The Effects of Freeway Construction on Auto Sales

Determining Consequential Damages for Eminent Domain Appraisal

■

By Charles A. Smith, Ph.D. and David W. Durr, Ph.D.

Introduction

This article examines the influence that freeway construction, traffic counts, and other area demographic variables have on an automobile dealership's ability to generate sales. Specifically, this study tests whether such variables positively or negatively impact a dealership's volume of car/truck sales.

The real estate and business valuation implications of this research are clear. Vehicle sales translate into cash flows, which directly impact the value of the property from an income approach. The study has practical applications for right of way appraisers who estimate consequential damages for eminent domain appraisal work, as well as for other commercial real estate appraisers.

The car/truck market in Harris County, Texas from 1982 through 1992 is the focus of this study. Specific site and freeway characteristics for dealerships located on major traffic arteries were obtained. An ordinary least squares regression was used to determine the significance of these characteristics in explaining vehicle sales.

The findings reported here suggest that freeway construction does not adversely affect vehicle sales volume. Vehicle brand is a highly significant determinant of sales volume. Building size is also positively related to sales volume; however, the age of an automobile dealer's facilities is found to detract from sales. This research, therefore, makes a relevant contribution to valuation literature as well as to the practical aspects of real estate appraisal.

Motivation for the Study

A basic principle of real estate valuation suggests that maximum asset value is achieved when agents of production (labor, capital, coordination and land) are in economic balance. Since real property is unique, there is a theoretical equilibrium for every property that will produce the greatest net return. Related to that idea is the

principle of increasing and decreasing returns. Increasing the amounts of agents in production generate greater net income up to a certain level. At that point maximum value has been attained and further expenditures will not produce a return commensurate with additional investments.

Real estate appraisers are often called upon to determine the size and character of the structural improvements that will enable a property to attain the greatest value.

An imbalance in the optimal mix of production factors will produce disequilibrium. One example of an imbalance is when a building represents an underimprovement or overimprovement of its site[1]. An external property influence may create an imbalance as well. An example of an external influence is temporary road construction on streets and major thoroughfares.

One might speculate that forced circuitry of travel, inconvenient detours, and travel time delays adversely affect the optimal mix of production factors, and thus negatively impact real estate values. Right of way appraisers are often called upon to assess the economic impact of a temporary disequilibrium caused by freeway construction.

Harris County Car/Truck Market

The car/truck market in Harris County, Texas from 1982 through 1992 is the focus of this study. Specific site and freeway characteristics for dealership locations on I-45 North, Northwest Freeway (Highway 290), Katy Freeway (I-10 West), Southwest Freeway (Highway 59 South), Gulf Freeway (I-45 South), and the Eastex Freeway (Highway 59 North) were obtained. The freeways are identified in Exhibit 1.

To put the vehicle sales analysis into perspective, an overview of historical car and truck sales in Harris County, Texas is presented in Table 1. The table shows new vehicle registrations and average yearly employment for the period 1977 through 1992. The information reveals that sales of new cars and trucks in the greater Houston area increased from the recession levels of 1986 to 1988, but by 1992 had not
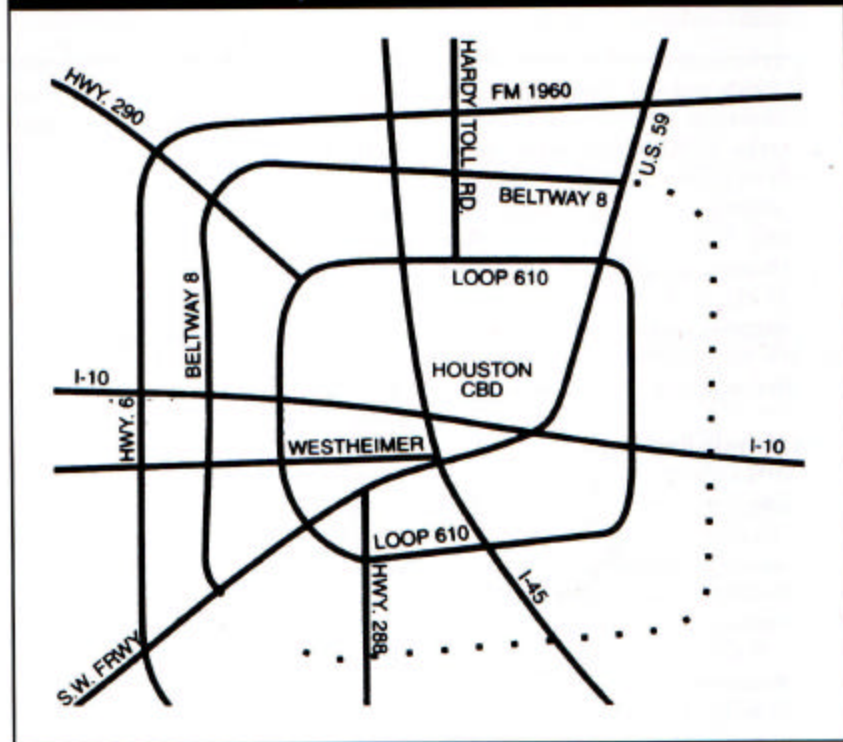

Exhibit 1
Map of Harris County, Texas

Table 1
New Vehicle Registration in Harris, County, Texas

Year	Total*	Average Employment/Year**
1992	200,462	1,636,400
1991	198,852	1,636,400
1990	209,401	1,605,700
1989	201,413	1,515,600
1988	189,902	1,448,300
1987	177,343	1,386,600
1986	181,255	1,410,900
1985	212,276	1,479,000
1984	223,451	1,476,100
1983	192,334	1,444,900
1982	198,169	1,541,500
1981	208,571	1,517,200
1980	187,257	1,399,000
1979	218,071	1,318,800
1978	221,987	1,229,800
1977	205,623	1,126,000

Data Sources: Wilson Data Services, the Houston Automobile Dealer's Association, *The Real Estate Handbook*, by REVAC.

* Includes cars and trucks

** The average employment for the year is the total non-agricultural wage and salary employment for the Houston PMSA. Employment does not include part time workers.

fully rebounded to the levels of the early 1980s and late 1970s. This type of information is relevant because by the early 1990s there were more brands to choose from, but aggregate sales volumes were not as great as in the early 1980s and late 1970s, even though more people were employed than in the high sales volume years. This suggests tougher competition for the new car/truck buyer spread among a greater variety of brands and dealers.

New Vehicle Registration in Harris County, Texas

Table 2 is a comprehensive market share analysis by vehicle brand. The compilation of information in the table reveals shifts in market share by brand of vehicle over the 11-year period of study[2]. Since all vehicles are not perfect substitutes, demand for individual brands will likely vary based upon current preferences. This perspective is critical, because subsequent tests of the influence of site characteristics on vehicle sales need to be controlled for brand influence.

Data Collection and Research Methodology

The data collection phase involved a visit to more than 80 dealership locations to ascertain selected property characteristics and site location factors, such as the number of front display rows and freeway construction in front of the property. To determine additional property characteristics, the records of Harris County Appraisal District were accessed. The additional characteristics included building size, building age, and land size. Traffic count maps were obtained from the Texas Department of Transportation in order to assess traffic count influences on sales volume. Area demographic information was obtained from the Equifax National Decision Systems database.

The information included the number of households and the average household income in 5-mile and 10-mile radii of each dealership. Finally, historical new vehicle sales information for the years 1982 to 1992 was obtained from Wilson Data Services. The vehicle sales at specific dealerships were cross tabulated to allow direct comparisons among dealers, brands and locations. Complete information was available on 40 of the dealerships visited and these dealerships serve as the sample for this study.

The location and demographic attributes for the 40 dealerships are summarized in Table 3. That table also contains the average new vehicle sales volume per year for the previous two years for each dealership, as well as area brand sales for the same time period.

For the study, the authors examined sales volumes and the aforementioned characteristics of dealership locations to determine if certain location attributes appear to influence new vehicle sales volumes. If it can be demonstrated that location characteristics affect sales volume, then dealerships can be engineered to produce maximum sales volume of new vehicles.

A multiple regression framework with dummy variables was utilized to gauge the impact of various variables on vehicle sales. Brand influence was eliminated by including brand sales as an independent variable in the multiple regression equation. The model takes the form below:

Results

The parameter estimates and associated t-statistics for the regressions are summarized in Table 4. The findings reported in Table 4 indicate that the dependent variable (dealership sales volume) is significantly influenced by the brand of vehicles that a dealership sells. This finding is not necessarily surprising, given the various shifts in market share that have occurred over the 11-year period of study (see Table 2). Since not all vehicle brands are perfect substitutes, then one might expect sales volume to vary among brands based on differentiation in prices, different customer groups, changing relative preferences for different vehicle types (utility vehicles, sport cars, family sedans, luxury cars, economy cars, etc.), perceived quality, perceived safety, and other distinguishing brand characteristics.

Perhaps more surprising is the fact that two site specific physical characteristics were more significant than vehicle brand in explaining sales volume. The size of the facility and the age of the building were significant at the 1 percent and 2 percent levels, respectively. There is a positive relationship between facility size and vehicle sales. One possible explanation for this finding is that the public may associate quality and perfor-

$$SALES_i = \beta_0 + \beta_1\ BRAND_j + \beta_2\ TRAFFIC_i + \beta_3\ INCOME_i + \beta_4\ HOUSE_i + \beta_5\ BLDG_i$$
$$+ \beta_6\ LAND_i + \beta_7\ AGE_i + \beta_8\ ROWS_i + \beta_9\ CONSTRUCT_i + \epsilon_i$$

where:
$SALES_i$	=	average sales per year for dealership i
$BRAND_i$	=	brand sales per year for brand j in Harris County, Texas
$TRAFFIC_j$	=	traffic counts in front of dealership i
$INCOME_i$	=	average household income within a 5-mile radius of dealership i
$HOUSE_i$	=	number of households within a 5-mile radius of dealership i
$BLDG_i$	=	dealership i's building size in square feet
$LAND_i$	=	dealership i's land size in square feet
AGE_i	=	age of dealership i's facility
ROW_i	=	number of front display rows at dealership i
$CONSTRUCT_i$	=	freeway construction dummy variable taking a value of 1 if freeway under construction during period of observation; 0 otherwise.
ϵ_i	=	regression error term

A separate regression was estimated using the 10-mile radius demographic data for the $HOUSE_i$ and $INCOME_i$ variables.

Table 2 - Market Share Analysis by Vehicle Brand

Brand	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982
Acura	2544	3150	2818	3028	2422	2506	1627				
Audi	156	112	230	274	299	701	1151	1627	1724	1289	1349
BMW	1119	1164	1268	1094	1295	1296	1700	2268	1975	1620	1449
%MKT	0.56%	0.59%	0.61%	0.55%	0.69%	0.74%	0.95%	1.08%	0.91%	0.86%	0.74%
Buick	6632	6597	5088	5071	4781	4246	6392	9549	11926	12488	14688
%MKT	3.33%	3.32%	2.56%	2.55%	2.40%	2.13%	3.21%	4.80%	6.00%	6.28%	7.38%
Cadillac	3719	3892	5319	4162	4023	4515	5297	6792	7589	6269	6163
%MKT	1.87%	1.96%	2.67%	2.09%	2.02%	2.27%	2.66%	3.41%	3.82%	3.15%	3.10%
Chevrolet	31691	31655	32062	30600	28494	27194	28832	36537	38795	34689	41492
%MKT	15.93%	15.91%	16.12%	15.38%	14.33%	13.67%	14.50%	18.37%	19.50%	17.44%	20.86%
Chrysler	2405	1962	3373	3503	3627	2884	3269	4505	4680	3639	2618
%MKT	1.21%	0.99%	1.70%	1.76%	1.82%	1.45%	1.64%	2.26%	2.35%	1.83%	1.32%
Dodge	10562	13595	13131	13136	12474	9933	8677	11279	9404	5801	5796
%MKT	5.31%	6.83%6	.60%	6.60%	6.27%	4.99%	4.36%	5.67%	4.73%	2.92%	2.91%
Eagle	275	328	382	600	406						
Ford	45892	41102	44407	45873	43996	36627	32026	30973	36986	31012	31872
%MKT	23.07%	20.66%	22.33%	23.06%	22.12%	18.41%	16.10%	15.57%	18.59%	15.59%	16.02%
GMC	4207	3537	3551	3587	3091	2715	2953	4484	5632	5761	6942
Honda	8924	10877	10701	8122	7469	6801	8408	8796	8063	6236	6076
%MKT	4.49%	5.47%	5.38%	4.08%	3.76%	3.42%	4.23%	4.42%	4.05%	3.14%	3.05%
Hyundai	1923	2029	2445	2796	3456	4669	2847				
Infiniti	1030	987	492	28							
Isuzu	2618	2896	2698	2521	1950	1803	1134	1437	1371	961	766
Jaguar	131	180	331	347	379	349	422	453	440	423	297
Jeep	2939	2096	1943	2576	2553	2145	2524	2472	2414	1300	1197
Lexus	2613	1993	2002	421							
Lincoln	3235	4423	5155	5377	5257	4771	4006	4624	5081	3331	3822
%MKT	1.63%	2.22%	2.59%	2.70%	2.64%	2.40%	2.01%	2.32%	2.55%	1.67%	1.92%
Mazda	7299	7366	7330	6288	5439	4451	4799	4604	4231	3789	3099
%MKT	3.67%	3.70%	3.69%	3.16%	2.73%	2.24%	2.41%	2.31%	2.13%	1.90%	1.56%
Mercedes	800	768	982	1009	1059	1103	1658	1805	1861	1693	1700
Mercury	5473	5535	4057	5124	4935	5752	4772	5162	6173	5602	6026
%MKT	2.75%	2.78%	2.04%	2.58%	2.48%	2.89%	2.40%	2.60%	3.10%	2.82%	3.03%
Mitsubishi	3645	3570	3755	3480	3128	3706	2631	3658	2604	1743	204
Nissan	9893	11797	11141	9044	7023	8064	10606	14372	13135	11613	10025
%MKT	4.97%	5.93%	5.60%	4.55%	3.53%	4.05%	5.33%	7.23%	6.60%	5.84%	5.04%
Oldsmobile	6669	6864	9873	8846	9069	8320	10801	15872	17957	18518	19519
%MKT	3.35%	3.45%	4.96%	4.45%	4.56%	4.18%	5.43%	7.98%	9.03%	9.31%	9.81%
Plymouth	3974	4620	5228	5951	5255	3880	4654	4988	4691	3023	2774
%MKT	2.00%	2.32%	2.63%	2.99%	2.64%	1.95%	2.34%	2.51%	2.36%	1.52%	1.39%
Pontiac	7026	5760	7513	6425	6006	6011	7290	9866	8811	7190	8303
%MKT	3.53%	2.90%	3.78%	3.23%	3.02%	3.02%	3.67%	4.96%	4.43%	3.61%	4.17%
Porsche	113	91	181	134	249	511	730	723	619	641	434
Saab	127	165	161	232	304	453	601	635	381	266	194
Saturn	2342	7									
Subaru	888	899	588	1382	1997	1631	1092	1487	1411	1249	1377
Suzuki	427	498	441	519	1164	2660	1379	41			
Toyota	15433	14446	14879	13858	12557	11721	12639	15188	15730	14170	13017
%MKT	7.76%	7.26%	7.48%	6.97%	6.31%	5.89%	6.35%	7.64%	7.91%	7.12%	6.54%
Volkswagen	981	1323	1680	1607	1628	1805	1697	2233	2379	1863	1862
Volvo	1198	1080	1677	1911	1869	1809	2399	2628	2121	2000	1575
Total	198904	197364	206882	198926	187654	175032	179013	209058	218184	188179	194636

Table 3 - Dealership Attributes

Dealer #	Avg Sales	Brand Sales	Traffic Counts	5 mi. HH Income	10 mi.HH Income	5 mi # households	10 mi # households	Bldg Size	Land Size	AGE	# FR	Construction
1	690	2544	159000	44868	43679	66388	198486	23835	4.831	6	2	1
2	1034	2544	124000	47325	58816	134772	346453	30667	4.945	6	4	0
3	2519	8924	183000	37933	44867	60995	255228	109681	8.161	21	2	0
4	2577	8924	183000	63075	55783	109729	413976	53070	5.114	7	4	0
5	1505	8924	159000	44868	43679	66388	198486	23193	5.560	2	2	1
6	1239	15433	159000	43718	42624	74514	208960	42312	7.150	13	3	1
7	2091	15433	205000	37978	45346	90429	296527	46830	5.000	5	1	0
8	2636	15433	169000	63451	55450	83516	358042	64676	6.633	14	3	0
9	2055	15433	67000	56095	57811	42140	176949	22906	7.348	6	2	0
10	4305	15433	124000	46898	58307	155539	376217	75396	10.408	2	3	1
11	667	15433	107000	46401	47250	16689	95710	10980	3.207	14	2	0
12	2540	45892	202000	34970	43412	95142	316442	78250	3.735	22	2	0
13	2849	45892	205000	37978	45346	90429	296527	59153	22.381	22	1	0
14	2207	45892	183000	63075	55783	109729	413976	118858	9.956	22	2	0
15	2559	45892	116000	52890	58051	51617	254039	34335	9.792	12	1	0
16	1037	45892	107000	46401	47250	16689	95710	38327	6.666	22	2	0
17	1003	45892	149000	59301	53471	186421	466703	78442	11.360	28	2	0
18	2400	45892	198000	57904	48229	154005	487119	31896	2.221	18	2	0
19	2361	45892	107000	55919	56224	36027	110375	50115	13.009	13	3	0
20	4213	31691	205000	38302	43872	80118	276625	103862	10.035	21	1	0
21	1338	31691	107000	46401	47250	16689	95710	62839	7.370	21	2	0
22	2218	31691	169000	63451	55450	83516	358042	119522	8.000	22	2	0
23	1415	31691	151000	48753	45539	54405	177775	57135	11.430	3	3	0
24	1128	31691	197000	58195	50430	148234	480507	40578	4.150	32	0	0
25	1881	31691	149000	59301	53471	186421	466703	72175	11.397	28	1	0
26	1673	10562	183000	38006	45430	57271	246443	22192	6.000	13	3	0
27	2063	10562	169000	63451	55450	83516	358042	21627	2.394	11	2	0
28	1980	10562	202000	34970	43412	95142	316442	50198	4.238	22	2	0
29	712	8708	205000	38336	43766	77561	274316	65322	4.500	21	1	0
30	1070	8708	149000	59301	53471	186421	466703	73630	5.232	22	1	0
31	649	7299	107000	46401	47250	16689	95710	18040	2.761	4	4	0
32	1032	7299	169000	62721	56145	100846	391047	18784	1.867	7	2	0
33	1105	7299	116000	52890	58051	51617	254039	18440	4.450	2	3	0
34	1144	7299	124000	47325	58816	134772	346453	28130	4.087	6	3	0
35	914	7026	169000	63451	55450	83516	358042	54016	7.571	18	2	0
36	721	7026	83000	58254	55497	22974	55793	34836	5.764	6	2	0
37	1342	7026	159000	44868	43679	66388	198486	23339	4.703	3	41	
38	1315	9893	107000	46401	47250	16689	95710	28053	12.703	1	4	0
39	2270	9893	67000	56095	57811	42140	176949	40461	6.245	4	4	0
40	1165	9893	159000	43718	42624	74514	208960	35072	5.889	8	2	1
41	1078	9893	183000	63075	55783	109729	413976	76489	7.000	16	0	0
42	1131	9893	205000	38093	44031	82625	279712	46064	2.650	19	0	0

mance with large and impressive dealership facilities. Also, larger facilities may have more capacity to service the cars and trucks after the sale. The findings suggest, however, that aging facilities detract from a dealerships ability to generate sales.

The regression that utilized demographic variables within a 10-mile radius from each dealership yielded similar results. The regression parameter estimates and associated t-statistics are reported in Table 5. Vehicle brand again was statistically significant at the 5 percent level. However, the building and age parameter estimates decreased in statistical significance (from 1 percent and 2 percent, to 5 percent and 10 percent, respectively).

Note that in both regressions, the coefficient for the construction dummy variable was not statistically significant. This is strong evidence that the presence of freeway construction in front of a dealership did not have a recognizable impact on the dealership's ability to generate sales during the period of study. The findings also suggest that traffic counts in front of a dealership also were not major determinants of sales volume. Also surprising is the apparent lack of influence that area demographics such as the number of households and household income have on dealership sales volume.

Summary

This study has examined the influence that freeway construction, area demographics, and property specific site characteristics have on car and truck sales volume. Building size and vehicle brand were found to have a positive influence on vehicle sales. However, the age of the dealership was found to be negatively correlated with sales volume. Perhaps surprisingly, none of the other variables used in the analysis (such as freeway construction, traffic counts, area households and household income) had a statistically significant effect on dealership sales.

The findings reported in this article have important implications for real estate professionals engaged in commercial real estate appraisal. It is also relevant for appraisers who must assess the economic impact of freeway construction in estimating consequential damages for eminent domain work. ■

Notes
1. The Appraisal of Real Estate, 10th edition, American Institute of Real Estate Appraisers, 1994.

2. The shift share analysis presented in Table 1 does not include some brands such as Yugo and Ferrari because the brands are not significant in the market. However, over 95% of sales volume is included in the shift share analysis. Also, market share percentages were computed only for a select group of brands to reveal trends by the major market participants. Additionally, some brands have been offered in Harris County for only a few years and therefore do not have eleven years of historial data

Table 4
Regression Parameter Estimates For 5-Mile Radius Demographics

Independent Variable	Parameter Estimate	Standard Error	T for H0: Parameter = 0	Prob > |T|
Intercept	880.22	1161.178	0.758	0.4540
Brand	0.0242	0.010356	2.334	0.0260
Traffic	0.0037	0.003932	0.937	0.3559
Income	-0.0126	0.014301	-0.878	0.3856
House	0.0023	0.003069	0.975	0.3367
Bldg	0.0157	0.005555	2.818	0.0082
Land	21.925	37.49468	0.585	0.5628
Age	-60.976	23.96769	-2.544	0.0160
Row	33.706	137.3749	0.245	0.8077
Construct	-131.444	366.5359	-0.359	0.7222

Table 5
Regression Parameter Estimates For 10-Mile Radius Demographics

Independent Variable	Parameter Estimate	Standard Error	T for H0: Parameter = 0	Prob > |T|
Intercept	-1632.086	2896.47	-0.563	0.5770
Brand	0.02343	0.01027	2.281	0.0294
Traffic	0.00742	0.00685	1.082	0.2873
Income	0.02735	0.04515	0.606	0.5490
House	0.00013	0.00218	0.061	0.9519
Bldg	0.01345	0.00573	2.347	0.0253
Land	29.6598	37.2639	0.796	0.4319
Age	-51.147	26.6683	-1.918	0.0641
Row	51.4436	138.6128	0.371	0.7130
Construct	150.756	417.9985	0.361	0.7207