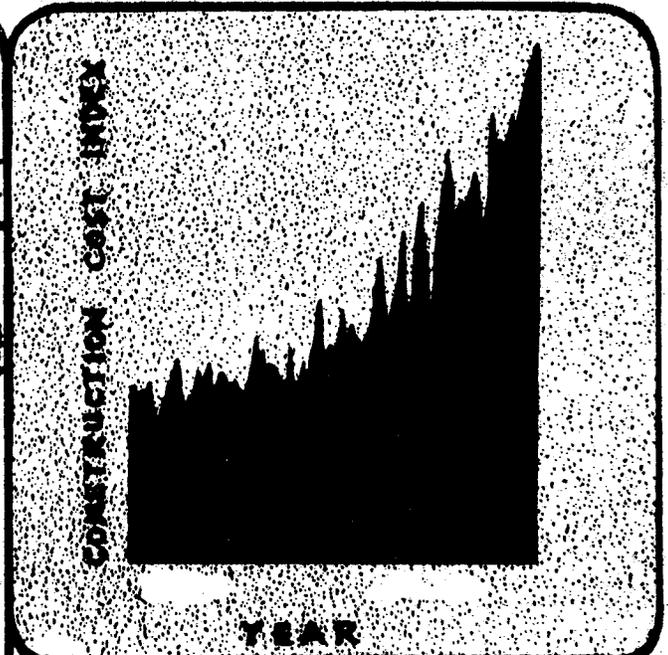
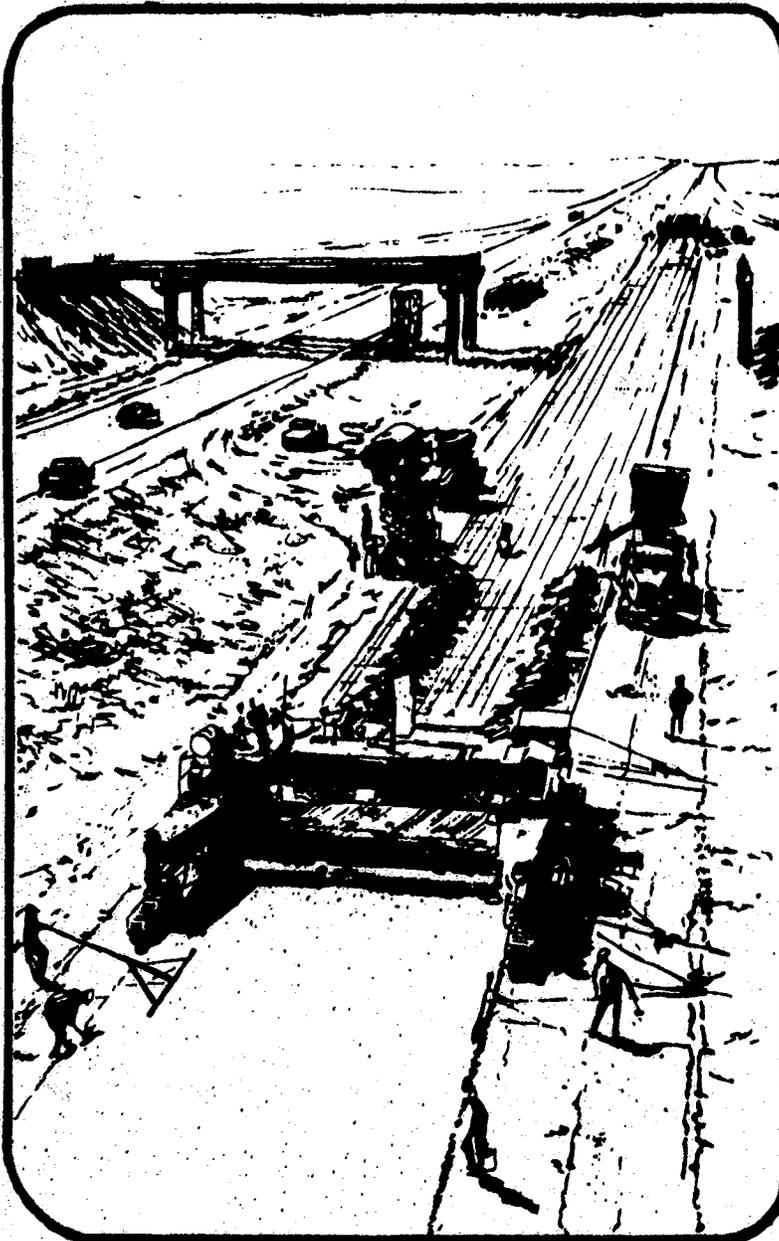


ENGINEERING ECONOMY AND ENERGY CONSIDERATIONS

CONSTRUCTION COST TRENDS

RESEARCH REPORT 214-29

JULY 1981



COOPERATIVE RESEARCH PROJECT
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"ENGINEERING, ECONOMY AND ENERGY
CONSIDERATIONS IN DESIGN,
CONSTRUCTION AND MATERIALS"

TEXAS STATE DEPARTMENT
OF HIGHWAYS
AND PUBLIC TRANSPORTATION

AND
TEXAS TRANSPORTATION INSTITUTE
TEXAS A&M UNIVERSITY

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CONSTRUCTION COST TRENDS

by

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Research Report 214-29

Sponsored by

State Department of Highways
and Public Transportation

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Texas Transportation Institute
Texas A&M University
College Station, Texas

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INTRODUCTION

Highway planning at both the project and network level requires the availability of current construction cost information as well as a methodology for predicting cost into the future. Current highway cost information for the United States and Texas is available from four main sources:

1. Federal Highway Administration (FHWA) (1, 2, 3)
2. Engineering News Record (ENR) (4)
3. U. S. Department of Labor, Bureau of Labor Statistics (5)
4. Texas State Department of Highways and Public Transportation (SDHPT) (6)

Current and historic cost data are summarized from those sources in this report.

Regression equations are being developed by the Texas Transportation Institute to predict future cost trends for highway construction. Those mathematical prediction models have not been finalized.

GENERAL COST INDICES

Four general cost matrixes are readily available in the published literature:

1. FHWA Highway Bid Price Index (1)
2. FHWA Maintenance and Operation Cost Trend Index (2)
3. ENR Construction Cost Index (4)
4. ENR Building Cost Index (4)

Historical summaries of the data are given in Tables 1, 2 and 3 and plotted in Figure 1. The base year (cost data on which index is normalized) for all FHWA and other U. S. governmental data is 1967. The ENR Construction Cost Index and Building Cost Index have a base year of 1913. All data have been reduced to a common 1967 base year for presentation in Figure 1.

Tables 1 to 3 and Figure 1 indicate that highway construction costs have increased substantially since 1967. Figure 2 and Table 4 indicate that construction costs have exceeded the rate of inflation experienced by consumer goods. For example, for the 7-year period since the Arab oil embargo (1973-1980), the Consumer Price Index has increased at an average annual rate of 9.2 percent while the FHWA Highway Bid Price Index has increased 12.5 percent.

COST INCREASES FOR SELECTED MATERIALS

Bid Prices Indices for selected materials used for highway construction are calculated by FHWA (1) and the Bureau of Labor Statistics (5). Data developed by FHWA are shown in Table 1 for the following items:

1. Common excavation,
2. Portland cement concrete surfacing material,
3. Bituminous concrete surfacing material,
4. Reinforcing steel for structures,
5. Structural steel and
6. Portland cement concrete for structures.

Figures 3 to 8 show the historical price trends associated with those items. Rates of inflation for the individual items are shown in Table 4. Those individual item construction costs have increased substantially since 1967 and have exceeded the rate of inflation experienced by consumer goods. For the period 1973-1980 the average annual rate of price increase for those items has been between 10.8 and 14.1 percent while the Consumer Price Index has increased 9.2 percent for the same period (Table 4).

A substantial portion of price increases of certain material can be attributed to the increased cost of funds for both manufacturing and transportation. Figures 9 and 10 show the increase in price for Mideast Crude Oil and rail transportation in the United States. For the period 1973 to 1980 Mideast Crude Oil has increased at an average annual rate of 45.7 percent while the rail freight rates for nonmetallic minerals and clay, concrete, glass and stone have increased 13.3 and 12.5 percent.

Table 4 indicates that bituminous concrete surfacing materials have experienced a relatively large annual rate of inflation for the period 1973 to 1980. Cost increases associated with transportation (Figure 10) and asphalt cement (Figure 11) account for a large portion of the increase in price of bituminous concrete as 50 to 60 percent of the total in-place price of this material is due to transportation and asphalt cement costs (9). During the 1973-80 period asphalt cement prices have increased at an average annual rate of nearly 25 percent (Figure 11).

PRICES IN TEXAS

FHWA published data (1) were utilized to prepare Figures 3 to 9 which show bid prices for Texas and Region 6 of the FHWA (Arkansas, Louisiana, New Mexico, Oklahoma and Texas) for selected construction items. Texas data can be compared with Region and United States average prices on those figures.

Common Excavation

Examination of Figure 3 indicates that bid prices in Texas were lower than the national average at the end of 1973, and were sharply higher at the end of 1974. Texas prices moderated during 1975, but rose sharply again by 1976, a downward trend occurred during 1977. Texas prices exceeded the Region and United States prices in 1979 and 1980.

Portland Cement Concrete

Texas once again had lower prices until 1974 (Figure 4). In 1974 the average annual contract price more than doubled. However, Texas prices were lower than the national average at the end of 1975. A sharp rise occurred by the end of 1976, and continued upward at a slower rate in 1977. Texas prices were below region prices in 1980.

Bituminous Concrete

Bid prices in Texas surpassed the national average at the end of

1971 and rose sharply in 1972 and 1973 (Figure 5). A precipitous rise occurred during 1974 and 1975, then fell off slightly in 1976 and rose moderately in 1977 with rapid growth for 1978 to 1980. A substantial price difference exists between Texas and the Region and United States prices (9).

Reinforcing Steel

Texas prices and national prices remained nearly the same during the study period (Figure 6). Each reached a peak at the end of 1974, with Texas prices much lower in 1975, and rising moderately through 1977 with substantial increases in 1979 to 1980.

Structural Steel

Texas and national prices were nearly identical until 1973, then Texas prices increased sharply being approximately 50 percent higher at the end of 1974 (Figure 7). A sharp decline in 1975 brought the prices close together at the end of 1975. They remained nearly constant in Texas in 1976, while national prices decreased. Texas prices rose sharply during the 1977 to 1979 period during which national prices rose moderately.

Structural Concrete

United States prices were 15 to 20 percent higher than Texas prices through 1972 then became nearly the same in 1973 (Figure 9). Texas prices dipped sharply by the end of 1975, then rose rapidly through 1980.

Texas Composite Highway Bid Price Index

The Texas composite price index is shown in Figure 2. Since 1973 the Texas index has deviated from the other United States indexes. The reasons for the deviations were not addressed in this study.

FUTURE TRENDS

Prediction of future price and costs for highway construction items is difficult but necessary for planning purposes. Historical trends have been widely utilized and in general give reasonable results provided major external factors do not affect the cost of the item. Dislocation in historical trends are noted for many highway construction items since 1973 due to inflation in all sectors of the economy caused by, among other factors, increased fuel costs and low productivity. The relative size (small one year, large the next year) of the highway program has also had an effect on bid prices in several states. When construction and rehabilitation programs are very large, costs will increase at a more rapid rate as compared to those times when the highway program is relatively small.

Predicted inflation rates for highway construction items are not readily available. Table 4 can be used as a basis for predicting future price and cost trends. Table 5 gives average annual rates of change for a number of economic indicators for the period 1981-1990. More recent information reviewed suggests that the inflation rate may be somewhat lower than that indicated on Table 5.

SUMMARY

Price and cost indices for highway construction and maintenance items have been presented. Construction material costs have in general increased more rapidly in Texas as compared to the immediate geographical region and the United States.

Reliable methods for predicting future cost trends are under study at the Texas Transportation Institute. Historical trend data have been analyzed and average annual inflation rates for a number of items have been calculated for the years 1970-1980, 1973-1980, 1975-1980 and 1979-1980. These rates often exceeded the rate associated with the Consumer Price Index.

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2. "Highway Maintenance and Operation Cost Trend Index", U. S. Department of Transportation, Federal Highway Administration, published yearly.
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8. U. S. News and World Report, June 23, 1980.
9. Epps, J. A. and Smoot, C. W., "Asphalt Concrete Price Escalation", Report 214-14, Texas Transportation Institute, August, 1980.
10. "Trends to Watch in This Decade", U. S. News and World Report, June 22, 1981 (based on research performed by Institute for the Future).

Table 1. Bid Price Trends on Federal Aid Highway Contracts.

	Exca- vation Price (y ³)	Index*	Surfacing			Structures				High- way Bid Price Index	ENR Build- ing Cost Index
			PCC Price (y ²)	Bit. Conc. Price (t)	Com- bined Index	Rein. Steel Price (1b)	Struc. Steel Price (1b)	Struc. Conc. Price (y ³)	Com- bined Index		
1967	0.54	100.0	4.43	6.47	100.0	0.131	0.247	70.30	100.0	100.0	100.0
1970	0.66	121.8	5.42	8.04	123.3	0.163	0.338	92.73	132.2	125.6	124.4
1971	0.67	123.8	6.06	8.54	134.5	0.177	0.348	92.02	138.5	131.7	141.1
1972	0.72	133.4	6.25	9.22	141.9	0.181	0.342	100.17	140.6	138.2	156.0
1973 Av.	.80	147.1	6.87	9.99	154.8	0.207	0.373	111.83	156.5	152.4	169.3
Q1	0.67	124.7	6.57	9.85	150.3	0.181	0.295	109.34	141.9	137.8	
Q2	.75	138.0	6.36	9.90	148.2	0.193	0.352	113.51	153.4	145.9	
Q3	.81	149.5	7.10	9.61	154.7	0.212	0.422	110.60	162.1	155.1	
Q4	.93	172.7	7.43	10.83	167.7	0.233	0.379	113.51	162.0	167.8	
1974 Av.	1.00	184.1	8.67	14.74	211.3	0.340	0.551	136.80	214.5	201.8	119.2
Q1	.97	179.1	8.17	13.28	194.6	0.281	0.459	129.64	190.2	187.4	
Q2	.96	178.0	8.48	15.77	216.8	0.342	0.555	137.07	215.4	201.4	
Q3	1.02	187.9	8.82	14.64	212.4	0.371	0.577	152.57	233.7	209.7	
Q4	1.03	190.6	9.10	15.18	219.7	0.362	0.648	130.33	224.1	209.9	
1975 Av.	1.03	190.6	8.62	15.13	213.8	0.297	0.554	138.76	210.5	203.8	194.3
Q1	1.02	188.1	9.84	13.95	219.1	0.332	0.577	140.93	219.7	207.3	
Q2	1.00	184.9	8.22	14.35	203.2	0.320	0.542	139.85	213.1	199.3	
Q3	1.02	188.8	8.49	15.58	215.5	0.283	0.556	142.13	211.5	203.9	
Q4	1.10	202.6	9.00	16.41	227.7	0.277	0.548	131.90	207.9	209.8	
1976 Av.	1.03	191.2	8.65	15.07	213.7	0.257	0.493	138.75	198.1	200.4	212.1
Q1	1.04	192.0	7.70	16.28	212.3	0.251	0.543	133.72	199.3	200.3	
Q2	1.05	194.3	8.56	14.13	205.5	0.242	0.510	145.65	203.1	200.4	
Q3	1.03	191.1	9.18	15.12	219.4	0.264	0.438	135.28	189.6	199.0	
Q4	1.01	187.3	9.17	14.76	217.4	0.271	0.481	141.34	200.4	200.4	

Table 1. (continued)

	Exca- vation Price (y ³)	Index *	Surface			Structures				High- way Bid Price Index	ENR Build- ing Cost Index**
			PCC Price (y ²)	Bit. Conc. Price (t)	Com- bined Index	Rein. Stee. Price (lb)	Struc. Steel Price (lb)	Struc. Conc. Price (y ³)	Com- bined Index		
1977 Av.	1.16	215.2	9.68	15.47	228.4	0.272	0.520	143.51	206.8	216.4	229.9
Q1	1.03	189.8	8.69	14.88	212.6	0.262	0.562	139.60	207.6	202.2	
Q2	1.16	214.6	9.41	15.29	224.1	0.268	0.499	149.54	208.3	215.4	
Q3	1.19	219.5	10.05	15.32	231.8	0.273	0.462	139.42	196.9	215.9	
Q4	1.29	237.7	10.32	16.94	247.1	0.285	0.536	148.34	214.1	233.0	
1978 Av.	1.54	233.7	11.49	17.15	262.3	0.315	0.603	172.41	244.4	264.9	249.1
Q1	1.13	209.1	9.68	16.10	233.3	0.283	0.563	151.43	219.4	219.5	
Q2	1.43	263.8	11.96	17.54	270.6	0.310	0.570	171.78	239.5	258.1	
Q3	1.84	339.8	12.04	17.11	268.4	0.346	0.638	198.97	268.9	296.1	
Q4	1.90	350.3	13.06	18.09	237.5	0.334	0.681	176.17	259.0	302.7	
1979 Av.(p)	1.62	298.7	13.47	21.21	315.7	0.421	0.759	220.28	313.1	308.3	270.7
Q1	1.48	278.2	11.59	18.35	272.3	0.381	0.737	195.60	286.6	277.2	
Q2	1.54	284.7	12.91	20.72	305.4	0.411	0.749	202.82	297.5	294.9	
Q3	1.81	334.9	15.09	22.08	341.1	0.429	0.755	215.41	310.1	328.8	
Q4(p)	1.86	343.6	16.85	23.67	373.6	0.489	0.804	240.14	342.6	352.1	
1980 Av.	1.83	338.3	14.69	25.29	360.5	0.483	0.941	226.68	348.0	347.9	289.1
Q1	1.84	339.7	12.34	23.89	322.5	0.472	0.894	234.32	346.7	336.9	
Q2	1.89	350.1	16.29	25.81	383.0	0.515	1.063	206.12	351.4	360.2	
Q3	1.72	317.0	15.78	26.28	380.5	0.475	0.792	250.66	347.2	345.4	
Q4	1.89	349.4	14.75	25.36	361.7	0.467	0.834	234.63	339.1	349.7	
1981 Av.											
Q1	1.73	320.4	15.10	24.75	359.3	0.455	0.847	245.17	240.4	346.2	

*1967 Base Year

After Reference 1 and 4

Table 2. Cost Trends.

Highway Maintenance and Operation¹

1967 = Base Year

Year	Labor	Material	Equipment	Overhead	Total
1950	43.58	74.53	57.66	57.07	51.31
1951	47.76	81.07	64.34	62.23	56.41
1952	51.15	81.99	66.86	65.05	59.28
1953	52.00	82.54	68.76	65.73	60.33
1954	54.89	83.49	70.40	66.42	62.55
1955	55.94	82.80	74.24	67.71	64.09
1956	58.70	86.91	74.06	70.55	66.31
1957	63.20	60.86	75.66	78.22	70.28
1958	65.74	92.27	78.91	81.21	72.90
1959	67.82	92.40	83.15	81.88	75.17
1960	71.02	94.68	86.98	84.19	78.35
1961	73.25	95.18	87.19	85.08	79.82
1962	76.06	96.66	88.76	86.47	82.09
1963	79.46	96.87	89.25	88.05	84.32
1964	81.79	97.48	91.25	89.98	86.35
1965	85.69	99.23	94.23	92.31	89.66
1966	98.02	99.68	96.70	96.28	97.76
1967	100.00	100.00	100.00	100.00	100.00
1968	103.63	102.03	100.42	105.03	102.79
1969	113.71	106.24	104.24	110.24	110.44

Table 2. (Continued).

Year	Labor	Material	Equipment	Overhead	Total
1970	122.02	111.03	106.56	116.81	116.78
1971	129.67	117.37	107.93	122.76	122.68
1972	138.21	124.27	119.98	128.71	131.68
1973	148.04	130.42	133.70	134.66	141.75
1974	160.67	170.41	153.50	140.61	158.65
1975	173.15	198.74	170.58	145.56	172.97
1976	192.99	192.74	184.37	152.51	188.08
1977	211.89	202.66	194.17	158.51	202.92
1978	226.70	233.41	208.63	164.41	218.80
1979	242.63	276.14	234.64	170.37	239.79

¹These data are prepared for the unit cost information submitted each year by State highway departments, and cover both physical maintenance and major traffic service items including snow and ice control. Previous issues of this table used base period 1957-1959.

1967 Base Year

After Reference 2

Table 3. ENR Construction Cost Index History 1960-1981*.

	Monthly												Annual Average
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
1960	812	813	813	815	823	827	829	830	831	830	830	831	824
1961	834	834	834	838	847	850	854	854	854	854	855	855	847
1962	855	858	861	863	872	873	877	881	881	880	880	880	872
1963	883	883	884	885	894	899	909	914	914	916	914	915	901
1964	918	920	922	926	930	935	945	948	947	948	948	948	936
1965	948	957	958	957	958	969	977	984	986	986	986	988	971
1966	988	997	998	1006	1014	1029	1031	1033	1034	1032	1033	1034	1019
1967	1039	1041	1043	1044	1059	1068	1078	1089	1092	1096	1097	1098	1070
1968	1107	1114	1117	1124	1142	1154	1158	1171	1186	1190	1191	1201	1155
1969	1216	1229	1238	1249	1258	1270	1283	1292	1285	1299	1305	1305	1269
1970	1309	1311	1314	1329	1351	1375	1414	1418	1421	1434	1445	1445	1385
1971	1465	1467	1496	1513	1551	1589	1618	1629	1654	1657	1665	1672	1581
1972	1686	1691	1697	1707	1735	1761	1772	1777	1786	1794	1808	1816	1753
1973	1838	1850	1859	1874	1880	1896	1901	1902	1929	1933	1935	1938	1895
1974	1940	1940	1940	1961	1961	1993	2040	2076	2089	2100	2094	2101	2020
1975	2103	2128	2128	2135	2164	2205	2248	2274	2275	2293	2292	2297	2212
1976	2305	2314	2322	2327	2357	2410	2414	2445	2465	2478	2486	2490	2401
1977	2494	2505	2513	2514	2515	2541	2579	2611	2644	2675	2659	2669	2577
1978	2672	2681	2693	2698	2733	2753	2821	2829	2851	2851	2861	2869	2776
1979	2872	2877	2886	2886	2889	2984	3052	3071	3120	3122	3131	3140	3003
1980	3132	3134	3159	3143	3139	3198	3260	3304	3319	3327	3357	3376	3237
1981	3372	3373	3384										

How ENR builds the Index: 200 hours of common labor at the 20-cities average rate, plus 25 cwt of standard structural steel shapes at the mill price, plus 22.56 cwt (1.128 tons) of portland cement at the 20-cities average price, plus, 1,088 board feet of 2 x 4 lumber at the 20-cities average price.

* 1913 Base Year

After Reference 4.

Table 4. Annual Rates of Inflation for Various Construction and Maintenance Items.

Item or Index		Annual Rate of Inflation for Years Indicated			
		70-80	73-80	75-80	79-80
FHWA U.S. Composite Price Index	(1)	10.7	12.5	11.2	12.8
FHWA U.S. Common Excavation Index	(1)	10.7	12.5	12.1	13.3
FHWA U.S. Portland Cement Concrete Surfacing Index	(1)	10.5	11.5	11.2	9.1
FHWA U.S. Bituminous Concrete Surfacing Index	(1)	12.1	14.1	10.8	19.2
FHWA U.S. Reinforcing Steel Index	(1)	11.4	12.8	10.1	14.7
FHWA U.S. Structural Steel Index	(1)	10.7	14.1	11.1	24.0
FHWA U.S. Structural Concrete Index	(1)	9.4	10.8	10.2	2.9
FHWA Texas Composite Price Index	(1)	15.6	16.6	15.9	8.1
FHWA Texas Common Excavation Index	(1)	15.3	15.1	17.3	-2.8
FHWA Texas Portland Cement Concrete Surfacing Index	(1)	14.4	15.7	14.1	-4.3
FHWA Texas Bituminous Concrete Surfacing Index	(1)	19.5	19.7	13.0	22.9
FHWA Texas Reinforcing Steel Index	(1)	12.4	13.5	15.9	6.2
FHWA Texas Structural Steel Index	(1)	13.5	15.6	14.4	-0.5
FHWA Texas Structural Concrete Index	(1)	15.0	17.8	20.4	30.3
FHWA Maintenance Total Index	(2)	8.1	8.9	8.6	9.6
FHWA Maintenance Labor Index	(2)	7.9	8.4	8.6	7.0
FHWA Maintenance Material Index	(2)	10.0	12.1	10.1	18.3
FHWA Maintenance Equipment Index	(2)	8.5	10.3	8.8	12.5
FHWA Maintenance Overhead Index	(2)	4.8	4.1	4.0	3.6
ENR Construction Cost Index	(4)	8.9	8.0	7.9	7.8
ENR Building Cost Index	(4)	8.8	8.0	8.2	6.8
U.S. - Paving Asphalt	(5)		25.8	15.6	34.6
U.S. - Portland Cement	(5)		12.3	9.9	9.5
U.S. - Sand, Gravel & Crushed Stone	(5)		9.6	9.4	14.8
U.S. - Imported Mideast Crude Oil	(8)		45.7	21.8	113.3
U.S. - Railroad Freight (Nonmetallic minerals)	(5)	11.1	13.3	12.6	19.9
U.S. - Railroad Freight (clay, concrete, glass, stone)	(5)	10.5	12.5	11.4	17.3
U.S. - Consumer Price Index	(7)	7.9	9.2	8.9	13.4

Table 5. Predicted Inflation Rates 1981-1990.

Economic Indicator	Average Annual Rates of Change, Percent
Consumer Price Index	9.0
Fuel	15.0
International Commodity Prices (non fuel)	13.0
Average hourly wages	10.0
Farm Prices	8.0
Transportation Equipment	7.5
Furniture, household durable goods	7.0

After Reference 10

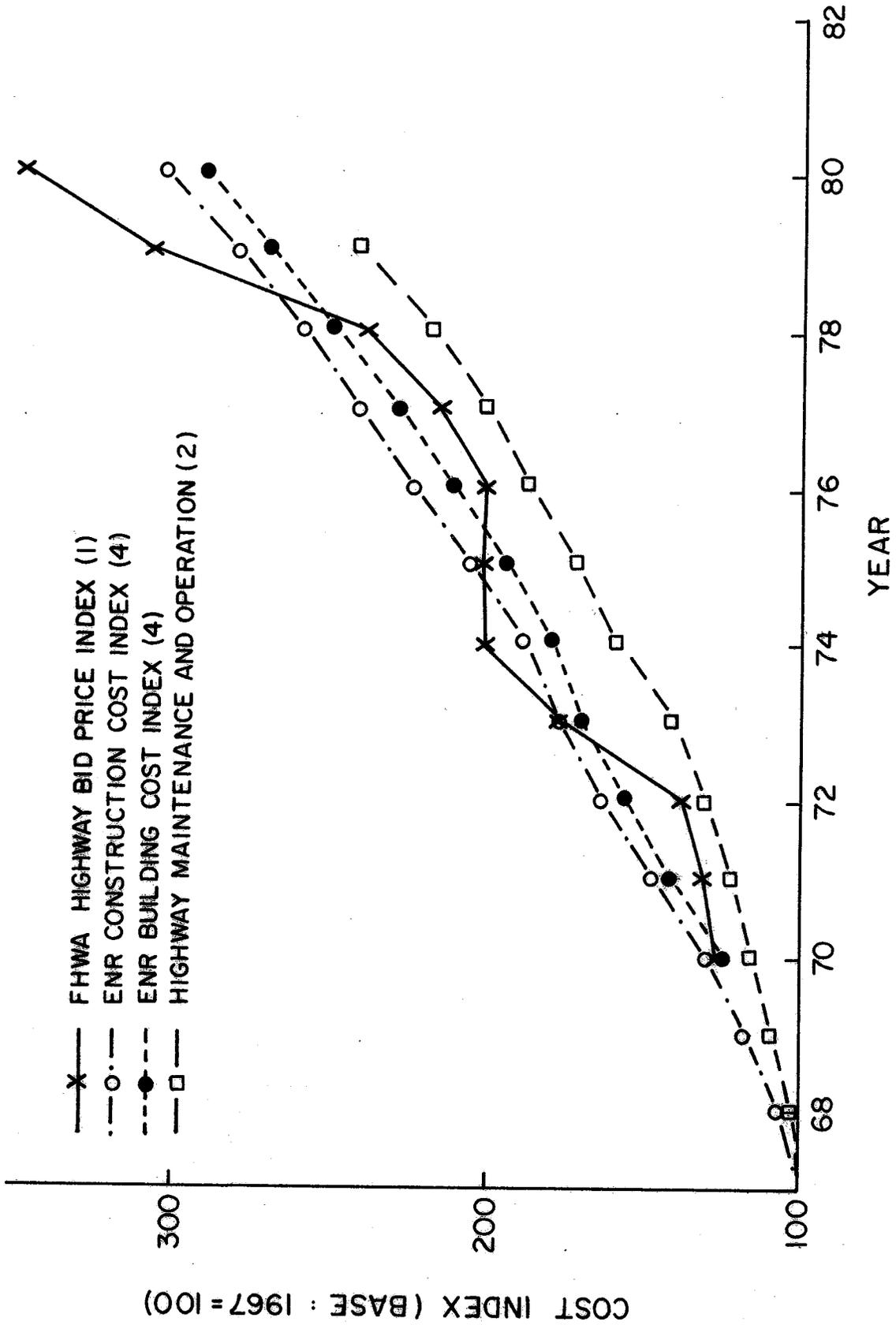


FIGURE 1. GENERAL CONSTRUCTION COST INDEXES

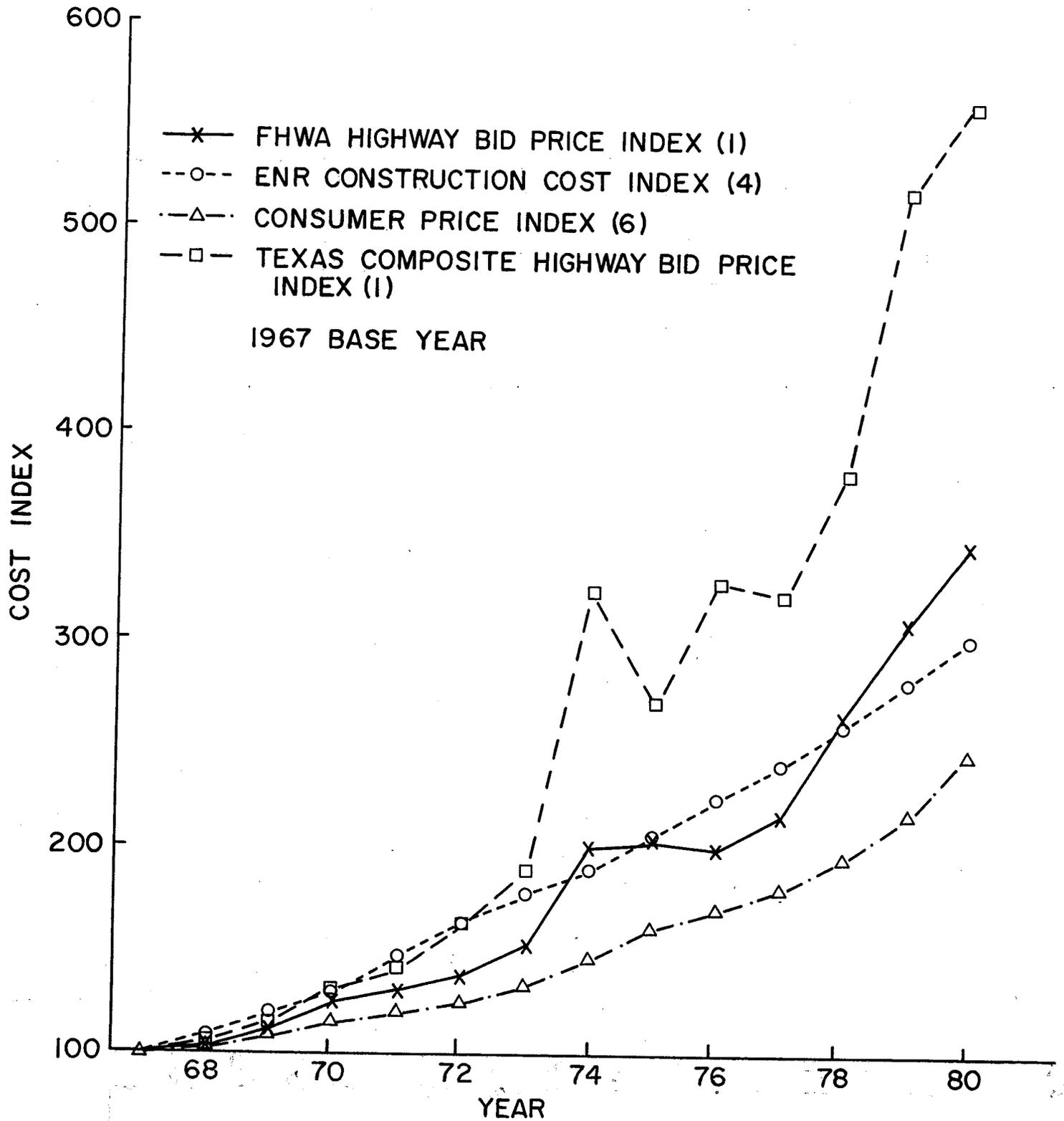


FIGURE 2. A COMPARISON AMONG CONSTRUCTION COST INDEXES AND CONSUMER PRICE INDEX

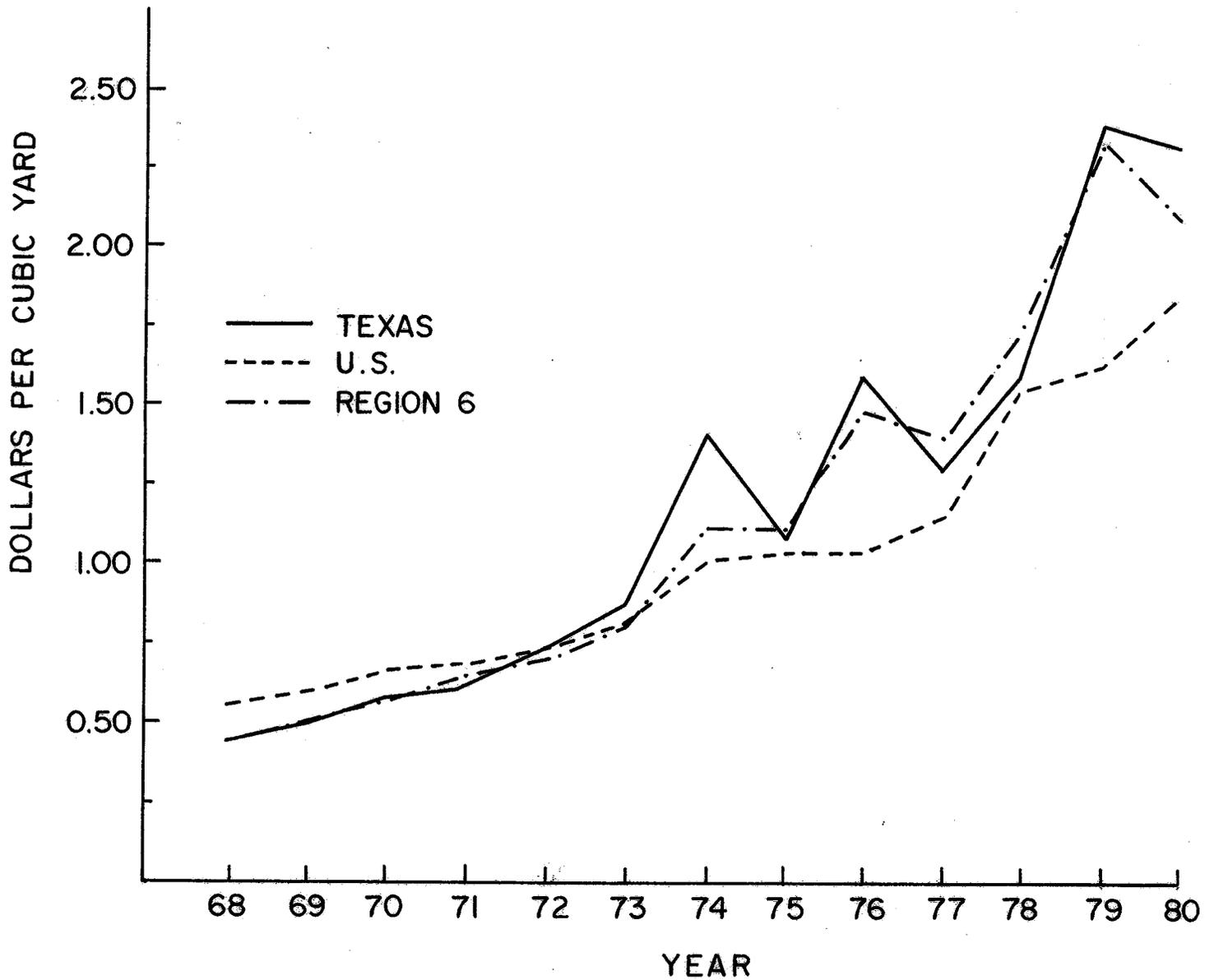


FIGURE 3. AVERAGE ANNUAL CONTRACT PRICE FOR COMMON EXCAVATION

(AFTER REFERENCE 1)

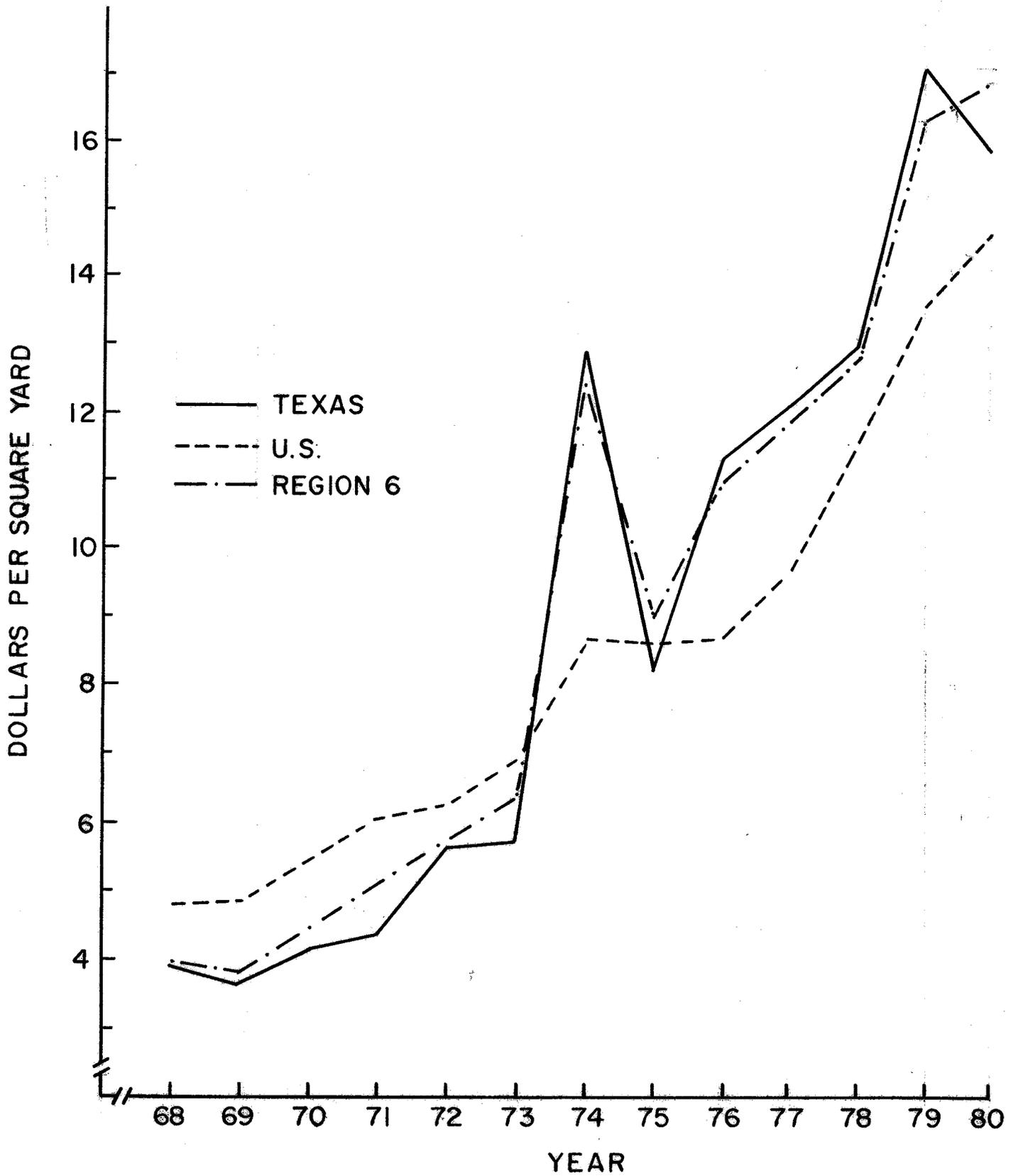


FIGURE 4. AVERAGE ANNUAL CONTRACT PRICE FOR PORTLAND CEMENT CONCRETE PAVEMENT

(AFTER REFERENCE 1)

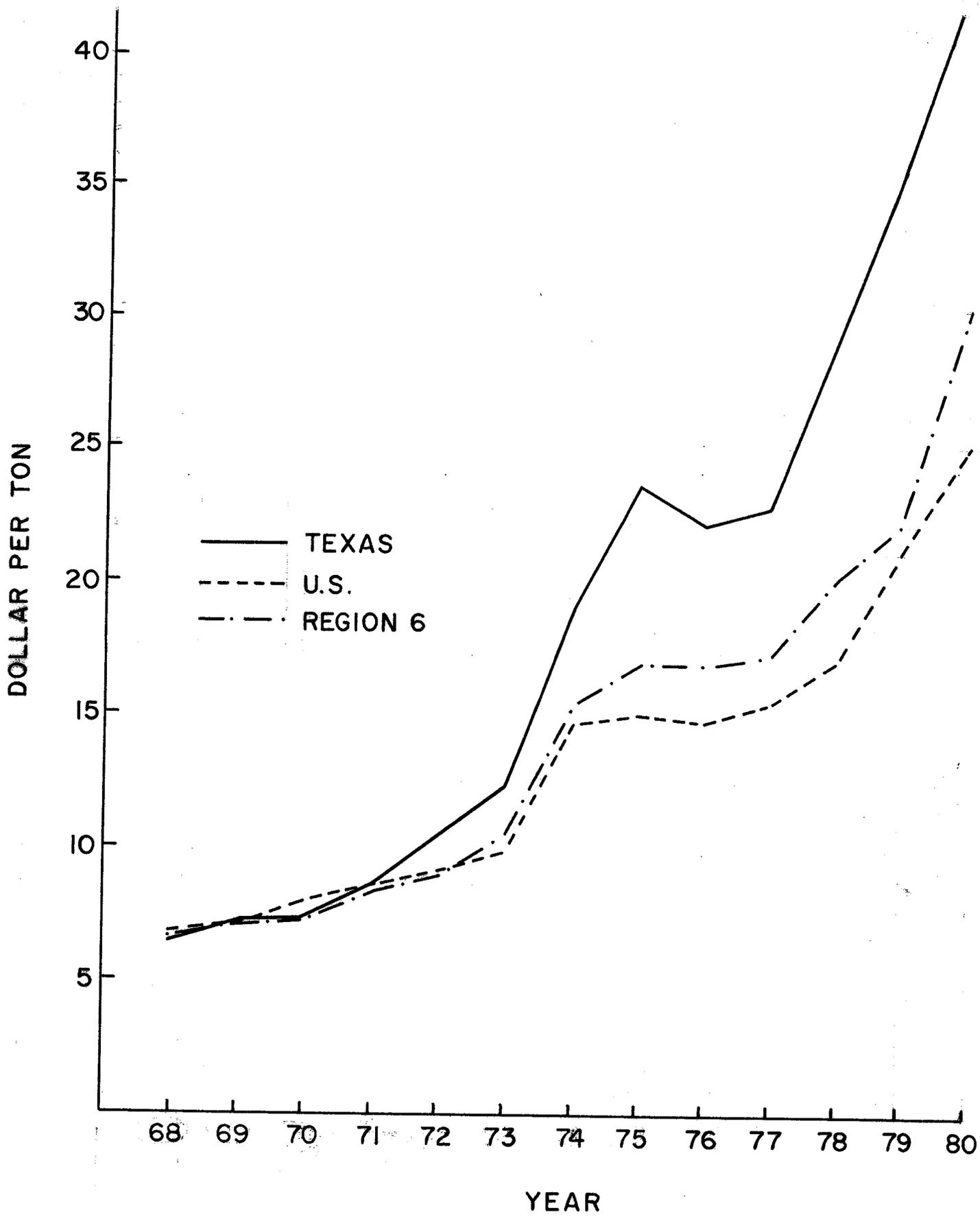


FIGURE 5. AVERAGE ANNUAL CONTRACT PRICE FOR BITUMINOUS CONCRETE

(AFTER REFERENCE 1)

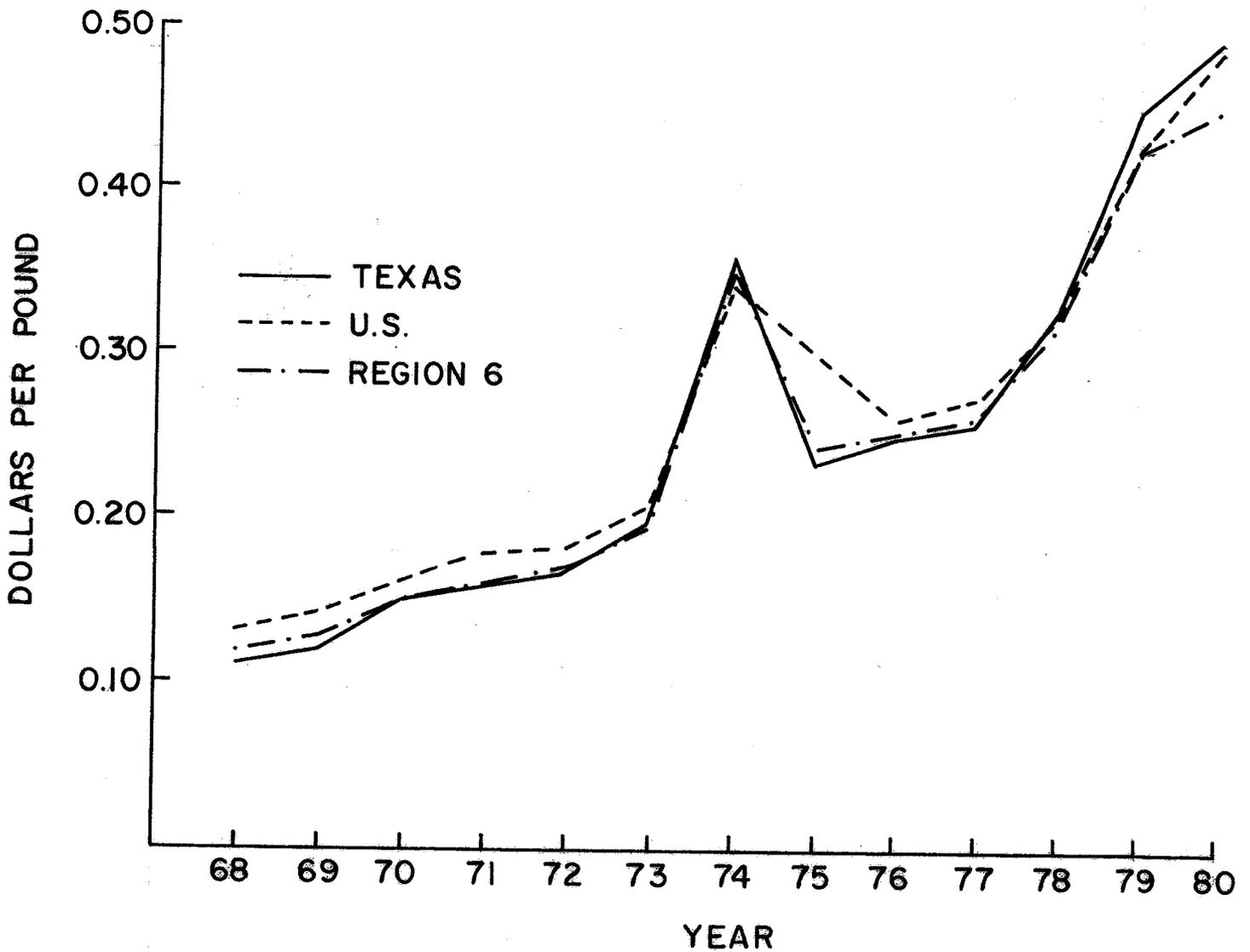


FIGURE 6. AVERAGE ANNUAL CONTRACT PRICE FOR REINFORCING STEEL

(AFTER REFERENCE 1)

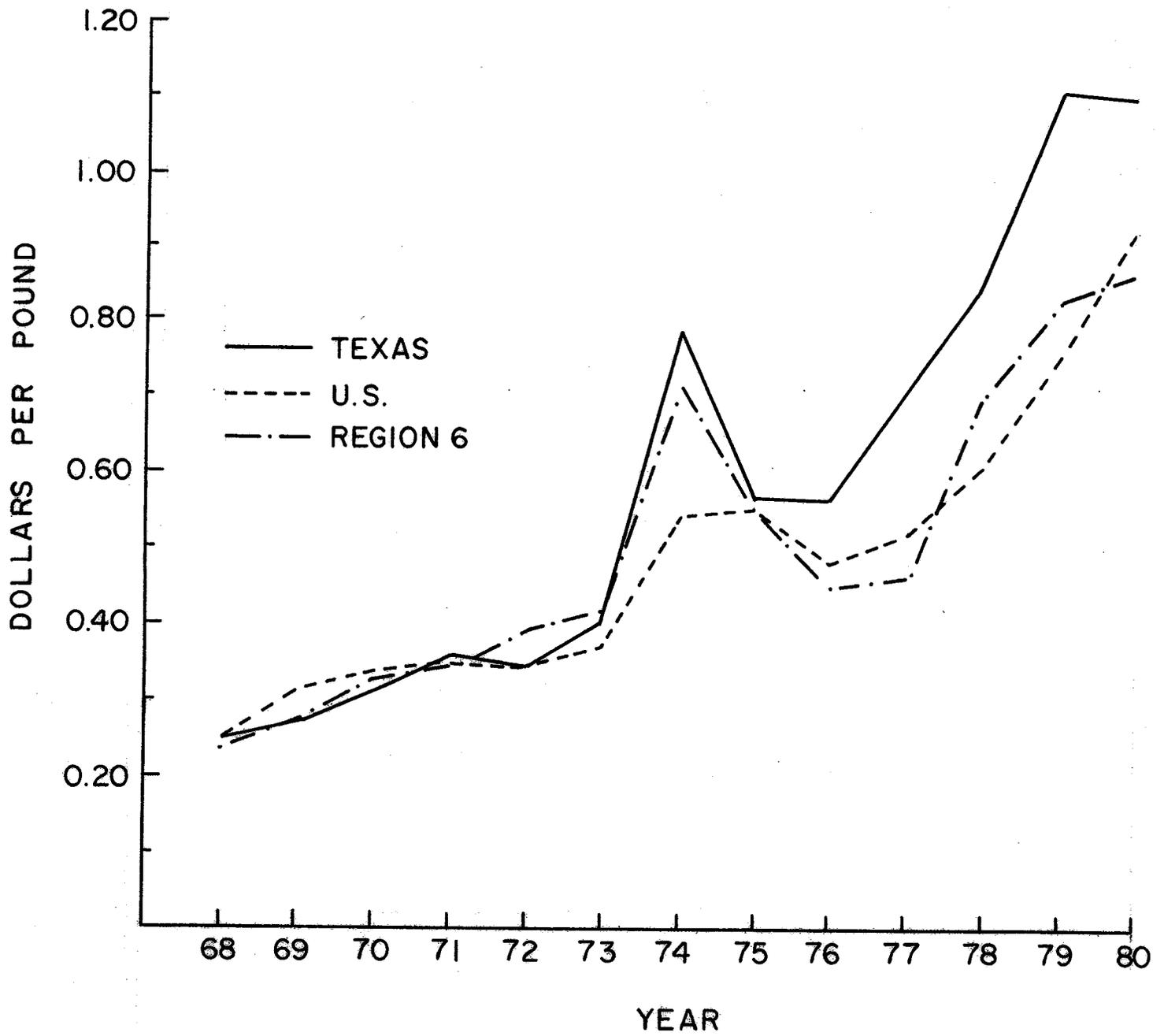


FIGURE 7. AVERAGE ANNUAL CONTRACT PRICE FOR STRUCTURAL STEEL

(AFTER REFERENCE 1)

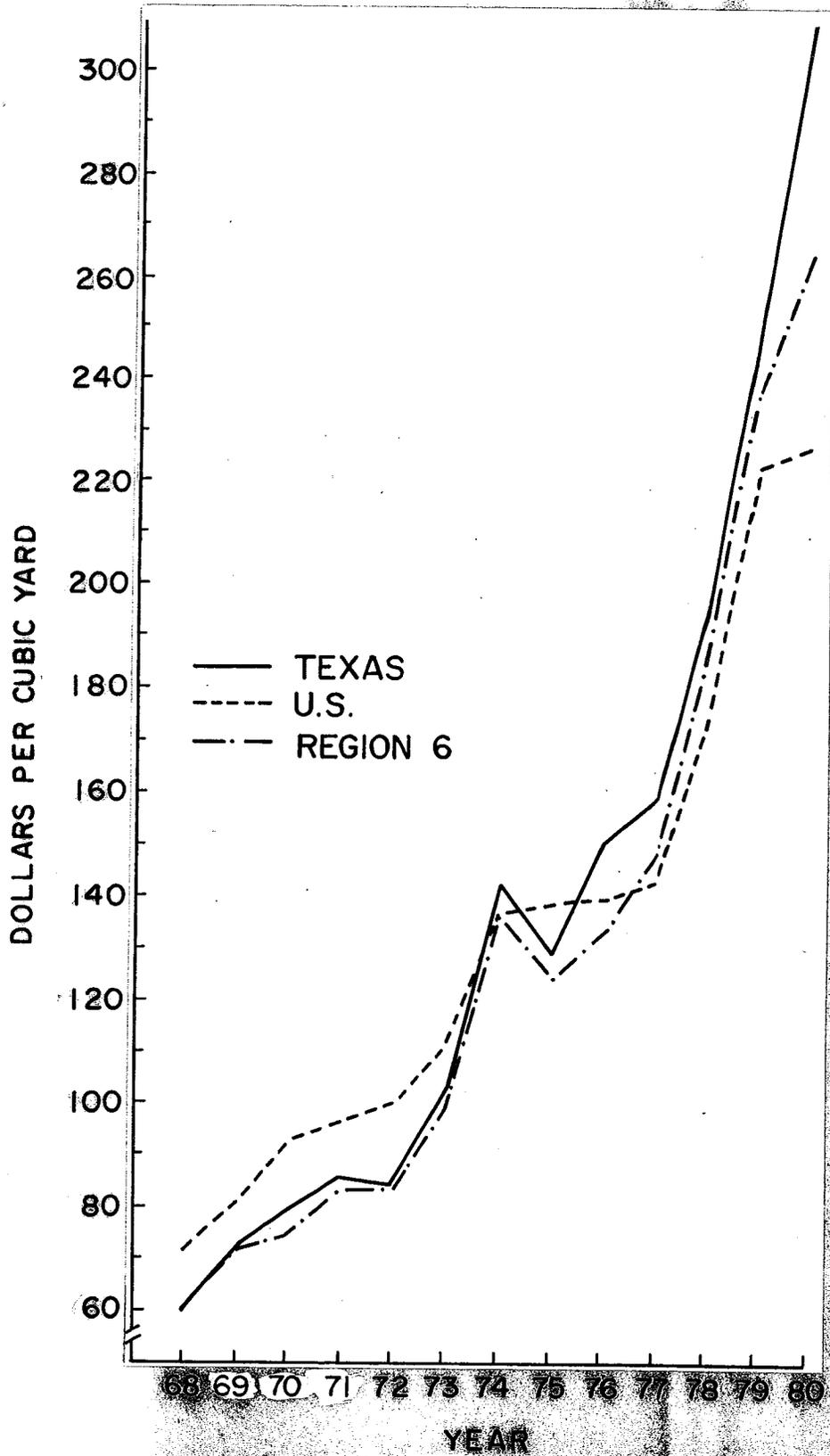


FIGURE 8. AVERAGE ANNUAL CONTRACT PRICE FOR STRUCTURAL CONCRETE (AFTER REFERENCE 1)

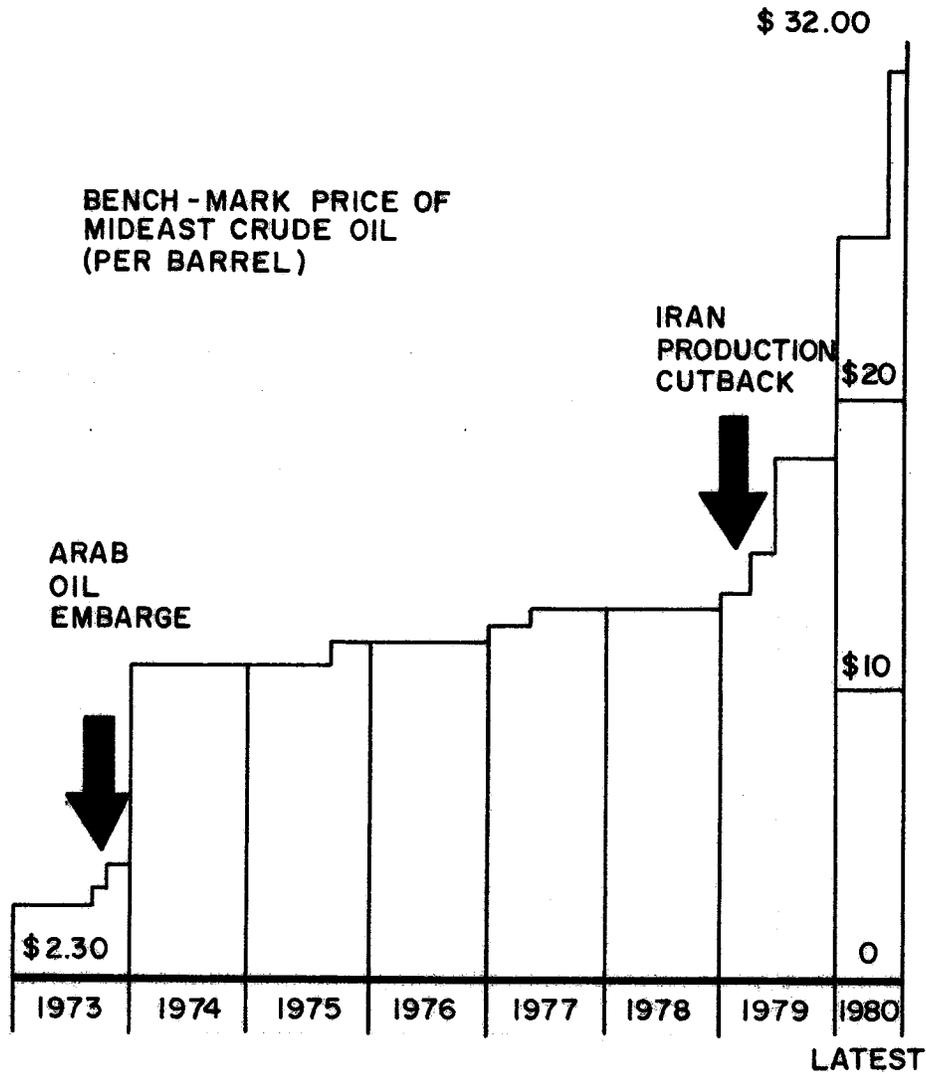


FIGURE 9. IMPORTED MIDEAST CRUDE OIL PRICE TRENDS 1973 TO 1980 (AFTER REFERENCE 8)

NOTE: PRICE EXCLUDES SHIPPING COST TO U.S.

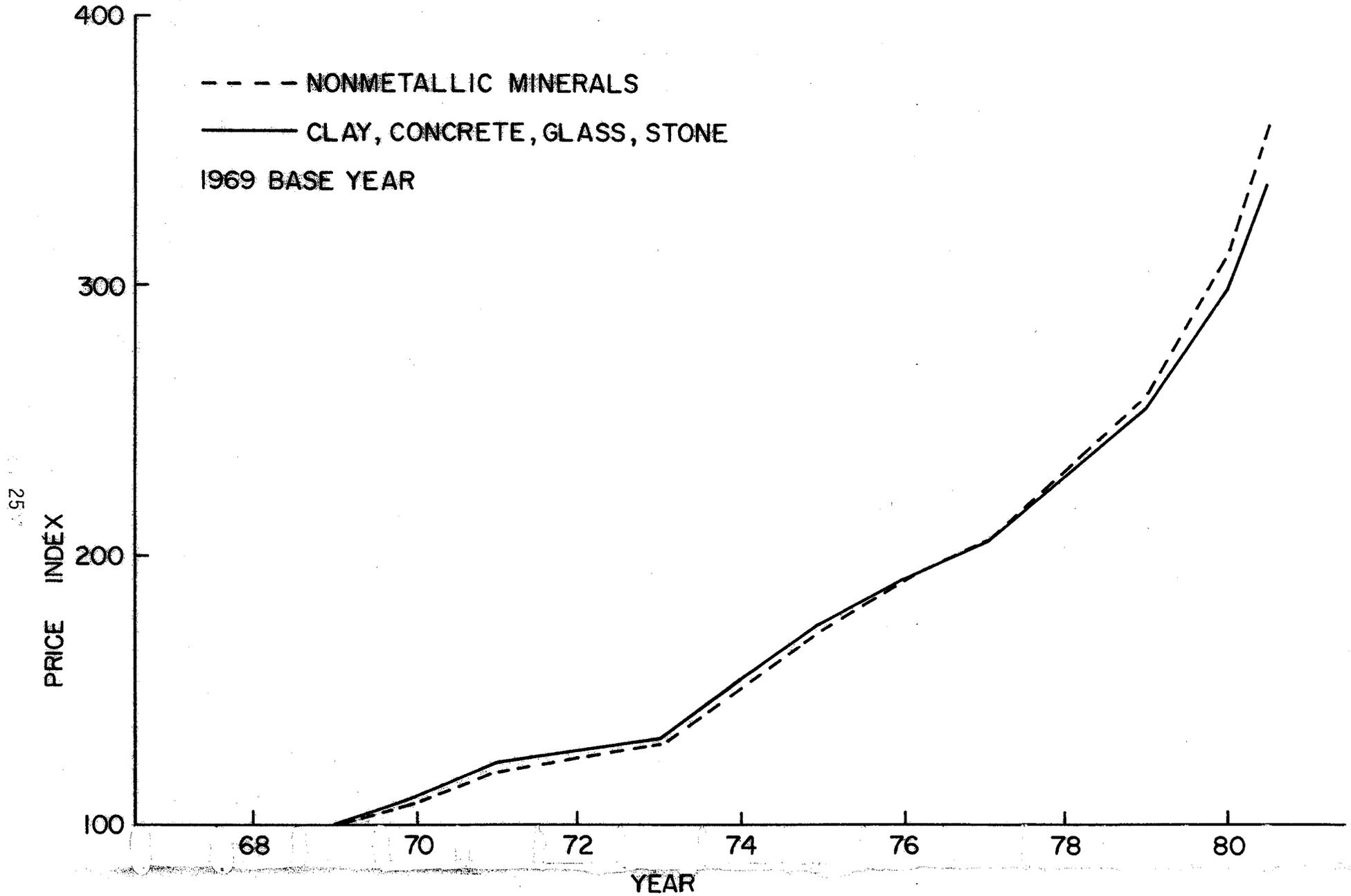


FIGURE 10. UNITED STATES PRICE INDEX FOR RAILROAD FREIGHT

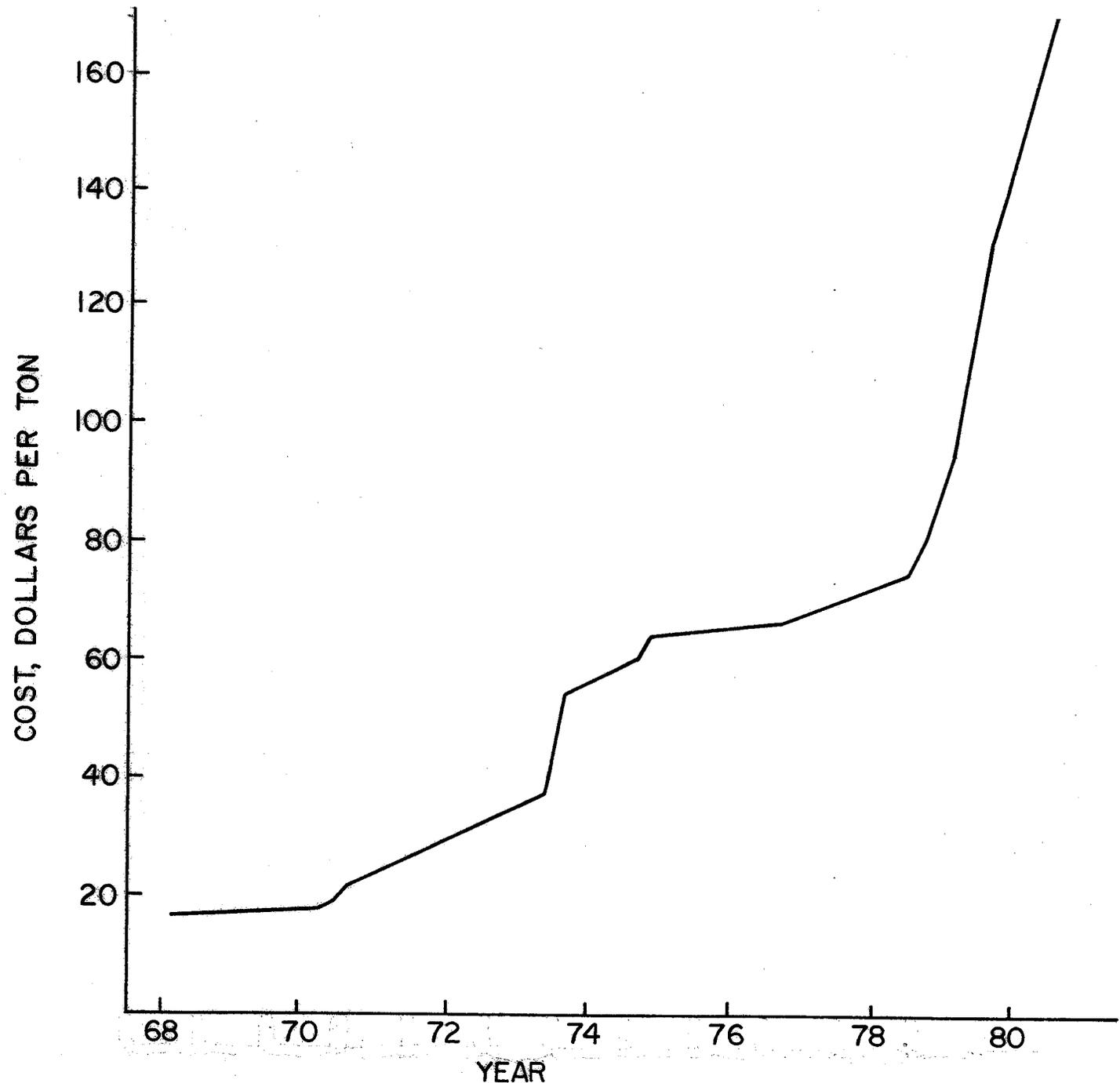


FIGURE II. POSTED PRICE OF AC-10/20 ASPHALT CEMENT - TEXAS (AFTER REFERENCE 9)