars-per-bargeload gives an advantage to its users since the barge can be loaded in excess of the limitation if the case was dollars-per-ton, and the additional cargo will be moving on the river at no additional cost.

Water levels are hard to predict, especially during the long-term contracts between shippers and carriers. If the contract period is short and the water levels, for one reason or the other, could be predicted, dollars-per-ton should be selected for low-water level operation and dollars-per-bargeload should be selected for the opposite case.

In addition to the transportation cost, the Merchant's Exchange of St. Louis utilizes what is called a demurrage charge that is paid by the shipper. All contracts include a specified number of days for loading and unloading barge [47]. If more time for loading/unloading is needed than is stipulated in the contract, the carrier charges the shipper a demurrage charge of between $100 and $250 per day.

Finally, between nose and destination points, if a barge is stopped for partial loading and unloading, the carrier charges the shipper a stop-off charge. The amount of stop-off charges differ in every contract but generally tend to be around $650 per stop-off.

E. Carrier Selection Decision Rules and Shipping Needs Identifiers:

Certain rules should be followed when looking for barge carriers. These rules are outlined in Table 2.6 [6].

• Seek a carrier who knows how to handle your goods
• Go shopping since rates can vary
• Many carriers provide maps and facility guides to help in planning
• When going overland, use routes parallel to river routes, where practicable. Competitive mode can keep truck and rail rates in check.
• Consider information systems and ancillary services.
• Buy on a flat-rate, per-barge basis if you are certain that will exceed a carrier's tonnage minimums. If buying on a dollars-per-net-ton basis, seek a per-barge averaging agreement, perhaps with a quarterly reconciliation.
• Stay within unloading free-time allotment.
• Examine carrier shipping patterns to find opportunities to create backhauls for the carrier or allow the carrier to stage barges for other forehauls. Helping the carrier develop efficient patterns can often win below-market rates.

Table 2.6 -- Carrier Selection Decision Rules [6]

Shippers also need to inform carriers of their exact requirements. The list, as shown in Table 2.7, helps shippers identify their needs and communicate them to carriers [47].

• What exactly is the product or commodity you wish to ship?
• What is the size, weight, and value of the product
• When do you plan to make the first shipment of the product
• Which specific barge loading facility will be used, and how long will the facility need the barge for loading? (If you don't know any transfer terminals in the loading city, ask barge carriers for the names of several transfer terminals from which you can obtain rates. Transfer terminals are the facilities used to move freight from a barge to a land-based transportation mode, or vice versa.)
• Which landslide carrier (truck or rail) will participate in the shipment by bringing the freight to the transfer terminal?
• Which type of river barge will your freight require? (You may choose covered barges or open-hopper barges for various types of dry freight tank barges for liquid freight, or flat deck barges for very large types of machinery or, perhaps, vehicles.)
• Will the freight require any barge cleaning before or after loading?
• Will the freight need to be specially secured to the barge floor or walls before shipment? (You need to ask permission to weld securing eyes or rings inside the barge)
• What are the time requirements of the other players involved in the shipments, such as inspectors, company representatives, surveyors, insurance personnel, or landside transportation providers?
• How soon after loading at the point of origin does the barge need to be delivered to its destination?
• If several barges are loaded at the same time at the point of origin, do they need to arrive together at their destination?
• Will you require intermediate stops in transit for partial loading or unloading of freight?
• How much time will the destination transfer facility require to unload the freight?
• Are there any bills of lading required for the movement of freight?

Table 2.7 -- Shipping Needs Identifiers [47]

F. Productivity Dimensions for Barge Transportation:

The productivity of barge transportation, from the carrier's standpoint as well as the shipper's standpoint, could be evaluated in three different aggregate dimensions: labor productivity, capital productivity and energy efficiency. In each of the dimensions, water productivity is better compared to rail, truck, and combination transportation modes. Tables 2.8 and 2.9 exhibit the labor and capital productivity for various modes.

Thousands of Ton-Miles Per Employee Year

Year	Water	Rail	Truck	Water/Rail (%)	Water/Truck (%)
1955	2,010	524	222	26	11
1960	2,817	654	147	23	5.2
1965	5,040	965	173	19	3.4
1970	9,097	1,230	162	13	1.8
1975	8,627	1,411	144	16	1.7
1976	9,557	1,515	155	16	1.6
1977	9,718	1,632	184	17	1.9
1978	8,280	1,622	140	19	1.7
1979	7,805	1,658	180	21	2.3

Table 2.8 -- Aggregate labor productivity for water, rail, and truck: 1955-1979 [23]

	Property and Equipment Ton-Miles per Dollar					Total Assets Ton-Miles per Dollar				
Year	Water	Rail	Truck	Water/Rail (%)	Water/Truck (%)	Water	Rail	Truck	Water/Rail (%)	Water/Truck (%)
1955	83.0	55.1	48.6	66.4	58.5	86.3	21.2	48.4	24.5	56.1
1960	73.0	43.8	25.8	60.0	35.3	79.7	19.3	27.6	24.1	34.5
1965	80.5	48.8	23.3	60.6	28.9	81.6	23.0	23.1	28.2	28.3
1970	130.2	46.2	17.1	35.5	13.1	144.4	23.0	15.5	15.7	10.7
1975	91.1	41.8	21.1	45.9	23.2	87.5	20.1	10.3	23.0	11.8
1976	99.1	44.7	21.8	45.1	22.0	88.1	22.2	10.5	25.2	11.9
1977	85.9	43.5	21.7	50.7	25.3	76.2	21.7	10.4	28.5	13.6
1978	85.7	44.2	20.7	51.6	23.8	74.6	22.3	9.95	29.9	13.3
1979	86.4	44.0	17.6	50.9	20.4	65.9	22.0	8.78	33.4	13.3

Table 2.9 -- Aggregate capital productivity for water, rail, and truck: 1955-1979 [23]

These productivity measures are for both shipper and carrier use. The carrier evaluates the companies performance and the shipper can compare different transportation modes and their productivity measures. To be able to determine the productivity levels for specific operations, the following formulas illustrate how productivity dimensions are computed for barge transportation:

$$\frac{(\#\text{tons} \ / \ \text{barge}) \times (\#\ \text{barges}) \times (\text{distance traveled})}{(\text{total yearly capital charge}) \times \dfrac{(\#\ \text{days to travel})}{(\#\ \text{of operating days} \ / \ \text{yr})}} = \text{capital prod.} \qquad \textit{(equation 1)}$$

$$\frac{(\#\ \text{tons} / \text{barge}) \times (\#\ \text{barges}) \times (\text{distance traveled})}{(\#\ \text{days to cover destination}) \times (\#\ \text{of crew members})} = \text{labor prod.} \qquad \textit{(equation 2)}$$

Energy efficiency, however, depends on varying criterias like the water current, amount of the commodity being carried, and the condition of the equipment. But almost all historical studies that compared energy efficiency of barge transportation to other modes of transportation found barge transportation to be the most energy efficient mode of transportation. The results of an example study are shown in Table 2.10 [23]:

	Btu per Ton-Mile		Ton-Miles per Gallon	
Case	Barge	Rail	Barge	Rail
Best	103	396	1,347	350
Average	270	686	514	202
			($3.17)	($11.62)

Table 2.10 – Freight Efficiency Comparisons [23]

A popular measure of productivity that is less aggregate than labor, capital, and energy is equipment utilization. Transportation equipment utilization is generally measured in two ways: (1) frequency with which the piece of equipment - rail, barge, truck - is in the process of producing transportation, and (2) relates to whether that piece of equipment; while in motion, is carrying a load, part of a load, or moving empty into position for a load. Comparable historical data on barges are not available, but a 1978 U.S. Army Corps of Engineers study found that an average of 64.5 percent of the barges moving were loaded (See Table 2.11) [23]. This is a substantially higher rate of utilization than the 56.8 percent found for rail transportation in 1977 (See Table 2.12).

Waterway	Direction	Barges Loaded (%)	Ton - Miles (000,000)	% of Total	Weighting
Allegheny River	Downriver	54			
	Upriver	55			
	Total	54.5	79.5	< .1	0
Arkansas River	Downriver	66.5			
	Upriver	50			
	Total	55.5	1,694.9	.9	.499
Black Warrior-	Downriver	72.5			
Tombigbee River	Upriver	78.5			
System	Total	75.5	3,971.9	2.2	1.661
Cumberland River	Downriver	50			
	Upriver	91.5			
	Total	55.5	989.4	.5	.277
Illinois River	Downriver	50			
	Upriver	86			
	Total	66	7,683.9	4.3	2.838
Lower Mississippi	Downriver	67			
River	Upriver	63.5			
	Total	65	105,256.6	58.9	38.285
Missouri River	Downriver	88.5			
	Upriver	64			
	Total	75.5	1,528.6	.8	.604
Monongahela	Downriver	50			
River	Upriver	91			
	Total	61.5	1,223.8	.7	.430
Ohio River	Downriver	59			
	Upriver	65.5			
	Total	62.5	38,823.9	21.7	13.563
Tennessee River	Downriver	50			
	Upriver	88.5			
	Total	59.5	4,416.6	2.5	1.487
Upper Mississippi	Downriver	86			
River	Upriver	50			
	Total	67.5	12,908.4	7.2	4.860
Total			178,577.5	99.7	64.504

Table 2.11 -- Measures of Barge Use: 1978 [23]

	Car Miles (Billions)			
Year	Loaded	Empty	Total	% of Loaded Total Car Miles
1947	21.4	10.8	32.2	66.4
1951	20.6	10.6	31.2	66.0
1955	20.1	11.1	31.2	64.5
1959	17.8	10.8	28.6	62.3
1963	17.1	11.0	28.1	60.9
1967	17.4	12.2	29.6	58.9
1968	17.8	12.3	30.1	59.3
1969	18.0	12.4	30.4	59.2
1970	17.3	12.6	29.9	57.8
1971	16.5	12.7	29.2	56.6
1972	17.1	13.2	30.3	56.5
1973	18.0	13.2	31.2	57.7
1974	17.6	13.1	30.7	57.2
1975	15.1	12.5	27.6	54.7
1976	15.8	12.7	28.5	55.4
1977	16.3	12.4	28.7	56.8

Table 2.12 -- Measures of Freight Car Use for Class I Railroads: 1947 - 1977 [23]

G. Environmental Issues Involving Barge Transportation:

Compared to the other transportation modes, barge transportation seems to be the most environment-friendly operation. One area in which barge transportation outclasses other modes is that of traffic congestion. Traffic congestion curtails the movement of people and goods, wastes valuable energy resources, increases personal trip times, impairs productivity, creates social tension, and damages the environment [21]. In addition, it increases the probability of accidents and also causes environmental damage. Barge transportation, compared to other modes of transportation, has few congestion problems and seldom causes them for others [21]. As long as pleasure boats stay clear of the commercial traffic, barge transportation should continue to be safe, quiet, virtually invisible, and capable of carrying tremendous amounts of commodities.

Another area in which barge transportation has a huge advantage over other modes of transportation is air and noise pollution. Barges have a relatively minor effect on air quality. Tables 2.13 and 2.14 compare barge transportation to other transportation modes based on air pollution studies.

Emission Source	Towboats	Other Transportation	Total Emissions
Nox	3,297	105,932	433,637
THC	939	198,063	295,124
CO	2,101	980,944	3,852,753
Sox	462	7,887	123,4395
Part	198	8,940	354,672

NOx - oxides of Nitrogen
THC - Hydrocarbond
CO - Carbon Monoxide
Sox - Oxides of Sulfur
Part - Particulates

Table 2.13 -- Annual Emissions for St. Louis Air Quality Control Region (In tons) [21]

Mode	Hydrocarbon	Carbon Monoxide	Nitrus Oxide
Tow Boat	.09	.20	.53
Train	.46	.64	1.83
Truck	.63	1.90	10.17

Table 2.14 -- Emissions Produced [21]

Pollutants (in lbs) produced in moving one ton of cargo 1,000 miles

Little data exists on noise levels of barge operations. However, a study by the Engineering Committee of the International Association of Great Lakes Ports calculated that barges produced peak noise levels lower than those produced by either a truck operating under normal conditions or by a standing diesel locomotive [21].

Another dimension to be considered is the land use and social impacts in barge transportation. Most of the rights-of-way in water transportation is provided by nature and does not compete for land usage as much as other modes of transportation like trucks and rail which require more land usage as they expand. Commercial waterway activity usurps very little land concerning new land acquisition.

A recent study of transport impacts on the environment was done for the twelve European countries that make up the European Community (EC) [21]. This study compared, by mode, the social costs of air and noise pollution, land coverage, construction/maintenance, and accidents. As seen in Table 2.15, for all categories, water had the least environmental impacts. In noise pollution, accidents, and land coverage, water transportation had either little or no impact. As a result of this study and others, there is a growing demand by EC member countries to include inland navigation in international traffic management since it is far less detrimental to the environment than shipping by other modes [21].

Social Costs	Air	Rail	Inland Waterways	Road	Total
Air Pollution	2	4	3	91	100
Noise Pollution	26	10	0	64	100
Land Coverage	1	7	1	91	100
Construction/ Maintenance	2	37	5	56	100
Accidents/ Casualties	1	1	0	98	100
Total in Billion DM*/year	2	14	2	67-77	100

*DM = German Marks, 1 USD = 1.512 DM

Table 2.15 -- Social Costs In Relation to Transport Modalities [21]

H. Barge Transportation Safety:

Much like any other mode of transportation, waterway transportation has to face certain safety considerations and legal issues. For example, in a huge accident on September 22, 1993, a towboat slammed into a CSX railroad bridge in Mobile, AL and 10 minutes later a train derailed on the bent rails and the bridge collapsed [38]. The results of that accident were 42 deaths and 103 injuries. Also, several other accidents occurring between January 7th and the end of May 1994 raised doubts about the industry's safety standards. These accidents prompted companies, Congress, and the Coast Guard to rethink the rules governing barge transportation. A report by the Coast Guard states that between 1982 and 1991, 88 percent of the 12,000 incidents could be attributed to human error. Another report found that 17 percent of the accidents resulted from vessel and mechanical causes.

As of September 1994, a revised bill focusing on requiring basic navigation tools, improved training, inspections, and various other measures was before Congress. Barge crews, however, argued that river traffic is the primary danger. Pleasure craft, fishing boats, oceangoing ships, and barge tows all compete for the same space. The bills, before Congress, which would impose a wide array of new training and equipment standards on the towing industry, passed the U.S. House of Representatives, but collided with a smaller measure during the October 1994 Senate session. The barge reform bill did not get the needed support to make it through Congress. American Waterways Operators (AWO) president stated that the industry plans to pursue the safety initiatives it favored by petitioning the Coast Guard to begin rulemakings. But, the Department of Transportation

(DOT) may introduce a similar bill again next year. Some barge companies are starting their own training programs for future barge crews.

All modes of transportation have risk factors. The trucking industry has always been the biggest contributor to transportation accidents. Barge rights-of-way are determined by nature, thus barge operations do not present as much threat to human lives as other modes of transportation.

2. RAIL TRANSPORTATION:

This section outlines the relevant literature regarding rail transportation. The literature includes background information about rail transportation, economic and market structure, rate types, cost structure and cost functions, service characteristics, grain transportation by rail, and rail mergers.

A. Background Information about Rail Transportation in the U.S.:

The development of railroads started in the U.S. around the 1830's, mainly in the eastern states. Approximately, 30,000 miles of railroad were constructed in the eastern part of the country prior to the Civil War [28]. During the post-Civil War period, thousands of miles of railroads were built with the peak time occurring during the decade of 1880s. The construction period was over by 1910. Since 1916, there has been very little railroad construction and considerable abandonment of rail line.

The freight railroads were a critical element in the early development and ensuing growth of the U.S. and remain a vital force in the U.S. economy and a crucial component of today's transportation system [1]. Today, it is almost completely privately owned and provides a safe, low cost, environmentally friendly, and efficient transportation mode.

Railroads, for regulatory purposes, are classified into three groups - Class I, Class II (Regional), and Class III(Local)- by the InterState Commerce Commission based on annual operating revenue. In 1994, the ICC Class I threshold was $255.9 million [13]. The threshold is indexed to a base of $250 million in 1991 and is adjusted annually. Regional railroads are freight railroads which operate at least 350 miles of road and earn at least $40 million in revenue. Finally, local railroads operate under 350 miles and earn less than $40 million annually.

Table 2.16 summarizes some vital statistics about freight railroads in the U.S.:

Number of Railroads	541
Total Rail Miles	146,785
Rail Carloads Originated	27,316,333
Total Tons Originated	1,806,437,303
Total Railroad Employment	212,440
Total Wages of Railroad Employees	$9,940,978,566
Average Wages Per Rail Employee	$46,794
Average Fringe Benefits Per Rail Employee	$17,611
Railroad Retirement Beneficiaries	783,800
Payments to Railroad Retirement Beneficiaries	$7,982,184,000

Table 2.16 – Key 1995 U.S. Freight Railroad Statistics [1]

Figures 2.1 and 2.2 provide additional information on rail transportation in the U.S:

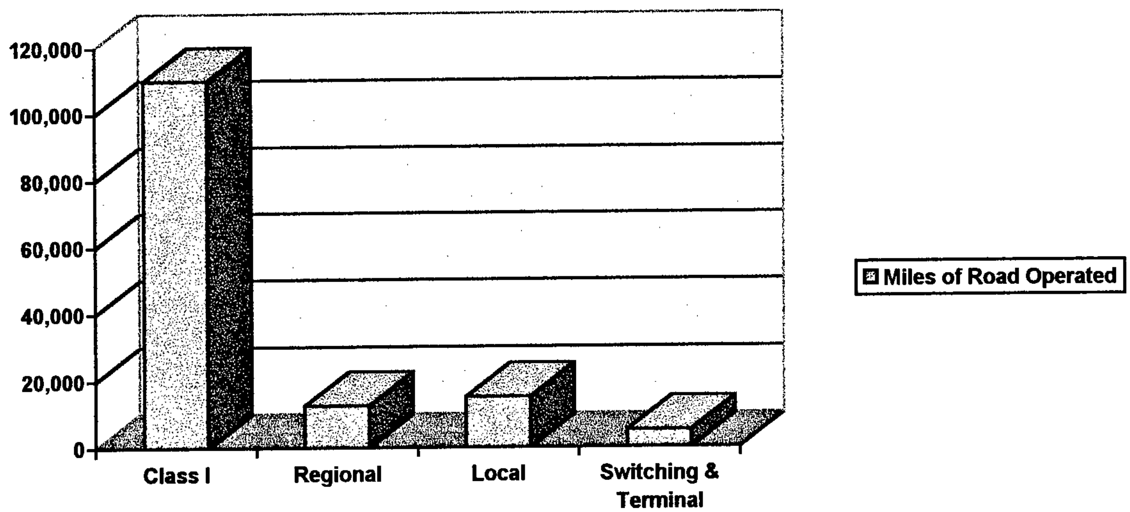

Figure 2.1 – Miles of Road Operated in 1995 [1]

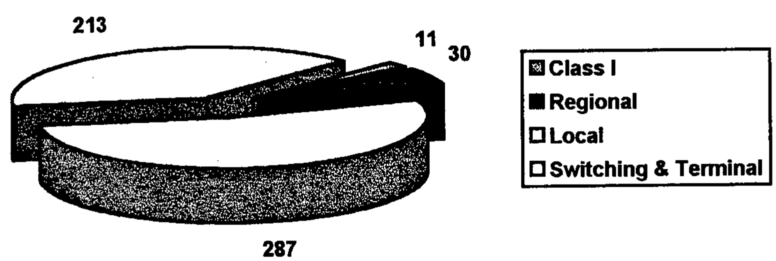

Figure 2.2 – Number of Railroads in 1995 [1]

The U.S. rail freight transportation system is almost completely privately owned. Some of the major rail carriers for Class I railroads include those listed in Table 2.17 [13]:

Rank	Railroad	Operating Revenue (thousands $)	Percent of Total
1	Union Pacific Railroad Company	$5,167,248	16.77%
2	Burlington Northern Railroad Company	4,994,663	16.21
3	CSX Transportation	4,625,359	15.01
4	Norfolk Southern Corporation	3,918,069	12.72
5	Consolidated Rail Corporation	3,641,473	11.82
6	Southern Pacific Lines	2,941,527	9.55
7	Atchison, Topeka & Santa Fe Railway Company	2,680,936	8.70
8	Chicago and North Western Transportation Co.	905,342	2.94
9	Illinois Central Railroad Company	593,869	1.93
10	Soo Line Railroad Company	551,582	1.79
11	Kansas City Southern Railway Company	472,487	1.53
12	Grand Trunk Western Railroad Corporation	316,422	1.03
	Total	**$30,808,977**	**100.00%**

Table 2.17 – Ranking of Railroads by 1994 Operating Revenue (Class I) [13]

All lines are connected and interconnected throughout the length and breadth of the country, and almost all the individual roads have the same gauge, and cars are permitted to move from one road to the other. This makes it possible for a freight car to move between any two freight stations in the U.S [17].

B. Economic and Market Structure for Rail Transportation

Railroads face more competition than any other transportation mode in the United States. Railroads encounter keen competition from trucks for a large variety of commodities throughout the country. Pipeline and water carriers, although they are more specialized by product and geography, also have cut deeply into traffic formerly moving by rail, and in some instances they have almost completely taken over certain movements [61]. Railroads also compete among themselves.

Transportation modes that own and operate their own specialized way (the railroads, the pipelines, and rail-based mass transit) have enormous capital requirements and are inflexibly committed once the capital is raised. Railroads are an example of this type of transportation, and the series of economic characteristics that emerge from ownership of way are [33]:

- Entry, exit, expansion, and contraction are difficult
- Competition frequently results in excessive provision
- Regulation of monopolistic practices is required
- Costs tend to be fixed, not changing with traffic volume
- Fixed and common costs allow a wide range of discretion in pricing services

These characteristics clearly outline why rail transportation is subject to significant increasing economies-of-scale; as volume increases, the total cost of production decreases on a per unit basis. This is because railroads are an industry with a high proportion of fixed costs, which does not vary with volume of business. As volume increases, fixed costs stay constant and hence become less per unit of output. These fixed costs include: the rights-of-way (including tunnels and bridges), classification yards, general management expense, and maintenance caused expenses by weathering and age, although not based on usage [76].

The economic structure of the railroad freight industry approximates what is referred to as oligopoly. Oligopoly exists when there are so few sellers of a product or service that the market activities (including pricing) of one seller have an important effect on the other sellers [31]. In such a situation, each seller is aware that the competing firms in the industry are interdependent and that in changing his prices or engaging in other market activities he must take into account the probable reactions of the other sellers [31].

Some users view the railroad freight industry as homogeneous oligopoly because they regard all railroads as being alike and think that their services are undifferentiated. Others believe that there are differences in the services provided by different competing railroads, that is, differential oligopoly exists. Although the amount of differentiation in many cases are minimal, this is the true situation. The rate bureau system of pricing involves a rate bureau representing the carriers of a given node in a geographic area that publishes freight rate tariffs for carrier members and receives rate proposals from the carriers in the area. This system of pricing and the economic regulatory system tend to result in competing railroads charging identical rates.

The uncertainties regarding the reaction of competitors to price changes made by one or more railroads are reduced by the rate bureau method of pricing by permitting the railroads in a region to review the rate proposals of other railroads before the new rates go into effect [31]. In addition, the economic regulatory system reduces the amount of uncertainty regarding the reactions of competitors to rate changes by requiring that notice be given in advance of proposed rate changes [31].

C. Different Rate Types in Rail Transportation:

There are a number of different rates that can be applied in rail transporting of goods. These rates are:

- Class Rates - an alphabetical listing of rates for commodities along with the class or group to which the particular commodity has been assigned, or its class "rating". This system was designed to alleviate the problem of dealing with and quoting rates for each commodity and every pair of origin and destination points.

- Exceptions to the Classification - an exception to the classification is a substitution of a different class rating for that contained in a classification [31]. Exceptions are brought about by competitive or other conditions affecting a particular carrier and his users that cause him to find the class rating unacceptable.
- Commodity Rates - Rates published by a carrier or carriers on a commodity or segment of traffic directly without reference to the freight classification device. This rate is usually the lowest rate available, if one exists.
- Vehicle-Load-Rate - A certain minimum weight is tendered in order to qualify for a vehicle-load rate which is lower than the rate on a smaller shipment.
- Less-Than-Vehicle-Load-Rate - This rate is for loads that are too small to qualify for the vehicle-load rate.
- Unit-Train Rate - A unit train is a train permanently coupled together that moves in a continuous cycle from an origin to a destination point and back to the origin [31].

Other types of rates include:

- Any- Quantity Rate
- Multiple-Car, Multiple-Trailer, and Trainload Rates
- All-Commodity Rate
- Local Rate
- Joint Rate
- Through Rate

- Combination Rate
- Section 22 Rate
- TOFC Rate
- Container Rate
- Rent-a-Train Rate
- Incentive Rates
- Space-Available or Deferred Rate

Railroad and motor carriers determine their rates, classifications, and other charges through group consideration. These carriers are subject to federal regulations, and internal economies of scale, external economies of scale, joint cost, unused capacity, or some combination of these are common. Fixed costs of an operation tend to be much higher than variable costs since the equipment for this industry is rather expensive. However, as long as plant utilization increases, costs per unit of traffic tend to decrease [19].

D. Cost Structure and Cost Functions in Rail Transportation:

Railroad cost structure enables this mode of transportation to be very competitive in short-term pricing and in the pricing of particular services, mainly bulk items. The fixed cost investments for the rail industry is quite large, but these investments tend to last a reasonable amount of time. In addition, direct and indirect costs for these investments do not vary with the amount of traffic handled [19]. Railway revenues between 1983 and 1992 are shown in Table 2.20.

Year	Operating Revenue	Operating Expenses	Ordinary Income	Net Railway Operating Income	Revenue Ton-Miles	Capital Expenditure
1983	26,729,392	24,106,254	1,777,916	1,837,854	828,275	2,760,909
1984	29,453,446	25,800,454	2,653,814	2,536,673	921,542	3,744,395
1985	27,586,441	25,225,295	1,788,151	1,746,386	876,984	4,422,903
1986	26,204,122	24,896,015	746,941	506,591	867,722	3,600,682
1987	26,622,482	23,878,116	1,965,475	1,756,460	943,747	2,970,805
1988	27,934,285	24,811,138	2,286,003	1,979,719	996,182	3,681,447
1989	27,955,969	25,037,666	2,009,094	1,894,315	1,013,821	3,708,662
1990	28,369,803	24,651,542	1,961,127	2,648,258	1,033,969	3,639,838
1991	27,845,206	28,061,187	(90,849)	(37,455)	1,038,875	3,437,363
1992	28,348,741	25,316,364	2,060,179	1,959,553	1,066,781	3,702,367

Table 2.18 -- Railway Revenue Ton-Miles and Expenses (millions of dollars) [19]

Fixed costs for rail transportation decrease per unit as volume to be carried increases. In the same manner, variable costs also vary with volume. These variable costs are: maintenance of equipment, rights-of-way based on usage, labor costs, fuel, and lubrication oil [19].

The short-run variable cost function for rail transportation is based on a modified version of the Translog Hedonic Cost Function [19]:

$$C = C(y_p, y_f, x, v, t) \qquad \textit{(equation 3)}$$

where,

y_p = passenger service output,

y_f = freight service output,

v = vector of prices of variable factors,

x = quantity of way-and-structure capital,

t = vector of technological conditions

The focus of this study is freight transportation rather than passenger transportation, therefore, y_p could be ignored in this cost model. For freight service, ton-miles is used as an indicator of service since it reflects both weight and distance.

Equipment, general and maintenance labor, traffic and transportation labor (other than train), on-train labor, and fuel & material are the five variables used in estimating rail expenditures. Operating cost for a railroad is equal to the sum of net way and structures, equipment depreciation, fringe benefit, labor taxes on employee compensation chargeable to operating expenses, net equipment rental expenses, and imputed opportunity and depreciation cost on equipment capital [19].

E. Service Characteristics:

There are numerous transportation modes used by different industries. And of these modes, the largest number of competitors are within the railroad industry. Despite the great problems faced by railroads since World War II, they are still our most important freight carrier in terms of intercity ton-miles carried and there are a large number of users that rely on the railroad system (see Table 2.19).

Year	Railroads	Trucks	Water	Oil Pipelines	Air
1985	36.4 %	24.8 %	15.5 %	22.9 %	0.3 %
1986	35.6	25.3	15.7	23.1	0.3
1987	36.8	25.1	15.6	22.2	0.3
1988	37.0	25.3	15.8	21.6	0.3
1989	37.8	25.3	15.8	20.6	0.4
1990	37.7	25.4	16.5 r	20.2	0.4
1991	37.7 r	26.0 r	16.1 r	19.8 r	0.3
1992	37.5 r	26.9 r	15.9 r	19.4 r	0.4
1993	38.0 r	27.6 r	15.0	19.0 r	0.4
1994 p	38.9	27.7	14.5	18.5	0.4

r - revised
p - preliminary

Table 2.19 --Distribution of Intercity Freight Traffic: Ton-Miles [13]

The railroad system has many qualities which have made them a viable transportation mode, some of them are described below:

<u>Completeness of Service:</u> The completeness of service is defined by how far the carrier service reaches from point of consumption in satisfying customer needs. The higher the number of connections between the origin and destination points, the less complete a service is. Trucks, of course, offer the most complete freight service, reaching from store to door and enjoy the competitive advantage of originating and terminating most shipments [33]. As a result, railroads started to withdraw from the LCL (less-than-carload) shipments in favor of CL (carload) quantities [31].

Therefore, railroads can perform a complete door-to-door service when the shipper, and the receiver each have a railroad siding. However, a door-to-door service is not possible if the shipper and/or receiver does not have a rail siding, and this is increasingly the case as industry locates away from railroad lines.

Cost: Because of rail transportation's economies-of-scale, railroad freight service is cheaper on longer hauls than some other modes but also higher on shorter hauls than the rates of their competitors. The same principle applies in shipping large shipments versus small size shipments.

Time: The user of the rail service is concerned with the overall speed of the service. This speed takes into effect the delays that take place in terminal operations. Therefore, on short hauls the railroads are at a time disadvantage, but on long hauls, where the terminal delay is a smaller part of the total time elapsed, a railroad may do better timewise than its surface competitors.

Flexibility: Flexibility refers to what the specific mode can carry. Railroads do not have serious limitations on what they can carry, in terms of size and weight. Special routing can be arranged for unusual size shipments in order to avoid unsuitable roadbed conditions, tunnel size, or other problems.

Dependability: Dependability refers to assurance by the service providers that the freight will be available when, where, and at the time and in the condition it is needed [33]. Since railroads are not affected by weather as much as other modes are, they have the opportunity to provide more dependable service. However, derailment and other breakdowns reduce the dependability of railroads. In addition, railroad loss and damage is fairly high, the latter one generally caused by rough handling, vibration, and shocks.

Interchanging of Freight and Equipment: Railroads offer a nationwide service because they automatically interchange freight with one another by accepting each other's loaded freight cars for transportation.

Service and Rate Innovations: These include expanded trailer-on-flatcar and container-on-flatcar service, the use of run-through trains that bypass most intermediate terminals and are interchanged between railroads as a whole, and multi-level rack cars for carrying new automobiles. Pooling of boxcars by some railroads via the American Boxcar Company with the possibility of a nationwide pooling system in the future, more multiple-car and trainload service and rates, the development of unit trains and corresponding rates, and various other incentive rates are also in this class.

Since 1945, there has also been technological changes that resulted in better productivity and service. Some of these changes include: use of diesel fuel and turbine power, new freight cars with higher capacity, use of computers, computerized freight yard operations.

F. Grain Transportation by Rail:

The transportation of farm products by rail is quite common. This section provides statistical information on grain transportation in the United States and also outlines the highlights of the Grain Car Supply Conference in April 1994. The conference focused on the problems faced by the rail industry in the grain trade.

Table 2.20 summarizes the amount of grain in millions of tons and the number of carloads in thousands that the railroads handled in transporting grain. The total revenue from transporting the grain is also included. The last three columns of the table present the percentage tons, carloads, and the total revenue contributed by grain transportation.

Year	Tons Originated (millions)	Carloads Originated (thousands)	Grain Revenue (millions $)	** Tonnage	** Carloads	** Revenue
1985	117	1,235	$1,608	8.9%	6.3 %	5.7%
1986	126	1,324	1,625	9.6	6.8	6.0
1987	151	1,594	1,853	11.0	7.7	6.7
1988	159	1,679	2,161	11.1	7.8	7.3
1989	145	1,514	2,100	10.3	7.1	7.2
1990	138	1,460	2,101	9.7	6.8	7.1
1991	137	1,423	2,040	9.9	6.8	7.0
1992	141	1,451	2,130	10.1	6.8	7.2
1993	140	1,459	2,239	10.0	6.7	7.4
1994	123	1,277	2,090	8.4	5.5	6.4

** - Grain as Percent of Total Traffic

Table 2.20 -- Rail Transportation of Grain [13]

Table 2.21 summarizes the top nine companies in grain transportation according to the volume they carried, and the percent of grain handled by each company as a percentage of total grain transportation in 1994. The rest of the railroads that transported grain are gathered under a single entry.

Railroad	Tons of Grain Originated	Percent of Total
Burlington Northern Railroad Company	32,528,725	26.4 %
Union Pacific Railroad Company	22,811,546	18.5
Norfolk Southern Corporation	13,282,026	10.8
CSX Transportation	11,224,963	9.1
Chicago and North Western Transportation Company	10,966,910	8.9
Atchison, Topeka & Santa Fe Railway Company	9,262,651	7.5
Illinois Central Railroad Company	8,306,414	6.8
Kansas City Southern Railway Company	4,263,631	3.5
Consolidated Rail Corporation	4,258,633	3.5
Top Nine	116,905,499	95.0 %
Others	6,138,403	5.0
TOTAL	123,043,902	100.0 %

Table 2.21 -- Major Grain-Carrying Railroads in 1994 [13]

Table 2.22 gives the annual number of grain hoppers and their total capacity in grain transportation between 1985 and 1994. Capacity figures assume that an average covered hopper carries 3,400 bushels.

Year	Grain Hoppers	Total Capacity (bushels)
1985	211,492	719,072,800
1986	216,957	737,653,800
1987	225,413	766,404,200
1988	211,428	718,855,200
1989	206,781	703,055,400
1990	205,402	698,366,800
1991	207,080	704,072,000
1992	210,788	716,679,200
1993	215,663	733,254,200
1994	213,221	724,951,400

Table 2.22 -- Grain Fleet [13]

Table 2.23 provides the average weekly number of carloads carrying grain from 1985 through 1994.

Year	Carloads Originated	Total Bushels (millions)	Weekly Average (millions of bushels)
1985	1,235,290	4,200	80.8
1986	1,323,836	4,501	86.6
1987	1,593,623	5,418	104.2
1988	1,679,445	5,710	109.8
1989	1,513,713	5,147	99.0
1990	1,460,160	4,965	95.5
1991	1,422,523	4,837	93.0
1992	1,451,444	4,935	94.9
1993	1,458,838	4,960	95.4
1994	1,276,966	4,342	83.5

Table 2.23 -- Grain Traffic [13]

Table 2.24 displays valuable information on how the rail industry contributes to the transportation of grain in the United States. The last column summarizes the percent of grain produced in the U.S. transported by rail. From this column, one can see that between 1985 and 1994, the lowest point occurred when 26.6 percent of the grain produced was transported by rail. However, the year 1988 represented the peak point when 60.4 percent of the grain produced was transported by rail.

Year	Total Bushels U.S. Production (thousands)	Bushels Originated (thousands)	Percent of Production
1985	15,768,872	4,199,986	26.6
1986	14,317,457	4,501,042	31.4
1987	12,922,846	5,418,318	41.9
1988	9,454,306	5,710,113	60.4
1989	12,958,698	5,146,624	39.7
1990	14,044,643	4,964,544	35.3
1991	12,880,793	4,836,578	37.5
1992	15,864,526	4,934,910	31.1
1993	11,848,530	4,960,049	41.9
1994	16,428,478	4,341,684	26.4

Table 2.24 –Rail Grain Traffic as a Percent of Domestic Grain Production [13]

Table 2.25 depicts a synopsis of the Grain Car Supply Conference that was held in Omaha in April 1994. It provides an overall view of the problems and facts about grain trade with regard to rail transportation.

• The ICC's sponsorship didn't imply endorsement of more regulation.
• The railroads aren't required to supply cars as a part of their common carrier obligation.
• The current system pits the grain companies against the railroads.
• Freight divisions don't enable many shortlines to purchase equipment. Should the states get involved in car acquisitions?
• Grain merchandising defies a comparison to the transportation methods used by other industries.
• Much of the grain is shipped when the Mississippi is frozen, increasing pressure on car supply and railroad operations.
• Buying and selling of grain and the relationship of futures prices to cash prices can cause spikes in car demand when the cash prices approach future prices.
• While the market determines grain and barge prices, freight rates and car hire rates are non-responsive to market forces.
• The failure of car hire rates to be responsive to supply and demand factors acts to dampen investment decisions.
• Set contract and tariff rates to increases and decreases in per diem rates. Higher freight rates tied to higher grain prices will tend to clear the market.
• Find a way to determine the quality of grain before it is loaded into the rail cars. Covered hoppers are not inspection containers, they are transportation containers.
• Establish a permit system for supplying cars to all grain elevators. Allow grain to be loaded and shipped only when the destination facility has purchased the grain and has it scheduled for unloading.
• Encourage the large railroads to set divisions to insure that small railroads and grain elevators have adequate financial return for their investment in cars.
• Encourage shippers and receivers to load and unload promptly. Don't set multiple car rates for customers who can't load and unload cars promptly. Schedule switching and line-haul railroad operations to handle cars promptly and consistently.
• Have federal and state governments reconsider infrastructure investments. Current policy contributes to increased pollution and to the grain car problem.

Table 2.25 --Grain Trade Facts and Problems by Rail [23]

G. Rail Mergers:

For purposes of discussion by economists, a merger of two railroads means effective consolidation of the two from an operating point of view [40]. There are two general types of rail mergers that are possible: side-by-side(parallel) and end-to-end mergers. Parallel mergers involve two or more carriers whose route systems are parallel and overlapping. This kind of merger eliminates redundant trackage but lowers the number of companies in competition. End-to-end mergers involves two or more carriers joining together when each serves different regions of the country. Competition is not reduced by this type of merger and each railroad is now part of a larger rail system.

Benefits of Rail Mergers: Two general benefits can be noted for an end-to-end merger [76]. First, service is improved to the shipping public since the customers are offered single carrier service and responsibility from origin to destination [76]. Second, operation costs are reduced. When there are two or more servers, a shipment might have to be interchanged from train to train, boosting up operational and clerical costs. With rail mergers, this process is eliminated.

Disadvantages of Rail Mergers: The major disadvantage of rail mergers is reduced competition, especially in parallel mergers. An increase in the monopoly in an industry may lead to any of the possible evils familiar from a discussion of the case against monopoly: high prices, excessive profits, reduced output, and a lazy toleration of inefficiency and high costs of production [44]. In addition, operational problems may arise if the merging companies do not properly plan for the merger prior to its completion. Financial problems may occur if one or both of the companies are in a financial downfall and the merger does not take into account the reasons for the downfall. Finally, people problems may arise if the merging companies' workers still tend to compete against one another.

H. Recent Rail Mergers and Their Pros/Cons:

Recent rail mergers and merger proposals – Burlington Northern and Santa Fe (1995), Union Pacific and Southern Pacific (1996), Union Pacific and Chicago & North Western (1995), and Norfolk Southern, CSX, and Conrail (1997) all have similar goals behind them: 1) to simplify routing and interchanges; 2) to improve transit times and on - time service; 3) to more efficiently manage equipment; 4) to differentiate routes according to time-sensitivity of traffic; 5) to further long-term capital improvements and expansion through economies-of-scale; and 6) to permit increased competition through the offering of new, more customer-responsive products and services [10].

As a whole, the trend toward mergers, consolidations, partnerships and spin-offs in domestic transportation is considered to be a positive thing. Many shippers have supported mergers because they offer more direct routes among a larger network of terminals. Cost savings and improved efficiencies, meanwhile, will help pay for needed capital improvements to track, terminals, switching and electronic data interchange (EDI) systems. It is helpful to look more closely at several mergers at this point to better understand their overall market impacts.

Burlington Northern-Santa Fe created a single railroad with a 31,000-mile network covering 27 states and two provinces in Canada. The merger combines Santa Fe's route structure, its terminals, and its marketing and operational strengths in intermodal, with Burlington Northern's extensive coal, grain, and other bulk capability over more than a dozen routes. One result is that Santa Fe's simpler route system can be augmented by Burlington Northern's premium routes and dedicated to time-sensitive intermodal moves, separate from slower, heavier bulk unit trains. In addition, the combined routes strengthen the railroads' position in serving the north-south NAFTA market.

Union Pacific-Southern Pacific merged to form the nation's largest railroad. The resultant railroad serves 32,000 route miles, employs 53,000 people, and operates 5,500 locomotives and nearly 127,000 freight cars [10]. Merging produced improved service in several corridors, and made it possible for eastbound service from the West Coast to the Midwest, as well as single-line, truck competitive service between Seattle and Los Angeles.

Union Pacific-Chicago & North Western merger strengthened United Pacific's position as a coal carrier serving the Powder River Basin Area in Wyoming. It also made possible one-stop shopping for grain and intermodal shippers between the West Coast and Midwestern cities.

Norfolk Southern & CSX-Conrail merger introduced competition in freight rail service to New York for the first time in 29 years. The merger also presented a more direct line to the coal regions of West Virginia and Pennsylvania that supply New York State Electric and Gas Corp. and Niagara Mohawk Power Corporation.

However, there are concerns about the mergers that have taken place so far. Most of these concerns are concentrated around increased rail rates. The mergers can lead to various scenarios, some of which are presented below [10]:

- the reduction of competitors on some key routes
- as routes are consolidated or dedicated to particular types of service, access to and from specific customer facilities may be limited or abandoned

- merged 'mega-railroads' will have a greater ability to restrict trackage and interchange rights, and/or raise changes for competitors
- freight rates will increase to fund short-term administrative and capital merger costs

In addition to the rail mergers that have been mentioned, several mergers have taken place in the trucking industry. Similar benefits and concerns exists regarding these mergers.

The recent mergers in the rail and trucking industries create a need to evaluate other transportation modes in order to assess their feasibility. This project, focuses on the transporting of grain via barge as an alternative to rail transportation. The future of rail transportation in terms of more potential mergers and their effects on the pricing system is somewhat unclear. Thus, it is necessary to evaluate the economic feasibility of other modes of transportation.

3. PRIOR PROJECTS INVOLVING COST EVALUATIONS IN GRAIN TRANSPORTATION

There are a number of cost evaluation studies that have been made in the past between rail and barge and/or other transportation modes. This section summarizes a few of the studies that have been conducted with conclusions that are relevant to the focus of this project.

Competitive Forces in the U.S. Inland Grain Transport Industry: A Regional Perspective This is an empirical study of interregional and intertemporal characteristics of U.S. grain transportation rates from various regions by various modes to various export points. The purpose of the study is: (1) to describe regional rail rate structures relative to structures of alternative transport opportunities for export-bound grain in terms of rate level and in terms of the implied grain price received at the origin, during September 1978 through March 1983; (2) to make interregional comparisons over time of the intermodal relative rate structures and of standardized (mileage) rail rates; and (3) to suggest what the regional and interregional measurements imply about competitive characteristics across region and grain type [32].

Transport modes considered were direct rail, rail-barge, direct truck, and truck-barge. Three perspectives were used to examine the grain transport industry: the transport rates are presented in terms of cents per 100 pounds per shipment, rail rates are converted to a per-mile basis so that comparison of standardized rate levels across regions can be made, and the focus is on the grain price found by subtracting the transport rate from the appropriate port grain price. An example of this calculation is given in Table 2.26.

	Rail-Gulf			*Truck-Barge-Gulf*			*Rail-West*		
Week	Port Price	Rail Rate	Net Price	Port Price	Truck Barge	Net Price	Port Price	Rail Rate	Net Price
1	4.80	.80	4.00	4.80	.85	3.95	5.15	1.25	3.90
2	4.80	.80	4.00	4.80	.75	4.05	5.15	1.25	3.90
3	4.80	.80	4.00	4.80	.75	4.05	5.35	1.25	4.10

Table 2.26 – An Illustration of Net-Price Changes

When gathering rates for different modes of transportation, different techniques are used. Rail rates for grain shipments from each crop reporting districts among the regions were collected from public rate tariffs, rate books of regional grain cooperatives, and rate books of grain exchanges. For barge rates, contract rates and spot rates are used. Contract rates are based on surveying shipping barge firms, and spot rates are based on bids and offers made at the Merchants Exchange of St. Louis for shipments within 30 days. Truck rates are derived from state specific cost functions of mileage [32]. Ten truck-cost functions are estimated under ten different trip lengths and these functions are combined and smoothed with least squares regression. Finally, weekly port prices were taken from Grain Market News. Table 2.27 summarizes pertinent findings from this project:

Region	Crop	Mode	1978	1979			1980			1981			1982			1983
			P3	P1	P2	P3	P1	P2	P3	P1	P2	P3	P1	P2	P3	P1
1	Corn	R	71.9	94.9	67.2	57.6	80.3	10.1	4.3	68.5	17.2	12.3	68.5	15.2	15.4	43.6
		R-B	3.9	0	0	0	3.5	56.6	52.5	8.4	40.4	54.9	9.3	51.5	51.3	29.9
		NR	24.2	5.1	32.8	42.4	16.2	33.3	43.2	23.1	42.4	32.7	22.2	33.3	33.3	26.5
2	Corn	R	62.6	58.5	57.5	60.6	53.5	24.8	36.9	53.7	23.2	42.1	55.4	45	39.7	53.1
		NR	37.4	41.5	42.5	39.4	46.5	75.2	63.1	46.3	76.8	57.9	44.6	55	60.3	46.9
3	Wheat	R	17.4	49.6	26.3	3	84.3	23.2	9.9	88.9	43.9	17.9	100	39.4	64.2	76.9
		R-B	0	0	3.5	9.6	4.6	16.2	0	6.5	24.7	43.2	0	52.5	29	23.1
		NR	82.6	50.4	70.2	87.4	11.1	60.6	90.1	4.6	31.3	38.9	0	8.1	6.8	0
4	Wheat	R	38.3	12.5	60.8	23.3	59.4	62.5	27.8	100	100	78.5	100	98.9	95.8	99
		R-B	0	0	1.7	26.7	3.1	0	20.1	0	0	18	0	1.1	0	1
		NR	61.7	87.5	37.5	50	37.5	37.5	52.1	0	0	3.5	0	0	4.2	0
5	Wheat	R	86.5	97.4	99.2	98.9	86.1	85	91.7	68.1	65.2	86.1	58.3	75	98.1	83
		R-B	0	0	0	0	0	0	0	5.5	15.1	4.6	16.7	22	1.9	5.6
		NR	13.5	2.6	0.8	1.1	13.9	15	8.3	26.4	19.7	9.3	25	3	0	11.1
6	Corn	R	87.1	96.9	95.5	98.7	98.5	100	100	100	94.5	100	100	98.2	100	93.8
		R-B	0	0	0	0	1.5	0	0	0	0	0	0	1.8	0	3.1
		NR	12.9	3.1	4.5	1.3	0	0	0	0	5.5	0	0	0	0	3.1

* R is direct rail; R-B is rail-barge; NR is non rail – truck-barge or direct truck.
* P1: January-March; P2: April-August; P3: September-December.

Table 2.27 – Percentage of Highest Net Prices by Region, Period, and Mode [32]

The analysis reveals that in the western Corn Belt (region 1) of Iowa, direct rail was the predominant mode-destination combination in terms of yielding the largest proportion of highest net prices to the Gulf during September, 1978 through March, 1980. During the same period, direct rail was also the predominant mode-destination alternative in the eastern Corn Belt (region 2) of Indiana, Ohio, and part of Michigan [32]. However, in general, the second half of the study period for region 1 was characterized by a very strong truck- and rail-barge Gulf market relative to other mode-destination alternatives. At the same time period, the outcome for region 2 is non-rail; that is either truck-barge or direct truck.

In region 3 (eastern North Dakota, northwest Minnesota, and northeast South Dakota) and region 4 (Montana and western North Dakota) the composition of mode-destination pairs associated with the highest net price changed considerably from period to period during 1978-1981 (Refer to Table 2.27). The net prices in region 3 reflected a high degree of modal and destination competition for the years 1978-81. Region 4, on the other hand, is characterized by relatively "high" rail rates.

Throughout regions 5, 6, and 7 (eastern Colorado, Kansas, and Nebraska) direct-rail to the Gulf and West Coast was predominant in net-price terms, particularly through 1980. However, the nonrail and rail-barge alternatives accounted for up to 42 percent (P1, 1982) of the highest net prices during the second half of the study.

In summary, it can be stated from this project that the importance of individual factors in changing net-price relationships varies by region and period; however, each region exhibits dynamic characteristics of competition that are directly attributable to port grain prices and the regions transport rates. In most regions, rail transportation faces a high degree of competition from net prices caused by changes in barge-rate and port-price relationships and it appears that rail rates responded to these changes under deregulated conditions.

Thus, when projecting future rail rate levels, at least two general factors must be analyzed closely. First, projection of barge rate levels is important insofar as railroads act as rate followers [32]. Rail rates could be estimated by determining the barge rates' tendency to move, the direction of the move, and the reason for the move. Second, grain price relationships among ports is important in describing grain transport competition. These relationships might change because of: (1) ocean-going-vessel rate relationships; (2) the composition of grain imports by amount and country; (3) the effects of new exporting houses; and (4) the interrelationships between transportation rates to the ports and port grain prices.

Regional Barge Service Demand Elasticities This study presents an analysis of the elasticity of demand for barge services on a regional basis. The impact of user charges to the elasticities are also estimated in the study. In total, there are 218 corn, 200 soybean, and 156 wheat-originating regions specified in the model [15]. Sixty seven regions serve as domestic demand destinations; grain is transported to these destinations to satisfy livestock feed or processing deficits. Transport activities are defined as:

1. single, three to five, 25, 30, 50 to 54, 60 to 65, 75 to 100, and 125 car rail shipments
2. single, three, five, 25, and 50 car rail-barge combination shipments
3. truck
4. truck barge
5. ocean-going vessels (for foreign import demand regions).

Rail rates for the study were obtained from freight tariff publications. Rate selection for individual origin-destination pairs is based primarily on consultation with shippers and railroad executives. Truck rates are based upon estimated truck cost plus a two percent profit margin. Ocean-going vessel rates are estimated by calculating the average ocean grain rates weighted by ship payload capacity, published by the Journal of Commerce and Commercial for the period of October 1979-September 1980 [15]. Contract and spot rates were used for barges; contract rates were based on consultation with barge company executives and spot rates were based on an average of daily barge freight call sessions at the Merchant's Exchange of St. Louis.

Elasticity is defined as the responsiveness in quantity demanded of a product to a change in the price of the product with all else held constant. The general formula used consists of [15]:

$$E = \frac{\Delta}{\Delta}\frac{Q}{P}\frac{P}{Q} \qquad \textit{(equation 4)}$$

where

E = own price elasticity of quantity demanded for the product

Q = quantity demanded of the product

P = price of the product

Δ Q, Δ P = changes in quantity and price from the initial situation

If the demand is elastic, a price increase will result in reduced total revenue received by the shippers. If the demand is inelastic, a rate increase will increase total revenue. The study finds that the demand is elastic (>1) on the Upper Mississippi, Missouri, and Arkansas rivers. On the Lower Mississippi, Illinois, and Columbia-Snake the demand is inelastic (<1). The results for the Ohio River indicate that elasticities are only valid over a particular range of prices. It is found that the demand elasticity depends on the geographic location of the regions. For example, when the region is in close proximity to the river, the rate on substitute transportation does not become competitive even after user charges are imposed.

Several market factors tend to effect the elasticities of demand on a regional basis. These are: regional grain usage, barge related factors, and rail related factors. Regional grain usage includes the grain surplus - defined as regional production minus seed, feed, and local processing - as a percentage of production (%SUR), and the total processing demand as a percentage of production (% PROC). Barge related factors includes the total mileage, the average barge rate, and the percent of all grain flows originating in the region and traveling by barge in the base solution of the model. Rail related factors consists of the difference between the minimum export rail rate and total barge rate (truck or rail-barge) in cents per hundredweight, the regional percentage utilization of multiple-car train loading facilities, and the percentage of all export grain flows traveling by rail in the base solution.

<u>The Logistics of Rail-Barge Transportation Involving Non-Integrated Firms: A Purchasing Case Study</u> This study is an evaluation of a proposed rail-barge movement of coal for a midwestern utility to replace an existing all-rail movement. The purpose of the study was to shed light on the various calculations needed, decisions to be made, and institutional arrangements involved in developing a large integrated transportation movement using non-integrated transportation firms [3]. Of particular importance is the uncertainty associated with future market conditions and the importance of environmental regulations concerning the types (hence source) of coal which can be used by the utility.

Current alternatives for transporting coal from the mines to the power plants are selected to be all-rail, 45% rail-barge and 55% all-rail, 55% rail-barge and 45% all-rail, and all rail-barge. The partial use of all-rail and rail-barge is to evaluate the effects of different volume levels on the viability of the transportation options. The rate quotes submitted by barge companies differed substantially, but the barge rate offered by the low bidder was about $1.00 per ton higher than the existing market rates.

In addition to the rates, a possible barge movement included infrastructure costs. One option involved using the barge loading devices at a nearby terminal and transporting the coal via a conveyor system to the facility. The other consisted of constructing the necessary facilities to unload the barges directly at the plant.

In comparing the alternatives, two scenarios were used: (1) the cost difference between rail and rail-barge would continue over the twenty year period (scenario A); (2) the rail-barge cost would be equivalent to the all-rail movement after five years (scenario B). Accordingly, the basic costs and tax calculations used in this analysis to compare the all-rail and rail-barge alternatives were: (1) transportation costs; (2) conveying system construction costs; (3) conveying system maintenance and operating costs; (4) coal inventory carrying costs; and (5) tax implications. Tables 2.28, 2.29, and 2.30 outline the costs found for transportation and overall costs.

	Option 1 Use of Existing Nearby Terminal	Option 2 Unloading at Plant Site
1. Cost to move entire volume by rail	$17,941,000	$17,941,000
2. Cost to move 45% by all-rail; 55% by rail-barge	$17,926,200	$17,329,600
3. Cost to move 55% by all-rail; 45% by rail-barge	$17,595,200	$17,462,120
4. Cost to move entire volume by rail-barge	$17,328,800	$16,235,240

Table 2.28 – Total Transportation Costs for 1984 [3]

	Option 1 Use of Existing Nearby Terminal	Option 2 Unloading at Plant Site
1. Present value of after-tax costs to move 1.1 million tons by all-rail	$96,583,000	$96,583,000
2. Present value of after-tax costs to move 45% by all-rail, 55% by rail-barge	$98,193,470	$95,033,800
3. Present value of after-tax costs to move 55% by all-rail, 45% by rail-barge	$98,371,080	$95,747,080
4. Present value of after-tax costs to move 1.1 million tons by rail-barge	$94,977,230	$89,142,510

Table 2.29 – Present Value of After Tax Costs (Scenario A) [3]

	Option 1 Use of Existing Nearby Terminal	Option 2 Unloading at Plant Site
1. Present value of after-tax costs to move 1.1 million tons by all-rail	$96,583,000	$96,583,000
2. Present value of after-tax costs to move 45% by all-rail, 55% by rail-barge	$98,243,920	$97,122,180
3. Present value of after-tax costs to move 55% by all-rail, 45% by rail-barge	$98,308,780	$97,382,970
4. Present value of after-tax costs to move 1.1 million tons by rail-barge	$97,068,110	$94,968,500

Table 2.30 -- Present Value of After Tax Costs (Scenario B) [3]

As a result, an all-rail movement was favored in this project of moving coal from the mines in Eastern Kentucky and West Virginia to the utility company in Illinois. When a capital investment is necessary, the risks associated with a change in transportation arrangements tend to favor the status quo, in this case continued use of all-rail movement [3]. Other factors involved favoring rail movement because of the nature of "coal" and how it needed to be handled. For example, the extra handling of the coal associated with the rail-barge option increases the "fines" in the coal. Additionally, excessive moisture in the coal is greater with the use of barge transportation due to the longer transit times of barge service, leaky barges, and the inability of barges to permit moisture runoff as effectively as railroad cars. The lead time of a rail movement of 3 days versus three weeks by barge was another additional factor. The fact that only one railroad served the coal mine made only a few rail-barge transportation options available to purchase. Finally, the transaction costs associated with the purchase and use of rail-barge transportation of coal are perceived to be insignificant by the utility's management.

In the previous pages, the relevant literature relating to the subject of this project has been outlined. The next chapter focuses on the methodology used in making the cost analysis for rail and barge transportation.

III. METHOD OF ANALYSIS

A. Introduction:

This chapter introduces a cost methodology that compares the cost of rail versus barge transportation. The developed methodology accounts for several variables that play a part in determining the cost of moving grain between a nose and a destination point via barge and rail.

Several objectives related to the transportation modes considered are accomplished. These are:

- Identification of the key cost elements in each transportation mode.
- Development of a mathematical cost model that utilizes the key cost elements found in each transportation mode.
- Incorporation of the cost model into an interactive computer software.

B. Transportation Mode Cost Model:

Previous research in this field shows that both rail and barge transportation have the same cost structure. Between a nose point and a destination point, the transportation cost structure is formulated as [17]:

$$TTC = AC + EC + SC \qquad \textit{(equation 5)}$$

where:

TTC = Total Transportation Cost

AC = Assembly Cost

EC = Elevation Cost

SC = Shipment Cost

These cost formula components are described below:

Total Transportation Cost (TTC)

- The total amount of money spent when transporting a given amount of goods between a nose and a destination point

Assembly Cost (AC)

- The cost of moving a commodity from the supplier to the load/unloading docks to be shipped. If the loading/unloading docks are in the same facility, this cost is negligible. Otherwise, the commodity needs to be transported to the loading/unloading docks for barge or rail via a possible conveyor belt (if the distance is short), or trucks, or by some other transportation activity.

Elevation Cost (EC)

- The cost of moving the commodity with the transportation mode selected. This is a major part of the cost equation.

Shipment Cost (SC)

- This is much like the assembly cost but occurs at the destination point. It is the cost of moving the commodity from the unloading dock to the final destination. If the unloading dock is in the facility, this cost is negligible. Otherwise, the commodity needs to be transported to the final destination from the unloading dock via a possible conveyor belt (if the distance is short), or trucks, or by some other transportation activity.

The cost components described above are utilized on a per unit basis. Since the equation involves the total cost for grain, transportation units per bushel is used.

C. Forecasting Analysis of Elevation Rates:

The assembly and shipment costs described above vary widely across the nation depending on the region, amount to be transferred, and many other factors. Therefore, the cost model requires specific per unit cost for assembly and shipping costs. However, a forecasting analysis is utilized to determine the future rates of elevation costs for both modes of transportation. This is done by analyzing the historical data on elevation rates, and predicting the future outcome of these rates based on the historical data.

D. Forecasting Characteristics:

There are some characteristics of forecasts that need to be known before conducting the analysis, they are [56]:

1. *They are usually wrong.* As strange as it may sound, this is probably the most ignored and most significant property of almost all forecasting methods. Forecasts, once determined, are often treated as known information. Resource requirements and production schedules may require modifications if the forecast of demand proves to be inaccurate. The planning system should be sufficiently robust to be able to react to unanticipated forecast errors.
2. *A good forecast is more than a single number.* Given that the forecasts are generally wrong, a good forecast also includes some measure of the anticipated forecast error. This could be in the form of a range, or an error measure such as the variance of the distribution of the forecast error.
3. *Aggregate forecasts are more accurate.* Recall from statistics that the variance of the average of a collection of independent identically distributed random variables is lower than the variance of each of the random variables; that is, the variance of the sample mean is smaller than the population variance. This same phenomenon is true in forecasting as well. On a percentage basis, the error made in forecasting sales for an entire product line is generally less than the error made in forecasting sales for an individual item.
4. *The longer the forecast horizon, the less accurate the forecast will be.* This property is quite intuitive. One can predict tomorrow's value of the Dow Jones Industrial Average more accurately than next years value.
5. *Forecasts should not be used to the exclusion of known information.* A particular technique may result in reasonably accurate forecasts in most circumstances. However, there may be information available concerning the future demand that is not presented in the past history of the sales.

Despite the negative characteristics of forecasting, it is still a widely accepted form of analysis.

E. Producer Price Indexes:

Historical data is a major part of forecasting analysis. Historical data on transportation rates for both rail and barge was extremely scarce. It was even harder to gather historical data for the same time period for both types of transportation. Therefore, the Producer Price Indexes (PPI) was used in this analysis.

Producer Price Indexes (PPI) measure average changes in prices received by domestic producers of commodities in all stages of processing. Most of the information used in calculating the indexes is obtained through the systematic sampling of nearly every industry in manufacturing and mining sectors of the economy. The PPI program also includes some information from other sectors.

There are three primary systems of indexes within the program: (1) Stage-of-processing indexes; (2) commodity indexes; and (3) indexes for the net output of industries and their products [73]. This last index takes a base year and month and assumes the index for that period to be one hundred (100). For every month and year after that period, PPI publishes another index number by which the average change in prices could be calculated through a set of calculations. For rail transportation, the index base is December 1984 which means the index number is one hundred (100). Similarly, the index base for barge transportation is December 1990.

The PPI consists of a number of tables where the commodities, products, services, etc. are listed. Rail and barge transportation is listed under "Producer Price Indexes for the Net Output of Selected Industries and Their Products". Monthly indexes used in our analysis are taken from this table. Rail transportation values are found in this table under the following listings [73]:

"Railroads,
Line haul operations,
Grain…"

,and barge transportation index values used are taken from:

"Water transportation of freight,
Primary services,
Mississippi River transportation,
Farm products…"

Figures 3.1 and 3.4 show these index values for rail and barge transportation, respectively. Similarly, Figures 3.2 and 3.5 show the unadjusted percentage change from the previous month for rail and barge transportation. Finally, Figures 3.3 and 3.6 outline the monthly index values for rail and barge transportation on a six-year time horizon to show the rate movement over an extended period of time.

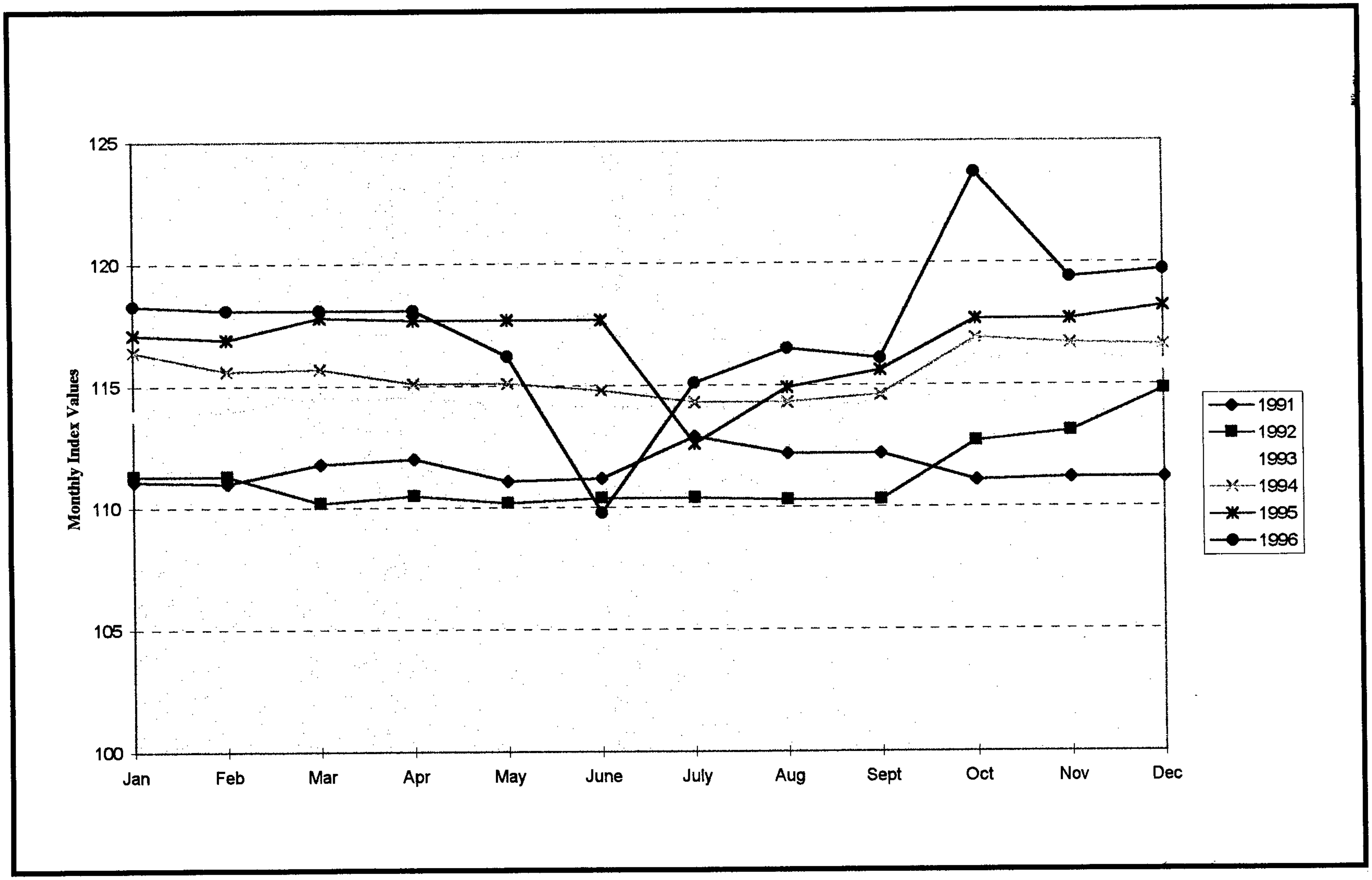

Figure 3.1 -- Monthly Producer Price Indexes for Rail Transportation of Grain

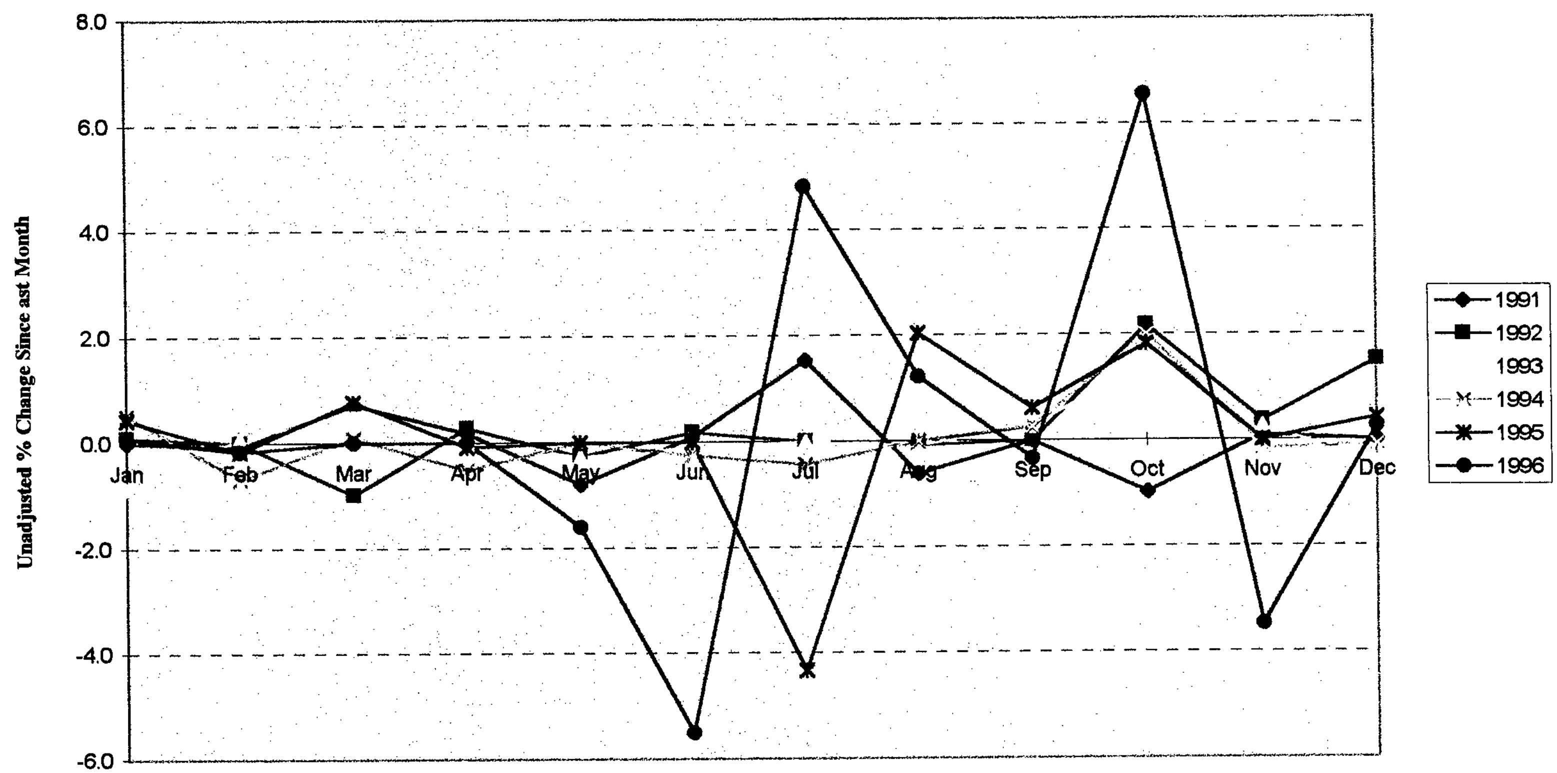

Figure 3.2 -- Rail Transportation of Grain

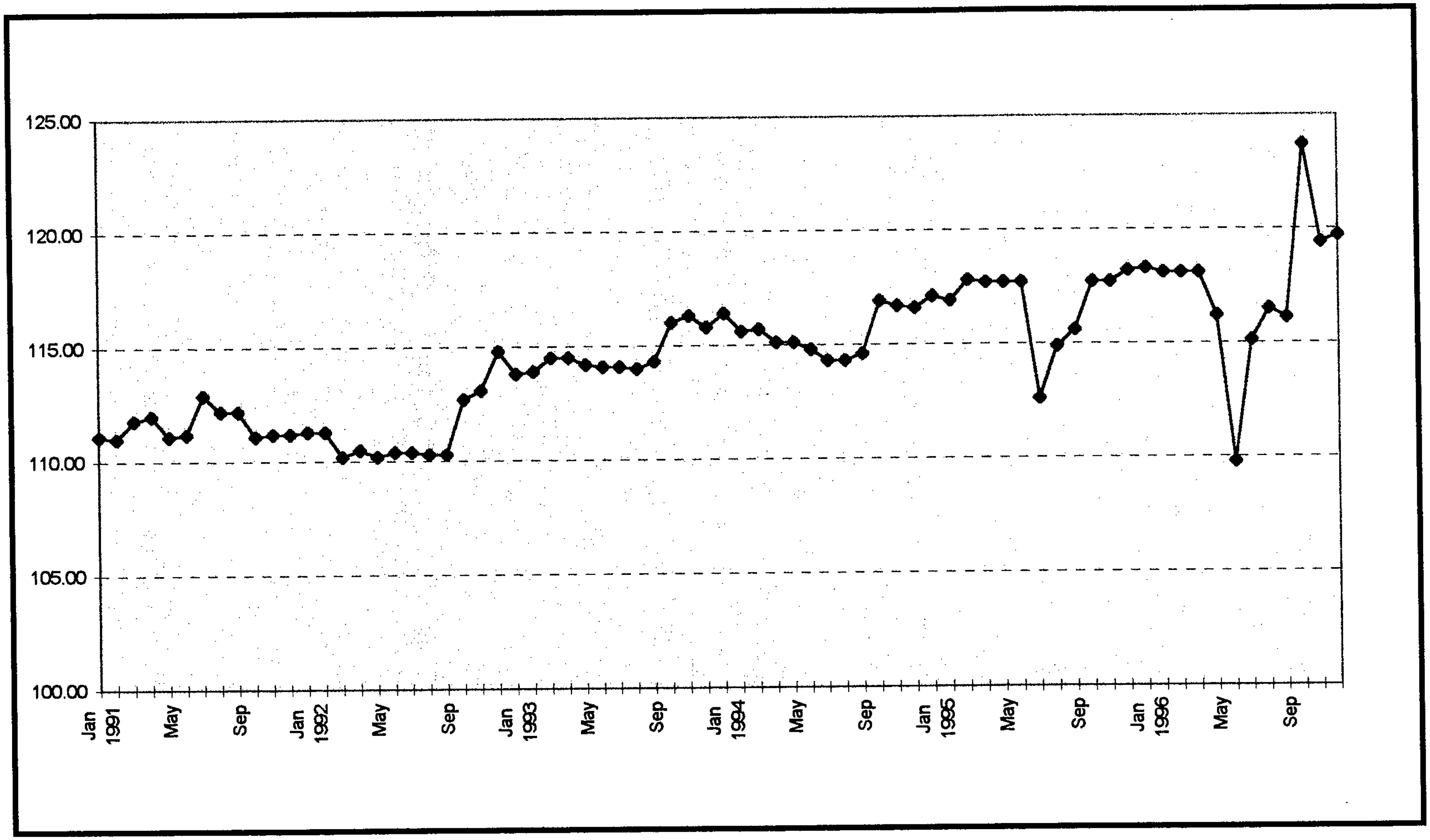

Figure 3.3 -- Monthly Producer Price Indexes for Rail Transportation Between 1991-1996 Between 1991-1996

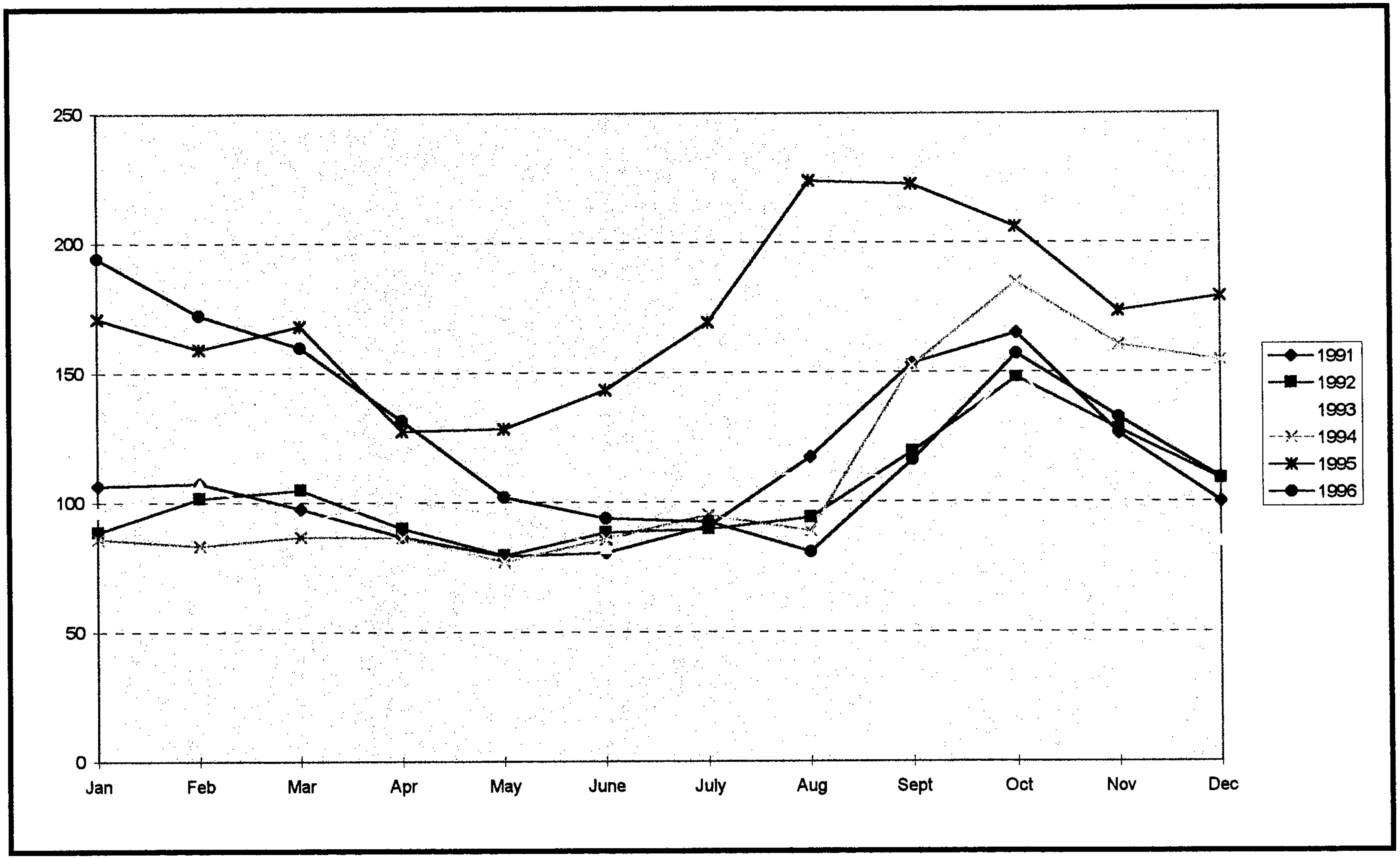

Figure 3.4 – Water Transportation of Farm Products on the Mississippi River

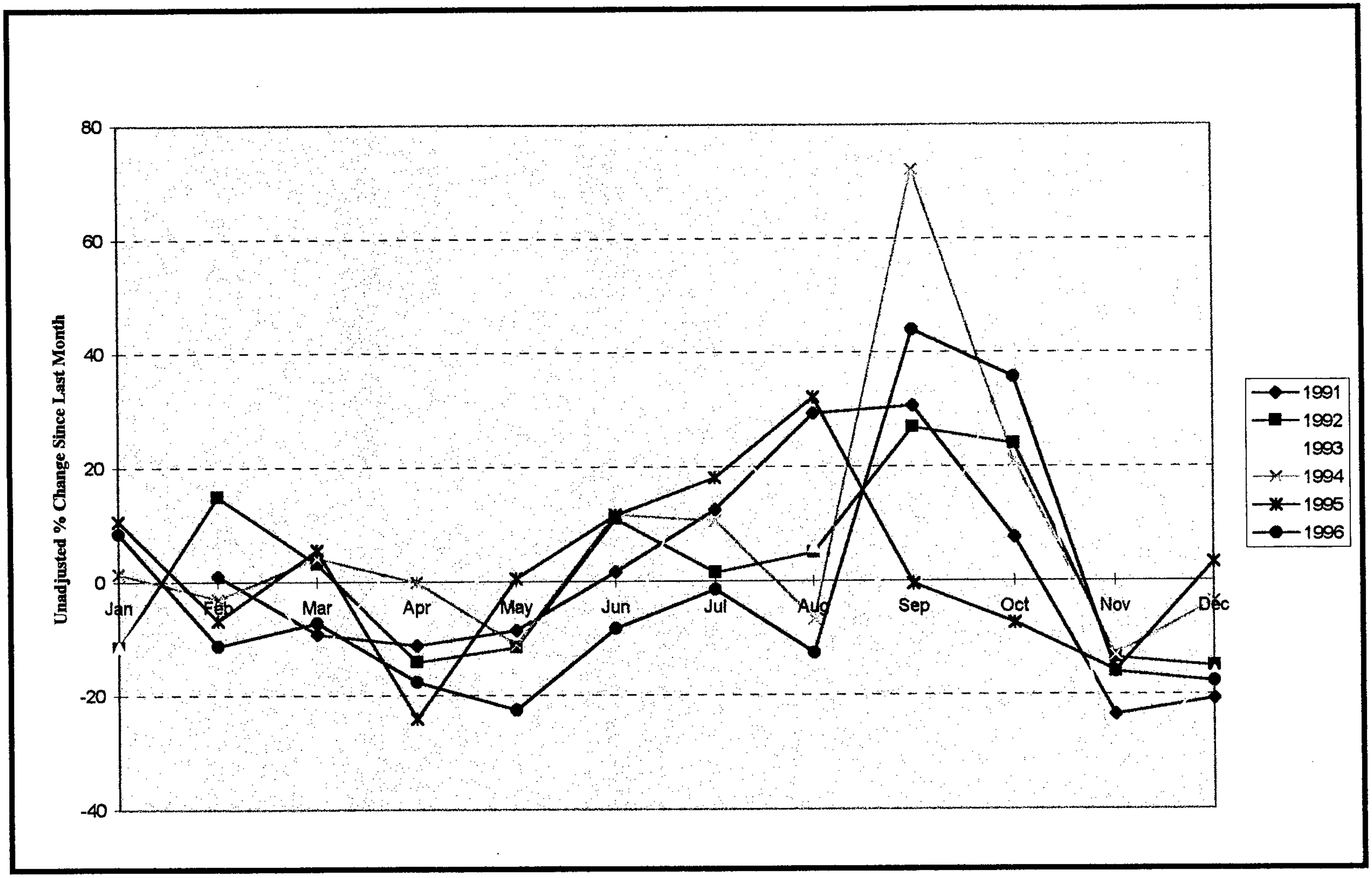

Figure 3.5 – Water Transportation of Farm Products on the Mississippi River

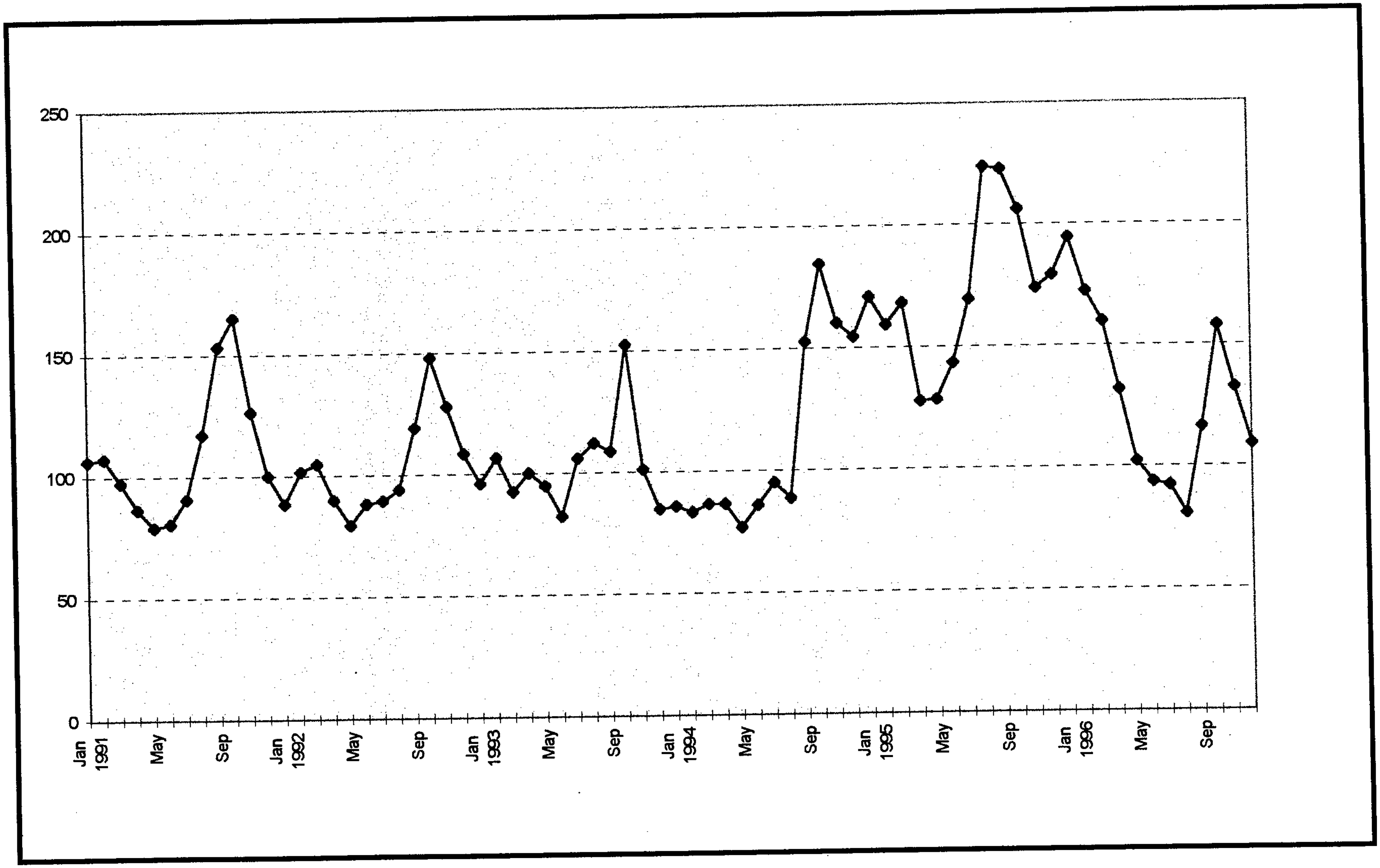

Figure 3.6 – Water Transportation of Farm Products on the Mississippi River

In order to keep the accuracy of our planning horizon equal for both types of transportation, historical data starting on January 1991 is used in developing the forecasts.

F. Forecasting Analysis:

There are three primary types of forecasting models used in industry: time series models, causal models, and judgmental models. Time series models develop forecasts by assessing the patterns and trends of past sales. It uses only the time series history of the variable being forecasted in order to develop a model for predicting future values. Some models include moving average, exponential smoothing, least squares models, and advanced time series models like Holt's two parameter double exponential smoothing, Winter's three parameter triple exponential smoothing, Brown's one parameter triple exponential smoothing models [22,74].

Causal models assume the future sales of a particular product or service are closely associated with changes in some other variables. They exploit the relationship between the time series of interest and one or more other time series. If these other variables are correlated with the variable of interest and if there appears to be some cause for this correlation, a statistical model describing this relationship can be constructed. Examples of this model are simple and multiple regression techniques [45].

Judgmental models rely on the subjective assessment of a person or a group of people. Survey of the marketplace, delphi method, use of analogs, and technological forecasting are considered to be judgmental methods. Some judgmental or subjective assessment is usually involved in all types of forecasts [22].

Utilizing historical data obtained from the PPI, a number of forecasting techniques were applied to barge and rail transportation rates. The following two (2) sections summarize the forecasting techniques applied to barge and rail transportation.

i) Barge Transportation

A number of different time series models was applied to the historical data and the most accurate one selected. However, as shown in Figures 3.3 and 3.4, barge transportation historical data had high fluctuations during the data period presented. In addition, the historical data did not show any significant trend. Therefore, only a few models could be applied. The applicable models were moving average, weighted moving average, and a very complex time-series model called Box - Jenkins. The Box-Jenkins model was selected for the analysis because of the number of variables it accounted for.

Box-Jenkins:

The Box-Jenkins model, also called the Autoregressive Integrated Moving Average Model (ARIMA) combines two basic strategies of designing forecasting models. First, a forecast of the next value in a time series is derived from the previous value of the same time series. Second, an emphasis is put on tracking forecast errors to determine the appropriate forecast [53]. These two strategies are defined as p and q. In forecasting language, they can be defined as:

p = the lag for autoregressive

q = the lag for moving average

This means that p stands for how far back we need to go for the actual observations to forecast next months rate, and q stands for how far back we need to go to determine the random noise in the equation.

In order to find the p and q values, the procedure is to look at the graphs of autocorrelation and partial autocorrelation of the data and compare these graphs to theoretical graphs where p and q are known and pick the appropriate values for the data set.

The Box-Jenkins model is a very complex and time-consuming forecasting model which can result in incorrect values because of possible human error caused by excessive computations. Thus, a large number of software packages are available which perform Box-Jenkins analysis. This analysis used SAS to design and execute the model [63].

Various values for p and q were tried to achieve the most accurate forecast. The criteria for selecting the most accurate forecast are shown below in order of importance:

- Are the Moving Average (MA) and Autoregressive (AR) estimates significant? Check the T-Ratios and reject the ones for which the T-Ratios are smaller than 2 or 3.
- Of the remainder, check the variance estimate, the standard error estimate, the AIC (Akaike's Information Criterion), and the SBC (Schwartz's Information Criterion)
- If there is still more than one model, compare the forecasts to the actual values and pick a single model.

For this project, the most accurate forecasts was achieved when p was equal to one, and q was equal to twelve. This means that this month's rate is dependent on last month's rate, the rate 12 months ago, and also random noise 12 months ago. The resultant formula is as follows:

$$(1-B^{12})(1-0.88535B)Z_t = (1-0.94152B^{12})a_t \qquad \textit{(equation 6)}$$

where:

Z_t = rate

B = backward operator constant

a_t = is the random noise at time t

The forecasted values for the upcoming year according to this analysis is listed in the next chapter. Figure 3.7 shows the forecast function developed, and the plot of the predicted future rates and confidence intervals accompanying them. The software program used and the output of the program including the forecasted values are listed in Appendix A.

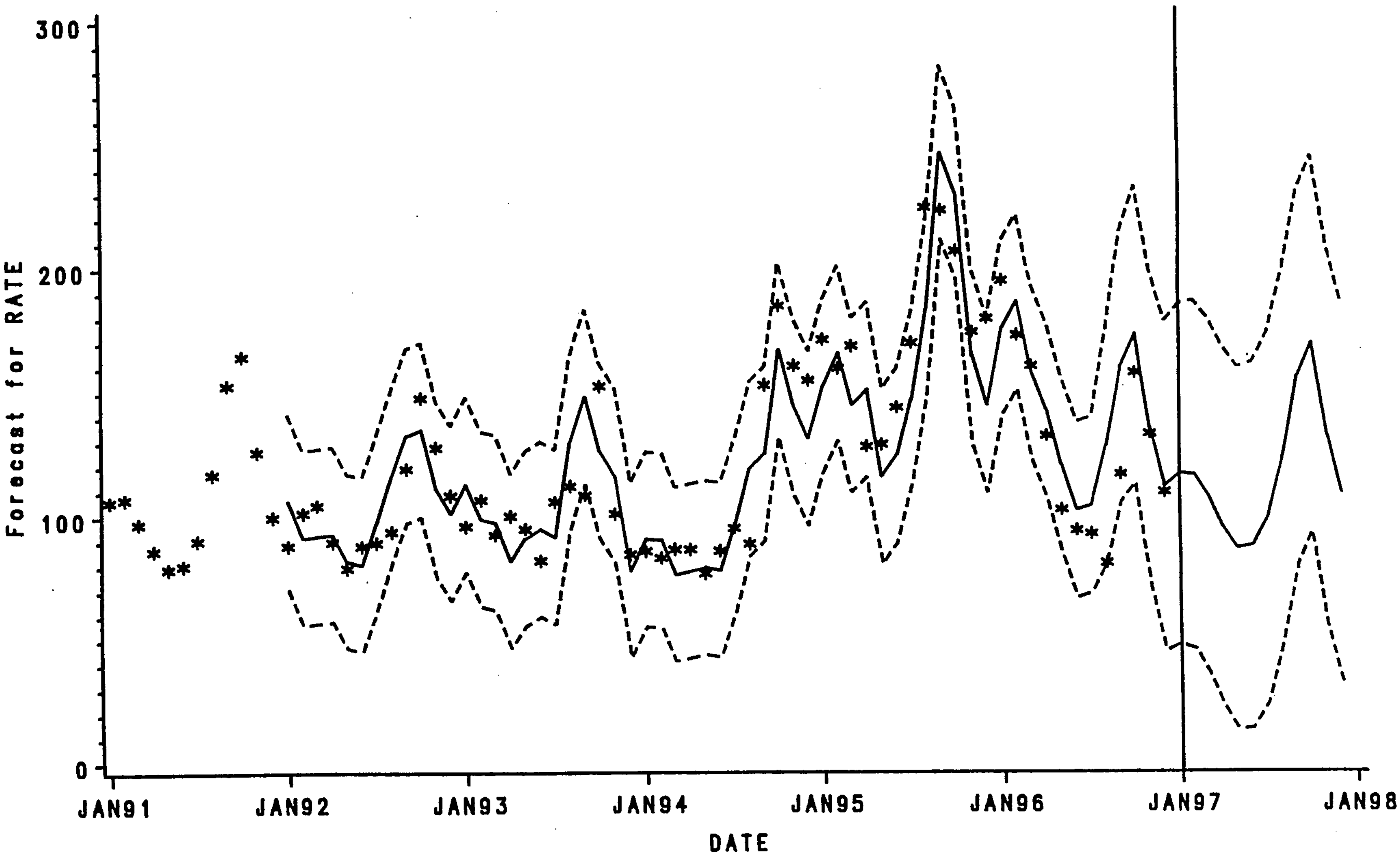

Figure 3.7 – Forecast Function for Barge Transportation (Box-Jenkins Model)

ii) Rail Transportation

The difference between the historical data for barge and rail was that the rail data was smoother with less fluctuations and a trend line. Thus, a large number of potential models could be used. After trying out Box-Jenkins which resulted in two possible solutions, autoregressive analysis, decomposition, moving and weighted moving average models, and regression analysis with ARIMA errors were analyzed, this last model resulted in the most accurate forecast values.

Regression Analysis with ARIMA Errors:

This model is very similar to the Box-Jenkins model explained above. The determination of p and q values also apply for this model but in a slightly different way than for the Box-Jenkins model. In this case, in order to find the p and q values, the procedure is to look at the graphs of autocorrelation and partial autocorrelation of the residuals instead of the data set itself and compare these graphs to theoretical graphs where p and q are known and pick the appropriate values for the data set [63]. The residuals could be explained as:

$$\text{residual} = \text{observed data} - \text{predicted data} \qquad \textit{(equation 7)}$$

This means that a graph of the actual data and the predicted data for the same periods are plotted and the residuals are equal to the difference between the actual data and the predicted data points. The predicted data(trend) are plotted according to the equation:

$$Y(t) = a + b(1/t) \qquad \textit{(equation 8)}$$

where:

$Y(t)$ = trend value

a = intercept

b = slope

1/t = 1/time

This equation was used after the classical linear and quadratic approaches did not produce satisfying results. The resultant forecasts are equal to these forecasted values plus the error term which is what is being modeled with p and q.

Like the Box-Jenkins analysis, various values for p and q were tried to achieve the most accurate forecast. The criteria for selecting the most accurate forecast are shown below in order of importance:

- Are the moving average (MA), autoregressive (AR), and the regression term estimates significant? Check the T-Ratios and reject the ones for which the T-Ratios are smaller than 2 or 3.
- Of the remainders, check the variance estimate, the standard error estimate, the AIC (Akaike's Information Criterion), and the SBC (Schwartz's Information Criterion)
- If there is still more than one model, compare the forecasts to the actual values and pick a single model.

For our project, the most accurate forecasts was achieved when p was equal to one, and q was equal one, three, and twelve. This means that the error term is not dependent on the difference of the actual rate of this month and the actual rate twelve months ago. The q values state that the error is dependent on the random error from one, three, and twelve months ago. The resultant formula is as follows:

$$(1-B^{12})Z_t = 1.93221913 + (-25.4063)\frac{1}{\text{TIME}} + (1+0.3658813+0.28447B^3-0.23307B^{12})a_t$$

(equation 9)

where:

Z_t = rate

B = backward operator constant

a_t = is the random noise at time t

The forecasted values for the upcoming year of 1997 according to this analysis is listed in the next chapter. Figure 3.8 shows the forecast function developed, and the plot of the predicted future rates and confidence intervals accompanying them. The software program used and the output of the program including the forecasted values are listed in Appendix B.

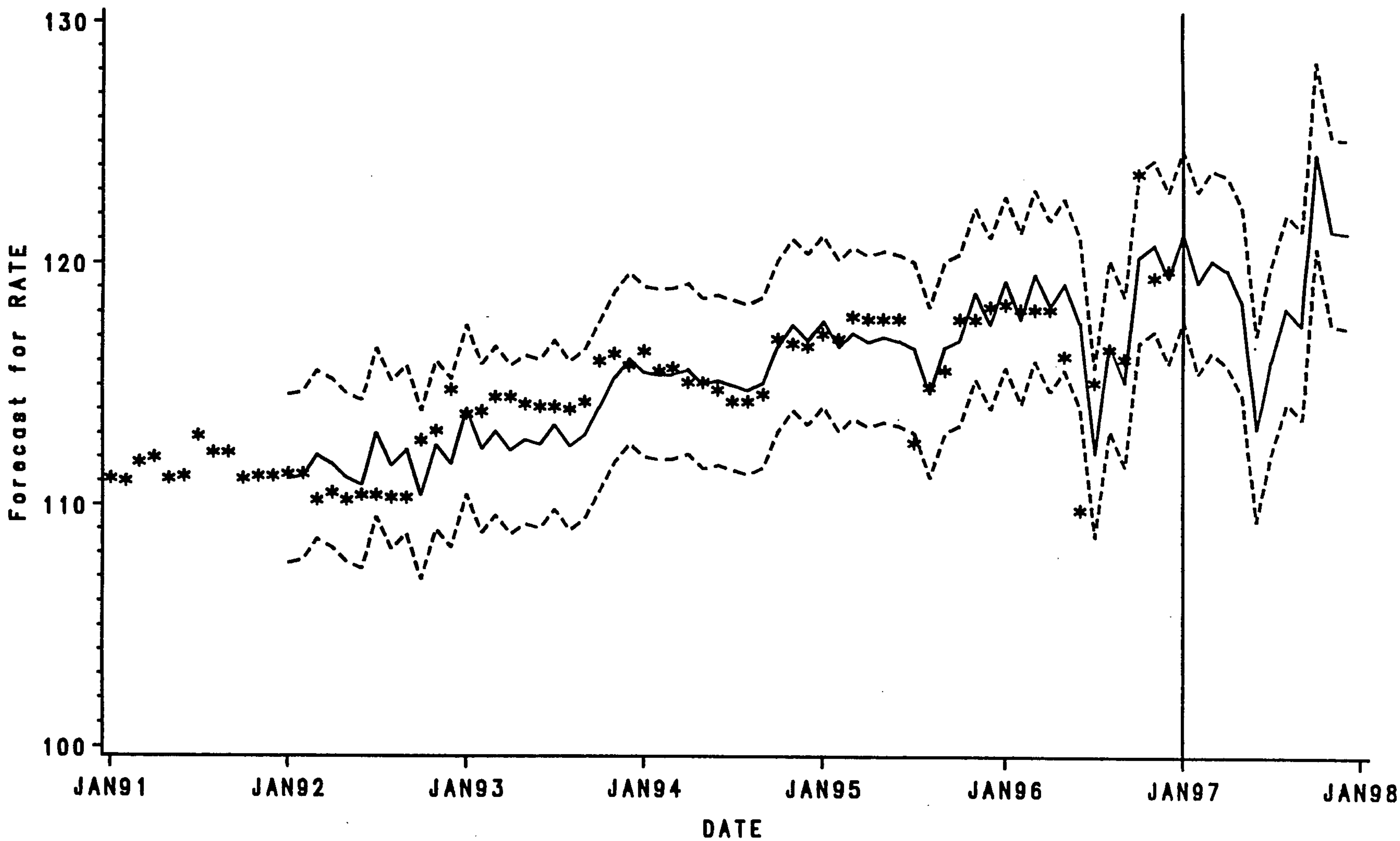

Figure 3.8 – Forecast Function for Rail Transportation (Regression Analysis with ARIMA Errors)

IV. RESULTS

According to the forecasting analysis conducted, the models yielded the following results.

Month	Forecast
January	116.40
February	115.85
March	107.54
April	94.97
May	86.27
June	87.55
July	98.51
August	122.53
September	155.10
October	168.55
November	131.08
December	108.54

Table 4.1 – 1997 Forecasted Index Values for Barge Transportation

Month	Forecast
January	121.18
February	119.22
March	120.10
April	119.73
May	118.49
June	113.22
July	116.03
August	118.15
September	117.49
October	124.52
November	121.34
December	121.26

Table 4.2 – 1997 Forecasted Index Values for Rail Transportation

The forecasted values above are for index values when the reference period equals 100. Movements of price indexes from one month to another are usually expressed as percent change rather than as changes in index points because index point changes are affected by the level of the index in relation to its base period, while percent changes are not. Therefore, what is relevant for the project is the index percent change from the reference period. This is calculated by:

$$\text{Index Point Change} = \text{Finished Goods Price Index} - \text{Previous Index} \qquad \textit{(equation 10)}$$

$$\text{Index Percent Change} = \frac{\text{Index Point Change}}{\text{Previous Index}} \times 100 \qquad \textit{(equation 11)}$$

These formulas lead to the index point and percentage changes listed in tables 4.3 and 4.4.

	I. Point Ch.	I. % Ch.
Jan	7.4	6.79
Feb	-0.55	-0.47
Mar	-8.31	-7.17
Apr	-12.57	-11.69
May	-8.7	-9.16
Jun	1.28	1.48
Jul	10.96	12.52
Aug	24.02	24.38
Sep	32.57	26.58
Oct	13.45	8.67
Nov	-37.47	-22.23
Dec	-22.54	-17.19

Table 4.3 – Index % Change for Barge

	I. Point Ch.	I. % Ch.
Jan	1.48	1.24
Feb	-1.97	-1.62
Mar	0.89	0.74
Apr	-0.37	-0.31
May	-1.25	-1.04
Jun	-5.27	-4.45
Jul	2.81	2.49
Aug	2.12	1.82
Sep	-0.66	-0.55
Oct	7.03	5.98
Nov	-3.18	-2.56
Dec	-0.08	-0.06

Table 4.4 – Index % Change for Rail

The index percentage changes have a specific interpretation. An index percentage increase of x means that prices are x percent higher than the reference period. For example, an increase of 5.5 percent from the reference period of a finished good could be expressed as "prices received by domestic producers of a systematic sample of finished goods have risen from $100 in 1982 to $105.50 today".[73]

In this analysis, the reference period for barge transportation is December 1990 and the base price for that period by the Merchants Exchange of St. Louis is 12.59 cents per bushel. This leads to future costs as shown in Table 4.5:

Months	Index % Change	Elevation Cost (cents)
Jan	6.79	13.44
Feb	-0.47	12.53
Mar	-7.17	11.69
Apr	-11.69	11.12
May	-9.16	11.44
Jun	1.48	12.78
Jul	12.52	14.17
Aug	24.38	15.66
Sep	26.58	15.94
Oct	8.67	13.68
Nov	-22.23	9.79
Dec	-17.20	10.43

Table 4.5 – Elevation Costs for Barge

Similarly, the reference year for rail transportation is December 1984 and the reference cost is considered to be 32.87 cents per bushel. Accordingly, the forecasted costs are as shown in Table 4.6:

Months	Index % Change	Elevation Cost (cents)
Jan	1.24	33.28
Feb	-1.62	32.34
Mar	0.74	33.11
Apr	-0.31	32.77
May	-1.04	32.53
Jun	-4.45	31.41
Jul	2.49	33.69
Aug	1.82	33.47
Sep	-0.55	32.69
Oct	5.98	34.84
Nov	-2.56	32.03
Dec	-0.06	32.85

Table 4.6 – Elevation Costs for Rail

It is possible to look at the actual values for 1997 from the Producer Price Index and compare the forcasted values to the actual values. Table 4.7 lists these PPI values that were available for 1997 as of December of 1997 and the MAD (Mean Absolute Deviation) and MSE (Mean Square Error) terms to show the accuracy of the forecasts.

	Rail(Actual)	Rail(Forecast)	Barge(Actual)	Barge(Forecast)
January	117.30	121.18	131.80	116.4
February	117.30	119.22	107.60	115.85
March	116.00	120.10	119.70	107.54
April	117.60	119.73	94.70	94.97
May	117.30	118.49	82.50	86.27
June	119.60	113.22	88.80	87.55
July	120.20	116.03	87.00	98.51
August	122.00	118.15	93.90	122.53
September		117.49		155.10
October		124.52		168.55
November		121.34		131.08
December		121.26		108.54
MAD		3.45		10.16
MSE		14.30		177.64

Table 4.7 – Actual Values vs. Forecasted Values

MAD (Mean Absolute Deviation) is a common measure of forecast error. It is the mean of the errors made by the forecast model over a series of time periods, without regard to whether an error was an overestimate or an underestimate [22]. Similarly, the MSE (Mean Square Error) can also be used as a measure of forecast error. It is found by squaring each of a series of errors made by the forecast model, summing these squared errors, and dividing them by the number of errors used in the calculation [22]. MAD and MSE are calculated by [22]:

$$\text{MAD} = \frac{\sum_{t=1}^{N} |At - Ft|}{n}$$

and

$$\text{MSE} = \frac{\sum_{t=1}^{n} (At - Ft)^2}{n}$$

where:

At = actual demand in period t

Ft = forecast demand in period t

n = number of periods being used

A software tool has been designed as part of this research. The tool is described in more detail in the chapter that follows.

V. SOFTWARE ANALYSIS

A goal of this study was to develop a software tool which utilizes the developed cost model in determining the barge and rail cost of transporting corn and feed grains. This software allows the user to determine the total cost of transporting a commodity via barge. Microsoft Access Database was used to develop a user-friendly, easy to understand and execute program. This program takes into account the total transportation cost formula introduced in Chapter 3. The formula is shown below:

$$TTC = AC + EC + SC \qquad \textit{(equation 5)}$$

where:

TTC = Total Transportation Cost

AC = Assembly Cost

EC = Elevation Cost

SC = Shipment Cost

The program queries the user to input variables which include the assembly and shipment costs per unit (bushels) as well as the amount to be transported and the month of transportation. A flow chart of the program is presented in Figure 5.1.

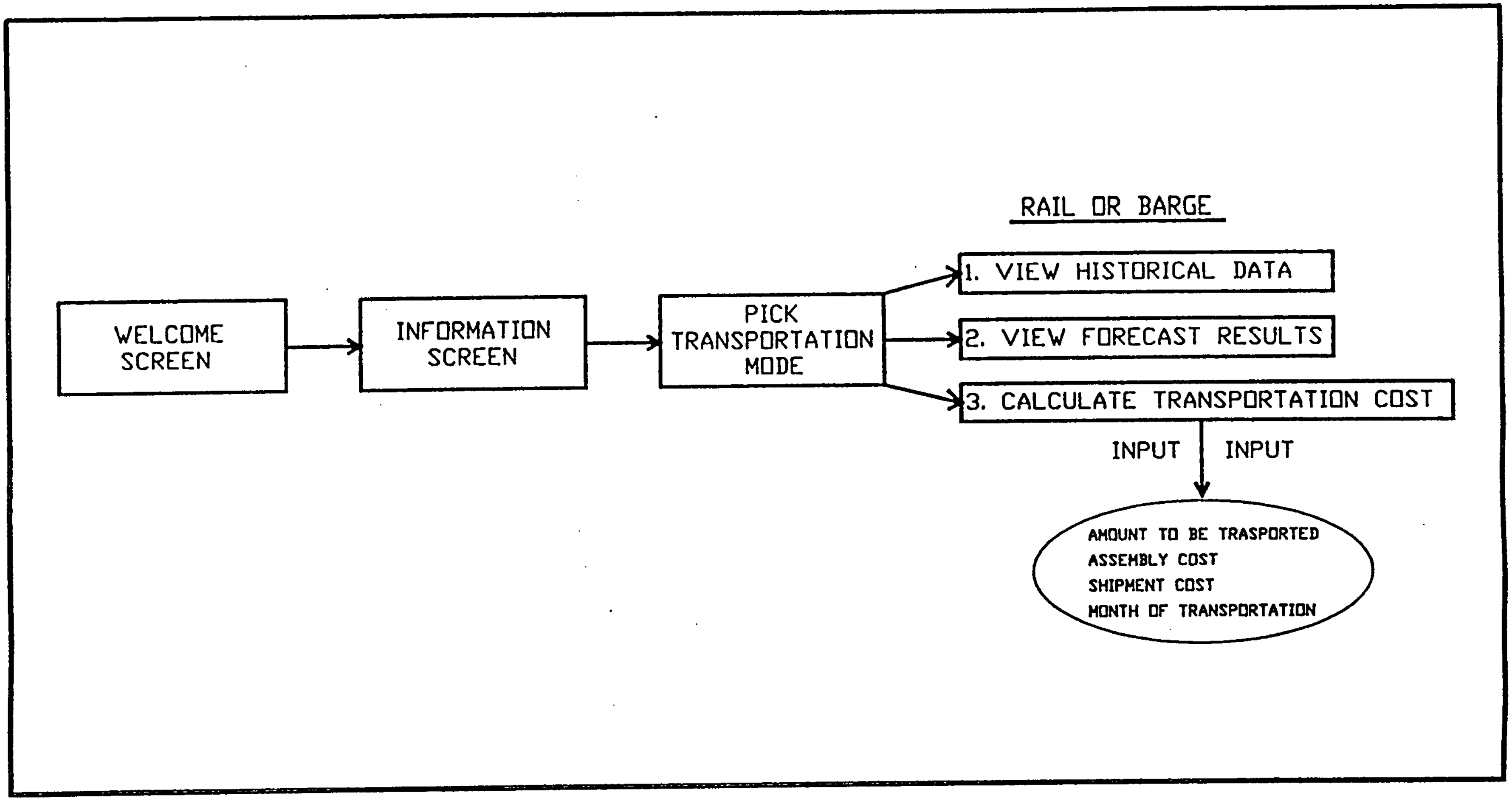

Figure 5.1 – Computer Software Flow Chart

A. Program Development

This software named BARRAIL was created by designing three entities in Microsoft Access: tables, forms, and macros. Tables store data, much like a Microsoft Excel table. Forms can display the data in these tables, as well as store data in tables, open other forms, and accept user inputs. A macro is a set of one or more actions.

The tables in BARRAIL include the historical rates gathered from the Producer Price Indexes (PPI) for barge and rail transportation, and the forecasted rates for 1997. A large number of macros are used to activate command buttons such as: proceed to next form, print a report, or pick a transportation mode. The forms and their functions are explained in the next section. The tables, forms, and macros developed in BARRAIL are shown as they appear in Microsoft Access database screens in Figures 5.2, 5.3, and 5.4.

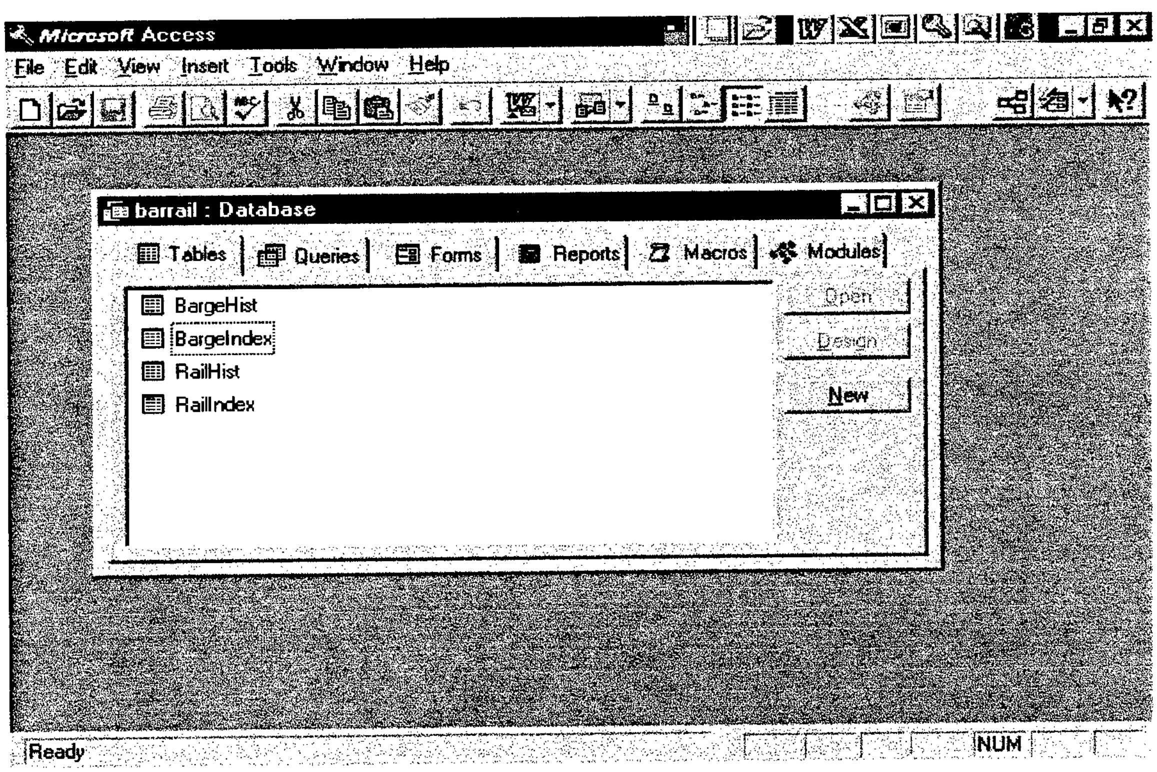

Figure 5.2 - Tables for "BARRAIL"

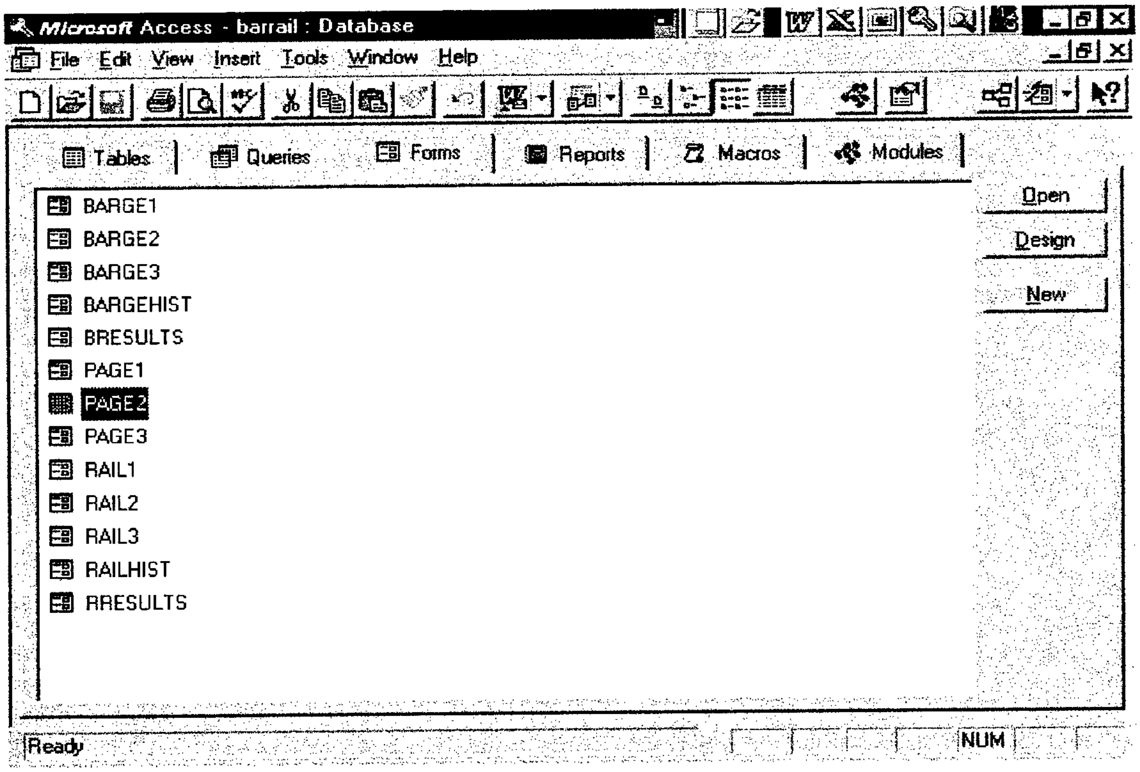

Figure 5.3 - Forms for "BARRAIL"

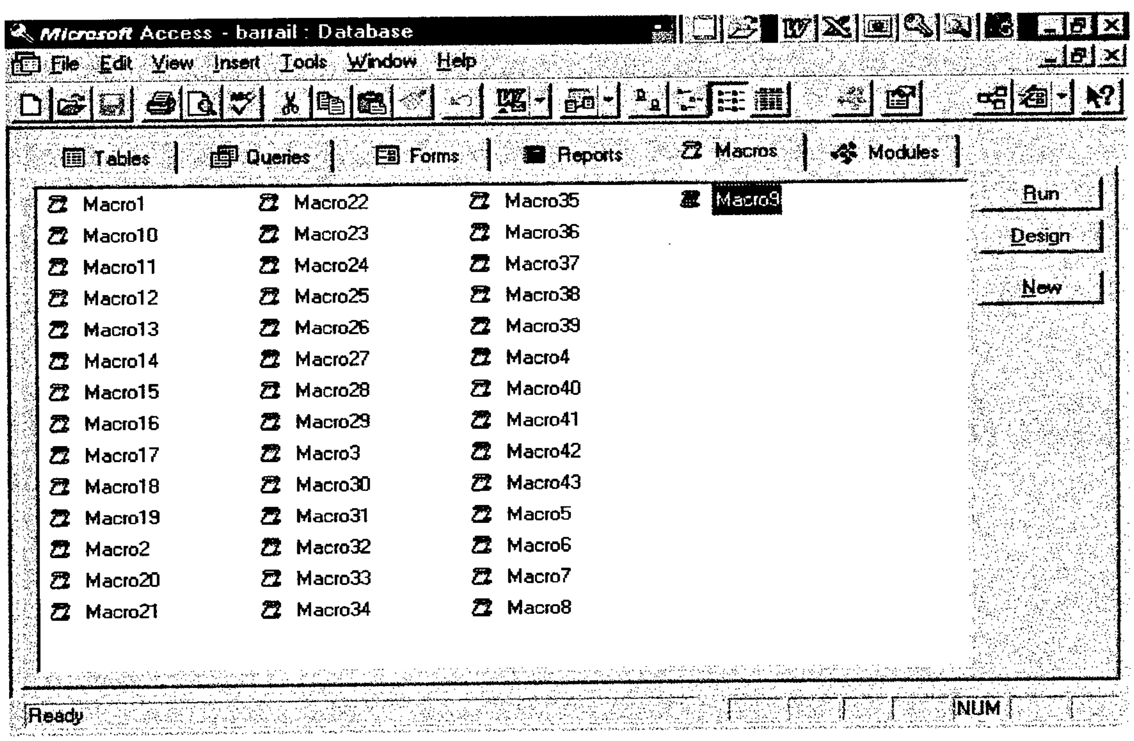

Figure 5.4 - Macros for "BARRAIL"

B. Program Execution

The program is started by opening form "PAGE 1"of the database BARRAIL. This is the first screen of the program that shows the program name, the name of the developer, and a "PROCEED" command button. This screen is presented in Figure 5.5. The "PROCEED" button enables the user to move to the next screen which is shown in Figure 5.6 The screen provides information regarding the programs function and "Go Back" and "NEXT" command buttons.

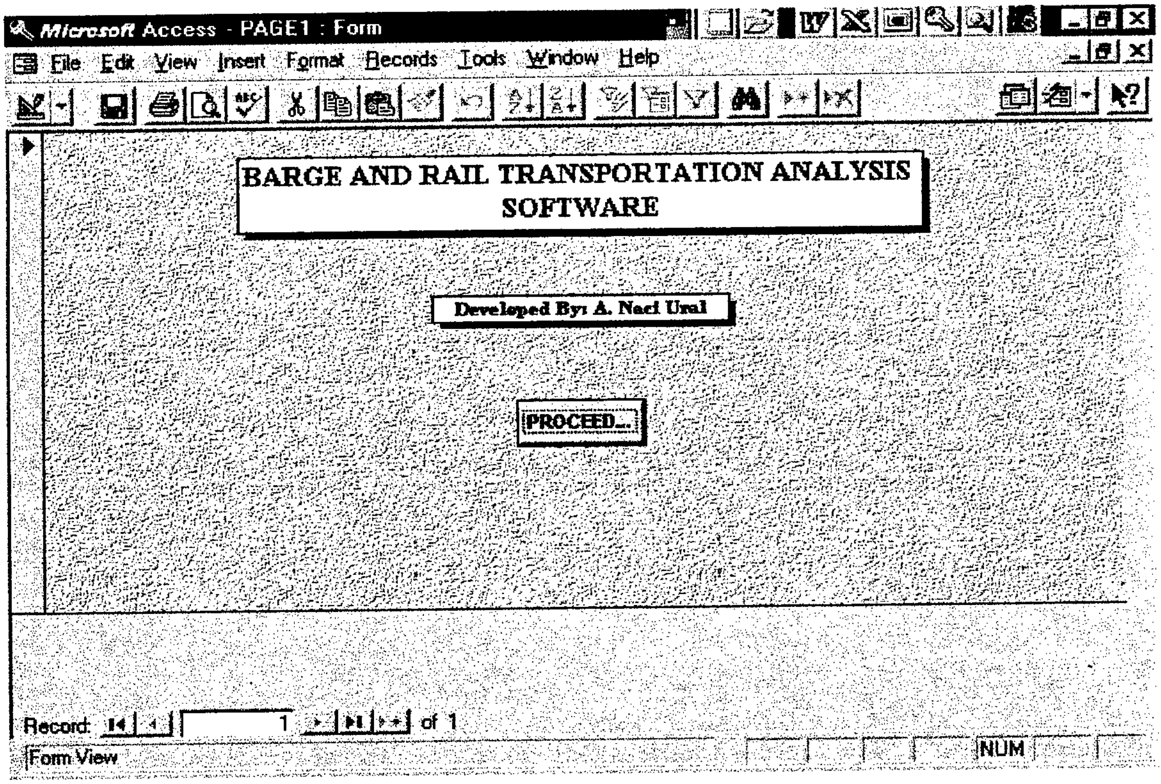

Figure 5.5 - Screen # 1

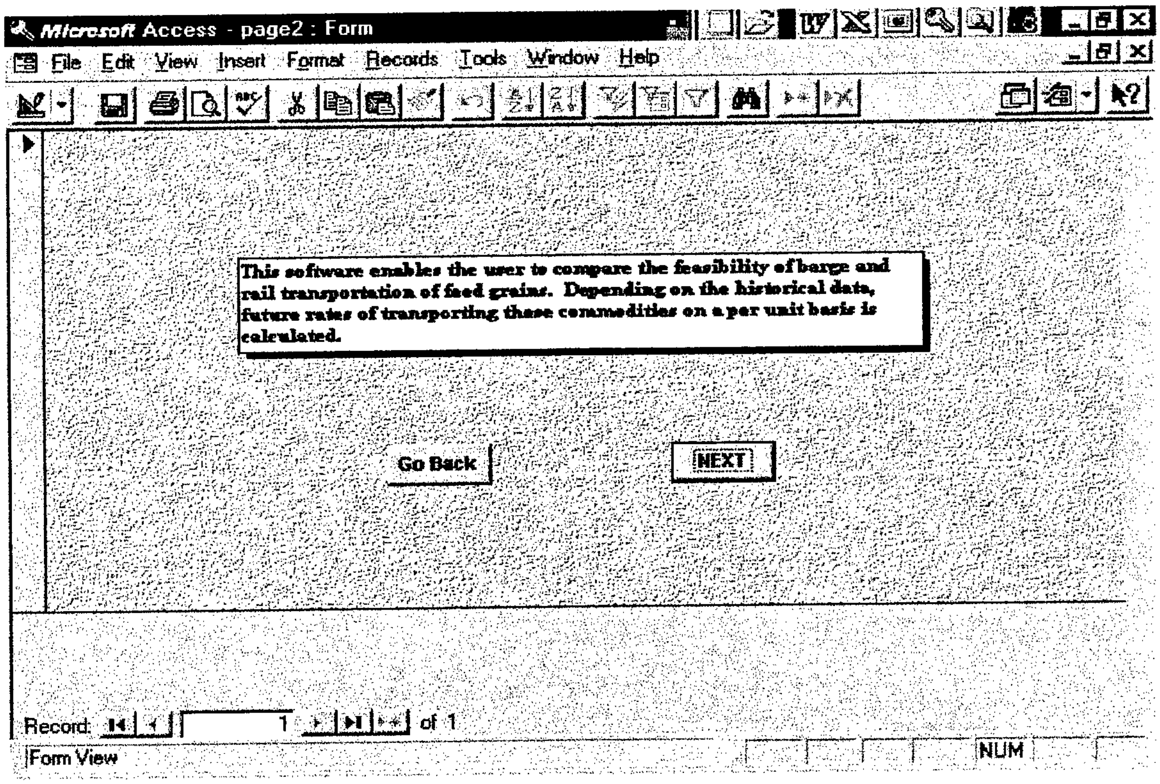

Figure 5.6 - Screen # 2

Clicking on the "NEXT" button allows the user to advance to the third screen. The third screen queries the user to select rail or barge transportation for analysis. This screen is shown in Figure 5.7.

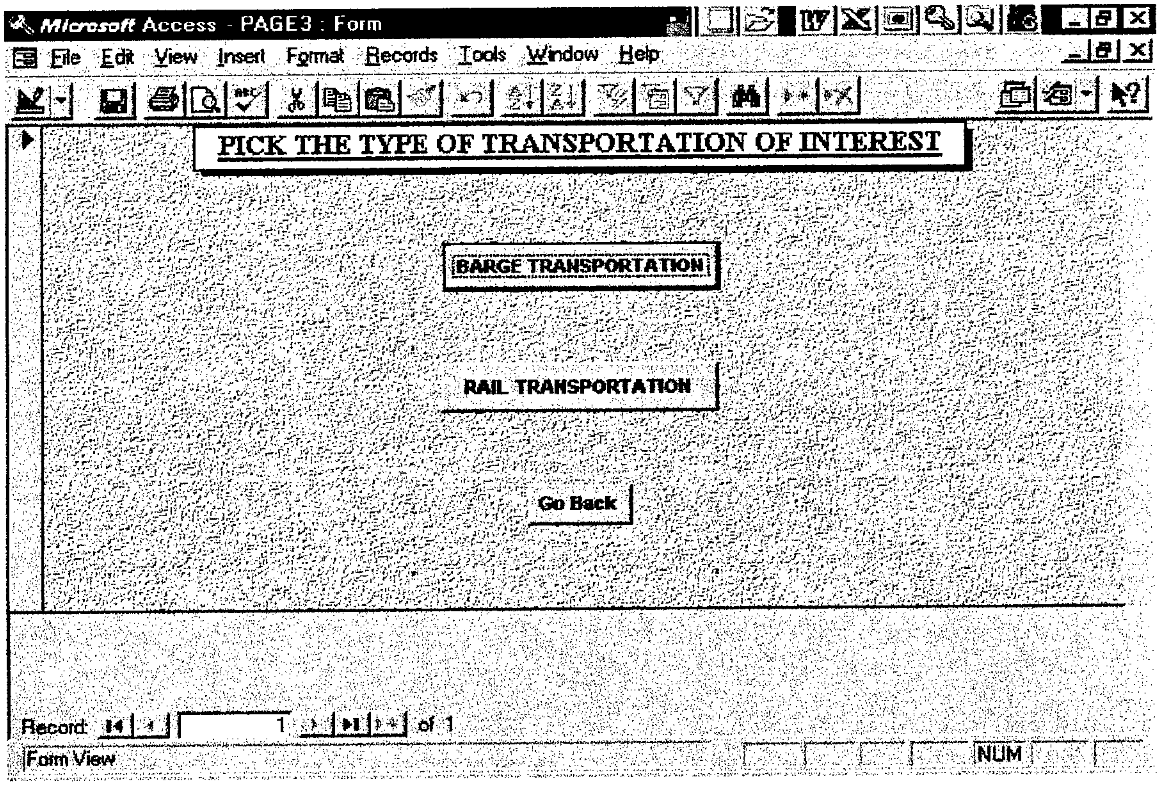

Figure 5.7 - Screen #3

From this point on, all the screens are identical for both modes of transportation. Therefore, if the user were to select rail transportation, the next screen will query the user to pick one of three options. These options are: 1) view the historical data relating to rail transportation, 2) view the forecasted values for 1997, and 3) calculate the total transportation cost for rail transportation. If the user selects barge transportation, the same aforementioned options would be presented. This screen is presented in Figure 5.8.

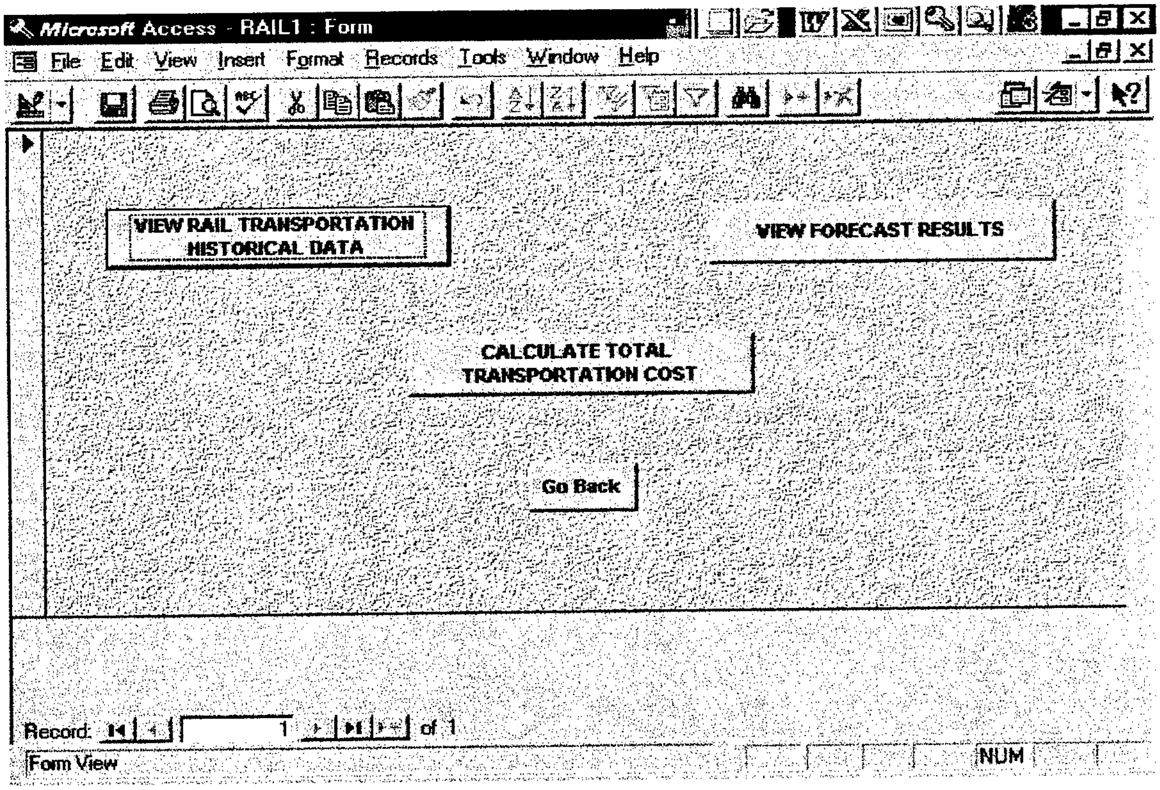

Figure 5.8 - Screen #4

If the user clicks on "VIEW RAIL TRANSPORTATION HISTORICAL DATA" button, the screen in Figure 5.9 is shown. The data presented on this screen includes a list of years, months, and the corresponding Producer Price Index values for rail transportation.

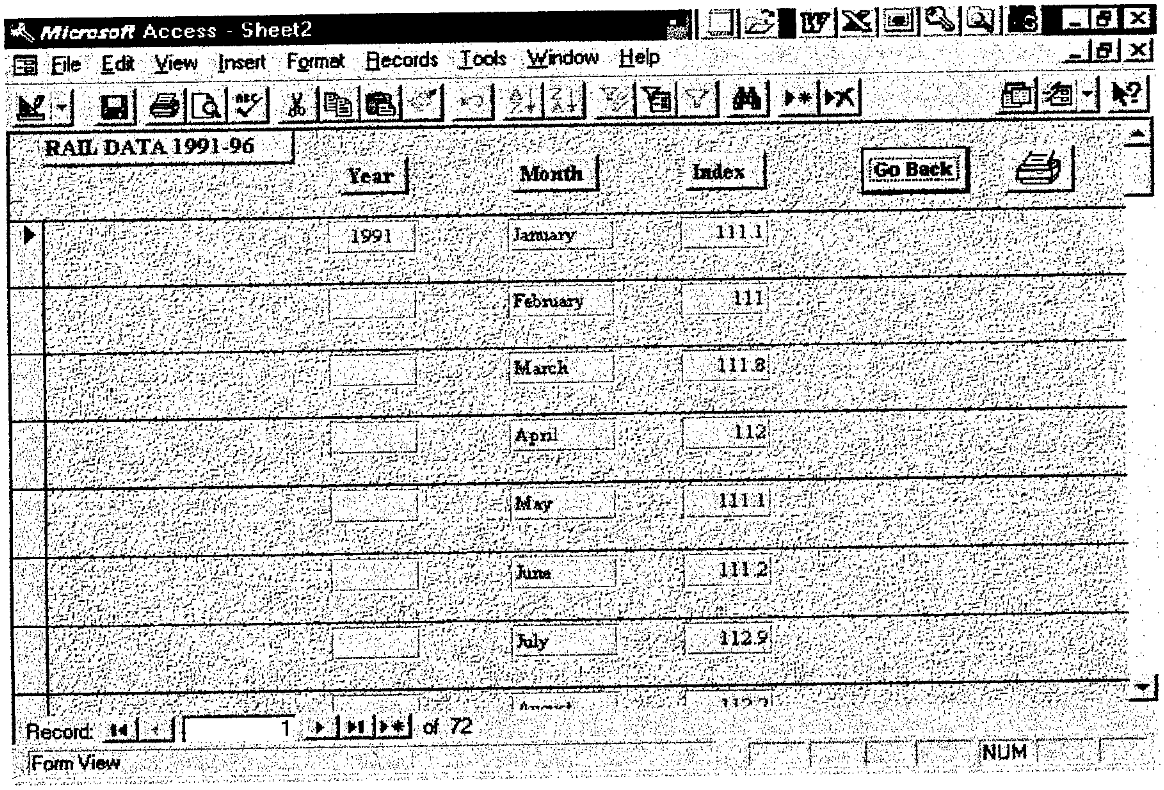

Figure 5.9 - Screen #5

If the user chooses "VIEW FORECAST RESULTS", the screen in Figure 5.10 is presented. This screen shows the 1997 index values and the resulting cents/bushel costs for rail transportation.

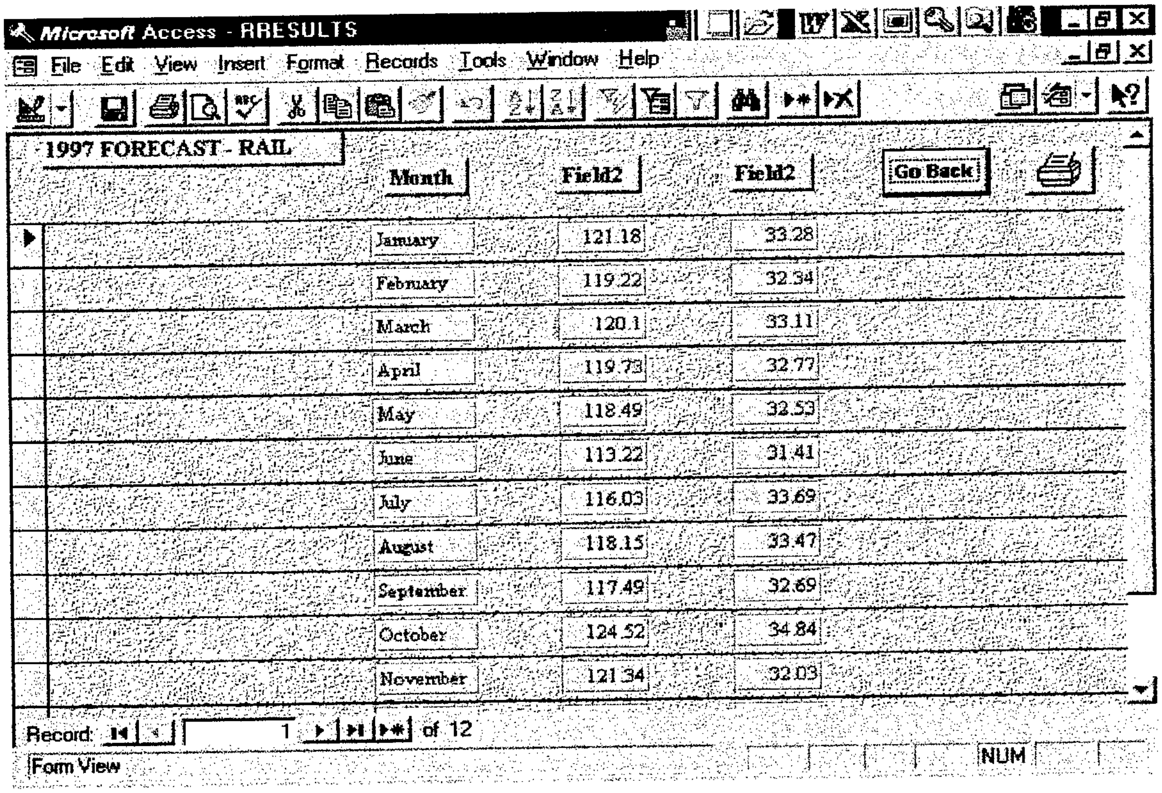

Figure 5.10 - Screen #6

If the user selects "CALCULATE TOTAL TRANSPORTATION COST" the screen in Figure 5.11 is presented. The user is required to input the amount of goods to be transported (bushels), the assembly and shipment costs (see Ch. 3), and the month in 1997 that transportation is to take place. The results are presented to the user by clicking on the "DONE!!!" command button.

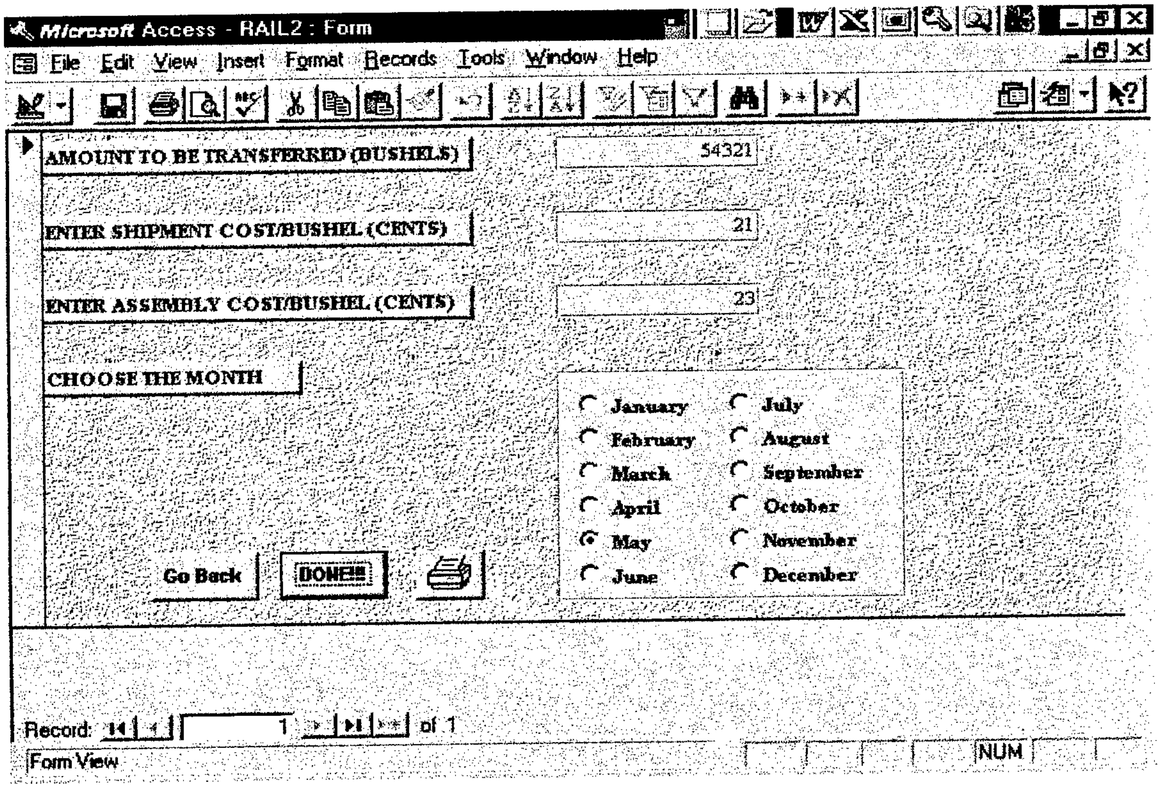

Figure 5.11 - Screen #7

The final screen (Figure 5.12) displays the total transportation cost. The "Go Back" command button allows the user to go back to the previous screens in order to select another type of transportation or to input different values for the same mode.

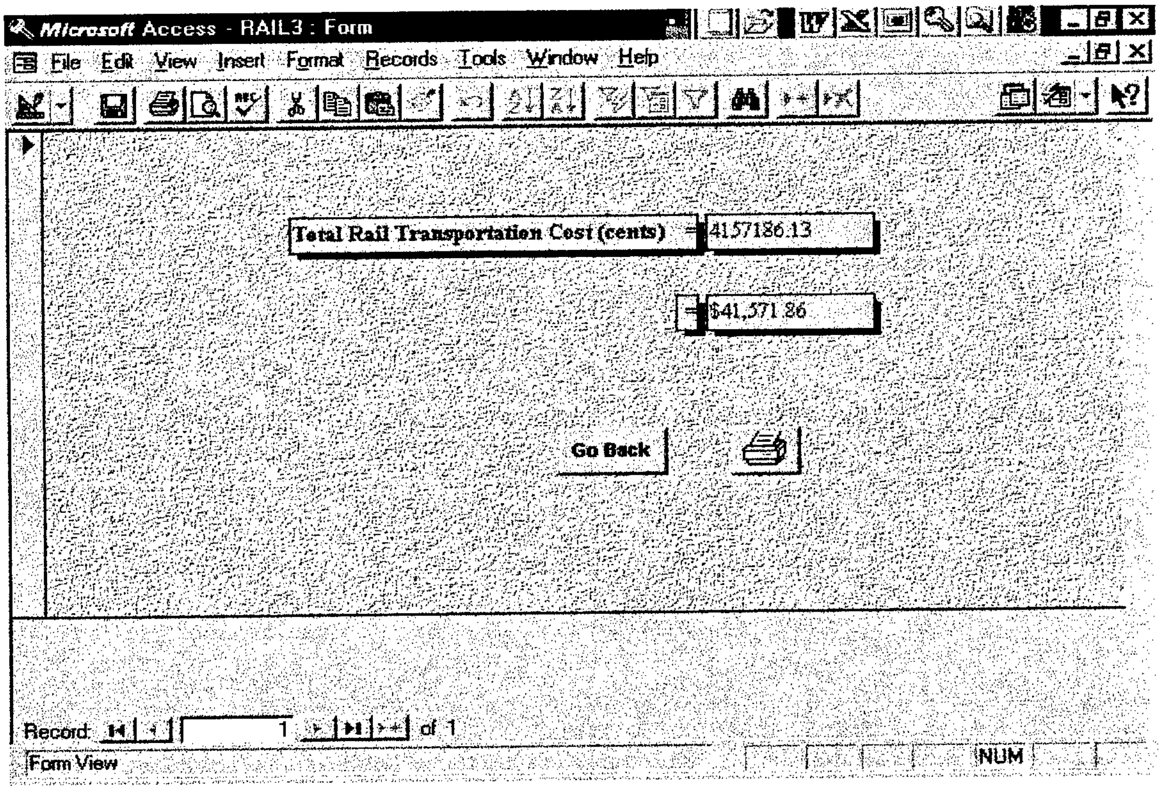

Figure 5.12 - Screen #8

VI. CONCLUSIONS AND RECOMMENDATIONS

The main objective of this research project was to compare the financial costs of transporting bulk materials via barge and rail. It involved gathering historical rate data for rail and barge transportation, and making future rate predictions based on this historical data. Historical rates for both modes of transportation, especially barge, was difficult to obtain and/or was very expensive considering the project budget.

A significant outcome of this project was the developed forecasting models and the resulting forecasted rates for rail and barge transportation. The results clearly show that barge rates are much cheaper than rail rates. Barge transportation has many disadvantages such as: slow delivery times, dependency on river and weather conditions, and rate fluctuations based on import/export activities. But it can provide shippers with very competitive rates. Therefore, barge transportation can be a very good alternative for industries that can adjust to some of its inherent problems.

The developed computer model provides the user with historical rates for rail and barge transportation. The project represents a good first run at estimating the future costs of transporting any commodity.

A recommendation for further research would be to expand the historical data in the forecast models. This project includes data from 1991 - 1996. The accuracy of any analysis increases as more data points are included in the analysis. Therefore, more historical data will guarantee a more accurate model.

Further research could allow the user to input index values from the PPI as they become available, execute the SAS programs, and therefore continuously forecast The software would need to update the model as new data points were added.

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APPENDIX A

BARGE TRANSPORTATION FORECASTING ANALYSIS

BOX-JENKINS MODEL

SAS PROGRAM

```
OPTIONS NOCENTER LS=80 NODATE NONUMBER NOSTIMER FORMDLIM=' ';

DATA BARGE;
INPUT RATE;
DATE = INTNX( 'month', '1dec1990'd, _n_);
FORMAT DATE MONYY.;
*INTER= DATE >= '1dec1994'd;
CARDS;
106.4
107.5
97.6
86.7
79.3
80.6
90.7
117.3
153.3
165
126.3
100.1
88.5
101.7
104.8
90
79.6
88.3
89.6
94.1
119.4
```

148
127.9
108.6
96.2
106.8
92.7
100.3
95
82.3
106
112.3
108.7
152.5
101.1
84.7
85.9
83.3
86.7
86.6
77
86
95.1
88.7
152.6
184.5
160.3
154.4
170.8
159.2
168.1
127.7
128.4
143.3

```
169.3
223.8
222.7
206.2
173.6
179.1
194.3
172.3
159.8
131.7
102.1
93.7
92.3
80.7
116.2
157
132.4
109
;
PROC ARIMA;
 I VAR=RATE(12);
 E P=(1) Q=(12) NOINT;
 F LEAD=18 BACK=6 OUT=NEW;
TITLE1 'ARIMA MODEL DIFFERENCED AT 12 P=1, Q=(12) NOINT';
RUN;
```

SAS OUTPUT

```
ARIMA MODEL DIFFERENCED AT 12 P=1, Q=(12) NOINT
ARIMA Procedure

Name of variable = RATE.

Period(s) of Differencing = 12.
Mean of working series =     3.845
Standard deviation     = 45.71045
Number of observations =        60
NOTE: The first 12 observations were eliminated by differencing.

Autocorrelations

Lag Covariance Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  0   2089.445    1.00000  |                    |********************|
  1   1719.686    0.82303  |               .    |****************    |
  2   1403.884    0.67189  |            .       |*************       |
  3   1201.654    0.57511  |           .        |************        |
  4    945.502    0.45251  |          .         |*********.          |
  5    744.930    0.35652  |          .         |*******   .         |
  6    561.377    0.26867  |          .         |*****     .         |
  7    317.227    0.15182  |          .         |***       .         |
  8    184.207    0.08816  |          .         |**        .         |
  9 -20.200929   -0.00967  |          .         |          .         |
 10   -283.121   -0.13550  |          .      ***|          .         |
 11   -498.867   -0.23876  |          .    *****|          .         |
 12   -808.413   -0.38690  |          . ********|          .         |
 13   -781.143   -0.37385  |         .   *******|           .        |
 14   -697.187   -0.33367  |         .   *******|           .        |
 15   -764.403   -0.36584  |         .   *******|           .        |
                            "." marks two standard errors
```

ARIMA MODEL DIFFERENCED AT 12 P=1, Q=(12) NOINT
ARIMA Procedure

Inverse Autocorrelations

```
Lag Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  1   -0.59263   |        ************|    .               |
  2    0.15279   |               .    |*** .               |
  3   -0.03249   |               .   *|    .               |
  4   -0.12445   |               .  **|    .               |
  5    0.23225   |               .    |*****               |
  6   -0.23759   |               *****|    .               |
  7    0.18147   |               .    |****.               |
  8   -0.04927   |               .   *|    .               |
  9   -0.11213   |               .  **|    .               |
 10    0.17763   |               .    |****.               |
 11   -0.29195   |              ******|    .               |
 12    0.36503   |               .    |*******             |
 13   -0.14141   |               . ***|    .               |
 14   -0.04801   |               .   *|    .               |
 15    0.03651   |               .    |*   .               |
```

Partial Autocorrelations

```
Lag Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  1     0.82303  |              .    |****************   |
  2    -0.01703  |              .    |   .               |
  3     0.08283  |              .    |** .               |
  4    -0.12437  |              .  **|   .               |
  5     0.01564  |              .    |   .               |
  6    -0.05782  |              .   *|   .               |
  7    -0.13448  |              . ***|   .               |
  8     0.06115  |              .    |*  .               |
  9    -0.18525  |              .****|   .               |
 10    -0.14490  |              . ***|   .               |
 11    -0.12419  |              .  **|   .               |
 12    -0.28795  |             ******|   .               |
 13     0.38711  |              .    |********           |
 14    -0.04725  |              .   *|   .               |
 15    -0.09345  |              .  **|   .               |
```

Autocorrelation Check for White Noise

To Lag	Chi Square	DF	Prob	Autocorrelations					
6	120.42	6	0.000	0.823	0.672	0.575	0.453	0.357	0.269
12	139.90	12	0.000	0.152	0.088	-0.010	-0.136	-0.239	-0.387

ARIMA MODEL DIFFERENCED AT 12 P=1, Q=(12) NOINT
ARIMA Procedure

Conditional Least Squares Estimation

Parameter	Estimate	Approx. Std Error	T Ratio	Lag
MA1,1	0.94152	0.09944	9.47	12
AR1,1	0.88535	0.06125	14.45	1

Variance Estimate = 321.724282
Std Error Estimate = 17.9366742
AIC = 518.660226*
SBC = 522.848915*
Number of Residuals= 60
* Does not include log determinant.

Correlations of the Estimates

Parameter	MA1,1	AR1,1
MA1,1	1.000	0.079
AR1,1	0.079	1.000

Autocorrelation Check of Residuals

To Lag	Chi Square	DF	Prob	Autocorrelations					
6	4.09	4	0.395	0.072	-0.118	-0.014	-0.097	0.130	0.126
12	7.05	10	0.720	-0.047	0.099	-0.029	-0.031	0.112	-0.116
18	12.27	16	0.725	-0.086	0.115	-0.011	-0.075	0.018	-0.186
24	15.36	22	0.846	-0.009	0.024	-0.118	0.022	-0.093	0.087

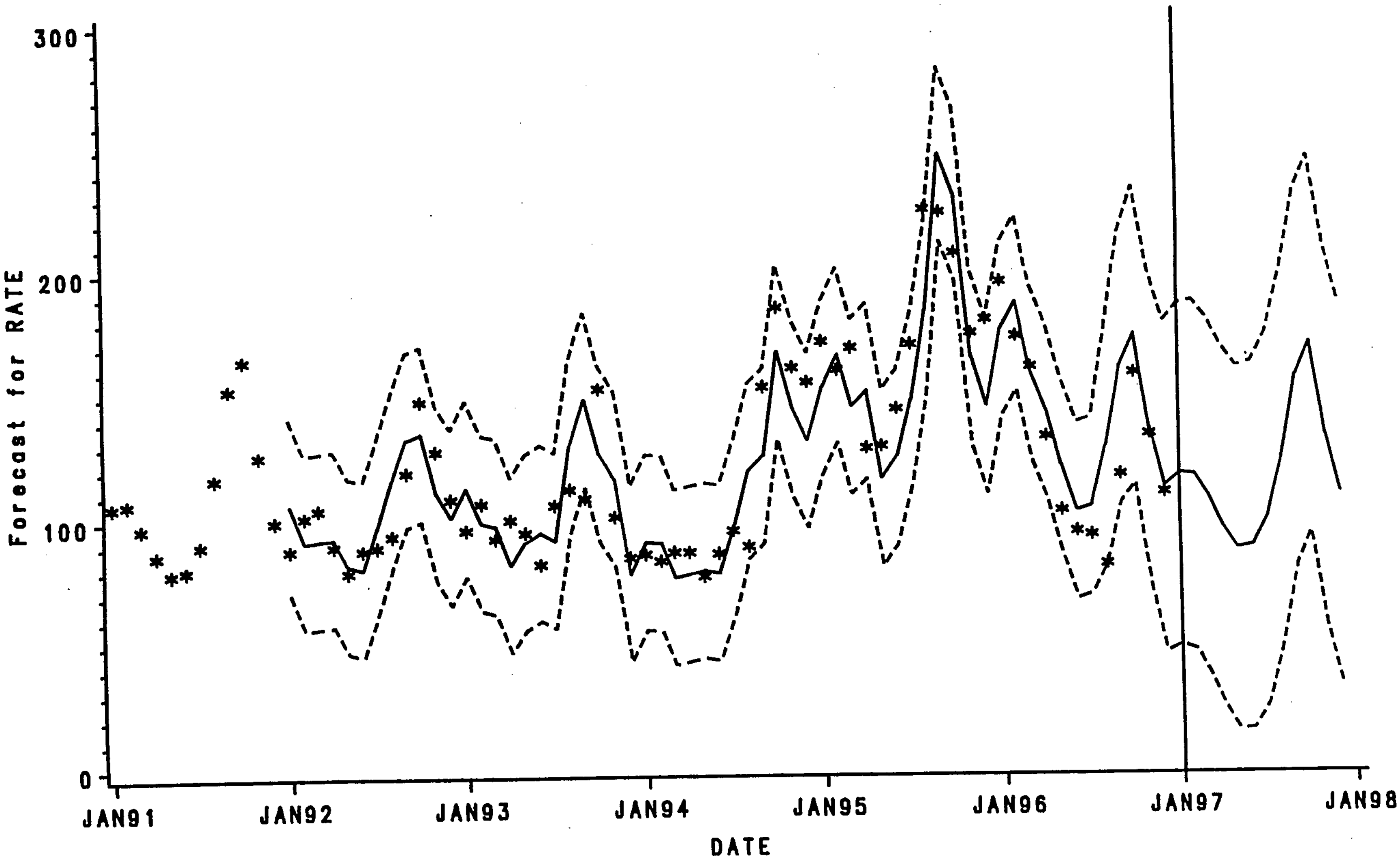
```
Model for variable RATE

No mean term in this model.
Period(s) of Differencing = 12.

Autoregressive Factors
Factor 1: 1 - 0.88535 B**(1)


Moving Average Factors
Factor 1: 1 - 0.94152 B**(12)
```

ARIMA MODEL DIFFERENCED AT 12 P=1, Q=(12) NOINT

ARIMA Procedure

Forecasts for variable RATE

Obs	Forecast	Std Error	Lower 95%	Upper 95%	Actual	Residual
67	103.9560	17.9367	68.8007	139.1112	92.3000	-11.6560
68	127.3593	23.9563	80.4058	174.3128	80.7000	-46.6593
69	159.3714	27.7772	104.9292	213.8137	116.2000	-43.1714
70	172.3334	30.4386	112.6748	231.9920	157.0000	-15.3334
71	134.4271	32.3722	70.9788	197.8753	132.4000	-2.0271
72	111.5025	33.8105	45.2351	177.7699	109.0000	-2.5025
73	116.4006	34.8965	48.0046	184.7966		
74	115.8544	35.7247	45.8352	185.8736		
75	107.5440	36.3607	36.2784	178.8097		
76	94.9652	36.8515	22.7375	167.1929		
77	86.2694	37.2318	13.2965	159.2423		
78	87.5464	37.5271	13.9946	161.0981		
79	98.5079	37.8869	24.2510	172.7648		
80	122.5358	38.1665	47.7309	197.3408		
81	155.1010	38.3843	79.8692	230.3328		
82	168.5526	38.5541	92.9879	244.1173		
83	131.0798	38.6867	55.2552	206.9043		
84	108.5390	38.7904	32.5113	184.5667		



Forecast Function for Barge Transportation (Box-Jenkins Model)

MOVING AVERAGE MODEL

	1997 index
Jan	131.80
Feb	107.60
Mar	119.70
Apr	94.70
May	82.50
June	88.80
July	87.00
August	93.90

	1997 FORECAST BY 91-96			
	2 MO	3 MO	5 MO	6 MO
	126.22	134.13	142.52	137.81
	128.01	133.20	141.93	140.86
	127.11	136.72	136.54	140.09
	127.56	134.68	136.47	135.30
	127.34	134.87	139.23	135.02
	127.45	135.42	139.34	137.09
	127.39	134.99	138.70	137.69
	127.42	135.09	138.06	137.68
MAD	27.96	34.14	38.35	36.94
MSE	980.18	1433.12	1714.64	1597.83

	1997 index
Jan	131.80
Feb	107.60
Mar	119.70
Apr	94.70
May	82.50
June	88.80
July	87.00
August	93.90

	1997 FORECAST BY 96			
	2 MO	3 MO	5 MO	6 MO
	114.85	124.73	126.73	118.32
	117.78	122.18	128.84	124.59
	116.31	126.57	123.21	125.98
	117.04	124.49	121.37	120.81
	116.68	124.41	123.84	118.88
	116.86	125.16	124.80	120.53
	116.77	124.69	124.41	121.52
	116.82	124.75	123.52	122.05
MAD	20.97	25.64	25.11	24.21
MSE	533.56	831.07	810.26	688.32

WEIGHTED MOVING AVERAGE MODEL (97 FORECAST BY 91-96)

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	106.4	88.5	96.2	85.9	170.8	194.3	123.68
Feb	107.5	101.7	106.8	83.3	159.2	172.3	121.80
Mar	97.6	104.8	92.7	86.7	168.1	159.8	118.28
Apr	86.7	90	100.3	86.6	127.7	131.7	103.83
May	79.3	79.6	95	77	128.4	102.1	93.57
June	80.6	88.3	82.3	86	143.3	93.7	95.70
July	90.7	89.6	106	95.1	169.3	92.3	107.17
Aug	117.3	94.1	112.3	88.7	223.8	80.7	119.48
Sept	153.3	119.4	108.7	152.6	222.7	116.2	145.48
Oct	165	148	152.5	184.5	206.2	157	168.87
Nov	126.3	127.9	101.1	160.3	173.6	132.4	136.93
Dec	100.1	108.6	84.7	154.4	179.1	109	122.65

1997 FORECAST BY 91-96 (3 MO. MOVING AVG.)

	Index 97'	.1 .1 .8	.1 .2 .7	.1 .3 .6	.1 .4 .5	.1 .5 .4	.1 .6 .3	.1 .7 .2	.1 .8 .1
Jan	131.80	128.92	129.31	129.42	129.25	128.78	128.04	127.00	125.68
Feb	107.60	128.27	128.81	129.39	130.08	130.99	132.18	133.75	135.79
Mar	119.70	128.38	129.04	129.61	130.04	130.23	130.06	129.38	128.00
Apr	94.70	128.42	129.02	129.53	129.98	130.46	131.13	132.20	134.00
May	82.50	128.40	129.01	129.54	130.01	130.40	130.59	130.38	129.38
June	88.80	128.40	129.01	129.54	130.00	130.41	130.86	131.56	132.94
July	87.00	128.40	129.01	129.54	130.00	130.41	130.73	130.80	130.19
Aug	93.90	128.40	129.01	129.54	130.00	130.41	130.79	131.29	132.31
	MAD	28.42	28.90	29.36	29.81	30.26	30.74	31.25	31.82
	MSE	1028.47	1062.39	1092.96	1121.32	1148.59	1176.04	1205.56	1241.51

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	106.4	88.5	96.2	85.9	170.8	194.3	123.68
Feb	107.5	101.7	106.8	83.3	159.2	172.3	121.80
Mar	97.6	104.8	92.7	86.7	168.1	159.8	118.28
Apr	86.7	90	100.3	86.6	127.7	131.7	103.83
May	79.3	79.6	95	77	128.4	102.1	93.57
June	80.6	88.3	82.3	86	143.3	93.7	95.70
July	90.7	89.6	106	95.1	169.3	92.3	107.17
Aug	117.3	94.1	112.3	88.7	223.8	80.7	119.48
Sept	153.3	119.4	108.7	152.6	222.7	116.2	145.48
Oct	165	148	152.5	184.5	206.2	157	168.87
Nov	126.3	127.9	101.1	160.3	173.6	132.4	136.93
Dec	100.1	108.6	84.7	154.4	179.1	109	122.65

1997 FORECAST BY 91-96 (3 MO. MOVING AVG.)

Index 97'	.2 .1 .7	.2 .2 .6	.2 .3 .5	.2 .4 .4	.2 .5 .3	.2 .6 .2	.2 .7 .1
131.80	132.98	132.77	132.27	131.49	130.42	129.07	127.43
107.60	130.95	131.14	131.52	132.17	133.17	134.62	136.60
119.70	131.62	132.19	132.68	132.98	132.97	132.46	131.24
94.70	131.83	132.09	132.25	132.36	132.56	133.08	134.23
82.50	131.63	131.92	132.23	132.57	132.89	133.02	132.61
88.80	131.65	132.01	132.33	132.57	132.74	132.94	133.47
87.00	131.68	132.01	132.28	132.53	132.78	133.01	133.02
93.90	131.67	131.99	132.28	132.55	132.78	132.97	133.25
MAD	31.00	31.26	31.48	31.73	32.13	32.58	33.07
MSE	1217.48	1236.95	1255.24	1273.50	1292.90	1314.68	1341.03

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	106.4	88.5	96.2	85.9	170.8	194.3	123.68
Feb	107.5	101.7	106.8	83.3	159.2	172.3	121.80
Mar	97.6	104.8	92.7	86.7	168.1	159.8	118.28
Apr	86.7	90	100.3	86.6	127.7	131.7	103.83
May	79.3	79.6	95	77	128.4	102.1	93.57
June	80.6	88.3	82.3	86	143.3	93.7	95.70
July	90.7	89.6	106	95.1	169.3	92.3	107.17
Aug	117.3	94.1	112.3	88.7	223.8	80.7	119.48
Sept	153.3	119.4	108.7	152.6	222.7	116.2	145.48
Oct	165	148	152.5	184.5	206.2	157	168.87
Nov	126.3	127.9	101.1	160.3	173.6	132.4	136.93
Dec	100.1	108.6	84.7	154.4	179.1	109	122.65

1997 FORECAST BY 91-96 (3 MO. MOVING AVG.)

	Index 97'	.3 .1 .6	.3 .2 .5	.3 .3 .4	.3 .4 .3	.3 .5 .2	.3 .6 .1
	131.80	136.11	135.30	134.20	132.81	131.14	129.18
	107.60	132.26	132.32	132.71	133.53	134.85	136.76
	119.70	134.35	135.03	135.58	135.85	135.64	134.71
	94.70	134.67	134.57	134.31	134.01	133.89	134.28
	82.50	133.91	133.98	134.21	134.60	135.05	135.28
	88.80	134.12	134.41	134.65	134.74	134.65	134.51
	87.00	134.26	134.37	134.42	134.47	134.62	134.91
	93.90	134.14	134.27	134.43	134.62	134.76	134.78
MAD		33.48	33.53	33.56	33.58	33.74	34.21
MSE		1373.58	1381.56	1390.53	1401.89	1416.82	1436.40

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	106.4	88.5	96.2	85.9	170.8	194.3	123.68
Feb	107.5	101.7	106.8	83.3	159.2	172.3	121.80
Mar	97.6	104.8	92.7	86.7	168.1	159.8	118.28
Apr	86.7	90	100.3	86.6	127.7	131.7	103.83
May	79.3	79.6	95	77	128.4	102.1	93.57
June	80.6	88.3	82.3	86	143.3	93.7	95.70
July	90.7	89.6	106	95.1	169.3	92.3	107.17
Aug	117.3	94.1	112.3	88.7	223.8	80.7	119.48
Sept	153.3	119.4	108.7	152.6	222.7	116.2	145.48
Oct	165	148	152.5	184.5	206.2	157	168.87
Nov	126.3	127.9	101.1	160.3	173.6	132.4	136.93
Dec	100.1	108.6	84.7	154.4	179.1	109	122.65

1997 FORECAST BY 91-96 (3 MO. MOVING AVG.)

Index 97'	.4 .1 .5	.4 .2 .4	.4 .3 .3	.4 .4 .2	.4 .5 .1
131.80	138.32	136.90	135.19	133.20	130.93
107.60	132.48	132.62	133.24	134.44	136.29
119.70	137.10	138.03	138.70	138.91	138.40
94.70	137.12	136.49	135.66	134.84	134.36
82.50	135.26	135.25	135.61	136.31	137.15
88.80	136.18	136.61	136.86	136.76	136.26
87.00	136.47	136.29	136.00	135.81	135.95
93.90	135.96	135.94	136.10	136.39	136.58
MAD	35.36	35.27	35.17	35.08	35.21
MSE	1501.07	1499.96	1502.59	1510.76	1525.39

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	106.4	88.5	96.2	85.9	170.8	194.3	123.68
Feb	107.5	101.7	106.8	83.3	159.2	172.3	121.80
Mar	97.6	104.8	92.7	86.7	168.1	159.8	118.28
Apr	86.7	90	100.3	86.6	127.7	131.7	103.83
May	79.3	79.6	95	77	128.4	102.1	93.57
June	80.6	88.3	82.3	86	143.3	93.7	95.70
July	90.7	89.6	106	95.1	169.3	92.3	107.17
Aug	117.3	94.1	112.3	88.7	223.8	80.7	119.48
Sept	153.3	119.4	108.7	152.6	222.7	116.2	145.48
Oct	165	148	152.5	184.5	206.2	157	168.87
Nov	126.3	127.9	101.1	160.3	173.6	132.4	136.93
Dec	100.1	108.6	84.7	154.4	179.1	109	122.65

1997 FORECAST BY 91-96 (3 MO. MOVING AVG.)

Index 97'	.5 .1 .4	.5 .2 .3	.5 .3 .2	.5 .4 .1
131.80	139.61	137.58	135.27	132.67
107.60	131.89	132.32	133.39	135.18
119.70	140.31	141.52	142.28	142.32
94.70	139.12	137.71	136.11	134.64
82.50	135.62	135.78	136.60	137.98
88.80	138.31	139.04	139.29	138.82
87.00	138.45	137.72	136.89	136.40
93.90	137.02	137.01	137.47	138.16
MAD	36.79	36.59	36.41	36.27
MSE	1603.42	1595.56	1595.77	1605.95

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	106.4	88.5	96.2	85.9	170.8	194.3	123.68
Feb	107.5	101.7	106.8	83.3	159.2	172.3	121.80
Mar	97.6	104.8	92.7	86.7	168.1	159.8	118.28
Apr	86.7	90	100.3	86.6	127.7	131.7	103.83
May	79.3	79.6	95	77	128.4	102.1	93.57
June	80.6	88.3	82.3	86	143.3	93.7	95.70
July	90.7	89.6	106	95.1	169.3	92.3	107.17
Aug	117.3	94.1	112.3	88.7	223.8	80.7	119.48
Sept	153.3	119.4	108.7	152.6	222.7	116.2	145.48
Oct	165	148	152.5	184.5	206.2	157	168.87
Nov	126.3	127.9	101.1	160.3	173.6	132.4	136.93
Dec	100.1	108.6	84.7	154.4	179.1	109	122.65

1997 FORECAST BY 91-96 (3 MO. MOVING AVG.)

Index 97'	.6 .1 .3	.6 .2 .2	.6 .3 .1
131.80	139.97	137.34	134.42
107.60	130.76	131.70	133.43
119.70	144.31	145.75	146.47
94.70	140.35	137.89	135.33
82.50	134.99	135.75	137.53
88.80	141.12	142.18	142.23
87.00	140.04	138.32	136.68
93.90	137.12	137.55	138.86
MAD	37.83	37.56	37.37
MSE	1683.40	1672.56	1676.81

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	106.4	88.5	96.2	85.9	170.8	194.3	123.68
Feb	107.5	101.7	106.8	83.3	159.2	172.3	121.80
Mar	97.6	104.8	92.7	86.7	168.1	159.8	118.28
Apr	86.7	90	100.3	86.6	127.7	131.7	103.83
May	79.3	79.6	95	77	128.4	102.1	93.57
June	80.6	88.3	82.3	86	143.3	93.7	95.70
July	90.7	89.6	106	95.1	169.3	92.3	107.17
Aug	117.3	94.1	112.3	88.7	223.8	80.7	119.48
Sept	153.3	119.4	108.7	152.6	222.7	116.2	145.48
Oct	165	148	152.5	184.5	206.2	157	168.87
Nov	126.3	127.9	101.1	160.3	173.6	132.4	136.93
Dec	100.1	108.6	84.7	154.4	179.1	109	122.65

1997 FORECAST BY 91-96 (3 MO. MOVING AVG.)

Index 97'	.7 .1 .2	.7 .2 .1
131.80	139.40	136.17
107.60	129.38	131.04
119.70	149.32	150.84
94.70	140.38	136.61
82.50	133.57	135.56
88.80	145.28	146.47
87.00	140.68	137.39
93.90	136.17	137.92
MAD	38.52	38.25
MSE	1745.31	1739.04

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	106.4	88.5	96.2	85.9	170.8	194.3	123.68
Feb	107.5	101.7	106.8	83.3	159.2	172.3	121.80
Mar	97.6	104.8	92.7	86.7	168.1	159.8	118.28
Apr	86.7	90	100.3	86.6	127.7	131.7	103.83
May	79.3	79.6	95	77	128.4	102.1	93.57
June	80.6	88.3	82.3	86	143.3	93.7	95.70
July	90.7	89.6	106	95.1	169.3	92.3	107.17
Aug	117.3	94.1	112.3	88.7	223.8	80.7	119.48
Sept	153.3	119.4	108.7	152.6	222.7	116.2	145.48
Oct	165	148	152.5	184.5	206.2	157	168.87
Nov	126.3	127.9	101.1	160.3	173.6	132.4	136.93
Dec	100.1	108.6	84.7	154.4	179.1	109	122.65

1997 FORECAST BY 91-96 (3 MO. MOVING AVG.)

Index 97'	.8 .1 .1
131.80	137.92
107.60	128.02
119.70	155.43
94.70	138.68
82.50	131.82
88.80	151.40
87.00	139.27
93.90	134.53
MAD	38.88
MSE	1799.87

WEIGHTED MOVING AVERAGE MODEL (97 FORECAST BY 96)

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	106.4	88.5	96.2	85.9	170.8	194.3	123.68
Feb	107.5	101.7	106.8	83.3	159.2	172.3	121.80
Mar	97.6	104.8	92.7	86.7	168.1	159.8	118.28
Apr	86.7	90	100.3	86.6	127.7	131.7	103.83
May	79.3	79.6	95	77	128.4	102.1	93.57
June	80.6	88.3	82.3	86	143.3	93.7	95.70
July	90.7	89.6	106	95.1	169.3	92.3	107.17
Aug	117.3	94.1	112.3	88.7	223.8	80.7	119.48
Sept	153.3	119.4	108.7	152.6	222.7	116.2	145.48
Oct	165	148	152.5	184.5	206.2	157	168.87
Nov	126.3	127.9	101.1	160.3	173.6	132.4	136.93
Dec	100.1	108.6	84.7	154.4	179.1	109	122.65

1997 FORECAST BY 1996 (3 MO. MOVING AVG.)

	Index 97'	.1 .1 .8	.1 .2 .7	.1 .3 .6	.1 .4 .5	.1 .5 .4	.1 .6 .3	.1 .7 .2	.1 .8 .1
Jan	131.80	117.05	117.98	118.43	118.42	117.94	116.99	115.58	113.69
Feb	107.60	116.16	117.18	118.21	119.37	120.83	122.70	125.14	128.29
Mar	119.70	116.24	117.47	118.53	119.37	119.85	119.79	118.95	117.03
Apr	94.70	116.32	117.46	118.43	119.28	120.15	121.26	122.95	125.70
May	82.50	116.29	117.43	118.44	119.32	120.07	120.52	120.37	119.03
June	88.80	116.29	117.44	118.44	119.31	120.09	120.89	122.03	124.17
July	87.00	116.29	117.44	118.44	119.31	120.08	120.71	120.96	120.21
Aug	93.90	116.29	117.44	118.44	119.31	120.08	120.80	121.65	123.26
	MAD	20.17	20.75	21.30	21.89	22.60	23.41	24.45	25.86
	MSE	503.38	540.98	577.02	612.32	648.07	685.93	728.86	784.18

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	106.4	88.5	96.2	85.9	170.8	194.3	123.68
Feb	107.5	101.7	106.8	83.3	159.2	172.3	121.80
Mar	97.6	104.8	92.7	86.7	168.1	159.8	118.28
Apr	86.7	90	100.3	86.6	127.7	131.7	103.83
May	79.3	79.6	95	77	128.4	102.1	93.57
June	80.6	88.3	82.3	86	143.3	93.7	95.70
July	90.7	89.6	106	95.1	169.3	92.3	107.17
Aug	117.3	94.1	112.3	88.7	223.8	80.7	119.48
Sept	153.3	119.4	108.7	152.6	222.7	116.2	145.48
Oct	165	148	152.5	184.5	206.2	157	168.87
Nov	126.3	127.9	101.1	160.3	173.6	132.4	136.93
Dec	100.1	108.6	84.7	154.4	179.1	109	122.65

1997 FORECAST BY 1996 (3 MO. MOVING AVG.)

	Index 97'	.2 .1 .7	.2 .2 .6	.2 .3 .5	.2 .4 .4	.2 .5 .3	.2 .6 .2	.2 .7 .1
Jan	131.80	122.04	122.25	121.99	121.26	120.07	118.41	116.28
Feb	107.60	119.32	119.80	120.48	121.49	122.97	125.07	127.91
Mar	119.70	119.92	120.99	121.96	122.69	122.99	122.59	121.18
Apr	94.70	120.28	121.00	121.52	121.93	122.40	123.24	124.91
May	82.50	120.05	120.76	121.45	122.15	122.81	123.21	122.90
June	88.80	120.05	120.85	121.57	122.17	122.64	123.10	123.97
July	87.00	120.10	120.87	121.52	122.11	122.67	123.20	123.41
Aug	93.90	120.08	120.84	121.52	122.14	122.68	123.14	123.70
MAD		21.92	22.56	23.21	23.88	24.58	25.34	26.16
MSE		631.81	662.24	691.57	721.20	752.77	788.32	831.40

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	106.4	88.5	96.2	85.9	170.8	194.3	123.68
Feb	107.5	101.7	106.8	83.3	159.2	172.3	121.80
Mar	97.6	104.8	92.7	86.7	168.1	159.8	118.28
Apr	86.7	90	100.3	86.6	127.7	131.7	103.83
May	79.3	79.6	95	77	128.4	102.1	93.57
June	80.6	88.3	82.3	86	143.3	93.7	95.70
July	90.7	89.6	106	95.1	169.3	92.3	107.17
Aug	117.3	94.1	112.3	88.7	223.8	80.7	119.48
Sept	153.3	119.4	108.7	152.6	222.7	116.2	145.48
Oct	165	148	152.5	184.5	206.2	157	168.87
Nov	126.3	127.9	101.1	160.3	173.6	132.4	136.93
Dec	100.1	108.6	84.7	154.4	179.1	109	122.65

1997 FORECAST BY 1996 (3 MO. MOVING AVG.)

	Index 97'	.3 .1 .6	.3 .2 .5	.3 .3 .4	.3 .4 .3	.3 .5 .2	.3 .6 .1
Jan	131.80	126.06	125.56	124.59	123.15	121.24	118.86
Feb	107.60	120.91	121.10	121.66	122.75	124.50	127.05
Mar	119.70	122.88	124.08	125.17	125.91	126.05	125.26
Apr	94.70	123.64	123.93	123.94	123.82	123.83	124.41
May	82.50	122.74	123.11	123.63	124.33	125.14	125.71
June	88.80	122.87	123.57	124.18	124.60	124.76	124.80
July	87.00	123.09	123.58	123.94	124.26	124.67	125.23
Aug	93.90	122.96	123.44	123.92	124.42	124.86	125.11
MAD		23.83	24.36	24.93	25.57	26.27	27.04
MSE		748.11	770.43	792.98	817.77	846.82	882.28

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	106.4	88.5	96.2	85.9	170.8	194.3	123.68
Feb	107.5	101.7	106.8	83.3	159.2	172.3	121.80
Mar	97.6	104.8	92.7	86.7	168.1	159.8	118.28
Apr	86.7	90	100.3	86.6	127.7	131.7	103.83
May	79.3	79.6	95	77	128.4	102.1	93.57
June	80.6	88.3	82.3	86	143.3	93.7	95.70
July	90.7	89.6	106	95.1	169.3	92.3	107.17
Aug	117.3	94.1	112.3	88.7	223.8	80.7	119.48
Sept	153.3	119.4	108.7	152.6	222.7	116.2	145.48
Oct	165	148	152.5	184.5	206.2	157	168.87
Nov	126.3	127.9	101.1	160.3	173.6	132.4	136.93
Dec	100.1	108.6	84.7	154.4	179.1	109	122.65

1997 FORECAST BY 1996 (3 MO. MOVING AVG.)

	Index 97'	.4 .1 .5	.4 .2 .4	.4 .3 .3	.4 .4 .2	.4 .5 .1
Jan	131.80	129.13	127.91	126.23	124.07	121.45
Feb	107.60	121.22	121.34	122.03	123.44	125.70
Mar	119.70	125.74	127.27	128.57	129.34	129.25
Apr	94.70	126.64	126.34	125.67	124.87	124.35
May	82.50	124.38	124.53	125.08	126.09	127.34
June	88.80	125.15	125.99	126.65	126.90	126.61
July	87.00	125.67	125.84	125.79	125.76	126.07
Aug	93.90	125.10	125.34	125.77	126.35	126.85
MAD		25.30	25.79	26.37	27.03	27.79
MSE		849.27	863.57	880.44	902.61	932.24

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	106.4	88.5	96.2	85.9	170.8	194.3	123.68
Feb	107.5	101.7	106.8	83.3	159.2	172.3	121.80
Mar	97.6	104.8	92.7	86.7	168.1	159.8	118.28
Apr	86.7	90	100.3	86.6	127.7	131.7	103.83
May	79.3	79.6	95	77	128.4	102.1	93.57
June	80.6	88.3	82.3	86	143.3	93.7	95.70
July	90.7	89.6	106	95.1	169.3	92.3	107.17
Aug	117.3	94.1	112.3	88.7	223.8	80.7	119.48
Sept	153.3	119.4	108.7	152.6	222.7	116.2	145.48
Oct	165	148	152.5	184.5	206.2	157	168.87
Nov	126.3	127.9	101.1	160.3	173.6	132.4	136.93
Dec	100.1	108.6	84.7	154.4	179.1	109	122.65

1997 FORECAST BY 1996 (3 MO. MOVING AVG.)

	Index 97'	.5 .1 .4	.5 .2 .3	.5 .3 .2	.5 .4 .1
Jan	131.80	131.24	129.30	126.90	124.04
Feb	107.60	120.53	120.83	121.89	123.85
Mar	119.70	129.00	130.95	132.46	133.18
Apr	94.70	129.27	128.10	126.51	124.87
May	82.50	124.87	125.03	125.98	127.68
June	88.80	127.38	128.61	129.38	129.31
July	87.00	128.08	127.64	126.93	126.44
Aug	93.90	126.41	126.53	127.19	128.21
	MAD	26.49	27.00	27.63	28.39
	MSE	934.63	941.66	955.30	978.95

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	106.4	88.5	96.2	85.9	170.8	194.3	123.68
Feb	107.5	101.7	106.8	83.3	159.2	172.3	121.80
Mar	97.6	104.8	92.7	86.7	168.1	159.8	118.28
Apr	86.7	90	100.3	86.6	127.7	131.7	103.83
May	79.3	79.6	95	77	128.4	102.1	93.57
June	80.6	88.3	82.3	86	143.3	93.7	95.70
July	90.7	89.6	106	95.1	169.3	92.3	107.17
Aug	117.3	94.1	112.3	88.7	223.8	80.7	119.48
Sept	153.3	119.4	108.7	152.6	222.7	116.2	145.48
Oct	165	148	152.5	184.5	206.2	157	168.87
Nov	126.3	127.9	101.1	160.3	173.6	132.4	136.93
Dec	100.1	108.6	84.7	154.4	179.1	109	122.65

1997 FORECAST BY 1996 (3 MO. MOVING AVG.)

	Index 97'	.6 .1 .3	.6 .2 .2	.6 .3 .1
Jan	131.80	132.38	129.74	126.62
Feb	107.60	119.13	119.84	121.51
Mar	119.70	133.06	135.40	137.03
Apr	94.70	131.26	128.89	126.13
May	82.50	124.16	124.76	126.63
June	88.80	130.21	131.97	132.72
July	87.00	130.24	128.68	126.94
Aug	93.90	126.59	126.99	128.49
	MAD	27.63	28.05	28.80
	MSE	1004.60	1006.55	1021.93

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	106.4	88.5	96.2	85.9	170.8	194.3	123.68
Feb	107.5	101.7	106.8	83.3	159.2	172.3	121.80
Mar	97.6	104.8	92.7	86.7	168.1	159.8	118.28
Apr	86.7	90	100.3	86.6	127.7	131.7	103.83
May	79.3	79.6	95	77	128.4	102.1	93.57
June	80.6	88.3	82.3	86	143.3	93.7	95.70
July	90.7	89.6	106	95.1	169.3	92.3	107.17
Aug	117.3	94.1	112.3	88.7	223.8	80.7	119.48
Sept	153.3	119.4	108.7	152.6	222.7	116.2	145.48
Oct	165	148	152.5	184.5	206.2	157	168.87
Nov	126.3	127.9	101.1	160.3	173.6	132.4	136.93
Dec	100.1	108.6	84.7	154.4	179.1	109	122.65

1997 FORECAST BY 1996 (3 MO. MOVING AVG.)

	Index 97'	.7 .1 .2	.7 .2 .1
Jan	131.80	132.57	129.21
Feb	107.60	117.31	118.68
Mar	119.70	138.18	140.81
Apr	94.70	132.16	128.26
May	82.50	122.37	124.06
June	88.80	134.41	136.62
July	87.00	131.63	128.26
Aug	93.90	125.42	126.99
	MAD	28.51	29.01
	MSE	1061.93	1064.10

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	106.4	88.5	96.2	85.9	170.8	194.3	123.68
Feb	107.5	101.7	106.8	83.3	159.2	172.3	121.80
Mar	97.6	104.8	92.7	86.7	168.1	159.8	118.28
Apr	86.7	90	100.3	86.6	127.7	131.7	103.83
May	79.3	79.6	95	77	128.4	102.1	93.57
June	80.6	88.3	82.3	86	143.3	93.7	95.70
July	90.7	89.6	106	95.1	169.3	92.3	107.17
Aug	117.3	94.1	112.3	88.7	223.8	80.7	119.48
Sept	153.3	119.4	108.7	152.6	222.7	116.2	145.48
Oct	165	148	152.5	184.5	206.2	157	168.87
Nov	126.3	127.9	101.1	160.3	173.6	132.4	136.93
Dec	100.1	108.6	84.7	154.4	179.1	109	122.65

1997 FORECAST BY 1996 (3 MO. MOVING AVG.)

	Index 97'	.8 .1 .1
Jan	131.80	131.79
Feb	107.60	115.35
Mar	119.70	144.51
Apr	94.70	131.42
May	82.50	119.88
June	88.80	140.74
July	87.00	131.20
Aug	93.90	123.09
	MAD	29.00
	MSE	1115.48

DECOMPOSITION MODEL

		Index #	Centered	Ratio	S. Factors	Adj. Sales
1991	Jan	106.40				
	Feb	107.50				
	Mar	97.60				
	Apr	86.70				
	May	79.30				
	Jun	80.60				
	Jul	90.70	108.48750	0.84	0.90621	100.08664
	Aug	117.30	107.50000	1.09	1.02125	114.85888
	Sep	153.30	107.55833	1.43	1.22325	125.32171
	Oct	165.00	107.99583	1.53	1.40908	117.09752
	Nov	126.30	108.14583	1.17	1.11603	113.16936
	Dec	100.10	108.47917	0.92	0.99141	100.96748
1992	Jan	88.50	108.75417	0.81	0.98747	89.62282
	Feb	101.70	107.74167	0.94	0.98591	103.15304
	Mar	104.80	105.36250	0.99	0.97355	107.64763
	Apr	90.00	103.24167	0.87	0.87500	102.85743
	May	79.60	102.60000	0.78	0.78374	101.56436
	Jun	88.30	103.02083	0.86	0.79692	110.80178
	Jul	89.60	103.69583	0.86	0.90621	98.87280
	Aug	94.10	104.22917	0.90	1.02125	92.14169
	Sep	119.40	103.93750	1.15	1.22325	97.60869
	Oct	148.00	103.86250	1.42	1.40908	105.03292
	Nov	127.90	104.93333	1.22	1.11603	114.60302
	Dec	108.60	105.32500	1.03	0.99141	109.54114
1993	Jan	96.20	105.75833	0.91	0.98747	97.42051
	Feb	106.80	107.20000	1.00	0.98591	108.32591
	Mar	92.70	107.51250	0.86	0.97355	95.21885
	Apr	100.30	107.25417	0.94	0.87500	114.62890
	May	95.00	106.32500	0.89	0.78374	121.21374
	Jun	82.30	104.21250	0.79	0.79692	103.27278
	Jul	106.00	102.78750	1.03	0.90621	116.97005
	Aug	112.30	101.37917	1.11	1.02125	109.96293
	Sep	108.70	100.15000	1.09	1.22325	88.86151
	Oct	152.50	99.32917	1.54	1.40908	108.22649
	Nov	101.10	98.00833	1.03	1.11603	90.58925
	Dec	84.70	97.41250	0.87	0.99141	85.43402
1994	Jan	85.90	97.11250	0.88	0.98747	86.98983
	Feb	83.30	95.67500	0.87	0.98591	84.49015
	Mar	86.70	96.52083	0.90	0.97355	89.05581
	Apr	86.60	99.68333	0.87	0.87500	98.97171
	May	77.00	103.48333	0.74	0.78374	98.24693
	Jun	86.00	108.85417	0.79	0.79692	107.91566
	Jul	95.10	115.29583	0.82	0.90621	104.94200
	Aug	88.70	121.99583	0.73	1.02125	86.85407
	Sep	152.60	128.55000	1.19	1.22325	124.74946
	Oct	184.50	133.65417	1.38	1.40908	130.93631
	Nov	160.30	137.50833	1.17	1.11603	143.63459
	Dec	154.40	142.03750	1.09	0.99141	155.73805

		Index #	Centered	Ratio	S. Factors	Adj. Sales
1995	Jan	170.80	147.51667	1.16	0.98747	172.96697
	Feb	159.20	156.23750	1.02	0.98591	161.47458
	Mar	168.10	164.78750	1.02	0.97355	172.66762
	Apr	127.70	168.61250	0.76	0.87500	145.94327
	May	128.40	170.07083	0.75	0.78374	163.82994
	Jun	143.30	171.65417	0.83	0.90621	158.13026
	Jul	169.30	173.66250	0.97	1.02125	165.77671
	Aug	223.80	175.18750	1.28	1.22325	182.95498
	Sep	222.70	175.38750	1.27	1.40908	158.04616
	Oct	206.20	175.20833	1.18	1.11603	184.76265
	Nov	173.60	174.27917	1.00	0.99141	175.10444
	Dec	179.10	171.11667	1.05	0.98747	181.37228
1996	Jan	194.30	165.84167	1.17	0.98591	197.07607
	Feb	172.30	156.67083	1.10	0.97355	176.98174
	Mar	159.80	146.27083	1.09	0.87500	182.62909
	Apr	131.70	139.81250	0.94	0.78374	168.04052
	May	102.10	136.07500	0.75	0.79692	128.11848
	Jun	93.70	131.43750	0.71	0.90621	103.39711
	Jul	92.30				
	Aug	80.70				
	Sep	116.20				
	Oct	157.70				
	Nov	132.40				
	Dec	109.00				

		Period	Centered	T Value	Cyclical
1991	Jul	1.00	108.48750	93.09	1.16546
	Aug	2.00	107.50000	93.89	1.14502
	Sep	3.00	107.55833	94.68	1.13596
	Oct	4.00	107.99583	95.48	1.13104
	Nov	5.00	108.14583	96.28	1.12320
	Dec	6.00	108.47917	97.08	1.11739
1992	Jan	7.00	108.75417	97.88	1.11107
	Feb	8.00	107.74167	98.68	1.09181
	Mar	9.00	105.36250	99.48	1.05912
	Apr	10.00	103.24167	100.28	1.02953
	May	11.00	102.60000	101.08	1.01504
	Jun	12.00	103.02083	101.88	1.01121
	Jul	13.00	103.69583	102.68	1.00991
	Aug	14.00	104.22917	103.48	1.00726
	Sep	15.00	103.93750	104.28	0.99674
	Oct	16.00	103.86250	105.08	0.98845
	Nov	17.00	104.93333	105.88	0.99110
	Dec	18.00	105.32500	106.68	0.98734
1993	Jan	19.00	105.75833	107.47	0.98403
	Feb	20.00	107.20000	108.27	0.99008
	Mar	21.00	107.51250	109.07	0.98569
	Apr	22.00	107.25417	109.87	0.97617
	May	23.00	106.32500	110.67	0.96072
	Jun	24.00	104.21250	111.47	0.93488
	Jul	25.00	102.78750	112.27	0.91553
	Aug	26.00	101.37917	113.07	0.89660
	Sep	27.00	100.15000	113.87	0.87951
	Oct	28.00	99.32917	114.67	0.86622
	Nov	29.00	98.00833	115.47	0.84879
	Dec	30.00	97.41250	116.27	0.83783
1994	Jan	31.00	97.11250	117.07	0.82954
	Feb	32.00	95.67500	117.87	0.81172
	Mar	33.00	96.52083	118.67	0.81338
	Apr	34.00	99.68333	119.47	0.83441
	May	35.00	103.48333	120.26	0.86046
	Jun	36.00	108.85417	121.06	0.89914
	Jul	37.00	115.29583	121.86	0.94611
	Aug	38.00	121.99583	122.66	0.99456
	Sep	39.00	128.55000	123.46	1.04121
	Oct	40.00	133.65417	124.26	1.07559
	Nov	41.00	137.50833	125.06	1.09953
	Dec	42.00	142.03750	125.86	1.12853
1995	Jan	43.00	147.51667	126.66	1.16467
	Feb	44.00	156.23750	127.46	1.22578
	Mar	45.00	164.78750	128.26	1.28481
	Apr	46.00	168.61250	129.06	1.30649
	May	47.00	170.07083	129.86	1.30967
	Jun	48.00	171.65417	130.66	1.31378
	Jul	49.00	173.66250	131.46	1.32107
	Aug	50.00	175.18750	132.26	1.32461
	Sep	51.00	175.38750	133.05	1.31816
	Oct	52.00	175.20833	133.85	1.30895
	Nov	53.00	174.27917	134.65	1.29428
	Dec	54.00	171.11667	135.45	1.26329

		Period	Centered	T Value	Cyclical
1996	Jan	55.00	165.84167	136.25	1.21716
	Feb	56.00	156.67083	137.05	1.14315
	Mar	57.00	146.27083	137.85	1.06108
	Apr	58.00	139.81250	138.65	1.00838
	May	59.00	136.07500	139.45	0.97580
	Jun	60.00	131.43750	140.25	0.93717
	Jul	61.00	127.59886	141.05	0.90464
	Aug	62.00	123.76022	141.85	0.87248
	Sep	63.00	119.92158	142.65	0.84068
	Oct	64.00	116.08294	143.45	0.80924
	Nov	65.00	112.24430	144.25	0.77814
	Dec	66.00	108.40566	145.05	0.74739

		Period	Centered	T Value	Cyclical
1996	Jul	67.00	104.56702	145.85	0.71697
	Aug	68.00	100.72838	146.64	0.68689
	Sep	69.00	96.88974	147.44	0.65713
	Oct	70.00	93.05110	148.24	0.62769
	Nov	71.00	89.21246	149.04	0.59857
	Dec	72.00	85.37382	149.84	0.56976
1997	Jan	73.00	81.53518	150.64	0.54125
	Feb	74.00	77.69654	151.44	0.51305
	Mar	75.00	73.85790	152.24	0.48514
	Apr	76.00	70.01926	153.04	0.45752
	May	77.00	66.18062	153.84	0.43019
	Jun	78.00	62.34198	154.64	0.40315
	Jul	79.00	58.50334	155.44	0.37638
	Aug	80.00	54.66470	156.24	0.34988
	Sep	81.00	50.82606	157.04	0.32366
	Oct	82.00	46.98742	157.84	0.29770
	Nov	83.00	43.14878	158.64	0.27200
	Dec	84.00	39.31014	159.43	0.24656

	Trend	Cyclical	Seasonal	Forecast(1997)
Jan	150.64	0.54	0.98747	80.51
Feb	151.44	0.51	0.98591	76.60
Mar	152.24	0.49	0.97355	71.90
Apr	153.04	0.46	0.87500	61.27
May	153.84	0.43	0.78374	51.87
Jun	154.64	0.40	0.79692	49.68
Jul	155.44	0.38	0.90621	53.02
Aug	156.24	0.35	1.02125	55.83
Sep	157.04	0.32	1.22325	62.17
Oct	157.84	0.30	1.40908	66.21
Nov	158.64	0.27	1.11603	48.16
Dec	159.43	0.25	0.99141	38.97

APPENDIX B

RAIL TRANSPORTATION FORECASTING ANALYSIS

REGRESSION WITH ARIMA ERRORS MODEL

SAS PROGRAM

```
OPTIONS NOCENTER LS=80 NODATE NONUMBER NOSTIMER FORMDLIM=' ';

DATA RAIL;
  INPUT RATE;
  TIME=_N_;
  T2=TIME**2;  RTIME=1/TIME;
*  DATE = INTNX( 'month', '01dec90'd, _n_);
  CARDS;
111.1
111
111.8
112
111.1
111.2
112.9
112.2
112.2
111.1
111.2
111.2
111.3
111.3
110.2
110.5
110.2
110.4
110.4
110.3
```

110.3
112.7
113.1
114.8
113.8
113.9
114.5
114.5
114.2
114.1
114.1
114
114.3
116
116.3
115.8
116.4
115.6
115.7
115.1
115.1
114.8
114.3
114.3
114.6
116.9
116.7
116.6
117.1
116.9
117.8
117.7
117.7

```
117.7
112.6
114.9
115.6
117.7
117.7
118.2
118.3
118.1
118.1
118.1
116.2
109.8
115.1
116.5
116.1
123.7
119.4
119.7
;

DATA B;
RATE=.;
DO TIME = 73 TO 84;
T2 = TIME**2; RTIME=1/TIME;
OUTPUT; END;

DATA RAIL;
MERGE RAIL B; BY TIME;

PROC ARIMA;
I VAR=RATE(12) CROSSCORR=(RTIME);
E Q=(1,3,12) INPUT=(RTIME);
```

```
F LEAD=12 OUT=NEW ID=TIME ;
RUN;
```

SAS OUTPUT

```
The SAS System
ARIMA Procedure

Name of variable = RATE.

Period(s) of Differencing = 12.
Mean of working series = 1.168333
Standard deviation     = 2.118686
Number of observations =       60
NOTE: The first 12 observations were eliminated by differencing.

Autocorrelations

Lag Covariance Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  0   4.488831    1.00000  |                    |********************|
  1   2.228017    0.49635  |               .    |**********          |
  2   1.791378    0.39907  |              .     |********            |
  3   1.620805    0.36108  |             .      |*******             |
  4   0.360916    0.08040  |             .      |**    .             |
  5   0.441630    0.09838  |             .      |**    .             |
  6   0.248983    0.05547  |             .      |*     .             |
  7  -0.056111   -0.01250  |            .       |       .            |
  8  -0.232900   -0.05188  |            .      *|       .            |
  9  -0.570025   -0.12699  |            .    ***|       .            |
 10  -0.517112   -0.11520  |            .     **|       .            |
 11  -0.572831   -0.12761  |            .    ***|       .            |
 12  -1.492114   -0.33241  |            .*******|       .            |
 13  -1.313028   -0.29251  |            . ******|       .            |
 14  -1.279512   -0.28504  |            . ******|       .            |
 15  -1.215620   -0.27081  |           .   *****|        .           |
                           "." marks two standard errors
```

The SAS System

ARIMA Procedure

Inverse Autocorrelations

```
Lag Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  1   -0.22246   |                .****|    .                |
  2   -0.19629   |                .****|    .                |
  3   -0.28084   |               ******|    .                |
  4    0.36846   |                .    |*******              |
  5    0.00509   |                .    |    .                |
  6   -0.09989   |                .  **|    .                |
  7   -0.17954   |                .****|    .                |
  8    0.21795   |                .    |****.                |
  9    0.06648   |                .    |*   .                |
 10   -0.06184   |                .   *|    .                |
 11   -0.23729   |                *****|    .                |
 12    0.18947   |                .    |****.                |
 13    0.07555   |                .    |**  .                |
 14    0.04477   |                .    |*   .                |
 15   -0.06708   |                .   *|    .                |
```

```
Partial Autocorrelations

Lag Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  1     0.49635  |                    .   |**********         |
  2     0.20264  |                    .   |****.              |
  3     0.14191  |                    .   |***  .             |
  4    -0.25561  |                    *****|    .             |
  5     0.04888  |                    .   |*    .             |
  6     0.00673  |                    .   |     .             |
  7     0.01106  |                    .   |     .             |
  8    -0.11912  |                    .  **|    .             |
  9    -0.09902  |                    .  **|    .             |
 10     0.01536  |                    .   |     .             |
 11     0.00139  |                    .   |     .             |
 12    -0.33738  |                 *******|     .             |
 13    -0.08503  |                    .  **|    .             |
 14     0.00963  |                    .   |     .             |
 15     0.10758  |                    .   |**   .             |
```

Autocorrelation Check for White Noise

To Lag	Chi Square	DF	Prob	Autocorrelations					
6	35.55	6	0.000	0.496	0.399	0.361	0.080	0.098	0.055
12	47.72	12	0.000	-0.013	-0.052	-0.127	-0.115	-0.128	-0.332

```
The SAS System

ARIMA Procedure

Correlation of RATE and RTIME
Variance of input = 0.015879
Number of observations =        60

Crosscorrelations

Lag Covariance Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
-15 -0.0033244   -0.10032  |                   .  **|   .                  |
-14 -0.0033196   -0.10017  |                   .  **|   .                  |
-13 -0.0033778   -0.10193  |                   .  **|   .                  |
-12 -0.0036024   -0.10871  |                   .  **|   .                  |
-11 -0.0037363   -0.11275  |                   .  **|   .                  |
-10 -0.0038857   -0.11726  |                   .  **|   .                  |
 -9 -0.0038216   -0.11532  |                   .  **|   .                  |
 -8 -0.0038065   -0.11487  |                   .  **|   .                  |
 -7 -0.0033300   -0.10049  |                   .  **|   .                  |
 -6 -0.0012470   -0.03763  |                   .   *|   .                  |
 -5 -0.0018967   -0.05723  |                   .   *|   .                  |
 -4 -0.0023507   -0.07093  |                   .   *|   .                  |
 -3 -0.0025678   -0.07749  |                   .  **|   .                  |
 -2 -0.0042551   -0.12840  |                   . ***|   .                  |
 -1 -0.0048902   -0.14757  |                   . ***|   .                  |
  0 -0.0055539   -0.16760  |                   . ***|   .                  |
  1 -0.0053596   -0.16173  |                   . ***|   .                  |
  2 -0.0052582   -0.15867  |                   . ***|   .                  |
  3 -0.0034696   -0.10470  |                   .  **|   .                  |
  4 -0.0015704   -0.04739  |                   .   *|   .                  |
  5 2.41911E-6    0.00007  |                   .    |   .                  |
  6  0.0016523    0.04986  |                   .    |*  .                  |
```

```
 7  0.0050079    0.15112  |               .     |***  .                |
 8  0.0082326    0.24843  |               .     |*****                 |
 9   0.011858    0.35782  |               .     |*******               |
10   0.012799    0.38623  |               .     |********              |
11   0.013584    0.40991  |               .     |********              |
12   0.012937    0.39039  |               .     |********              |
13   0.013190    0.39801  |               .     |********              |
14   0.013388    0.40401  |               .     |********              |
15   0.012093    0.36492  |               .     |*******               |
                          "." marks two standard errors
```

The SAS System

ARIMA Procedure

Conditional Least Squares Estimation

Parameter	Estimate	Approx. Std Error	T Ratio	Lag	Variable	Shift
MU	1.93222	0.71034	2.72	0	RATE	0
MA1,1	-0.36588	0.12465	-2.94	1	RATE	0
MA1,2	-0.28447	0.13714	-2.07	3	RATE	0
MA1,3	0.23307	0.14550	1.60	12	RATE	0
NUM1	-25.40633	21.04992	-1.21	0	RTIME	0

Constant Estimate = 1.93221913

Variance Estimate = 3.21505009
Std Error Estimate = 1.79305608
AIC = 245.122518*
SBC = 255.59424*
Number of Residuals= 60
* Does not include log determinant.

Correlations of the Estimates

Variable	Parameter	RATE MU	RATE MA1,1	RATE MA1,2	RATE MA1,3	RTIME NUM1
RATE	MU	1.000	-0.053	-0.022	0.102	-0.883
RATE	MA1,1	-0.053	1.000	-0.485	0.127	0.075
RATE	MA1,2	-0.022	-0.485	1.000	0.357	0.053
RATE	MA1,3	0.102	0.127	0.357	1.000	-0.083
RTIME	NUM1	-0.883	0.075	0.053	-0.083	1.000

Autocorrelation Check of Residuals

To Lag	Chi Square	DF	Prob	Autocorrelations					
6	6.06	3	0.109	0.121	0.242	0.085	-0.037	0.072	0.083
12	8.73	9	0.463	-0.027	-0.003	-0.047	0.034	0.081	-0.156
18	14.10	15	0.518	-0.145	-0.140	-0.154	-0.012	-0.009	-0.040
24	14.57	21	0.844	0.022	-0.052	-0.006	-0.001	0.010	0.040

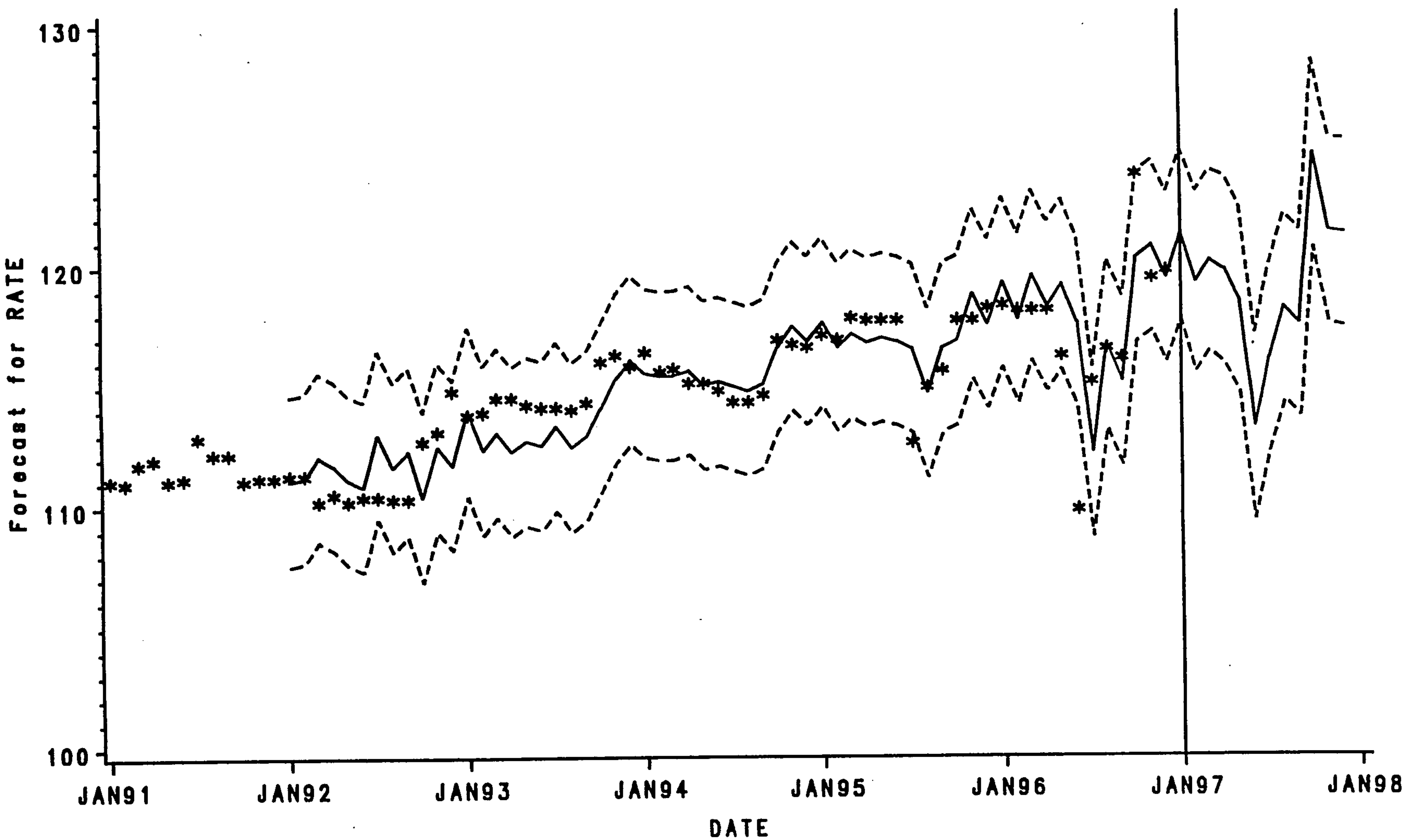
```
The SAS System

ARIMA Procedure


Model for variable RATE

Estimated Intercept = 1.93221913
Period(s) of Differencing = 12.

Moving Average Factors
Factor 1: 1 + 0.36588 B**(1) + 0.28447 B**(3) - 0.23307 B**(12)


Input Number 1 is RTIME.
Overall Regression Factor  = -25.4063
```

The SAS System

ARIMA Procedure

Forecasts for variable RATE

Obs	Forecast	Std Error	Lower 95%	Upper 95%
73	121.1849	1.7931	117.6706	124.6992
74	119.2172	1.9093	115.4750	122.9593
75	120.1043	1.9093	116.3622	123.8465
76	119.7308	1.9763	115.8574	123.6042
77	118.4852	1.9763	114.6117	122.3586
78	113.2168	1.9763	109.3434	117.0902
79	116.0311	1.9763	112.1576	119.9045
80	118.1465	1.9763	114.2731	122.0199
81	117.4908	1.9763	113.6174	121.3642
82	124.5206	1.9763	120.6472	128.3940
83	121.3382	1.9763	117.4648	125.2116
84	121.2618	1.9763	117.3883	125.1352



Forecast Function for Rail Transportation (Regression Analysis with ARIMA Errors)

BOX-JENKINS MODEL #1

SAS PROGRAM

```
OPTIONS NOCENTER LS=80 NODATE NONUMBER NOSTIMER FORMDLIM=' ';

DATA RAIL;
  INPUT RATE;
  TIME=_N_;
  DATE = INTNX( 'month', '01dec90'd, _n_);
  FORMAT DATE MONYY.;
  CARDS;
111.1
111
111.8
112
111.1
111.2
112.9
112.2
112.2
111.1
111.2
111.2
111.3
111.3
110.2
110.5
110.2
110.4
110.4
110.3
```

110.3
112.7
113.1
114.8
113.8
113.9
114.5
114.5
114.2
114.1
114.1
114
114.3
116
116.3
115.8
116.4
115.6
115.7
115.1
115.1
114.8
114.3
114.3
114.6
116.9
116.7
116.6
117.1
116.9
117.8
117.7
117.7

```
117.7
112.6
114.9
115.6
117.7
117.7
118.2
118.3
118.1
118.1
118.1
116.2
109.8
115.1
116.5
116.1
123.7
119.4
119.7
;

DATA RAIL;
MERGE RAIL B; BY TIME;

PROC ARIMA;
I VAR=RATE(12);
E P=2 Q=(12) NOINT;
F BACK=6 LEAD=18 OUT=NEW2;
RUN;
```

SAS PROGRAM

```
The SAS System
ARIMA Procedure

Name of variable = RATE.

Period(s) of Differencing = 12.
Mean of working series = 1.168333
Standard deviation     = 2.118686
Number of observations =       60
NOTE: The first 12 observations were eliminated by differencing.

Autocorrelations

Lag Covariance Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  0   4.488831    1.00000  |                    |********************|
  1   2.228017    0.49635  |              .     |**********          |
  2   1.791378    0.39907  |             .      |********            |
  3   1.620805    0.36108  |            .       |*******             |
  4   0.360916    0.08040  |            .       |**    .             |
  5   0.441630    0.09838  |            .       |**    .             |
  6   0.248983    0.05547  |            .       |*     .             |
  7  -0.056111   -0.01250  |           .        |       .            |
  8  -0.232900   -0.05188  |           .       *|       .            |
  9  -0.570025   -0.12699  |           .     ***|       .            |
 10  -0.517112   -0.11520  |           .      **|       .            |
 11  -0.572831   -0.12761  |           .     ***|       .            |
 12  -1.492114   -0.33241  |           .*******|       .            |
 13  -1.313028   -0.29251  |           .  ******|       .            |
 14  -1.279512   -0.28504  |           .  ******|       .            |
 15  -1.215620   -0.27081  |          .    *****|        .           |
                           "." marks two standard errors
```

The SAS System

ARIMA Procedure

Inverse Autocorrelations

```
Lag Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  1   -0.22246   |                .****|    .                   |
  2   -0.19629   |                .****|    .                   |
  3   -0.28084   |               ******|    .                   |
  4    0.36846   |                .    |*******                 |
  5    0.00509   |                .    |    .                   |
  6   -0.09989   |                .  **|    .                   |
  7   -0.17954   |                .****|    .                   |
  8    0.21795   |                .    |****.                   |
  9    0.06648   |                .    |*   .                   |
 10   -0.06184   |                .   *|    .                   |
 11   -0.23729   |                *****|    .                   |
 12    0.18947   |                .    |****.                   |
 13    0.07555   |                .    |**  .                   |
 14    0.04477   |                .    |*   .                   |
 15   -0.06708   |                .   *|    .                   |
```

Partial Autocorrelations

```
Lag Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  1     0.49635  |                .    |**********         |
  2     0.20264  |                .    |****.              |
  3     0.14191  |                .    |***  .             |
  4    -0.25561  |                *****|     .             |
  5     0.04888  |                .    |*    .             |
  6     0.00673  |                .    |     .             |
  7     0.01106  |                .    |     .             |
  8    -0.11912  |                .  **|     .             |
  9    -0.09902  |                .  **|     .             |
 10     0.01536  |                .    |     .             |
 11     0.00139  |                .    |     .             |
 12    -0.33738  |              *******|     .             |
 13    -0.08503  |                .  **|     .             |
 14     0.00963  |                .    |     .             |
 15     0.10758  |                .    |**   .             |
```

Autocorrelation Check for White Noise

To Lag	Chi Square	DF	Prob	Autocorrelations					
6	35.55	6	0.000	0.496	0.399	0.361	0.080	0.098	0.055
12	47.72	12	0.000	-0.013	-0.052	-0.127	-0.115	-0.128	-0.332

The SAS System

ARIMA Procedure

Conditional Least Squares Estimation

Parameter	Estimate	Approx. Std Error	T Ratio	Lag
MA1,1	0.47495	0.21100	2.25	12
AR1,1	0.54882	0.14147	3.88	1
AR1,2	0.28496	0.12947	2.20	2

```
Variance  Estimate = 3.20973906
Std Error Estimate = 1.79157446
AIC                = 243.166405*
SBC                = 249.449439*
Number of Residuals=          60
* Does not include log determinant.
```

Correlations of the Estimates

Parameter	MA1,1	AR1,1	AR1,2
MA1,1	1.000	0.438	-0.137
AR1,1	0.438	1.000	-0.729
AR1,2	-0.137	-0.729	1.000

Autocorrelation Check of Residuals

To Lag	Chi Square	DF	Prob	Autocorrelations					
6	5.85	3	0.119	-0.049	-0.078	0.142	-0.235	0.033	0.063
12	12.75	9	0.174	0.030	0.016	-0.052	0.120	0.263	-0.060
18	15.51	15	0.416	-0.020	0.001	-0.123	0.096	0.086	0.025
24	17.67	21	0.669	0.057	-0.037	0.020	0.039	0.086	0.089

Model for variable RATE

No mean term in this model.
Period(s) of Differencing = 12.

Autoregressive Factors
Factor 1: 1 - 0.54882 B**(1) - 0.28496 B**(2)

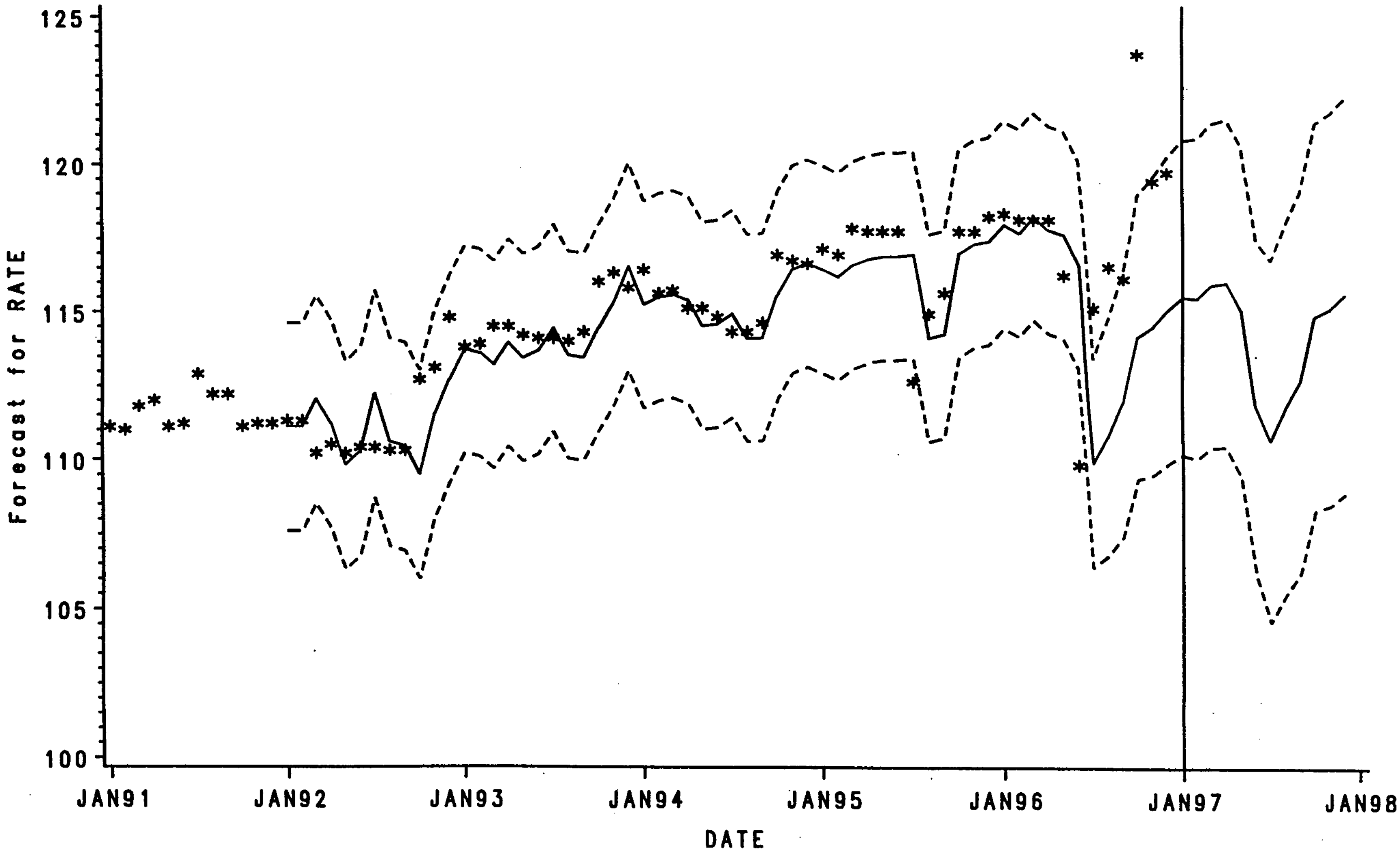
Moving Average Factors
Factor 1: 1 - 0.47495 B**(12)

The SAS System

ARIMA Procedure

Forecasts for variable RATE

Obs	Forecast	Std Error	Lower 95%	Upper 95%	Actual	Residual
67	109.8866	1.7916	106.3752	113.3980	115.1000	5.2134
68	110.7755	2.0437	106.7700	114.7810	116.5000	5.7245
69	111.9062	2.2977	107.4028	116.4096	116.1000	4.1938
70	114.1453	2.4521	109.3392	118.9514	123.7000	9.5547
71	114.4997	2.5700	109.4626	119.5368	119.4000	4.9003
72	115.0414	2.6550	109.8378	120.2451	119.7000	4.6586
73	115.4778	2.7186	110.1494	120.8063		
74	115.4417	2.7662	110.0200	120.8634		
75	115.8867	2.8021	110.3946	121.3787		
76	115.9650	2.8292	110.4197	121.5102		
77	115.0620	2.8498	109.4765	120.6476		
78	111.7919	2.8655	106.1756	117.4082		
79	110.6555	3.1075	104.5650	116.7461		
80	111.7651	3.1955	105.5020	118.0283		
81	112.6684	3.2827	106.2344	119.1024		
82	114.8457	3.3416	108.2962	121.3951		
83	115.1013	3.3877	108.4614	121.7411		
84	115.5712	3.4221	108.8640	122.2784		



Forecast Function for Rail Transportation (Box-Jenkins #1)

BOX-JENKINS MODEL #2

SAS PROGRAM

```
OPTIONS NOCENTER LS=80 NODATE NONUMBER NOSTIMER FORMDLIM=' ';

DATA RAIL;
  INPUT RATE;
  TIME=_N_;
  DATE = INTNX( 'month', '01dec90'd, _n_);
  FORMAT DATE MONYY.;
  CARDS;
111.1
111
111.8
112
111.1
111.2
112.9
112.2
112.2
111.1
111.2
111.2
111.3
111.3
110.2
110.5
110.2
110.4
110.4
110.3
```

110.3
112.7
113.1
114.8
113.8
113.9
114.5
114.5
114.2
114.1
114.1
114
114.3
116
116.3
115.8
116.4
115.6
115.7
115.1
115.1
114.8
114.3
114.3
114.6
116.9
116.7
116.6
117.1
116.9
117.8
117.7
117.7

```
117.7
112.6
114.9
115.6
117.7
117.7
118.2
118.3
118.1
118.1
118.1
116.2
109.8
115.1
116.5
116.1
123.7
119.4
119.7
;

DATA RAIL;
MERGE RAIL B; BY TIME;

PROC ARIMA;
I VAR=RATE(12);
E P=2 Q=1 NOINT;
F BACK=6 LEAD=18 OUT=NEW2;
RUN;
```

SAS PROGRAM

```
The SAS System
ARIMA Procedure

Name of variable = RATE.

Period(s) of Differencing = 12.
Mean of working series = 1.168333
Standard deviation     = 2.118686
Number of observations =       60
NOTE: The first 12 observations were eliminated by differencing.

Autocorrelations

Lag Covariance Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  0    4.488831    1.00000  |                   |********************|
  1    2.228017    0.49635  |              .    |**********          |
  2    1.791378    0.39907  |             .     |********            |
  3    1.620805    0.36108  |            .      |*******             |
  4    0.360916    0.08040  |            .      |**    .             |
  5    0.441630    0.09838  |            .      |**    .             |
  6    0.248983    0.05547  |            .      |*     .             |
  7   -0.056111   -0.01250  |           .       |       .            |
  8   -0.232900   -0.05188  |           .      *|       .            |
  9   -0.570025   -0.12699  |           .    ***|       .            |
 10   -0.517112   -0.11520  |           .     **|       .            |
 11   -0.572831   -0.12761  |           .    ***|       .            |
 12   -1.492114   -0.33241  |           .*******|       .            |
 13   -1.313028   -0.29251  |           . ******|       .            |
 14   -1.279512   -0.28504  |           . ******|       .            |
 15   -1.215620   -0.27081  |          .   *****|        .           |
                            "." marks two standard errors
```

The SAS System

ARIMA Procedure

Inverse Autocorrelations

```
Lag Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  1   -0.22246   |               .****|    .               |
  2   -0.19629   |               .****|    .               |
  3   -0.28084   |              ******|    .               |
  4    0.36846   |               .    |*******             |
  5    0.00509   |               .    |    .               |
  6   -0.09989   |               .  **|    .               |
  7   -0.17954   |               .****|    .               |
  8    0.21795   |               .    |****.               |
  9    0.06648   |               .    |*   .               |
 10   -0.06184   |               .   *|    .               |
 11   -0.23729   |               *****|    .               |
 12    0.18947   |               .    |****.               |
 13    0.07555   |               .    |**  .               |
 14    0.04477   |               .    |*   .               |
 15   -0.06708   |               .   *|    .               |
```

```
Partial Autocorrelations

Lag Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
  1     0.49635  |                .    |**********         |
  2     0.20264  |                .    |****.              |
  3     0.14191  |                .    |***  .             |
  4    -0.25561  |                *****|     .             |
  5     0.04888  |                .    |*    .             |
  6     0.00673  |                .    |     .             |
  7     0.01106  |                .    |     .             |
  8    -0.11912  |                .  **|     .             |
  9    -0.09902  |                .  **|     .             |
 10     0.01536  |                .    |     .             |
 11     0.00139  |                .    |     .             |
 12    -0.33738  |              *******|     .             |
 13    -0.08503  |                .  **|     .             |
 14     0.00963  |                .    |     .             |
 15     0.10758  |                .    |**   .             |

Autocorrelation Check for White Noise

 To    Chi                        Autocorrelations
Lag  Square DF   Prob
  6   35.55  6  0.000  0.496  0.399  0.361  0.080  0.098  0.055
 12   47.72 12  0.000 -0.013 -0.052 -0.127 -0.115 -0.128 -0.332
```

The SAS System

ARIMA Procedure

Conditional Least Squares Estimation

Parameter	Estimate	Approx. Std Error	T Ratio	Lag
MA1,1	0.32301	0.41823	0.77	1
AR1,1	0.74359	0.42656	1.74	1
AR1,2	0.09675	0.30182	0.32	2

```
Variance  Estimate = 3.51700424
Std Error Estimate = 1.87536776
AIC                =   248.6516*
SBC                = 254.934634*
Number of Residuals=         60
* Does not include log determinant.
```

Correlations of the Estimates

Parameter	MA1,1	AR1,1	AR1,2
MA1,1	1.000	0.951	-0.897
AR1,1	0.951	1.000	-0.964
AR1,2	-0.897	-0.964	1.000

Autocorrelation Check of Residuals

To Lag	Chi Square	DF	Prob	Autocorrelations					
6	5.25	3	0.155	-0.005	-0.020	0.178	-0.213	-0.003	0.045
12	11.10	9	0.269	-0.008	0.020	-0.029	0.087	0.157	-0.207
18	13.06	15	0.598	-0.067	-0.054	-0.099	0.056	0.058	-0.007
24	14.46	21	0.849	0.092	0.007	0.041	0.025	0.040	0.049

Model for variable RATE

No mean term in this model.
Period(s) of Differencing = 12.

Autoregressive Factors
Factor 1: 1 - 0.74359 B**(1) - 0.096753 B**(2)

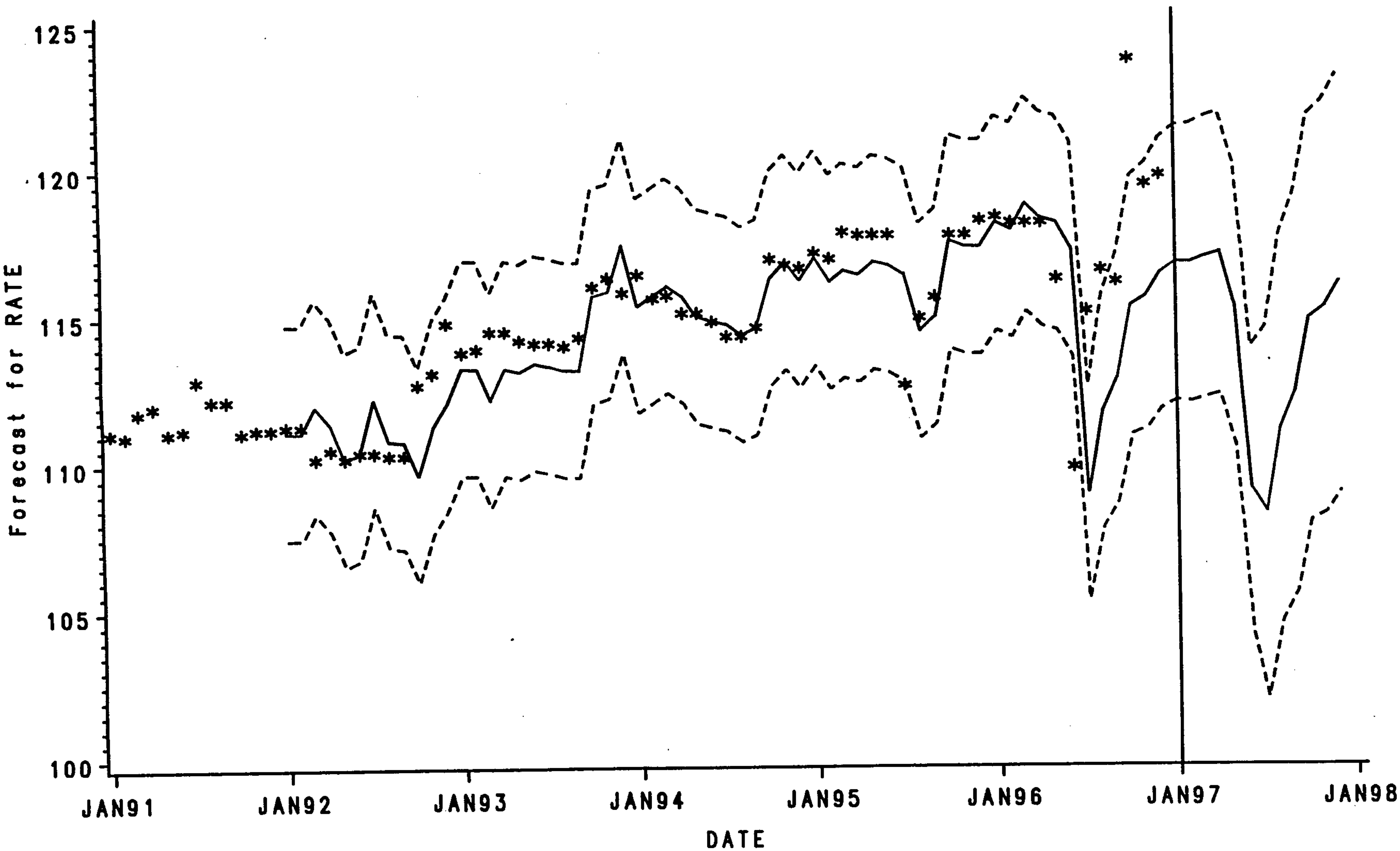
Moving Average Factors
Factor 1: 1 - 0.32301 B**(1)

The SAS System

ARIMA Procedure

Forecasts for variable RATE

Obs	Forecast	Std Error	Lower 95%	Upper 95%	Actual	Residual
67	108.9800	1.8754	105.3044	112.6557	115.1000	6.1200
68	111.4439	2.0345	107.4564	115.4314	116.5000	5.0561
69	112.6798	2.1746	108.4177	116.9419	116.1000	3.4202
70	115.1942	2.2689	110.7472	119.6411	123.7000	8.5058
71	115.5542	2.3359	110.9758	120.1325	119.4000	3.8458
72	116.3619	2.3839	111.6895	121.0343	119.7000	3.3381
73	116.7256	2.4185	111.9854	121.4658		
74	116.7515	2.4436	111.9622	121.5408		
75	116.9449	2.4618	112.1199	121.7700		
76	117.1106	2.4751	112.2595	121.9617		
77	115.3525	2.4848	110.4825	120.2226		
78	109.0741	2.4919	104.1901	113.9581		
79	108.3583	3.2181	102.0509	114.6656		
80	110.9113	3.3488	104.3477	117.4749		
81	112.2236	3.4641	105.4342	119.0131		
82	114.8035	3.5440	107.8573	121.7496		
83	115.2195	3.6017	108.1602	122.2788		
84	116.0753	3.6435	108.9341	123.2164		



Forecast Function for Rail Transportation (Box-Jenkins #2)

AUTOREGRESSIVE MODEL

SAS PROGRAM

```
DATA RAIL;
  INPUT RATE;
  TIME=_N_;
  DATE = INTNX( 'month', '01dec90'd, _n_);
  FORMAT DATE MONYY.;
  CARDS;
111.1
111
111.8
112
111.1
111.2
112.9
112.2
112.2
111.1
111.2
111.2
111.3
111.3
110.2
110.5
110.2
110.4
110.4
110.3
110.3
112.7
113.1
```

114.8
113.8
113.9
114.5
114.5
114.2
114.1
114.1
114
114.3
116
116.3
115.8
116.4
115.6
115.7
115.1
115.1
114.8
114.3
114.3
114.6
116.9
116.7
116.6
117.1
116.9
117.8
117.7
117.7
117.7
112.6
114.9

```
115.6
117.7
117.7
118.2
118.3
118.1
118.1
118.1
116.2
109.8
115.1
116.5
116.1
123.7
119.4
119.7
;
DATA B;
RATE=.;
DO TIME = 73 TO 84; OUTPUT; END;

DATA RAIL;
MERGE RAIL B; BY TIME;

PROC AUTOREG DATA=RAIL;
MODEL RATE=TIME/NLAG=1;
OUTPUT OUT=P P=YHAT PM=YTREND LCL=LCL UCL=UCL R=RESID;
RUN;
```

SAS OUTPUT

```
The SAS System

Autoreg Procedure

Dependent Variable = RATE


Ordinary Least Squares Estimates

SSE            214.7259    DFE               70
MSE            3.067513    Root MSE    1.751432
SBC            291.5546    AIC         287.0013
Reg Rsq          0.6415    Total Rsq     0.6415
Durbin-Watson    1.0060


Variable      DF        B Value   Std Error    t Ratio Approx Prob

Intercept      1     110.481964      0.4172    264.847      0.0001
TIME           1       0.111149     0.00993     11.191      0.0001


Estimates of Autocorrelations

 Lag  Covariance  Correlation -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1

   0    2.982304     1.000000 |                    |********************|
   1    1.470225     0.492983 |                    |**********          |
```

Preliminary MSE = 2.257508

Estimates of the Autoregressive Parameters

Lag	Coefficient	Std Error	t Ratio
1	-0.49298298	0.104740	-4.707

Yule-Walker Estimates

SSE	162.1043	DFE	69
MSE	2.349338	Root MSE	1.532755
SBC	275.8689	AIC	269.0389
Reg Rsq	0.4009	Total Rsq	0.7293
Durbin-Watson	2.0429		

Variable	DF	B Value	Std Error	t Ratio	Approx Prob
Intercept	1	110.476640	0.6965	158.628	0.0001
TIME	1	0.111915	0.0165	6.794	0.0001

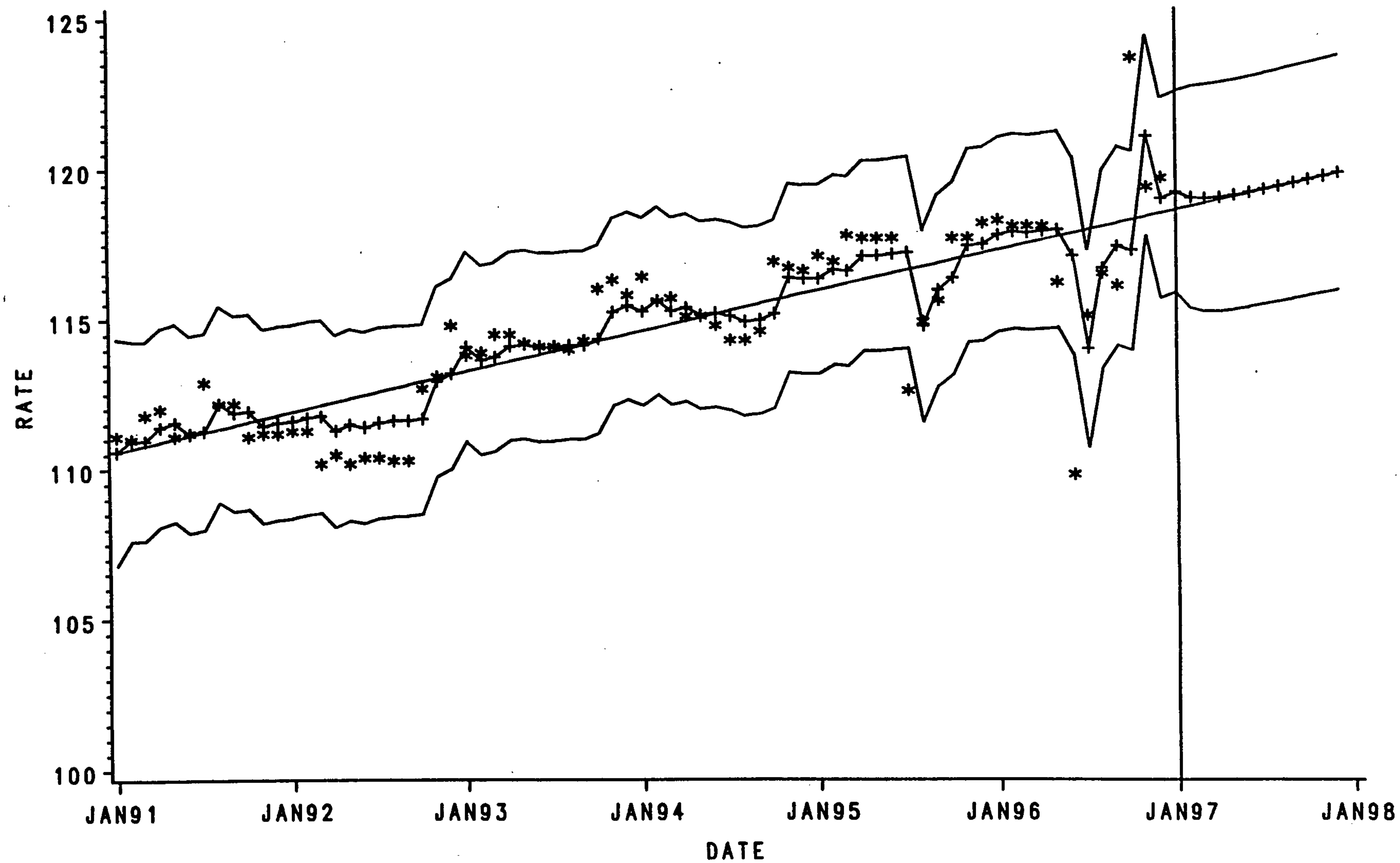
The SAS System

Forecasts for variable RATE

Obs	YHAT	RESID	LCL	UCL	YTREND	RATE
1	110.655	0.44498	107.308	114.002	110.589	111.1
2	110.953	0.04740	107.617	114.288	110.700	111.0
3	110.960	0.83995	107.635	114.285	110.812	111.8
4	111.411	0.58882	108.097	114.725	110.924	112.0
5	111.567	-0.46652	108.263	114.870	111.036	111.1
6	111.180	0.02043	107.886	114.473	111.148	111.2
7	111.286	1.61438	108.002	114.569	111.260	112.9
8	112.180	0.01957	108.906	115.454	111.372	112.2
9	111.892	0.30792	108.627	115.157	111.484	112.2
10	111.949	-0.84883	108.693	115.205	111.596	111.1
11	111.463	-0.26329	108.216	114.710	111.708	111.2
12	111.569	-0.36933	108.331	114.808	111.820	111.2
13	111.626	-0.32607	108.395	114.857	111.932	111.3
14	111.732	-0.43211	108.509	114.955	112.043	111.3
15	111.789	-1.58886	108.573	115.005	112.155	110.2
16	111.303	-0.80332	108.095	114.512	112.267	110.5
17	111.508	-1.30796	108.306	114.710	112.379	110.2
18	111.417	-1.01680	108.221	114.612	112.491	110.4
19	111.572	-1.17214	108.383	114.762	112.603	110.4
20	111.629	-1.32889	108.445	114.813	112.715	110.3
21	111.636	-1.33633	108.458	114.815	112.827	110.3
22	111.693	1.00693	108.520	114.866	112.939	112.7
23	112.933	0.16703	109.765	116.101	113.051	113.1
24	113.187	1.61309	110.023	116.351	113.163	114.8
25	114.082	-0.28172	110.922	117.242	113.275	113.8
26	113.645	0.25452	110.489	116.802	113.386	113.9
27	113.752	0.74847	110.599	116.904	113.498	114.5

28	114.104	0.39594	110.954	117.254	113.610	114.5
29	114.161	0.03920	111.014	117.308	113.722	114.2
30	114.070	0.03035	110.925	117.214	113.834	114.1
31	114.077	0.02291	110.935	117.219	113.946	114.1
32	114.134	-0.13384	110.993	117.274	114.058	114.0
33	114.141	0.15872	111.002	117.281	114.170	114.3
34	114.346	1.65408	111.208	117.484	114.282	116.0
35	115.241	1.05927	112.103	118.378	114.394	116.3
36	115.445	0.35463	112.308	118.583	114.506	115.8
37	115.256	1.14438	112.118	118.393	114.617	116.4
38	115.608	-0.00815	112.471	118.746	114.729	115.6
39	115.271	0.42949	112.132	118.409	114.841	115.7
40	115.377	-0.27655	112.237	118.516	114.953	115.1
41	115.138	-0.03750	111.997	118.278	115.065	115.1
42	115.194	-0.39425	112.052	118.337	115.177	114.8
43	115.103	-0.80309	111.959	118.248	115.289	114.3
44	114.913	-0.61335	111.767	118.060	115.401	114.3
45	114.970	-0.37009	111.821	118.120	115.513	114.6
46	115.175	1.72527	112.022	118.327	115.625	116.9
47	116.365	0.33467	113.209	119.521	115.737	116.7
48	116.323	0.27652	113.164	119.483	115.849	116.6
49	116.331	0.76908	113.167	119.495	115.960	117.1
50	116.634	0.26585	113.466	119.803	116.072	116.9
51	116.592	1.20770	113.419	119.765	116.184	117.8
52	117.093	0.60727	113.914	120.271	116.296	117.7
53	117.100	0.59983	113.917	120.284	116.408	117.7
54	117.157	0.54308	113.967	120.346	116.520	117.7
55	117.214	-4.61366	114.018	120.409	116.632	112.6
56	114.756	0.14381	111.554	117.958	116.744	114.9
57	115.947	-0.34679	112.738	119.155	116.856	115.6
58	116.349	1.35138	113.133	119.564	116.968	117.7
59	117.441	0.25937	114.218	120.664	117.080	117.7
60	117.497	0.70263	114.267	120.728	117.192	118.2

61	117.801	0.49939	114.562	121.039	117.303	118.3
62	117.907	0.19335	114.660	121.154	117.415	118.1
63	117.865	0.23521	114.609	121.121	117.527	118.1
64	117.922	0.17846	114.657	121.186	117.639	118.1
65	117.978	-1.77828	114.704	121.252	117.751	116.2
66	117.098	-7.29835	113.815	120.382	117.863	109.8
67	114.000	1.09999	110.707	117.293	117.975	115.1
68	116.670	-0.16956	113.366	119.973	118.087	116.5
69	117.416	-1.31648	114.103	120.730	118.199	116.1
70	117.276	6.42397	113.951	120.601	118.311	123.7
71	121.079	-1.67944	117.744	124.415	118.423	119.4
72	119.016	0.68364	115.669	122.363	118.535	119.7
73	119.221	.	115.540	122.902	118.646	.
74	119.042	.	115.275	122.808	118.758	.
75	119.010	.	115.215	122.805	118.870	.
76	119.051	.	115.241	122.861	118.982	.
77	119.128	.	115.305	122.951	119.094	.
78	119.223	.	115.388	123.057	119.206	.
79	119.326	.	115.480	123.172	119.318	.
80	119.434	.	115.576	123.292	119.430	.
81	119.544	.	115.673	123.414	119.542	.
82	119.655	.	115.771	123.538	119.654	.
83	119.766	.	115.870	123.662	119.766	.
84	119.878	.	115.969	123.787	119.877	.



Forecast Function for Rail Transportation (Autoregressive)

MOVING AVERAGE MODEL

	1997 index
Jan	117.30
Feb	117.30
Mar	116.00
Apr	117.60
May	117.30
June	119.60
July	120.20
August	122.00

	1997 FORECAST BY 91-96			
	2 MO	3 MO	5 MO	6 MO
	115.97	115.94	115.42	115.08
	115.93	116.01	115.74	115.01
	115.95	116.00	115.62	115.56
	115.94	115.98	115.59	115.43
	115.95	116.00	115.50	115.38
	115.94	115.99	115.57	115.26
	115.94	115.99	115.61	115.34
	115.94	116.00	115.58	115.38
MAD	2.47	2.42	2.83	3.07
MSE	9.55	9.32	11.49	12.97

	1997 index
Jan	117.30
Feb	117.30
Mar	116.00
Apr	117.60
May	117.30
June	119.60
July	120.20
August	122.00

	1997 FORECAST BY 97			
	2 MO	3 MO	5 MO	6 MO
	119.63	120.01	119.60	118.97
	119.59	120.21	120.30	119.38
	119.61	120.39	119.61	119.93
	119.60	120.20	119.66	119.30
	119.60	120.27	119.65	119.28
	119.60	120.29	119.76	119.21
	119.60	120.25	119.80	119.35
	119.60	120.27	119.70	119.41
MAD	1.94	2.26	2.02	1.90
MSE	4.88	6.77	5.32	4.62

WEIGHTED MOVING AVERAGE MODEL (97 FORECAST BY 91-96)

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	111.1	111.3	113.8	116.4	117.1	118.3	114.67
Feb	111	111.3	113.9	115.6	116.9	118.1	114.47
Mar	111.8	110.2	114.5	115.7	117.8	118.1	114.68
Apr	112	110.5	114.5	115.1	117.7	118.1	114.65
May	111.1	110.2	114.2	115.1	117.7	116.2	114.08
June	111.2	110.4	114.1	114.8	117.7	109.8	113.00
July	112.9	110.4	114.1	114.3	112.6	115.1	113.23
Aug	112.2	110.3	114	114.3	114.9	116.5	113.70
Sept	112.2	110.3	114.3	114.6	115.6	116.1	113.85
Oct	111.1	112.7	116	116.9	117.7	123.7	116.35
Nov	111.2	113.1	116.3	116.7	117.7	119.4	115.73
Dec	111.2	114.8	115.8	116.6	118.2	119.7	116.05

1997 FORECAST BY 91-96 (3 MO. MOVING AVERAGE)

	Index 97'	.1 .1 .8	.1 .2 .7	.1 .3 .6	.1 .4 .5	.1 .5 .4	.1 .6 .3	.1 .7 .2	.1 .8 .1
Jan	117.30	116.02	116.00	115.98	115.97	115.97	115.97	115.98	116.00
Feb	117.30	116.02	116.00	115.99	115.97	115.95	115.93	115.90	115.87
Mar	116.00	116.03	116.00	115.99	115.97	115.96	115.95	115.95	115.97
Apr	117.60	116.02	116.00	115.99	115.97	115.96	115.94	115.92	115.89
May	117.30	116.02	116.00	115.99	115.97	115.96	115.95	115.94	115.95
June	119.60	116.02	116.00	115.99	115.97	115.96	115.94	115.93	115.90
July	120.20	116.02	116.00	115.99	115.97	115.96	115.94	115.94	115.94
Aug	122.00	116.02	116.00	115.99	115.97	115.96	115.94	115.93	115.91
	MAD	2.40	2.41	2.43	2.44	2.46	2.47	2.48	2.49
	MSE	9.16	9.26	9.35	9.42	9.49	9.55	9.61	9.68

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	111.1	111.3	113.8	116.4	117.1	118.3	114.67
Feb	111	111.3	113.9	115.6	116.9	118.1	114.47
Mar	111.8	110.2	114.5	115.7	117.8	118.1	114.68
Apr	112	110.5	114.5	115.1	117.7	118.1	114.65
May	111.1	110.2	114.2	115.1	117.7	116.2	114.08
June	111.2	110.4	114.1	114.8	117.7	109.8	113.00
July	112.9	110.4	114.1	114.3	112.6	115.1	113.23
Aug	112.2	110.3	114	114.3	114.9	116.5	113.70
Sept	112.2	110.3	114.3	114.6	115.6	116.1	113.85
Oct	111.1	112.7	116	116.9	117.7	123.7	116.35
Nov	111.2	113.1	116.3	116.7	117.7	119.4	115.73
Dec	111.2	114.8	115.8	116.6	118.2	119.7	116.05

1997 FORECAST BY 91-96 (3 MO. MOVING AVERAGE)

	Index 97'	.2 .1 .7	.2 .2 .6	.2 .3 .5	.2 .4 .4	.2 .5 .3	.2 .6 .2	.2 .7 .1
Jan	117.30	116.01	115.98	115.97	115.96	115.96	115.96	115.97
Feb	117.30	116.02	116.01	116.00	115.99	115.97	115.95	115.93
Mar	116.00	116.03	116.01	115.99	115.98	115.96	115.95	115.95
Apr	117.60	116.03	116.01	115.99	115.98	115.97	115.95	115.94
May	117.30	116.03	116.01	115.99	115.98	115.96	115.95	115.94
June	119.60	116.03	116.01	115.99	115.98	115.96	115.95	115.94
July	120.20	116.03	116.01	115.99	115.98	115.97	115.95	115.94
Aug	122.00	116.03	116.01	115.99	115.98	115.96	115.95	115.94
	MAD	2.40	2.41	2.42	2.44	2.45	2.46	2.47
	MSE	9.16	9.25	9.32	9.39	9.45	9.50	9.55

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	111.1	111.3	113.8	116.4	117.1	118.3	114.67
Feb	111	111.3	113.9	115.6	116.9	118.1	114.47
Mar	111.8	110.2	114.5	115.7	117.8	118.1	114.68
Apr	112	110.5	114.5	115.1	117.7	118.1	114.65
May	111.1	110.2	114.2	115.1	117.7	116.2	114.08
June	111.2	110.4	114.1	114.8	117.7	109.8	113.00
July	112.9	110.4	114.1	114.3	112.6	115.1	113.23
Aug	112.2	110.3	114	114.3	114.9	116.5	113.70
Sept	112.2	110.3	114.3	114.6	115.6	116.1	113.85
Oct	111.1	112.7	116	116.9	117.7	123.7	116.35
Nov	111.2	113.1	116.3	116.7	117.7	119.4	115.73
Dec	111.2	114.8	115.8	116.6	118.2	119.7	116.05

1997 FORECAST BY 91-96 (3 MO. MOVING AVERAGE)

	Index 97'	.3 .1 .6	.3 .2 .5	.3 .3 .4	.3 .4 .3	.3 .5 .2	.3 .6 .1
Jan	117.30	115.99	115.97	115.95	115.94	115.94	115.95
Feb	117.30	116.02	116.01	116.01	116.00	115.99	115.98
Mar	116.00	116.04	116.02	116.00	115.98	115.96	115.95
Apr	117.60	116.03	116.01	115.99	115.98	115.97	115.97
May	117.30	116.03	116.01	116.00	115.99	115.97	115.96
June	119.60	116.03	116.01	116.00	115.98	115.97	115.96
July	120.20	116.03	116.01	116.00	115.98	115.97	115.96
Aug	122.00	116.03	116.01	116.00	115.98	115.97	115.96
	MAD	2.40	2.41	2.42	2.43	2.44	2.45
	MSE	9.16	9.24	9.30	9.36	9.42	9.47

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	111.1	111.3	113.8	116.4	117.1	118.3	114.67
Feb	111	111.3	113.9	115.6	116.9	118.1	114.47
Mar	111.8	110.2	114.5	115.7	117.8	118.1	114.68
Apr	112	110.5	114.5	115.1	117.7	118.1	114.65
May	111.1	110.2	114.2	115.1	117.7	116.2	114.08
June	111.2	110.4	114.1	114.8	117.7	109.8	113.00
July	112.9	110.4	114.1	114.3	112.6	115.1	113.23
Aug	112.2	110.3	114	114.3	114.9	116.5	113.70
Sept	112.2	110.3	114.3	114.6	115.6	116.1	113.85
Oct	111.1	112.7	116	116.9	117.7	123.7	116.35
Nov	111.2	113.1	116.3	116.7	117.7	119.4	115.73
Dec	111.2	114.8	115.8	116.6	118.2	119.7	116.05

1997 FORECAST BY 91-96 (3 MO. MOVING AVERAGE)

	Index 97'	.4 .1 .5	.4 .2 .4	.4 .3 .3	.4 .4 .2	.4 .5 .1
Jan	117.30	115.97	115.95	115.93	115.92	115.92
Feb	117.30	116.02	116.02	116.02	116.02	116.02
Mar	116.00	116.06	116.04	116.02	115.99	115.97
Apr	117.60	116.02	116.00	115.98	115.98	115.97
May	117.30	116.02	116.02	116.01	116.00	115.99
June	119.60	116.04	116.02	116.00	115.99	115.97
July	120.20	116.03	116.01	116.00	115.99	115.98
Aug	122.00	116.03	116.01	116.00	115.99	115.98
	MAD	2.41	2.41	2.42	2.43	2.44
	MSE	9.16	9.23	9.29	9.34	9.39

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	111.1	111.3	113.8	116.4	117.1	118.3	114.67
Feb	111	111.3	113.9	115.6	116.9	118.1	114.47
Mar	111.8	110.2	114.5	115.7	117.8	118.1	114.68
Apr	112	110.5	114.5	115.1	117.7	118.1	114.65
May	111.1	110.2	114.2	115.1	117.7	116.2	114.08
June	111.2	110.4	114.1	114.8	117.7	109.8	113.00
July	112.9	110.4	114.1	114.3	112.6	115.1	113.23
Aug	112.2	110.3	114	114.3	114.9	116.5	113.70
Sept	112.2	110.3	114.3	114.6	115.6	116.1	113.85
Oct	111.1	112.7	116	116.9	117.7	123.7	116.35
Nov	111.2	113.1	116.3	116.7	117.7	119.4	115.73
Dec	111.2	114.8	115.8	116.6	118.2	119.7	116.05

1997 FORECAST BY 91-96 (3 MO. MOVING AVERAGE)

	Index 97'	.8 .1 .1
Jan	117.30	115.82
Feb	117.30	116.05
Mar	116.00	116.19
Apr	117.60	115.88
May	117.30	116.05
June	119.60	116.15
July	120.20	115.92
Aug	122.00	116.04
	MAD	2.45
	MSE	9.26

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	111.1	111.3	113.8	116.4	117.1	118.3	114.67
Feb	111	111.3	113.9	115.6	116.9	118.1	114.47
Mar	111.8	110.2	114.5	115.7	117.8	118.1	114.68
Apr	112	110.5	114.5	115.1	117.7	118.1	114.65
May	111.1	110.2	114.2	115.1	117.7	116.2	114.08
June	111.2	110.4	114.1	114.8	117.7	109.8	113.00
July	112.9	110.4	114.1	114.3	112.6	115.1	113.23
Aug	112.2	110.3	114	114.3	114.9	116.5	113.70
Sept	112.2	110.3	114.3	114.6	115.6	116.1	113.85
Oct	111.1	112.7	116	116.9	117.7	123.7	116.35
Nov	111.2	113.1	116.3	116.7	117.7	119.4	115.73
Dec	111.2	114.8	115.8	116.6	118.2	119.7	116.05

1997 FORECAST BY 91-96 (3 MO. MOVING AVERAGE)

	Index 97'	.7 .1 .2	.7 .2 .1
Jan	117.30	115.86	115.84
Feb	117.30	116.03	116.06
Mar	116.00	116.15	116.11
Apr	117.60	115.94	115.91
May	117.30	116.02	116.05
June	119.60	116.11	116.07
July	120.20	115.98	115.96
Aug	122.00	116.02	116.05
	MAD	2.44	2.43
	MSE	9.23	9.25

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	111.1	111.3	113.8	116.4	117.1	118.3	114.67
Feb	111	111.3	113.9	115.6	116.9	118.1	114.47
Mar	111.8	110.2	114.5	115.7	117.8	118.1	114.68
Apr	112	110.5	114.5	115.1	117.7	118.1	114.65
May	111.1	110.2	114.2	115.1	117.7	116.2	114.08
June	111.2	110.4	114.1	114.8	117.7	109.8	113.00
July	112.9	110.4	114.1	114.3	112.6	115.1	113.23
Aug	112.2	110.3	114	114.3	114.9	116.5	113.70
Sept	112.2	110.3	114.3	114.6	115.6	116.1	113.85
Oct	111.1	112.7	116	116.9	117.7	123.7	116.35
Nov	111.2	113.1	116.3	116.7	117.7	119.4	115.73
Dec	111.2	114.8	115.8	116.6	118.2	119.7	116.05

1997 FORECAST BY 91-96 (3 MO. MOVING AVERAGE)

	Index 97'	.6 .1 .3	.6 .2 .2	.6 .3 .1
Jan	117.30	115.90	115.88	115.87
Feb	117.30	116.02	116.04	116.06
Mar	116.00	116.12	116.08	116.05
Apr	117.60	115.98	115.95	115.94
May	117.30	116.02	116.03	116.04
June	119.60	116.07	116.05	116.02
July	120.20	116.01	115.99	115.98
Aug	122.00	116.02	116.03	116.03
	MAD	2.42	2.43	2.43
	MSE	9.20	9.24	9.28

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	111.1	111.3	113.8	116.4	117.1	118.3	114.67
Feb	111	111.3	113.9	115.6	116.9	118.1	114.47
Mar	111.8	110.2	114.5	115.7	117.8	118.1	114.68
Apr	112	110.5	114.5	115.1	117.7	118.1	114.65
May	111.1	110.2	114.2	115.1	117.7	116.2	114.08
June	111.2	110.4	114.1	114.8	117.7	109.8	113.00
July	112.9	110.4	114.1	114.3	112.6	115.1	113.23
Aug	112.2	110.3	114	114.3	114.9	116.5	113.70
Sept	112.2	110.3	114.3	114.6	115.6	116.1	113.85
Oct	111.1	112.7	116	116.9	117.7	123.7	116.35
Nov	111.2	113.1	116.3	116.7	117.7	119.4	115.73
Dec	111.2	114.8	115.8	116.6	118.2	119.7	116.05

1997 FORECAST BY 91-96 (3 MO. MOVING AVERAGE)

	Index 97'	.5 .1 .4	.5 .2 .3	.5 .3 .2	.5 .4 .1
Jan	117.30	115.94	115.92	115.90	115.89
Feb	117.30	116.02	116.03	116.04	116.04
Mar	116.00	116.09	116.06	116.03	116.00
Apr	117.60	116.01	115.98	115.97	115.96
May	117.30	116.02	116.02	116.02	116.02
June	119.60	116.05	116.03	116.01	115.99
July	120.20	116.02	116.01	115.99	115.99
Aug	122.00	116.02	116.02	116.01	116.00
	MAD	2.41	2.42	2.42	2.43
	MSE	9.18	9.24	9.29	9.33

WEIGHTED MOVING AVERAGE MODEL (97 FORECAST BY 96)

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	111.1	111.3	113.8	116.4	117.1	118.3	114.67
Feb	111	111.3	113.9	115.6	116.9	118.1	114.47
Mar	111.8	110.2	114.5	115.7	117.8	118.1	114.68
Apr	112	110.5	114.5	115.1	117.7	118.1	114.65
May	111.1	110.2	114.2	115.1	117.7	116.2	114.08
June	111.2	110.4	114.1	114.8	117.7	109.8	113.00
July	112.9	110.4	114.1	114.3	112.6	115.1	113.23
Aug	112.2	110.3	114	114.3	114.9	116.5	113.70
Sept	112.2	110.3	114.3	114.6	115.6	116.1	113.85
Oct	111.1	112.7	116	116.9	117.7	123.7	116.35
Nov	111.2	113.1	116.3	116.7	117.7	119.4	115.73
Dec	111.2	114.8	115.8	116.6	118.2	119.7	116.05

1997 FORECAST BY 96 (3 MO. MOVING AVERAGE)

	Index 97'	.1 .1 .8	.1 .2 .7	.1 .3 .6	.1 .4 .5	.1 .5 .4	.1 .6 .3	.1 .7 .2	.1 .8 .1
Jan	117.30	119.97	119.91	119.86	119.81	119.77	119.74	119.71	119.69
Feb	117.30	119.95	119.91	119.89	119.87	119.85	119.84	119.83	119.83
Mar	116.00	119.96	119.93	119.89	119.86	119.82	119.79	119.75	119.72
Apr	117.60	119.96	119.92	119.89	119.86	119.83	119.82	119.81	119.80
May	117.30	119.96	119.92	119.89	119.86	119.83	119.80	119.77	119.74
June	119.60	119.96	119.92	119.89	119.86	119.83	119.81	119.79	119.79
July	120.20	119.96	119.92	119.89	119.86	119.83	119.80	119.78	119.75
Aug	122.00	119.96	119.92	119.89	119.86	119.83	119.81	119.79	119.78
	MAD	22.17	22.14	22.12	22.10	22.08	22.07	22.05	22.04
	MSE	633.86	632.38	631.12	630.04	629.11	628.29	627.56	626.90

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	111.1	111.3	113.8	116.4	117.1	118.3	114.67
Feb	111	111.3	113.9	115.6	116.9	118.1	114.47
Mar	111.8	110.2	114.5	115.7	117.8	118.1	114.68
Apr	112	110.5	114.5	115.1	117.7	118.1	114.65
May	111.1	110.2	114.2	115.1	117.7	116.2	114.08
June	111.2	110.4	114.1	114.8	117.7	109.8	113.00
July	112.9	110.4	114.1	114.3	112.6	115.1	113.23
Aug	112.2	110.3	114	114.3	114.9	116.5	113.70
Sept	112.2	110.3	114.3	114.6	115.6	116.1	113.85
Oct	111.1	112.7	116	116.9	117.7	123.7	116.35
Nov	111.2	113.1	116.3	116.7	117.7	119.4	115.73
Dec	111.2	114.8	115.8	116.6	118.2	119.7	116.05

1997 FORECAST BY 96 (3 MO. MOVING AVERAGE)

	Index 97'	.2 .1 .7	.2 .2 .6	.2 .3 .5	.2 .4 .4	.2 .5 .3	.2 .6 .2	.2 .7 .1
Jan	117.30	120.18	120.08	120.00	119.91	119.84	119.76	119.70
Feb	117.30	120.11	120.08	120.06	120.06	120.07	120.08	120.11
Mar	116.00	120.19	120.15	120.11	120.06	120.01	119.94	119.86
Apr	117.60	120.18	120.12	120.07	120.03	120.00	119.99	120.00
May	117.30	120.17	120.12	120.08	120.05	120.02	119.98	119.92
June	119.60	120.17	120.13	120.08	120.04	120.01	119.98	119.97
July	120.20	120.17	120.13	120.08	120.04	120.01	119.98	119.94
Aug	122.00	120.17	120.12	120.08	120.04	120.01	119.98	119.96
	MAD	22.32	22.30	22.27	22.25	22.24	22.22	22.21
	MSE	641.88	640.15	638.69	637.48	636.47	635.64	634.95

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	111.1	111.3	113.8	116.4	117.1	118.3	114.67
Feb	111	111.3	113.9	115.6	116.9	118.1	114.47
Mar	111.8	110.2	114.5	115.7	117.8	118.1	114.68
Apr	112	110.5	114.5	115.1	117.7	118.1	114.65
May	111.1	110.2	114.2	115.1	117.7	116.2	114.08
June	111.2	110.4	114.1	114.8	117.7	109.8	113.00
July	112.9	110.4	114.1	114.3	112.6	115.1	113.23
Aug	112.2	110.3	114	114.3	114.9	116.5	113.70
Sept	112.2	110.3	114.3	114.6	115.6	116.1	113.85
Oct	111.1	112.7	116	116.9	117.7	123.7	116.35
Nov	111.2	113.1	116.3	116.7	117.7	119.4	115.73
Dec	111.2	114.8	115.8	116.6	118.2	119.7	116.05

1997 FORECAST BY 96 (3 MO. MOVING AVERAGE)

	Index 97'	.3 .1 .6	.3 .2 .5	.3 .3 .4	.3 .4 .3	.3 .5 .2	.3 .6 .1
Jan	117.30	120.31	120.18	120.05	119.93	119.82	119.71
Feb	117.30	120.18	120.17	120.17	120.20	120.25	120.31
Mar	116.00	120.40	120.37	120.33	120.27	120.18	120.07
Apr	117.60	120.35	120.27	120.20	120.14	120.11	120.11
May	117.30	120.31	120.26	120.23	120.21	120.19	120.15
June	119.60	120.34	120.30	120.25	120.20	120.15	120.10
July	120.20	120.34	120.28	120.23	120.19	120.16	120.13
Aug	122.00	120.33	120.28	120.24	120.20	120.16	120.12
	MAD	22.44	22.42	22.40	22.38	22.37	22.36
	MSE	647.93	646.13	644.68	643.53	642.66	642.01

	1991	1992	1993	1994	1995	1996	Monthly Avg
Jan	111.1	111.3	113.8	116.4	117.1	118.3	114.67
Feb	111	111.3	113.9	115.6	116.9	118.1	114.47
Mar	111.8	110.2	114.5	115.7	117.8	118.1	114.68
Apr	112	110.5	114.5	115.1	117.7	118.1	114.65
May	111.1	110.2	114.2	115.1	117.7	116.2	114.08
June	111.2	110.4	114.1	114.8	117.7	109.8	113.00
July	112.9	110.4	114.1	114.3	112.6	115.1	113.23
Aug	112.2	110.3	114	114.3	114.9	116.5	113.70
Sept	112.2	110.3	114.3	114.6	115.6	116.1	113.85
Oct	111.1	112.7	116	116.9	117.7	123.7	116.35
Nov	111.2	113.1	116.3	116.7	117.7	119.4	115.73
Dec	111.2	114.8	115.8	116.6	118.2	119.7	116.05

1997 FORECAST BY 96 (3 MO. MOVING AVERAGE)

	Index 97'	.4 .1 .5	.4 .2 .4	.4 .3 .3	.4 .4 .2	.4 .5 .1
Jan	117.30	120.37	120.20	120.03	119.88	119.73
Feb	117.30	120.19	120.21	120.25	120.33	120.43
Mar	116.00	120.64	120.62	120.57	120.49	120.37
Apr	117.60	120.48	120.37	120.26	120.18	120.14
May	117.30	120.38	120.35	120.35	120.36	120.37
June	119.60	120.50	120.46	120.41	120.34	120.25
July	120.20	120.48	120.40	120.33	120.28	120.27
Aug	122.00	120.44	120.39	120.36	120.34	120.30
	MAD	22.54	22.53	22.51	22.50	22.50
	MSE	652.50	650.77	649.48	648.62	648.10

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	111.1	111.3	113.8	116.4	117.1	118.3	114.67
Feb	111	111.3	113.9	115.6	116.9	118.1	114.47
Mar	111.8	110.2	114.5	115.7	117.8	118.1	114.68
Apr	112	110.5	114.5	115.1	117.7	118.1	114.65
May	111.1	110.2	114.2	115.1	117.7	116.2	114.08
June	111.2	110.4	114.1	114.8	117.7	109.8	113.00
July	112.9	110.4	114.1	114.3	112.6	115.1	113.23
Aug	112.2	110.3	114	114.3	114.9	116.5	113.70
Sept	112.2	110.3	114.3	114.6	115.6	116.1	113.85
Oct	111.1	112.7	116	116.9	117.7	123.7	116.35
Nov	111.2	113.1	116.3	116.7	117.7	119.4	115.73
Dec	111.2	114.8	115.8	116.6	118.2	119.7	116.05

1997 FORECAST BY 96 (3 MO. MOVING AVERAGE)

	Index 97'	.5 .1 .4	.5 .2 .3	.5 .3 .2	.5 .4 .1
Jan	117.30	120.34	120.13	119.93	119.74
Feb	117.30	120.15	120.22	120.32	120.46
Mar	116.00	120.93	120.91	120.85	120.73
Apr	117.60	120.56	120.38	120.23	120.12
May	117.30	120.39	120.41	120.46	120.53
June	119.60	120.68	120.65	120.59	120.47
July	120.20	120.59	120.47	120.37	120.32
Aug	122.00	120.50	120.47	120.48	120.49
	MAD	22.63	22.62	22.62	22.62
	MSE	655.82	654.30	653.41	653.10

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	111.1	111.3	113.8	116.4	117.1	118.3	114.67
Feb	111	111.3	113.9	115.6	116.9	118.1	114.47
Mar	111.8	110.2	114.5	115.7	117.8	118.1	114.68
Apr	112	110.5	114.5	115.1	117.7	118.1	114.65
May	111.1	110.2	114.2	115.1	117.7	116.2	114.08
June	111.2	110.4	114.1	114.8	117.7	109.8	113.00
July	112.9	110.4	114.1	114.3	112.6	115.1	113.23
Aug	112.2	110.3	114	114.3	114.9	116.5	113.70
Sept	112.2	110.3	114.3	114.6	115.6	116.1	113.85
Oct	111.1	112.7	116	116.9	117.7	123.7	116.35
Nov	111.2	113.1	116.3	116.7	117.7	119.4	115.73
Dec	111.2	114.8	115.8	116.6	118.2	119.7	116.05

1997 FORECAST BY 96 (3 MO. MOVING AVERAGE)

	Index 97'	.6 .1 .3	.6 .2 .2	.6 .3 .1
Jan	117.30	120.23	119.99	119.75
Feb	117.30	120.10	120.23	120.40
Mar	116.00	121.29	121.27	121.17
Apr	117.60	120.54	120.29	120.09
May	117.30	120.35	120.45	120.60
June	119.60	120.93	120.91	120.79
July	120.20	120.64	120.45	120.31
Aug	122.00	120.49	120.54	120.63
	MAD	22.71	22.72	22.73
	MSE	657.98	656.93	656.80

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	111.1	111.3	113.8	116.4	117.1	118.3	114.67
Feb	111	111.3	113.9	115.6	116.9	118.1	114.47
Mar	111.8	110.2	114.5	115.7	117.8	118.1	114.68
Apr	112	110.5	114.5	115.1	117.7	118.1	114.65
May	111.1	110.2	114.2	115.1	117.7	116.2	114.08
June	111.2	110.4	114.1	114.8	117.7	109.8	113.00
July	112.9	110.4	114.1	114.3	112.6	115.1	113.23
Aug	112.2	110.3	114	114.3	114.9	116.5	113.70
Sept	112.2	110.3	114.3	114.6	115.6	116.1	113.85
Oct	111.1	112.7	116	116.9	117.7	123.7	116.35
Nov	111.2	113.1	116.3	116.7	117.7	119.4	115.73
Dec	111.2	114.8	115.8	116.6	118.2	119.7	116.05

1997 FORECAST BY 96 (3 MO. MOVING AVERAGE)

	Index 97'	.7 .1 .2	.7 .2 .1
Jan	117.30	120.04	119.76
Feb	117.30	120.05	120.25
Mar	116.00	121.74	121.69
Apr	117.60	120.38	120.05
May	117.30	120.28	120.52
June	119.60	121.31	121.24
July	120.20	120.56	120.27
Aug	122.00	120.44	120.64
	MAD	22.79	22.81
	MSE	659.06	658.95

	1991	1992	1993	1994	1995	1996	Monthly Avg.
Jan	111.1	111.3	113.8	116.4	117.1	118.3	114.67
Feb	111	111.3	113.9	115.6	116.9	118.1	114.47
Mar	111.8	110.2	114.5	115.7	117.8	118.1	114.68
Apr	112	110.5	114.5	115.1	117.7	118.1	114.65
May	111.1	110.2	114.2	115.1	117.7	116.2	114.08
June	111.2	110.4	114.1	114.8	117.7	109.8	113.00
July	112.9	110.4	114.1	114.3	112.6	115.1	113.23
Aug	112.2	110.3	114	114.3	114.9	116.5	113.70
Sept	112.2	110.3	114.3	114.6	115.6	116.1	113.85
Oct	111.1	112.7	116	116.9	117.7	123.7	116.35
Nov	111.2	113.1	116.3	116.7	117.7	119.4	115.73
Dec	111.2	114.8	115.8	116.6	118.2	119.7	116.05

1997 FORECAST BY 96 (3 MO. MOVING AVERAGE)

	Index 97'	.8 .1 .1
Jan	117.30	119.78
Feb	117.30	120.02
Mar	116.00	122.28
Apr	117.60	120.05
May	117.30	120.25
June	119.60	121.85
July	120.20	120.25
Aug	122.00	120.41
	MAD	22.87
	MSE	659.31

DECOMPOSITION MODEL

		Index #	Centered	Ratio	S. Factors	Adj. Sales
1991	Jan	111.10				
	Feb	111.00				
	Mar	111.80				
	Apr	112.00				
	May	111.10				
	Jun	111.20				
	Jul	112.90	111.59167	1.01	0.99004	114.03620
	Aug	112.20	111.61250	1.01	0.99133	113.18133
	Sep	112.20	111.55833	1.01	0.99260	113.03643
	Oct	111.10	111.42917	1.00	1.00452	110.59962
	Nov	111.20	111.32917	1.00	1.00477	110.67220
	Dec	111.20	111.25833	1.00	1.00732	110.39211
1992	Jan	111.30	111.12083	1.00	1.00774	110.44547
	Feb	111.30	110.93750	1.00	1.00537	110.70568
	Mar	110.20	110.77917	0.99	1.00557	109.59000
	Apr	110.50	110.76667	1.00	1.00370	110.09307
	May	110.20	110.91250	0.99	0.99788	110.43461
	Jun	110.40	111.14167	0.99	0.98542	112.03329
	Jul	110.40	111.39583	0.99	0.99004	111.51104
	Aug	110.30	111.60833	0.99	0.99133	111.26472
	Sep	110.30	111.89583	0.99	0.99260	111.12227
	Oct	112.70	112.24167	1.00	1.00452	112.19241
	Nov	113.10	112.57500	1.00	1.00477	112.56318
	Dec	114.80	112.89583	1.02	1.00732	113.96596
1993	Jan	113.80	113.20417	1.01	1.00774	112.92627
	Feb	113.90	113.51250	1.00	1.00537	113.29180
	Mar	114.50	113.83333	1.01	1.00557	113.86620
	Apr	114.50	114.13750	1.00	1.00370	114.07834
	May	114.20	114.40833	1.00	0.99788	114.44313
	Jun	114.10	114.58333	1.00	0.98542	115.78802
	Jul	114.10	114.73333	0.99	0.99004	115.24828
	Aug	114.00	114.91250	0.99	0.99133	114.99708
	Sep	114.30	115.03333	0.99	0.99260	115.15209
	Oct	116.00	115.10833	1.01	1.00452	115.47755
	Nov	116.30	115.17083	1.01	1.00477	115.74799
	Dec	115.80	115.23750	1.00	1.00732	114.95869
1994	Jan	116.40	115.27500	1.01	1.00774	115.50631
	Feb	115.60	115.29583	1.00	1.00537	114.98272
	Mar	115.70	115.32083	1.00	1.00557	115.05956
	Apr	115.10	115.37083	1.00	1.00370	114.67613
	May	115.10	115.42500	1.00	0.99788	115.34504
	Jun	114.80	115.47500	0.99	0.98542	116.49838
	Jul	114.30	115.53750	0.99	0.99004	115.45029
	Aug	114.30	115.62083	0.99	0.99133	115.29970
	Sep	114.60	115.76250	0.99	0.99260	115.45432
	Oct	116.90	115.95833	1.01	1.00452	116.37350
	Nov	116.70	116.17500	1.00	1.00477	116.14609
	Dec	116.60	116.40417	1.00	1.00732	115.75288

		Index #	Centered	Ratio	S. Factors	Adj. Sales
1995	Jan	117.10	116.45417	1.01	1.00774	116.20094
	Feb	116.90	116.40833	1.00	1.00537	116.27578
	Mar	117.80	116.47500	1.01	1.00557	117.14793
	Apr	117.70	116.55000	1.01	1.00370	117.26655
	May	117.70	116.62500	1.01	0.99788	117.95058
	Jun	117.70	116.73333	1.01	0.99004	118.88451
	Jul	112.60	116.85000	0.96	0.99133	113.58483
	Aug	114.90	116.95000	0.98	0.99260	115.75656
	Sep	115.60	117.01250	0.99	1.00452	115.07935
	Oct	117.70	117.04167	1.01	1.00477	117.14134
	Nov	117.70	116.99583	1.01	1.00732	116.84489
	Dec	118.20	116.60417	1.01	1.00774	117.29249
1996	Jan	118.30	116.37917	1.02	1.00537	117.66831
	Feb	118.10	116.55000	1.01	1.00557	117.44627
	Mar	118.10	116.63750	1.01	1.00370	117.66508
	Apr	118.10	116.90833	1.01	0.99788	118.35143
	May	116.20	117.22917	0.99	0.98542	117.91909
	Jun	109.80	117.36250	0.94	0.99004	110.90500
	Jul	115.10				
	Aug	116.50				
	Sep	116.10				
	Oct	123.70				
	Nov	119.40				
	Dec	119.70				

		Period	Centered	T Value	Cyclical
1991	Jul	1.00	111.59167	110.59	1.00903
	Aug	2.00	111.61250	110.70	1.00820
	Sep	3.00	111.55833	110.82	1.00670
	Oct	4.00	111.42917	110.93	1.00453
	Nov	5.00	111.32917	111.04	1.00262
	Dec	6.00	111.25833	111.15	1.00098
1992	Jan	7.00	111.12083	111.26	0.99875
	Feb	8.00	110.93750	111.37	0.99611
	Mar	9.00	110.77917	111.48	0.99369
	Apr	10.00	110.76667	111.59	0.99259
	May	11.00	110.91250	111.70	0.99291
	Jun	12.00	111.14167	111.82	0.99397
	Jul	13.00	111.39583	111.93	0.99525
	Aug	14.00	111.60833	112.04	0.99616
	Sep	15.00	111.89583	112.15	0.99774
	Oct	16.00	112.24167	112.26	0.99983
	Nov	17.00	112.57500	112.37	1.00181
	Dec	18.00	112.89583	112.48	1.00367
1993	Jan	19.00	113.20417	112.59	1.00542
	Feb	20.00	113.51250	112.70	1.00716
	Mar	21.00	113.83333	112.82	1.00902
	Apr	22.00	114.13750	112.93	1.01072
	May	23.00	114.40833	113.04	1.01212
	Jun	24.00	114.58333	113.15	1.01267
	Jul	25.00	114.73333	113.26	1.01300
	Aug	26.00	114.91250	113.37	1.01359
	Sep	27.00	115.03333	113.48	1.01366
	Oct	28.00	115.10833	113.59	1.01333
	Nov	29.00	115.17083	113.71	1.01289
	Dec	30.00	115.23750	113.82	1.01249
1994	Jan	31.00	115.27500	113.93	1.01183
	Feb	32.00	115.29583	114.04	1.01102
	Mar	33.00	115.32083	114.15	1.01026
	Apr	34.00	115.37083	114.26	1.00971
	May	35.00	115.42500	114.37	1.00920
	Jun	36.00	115.47500	114.48	1.00866
	Jul	37.00	115.53750	114.59	1.00823
	Aug	38.00	115.62083	114.71	1.00798
	Sep	39.00	115.76250	114.82	1.00824
	Oct	40.00	115.95833	114.93	1.00897
	Nov	41.00	116.17500	115.04	1.00987
	Dec	42.00	116.40417	115.15	1.01089
1995	Jan	43.00	116.45417	115.26	1.01035
	Feb	44.00	116.40833	115.37	1.00898
	Mar	45.00	116.47500	115.48	1.00858
	Apr	46.00	116.55000	115.59	1.00826
	May	47.00	116.62500	115.71	1.00794
	Jun	48.00	116.73333	115.82	1.00791
	Jul	49.00	116.85000	115.93	1.00795
	Aug	50.00	116.95000	116.04	1.00785
	Sep	51.00	117.01250	116.15	1.00742
	Oct	52.00	117.04167	116.26	1.00671
	Nov	53.00	116.99583	116.37	1.00535
	Dec	54.00	116.60417	116.48	1.00103

		Period	Centered	T Value	Cyclical
1996	Jan	55.00	116.37917	116.60	0.99815
	Feb	56.00	116.55000	116.71	0.99866
	Mar	57.00	116.63750	116.82	0.99846
	Apr	58.00	116.90833	116.93	0.99983
	May	59.00	117.22917	117.04	1.00162
	Jun	60.00	117.36250	117.15	1.00181
	Jul	61.00	117.41629	117.26	1.00131
	Aug	62.00	117.47008	117.37	1.00083
	Sep	63.00	117.52386	117.48	1.00034
	Oct	64.00	117.57765	117.60	0.99985
	Nov	65.00	117.63144	117.71	0.99936
	Dec	66.00	117.68523	117.82	0.99887

		Period	Centered	T Value	Cyclical
1996	Jul	67.00	117.73902	117.93	0.99839
	Aug	68.00	117.79280	118.04	0.99790
	Sep	69.00	117.84659	118.15	0.99742
	Oct	70.00	117.90038	118.26	0.99694
	Nov	71.00	117.95417	118.37	0.99646
	Dec	72.00	118.00796	118.48	0.99598
1997	Jan	73.00	118.06174	118.60	0.99550
	Feb	74.00	118.11553	118.71	0.99502
	Mar	75.00	118.16932	118.82	0.99454
	Apr	76.00	118.22311	118.93	0.99406
	May	77.00	118.27690	119.04	0.99359
	Jun	78.00	118.33068	119.15	0.99311
	Jul	79.00	118.38447	119.26	0.99264
	Aug	80.00	118.43826	119.37	0.99216
	Sep	81.00	118.49205	119.49	0.99169
	Oct	82.00	118.54584	119.60	0.99122
	Nov	83.00	118.59962	119.71	0.99075
	Dec	84.00	118.65341	119.82	0.99028

	Trend	Cyclical	Seasonal	Forecast(1997)
Jan	118.60	1.00	1.00774	118.98
Feb	118.71	1.00	1.00537	118.75
Mar	118.82	0.99	1.00557	118.83
Apr	118.93	0.99	1.00370	118.66
May	119.04	0.99	0.99788	118.03
Jun	119.15	0.99	0.98542	116.61
Jul	119.26	0.99	0.99004	117.20
Aug	119.37	0.99	0.99133	117.41
Sep	119.49	0.99	0.99260	117.62
Oct	119.60	0.99	1.00452	119.08
Nov	119.71	0.99	1.00477	119.17
Dec	119.82	0.99	1.00732	119.52