Summary of the Empirical Analyses in the GAO's Report: Effects of Mergers and Market Concentration in the U.S. Petroleum Industry

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Introduction – Motivation

- "Since the 1990's, the U.S. petroleum industry has experienced a wave of mergers and acquisitions and joint ventures." (GAO, p2.)

- The Ranking Minority Member, Permanent Subcommittee on Investigations, Senate Committee on Governmental Affairs asked GAO to examine the effect of the mergers that have occurred in the U.S. petroleum industry since the 1990's.

Introduction – Empirical Chapter

- Analyzes the effects of 8 mergers occurring between 1997 and 2000 on rack gasoline prices.
- Estimates the relationship between concentration (measured at the PADD level) and gasoline prices.
- Examines the wholesale price of three types of gasoline:
  - Conventional
  - RFG (formulated with MTBE)
  - CARB (formulated with MTBE)
- Examines both branded and unbranded prices for each formulation.

Introduction – Data Set and Model

- The basic data set used in the both the merger event and price concentration analyses is a panel of terminal rack prices weekly over a number of years

  - e.g. for branded conventional gasoline there are 282 terminal prices weekly for 7 years.

- The basic model is the same for both the merger event and the price concentration analyses.

(1) $Y_{it} = \theta + X_{it}\,\delta + v_i + \varepsilon_{it}$,

and $\varepsilon_{it} = |\rho|\,\varepsilon_{i,t-1} + \eta_{it}$,

where:

$i = 1,\ldots, N$, represents the individual units (racks) in the panel data.

$t = 1,\ldots, T$, represents the time periods (weekly).

Y_{it} = wholesale prices (wholesale gasoline prices less crude oil costs) at

rack i in week t.

X_{it} = a vector of explanatory variables consisting of market structure and

regulatory factors, other cost/supply factors, and other demand
factors at rack i in week t.

θ = constant term.

δ = the coefficients of X_{it}.

v_i = the rack city-specific error component, which is a fixed-effect or
random-effect specification.
ε_{it} = autoregressive error component.

η_{it} = white-noise error term, which is independently and identically
distributed (iid) with mean zero and variance σ^2. We later allow
correlations across the rack observations, i. (GAO Report, pp.123-124)

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Estimation Equation - Merger

$$PRICES_i = \alpha_0 + \Sigma \alpha_{1,k} \, MERGER_{ki} + \alpha_2 \, INVENTORIES \; RATIO_i$$

$$+ \, \alpha_3 \, UTILIZATION \; RATES_i + \alpha_4 \, MW \; CRISIS + \alpha_5 \, WC \; CRISIS + \mu_{1i},$$

where i represents the racks, k represents only the racks where the merging companies operated before they merged, $\alpha_{1,k}$ captures the effects of merger k on prices in those cities, and μ_{1i} is a random error term. Separate equations were estimated for the following gasoline specifications—conventional (branded, unbranded), CARB (branded, unbranded), and reformulated (branded, unbranded).

(GAO Report, pp.124-125)

Estimation Equation–Price Concentration

$$PRICES_i = \beta_0 + \beta_1\ HHI_i + \beta_2\ INVENTORIES\ RATIO_i$$

$$+ \beta_3\ UTILIZATION\ RATES_i + \beta_4\ MW\ CRISIS + \beta_5\ WC\ CRISIS + \mu_{2i},$$

where i represents the racks, and μ_{2i} is a random error term. Separate equations were estimated nationally and for various geographic areas— very broad geographic areas defined as the eastern half and the western half of the United States.[33] Furthermore, similar to the mergers models, the estimates were obtained for the following gasoline specifications and types, where data were available: conventional (branded, unbranded), CARB (branded, unbranded), and reformulated (branded, unbranded).

(GAO Report, p.125)

Data – Gasoline Price

- Price is measured as the difference between the rack price and the spot price of crude oil.
- GAO purchased rack prices from the Oil Price Information Service (OPIS).
- Weekly observation of branded and unbranded rack prices.
- A rack price from OPIS is for a particular terminal or aggregation of terminals as determined by OPIS.
  - For example, there are multiple terminal locations in the greater Fairfax, Virginia area but OPIS reports an aggregate Fairfax price. In other cities such as Dallas multiple prices are reported for terminals in the greater Dallas area.

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Data – Gasoline Price

- Number of Racks in Study
  - Conventional Gasoline
    - February 1994-December 2000
    - 282 Branded, 256 Unbranded
  - RFG Gasoline
    - March 1995-December 2000
    - 22 Branded, 19 Unbranded
  - CARB
    - May 1996-December 2000
    - 6 Branded, 7 Unbranded

Data – Competition Variables

- ## Overlap Racks
  - Defined as an overlap if both firms posted *any* gasoline price at the rack in the year prior to merger.
    - If two firms posted branded but not unbranded prices at a rack, those firms would be defined as competing at both the branded and unbranded rack.

- ## Merger Variable
  - The merger binary variable is 0 before the consummation of the merger (or completion of divestiture) and 1 thereafter for each rack which was defined as an overlap.
  - A rack may be affected by multiple mergers.

Data – Competition Variables

- Concentration
  - Measured using operable crude oil distillation capacity.
  - Measured at the PADD Level.
  - Measured using annual data.
  - Data is not available for 2 years (1996, 1998), data was linearly interpolated for the missing years.

Data – Control Variables

1. Crude Oil – West Texas Intermediate spot prices in 2000 dollars (deflated using the annual producer price index for finished energy) (weekly, national)

2. Utilization Rates – Refinery capacity utilization rates (weekly, national)

3. Supply Disruptions – Midwest gasoline in 2000 and California refinery outages in 1999 and 2000 (weekly, PADD)

4. Inventories Ratio – lagged gasoline inventories to expected demand (weekly, PADD)

Data – Control Variables

- Calculation of Inventory Ratio

  - Numerator is the weekly normalized gasoline inventory for a PADD.
  - Gasoline inventories of all types of gasoline (e.g. conventional and reformulated) were normalized using the PADD mean over the sample period. (weekly PADD)

  - Denominator is the monthly expected demand for the PADD.
  - Expected demand is estimated using a simplified demand equation for each state. (monthly state)

    $Nvol_{(t)} = Nvol_{(t-1)} + month + trend + trend^2$

Data – Control Variables

- Inventory ratio continued:
  - The predicted state level demands were then averaged to obtain predicted/expected PADD level demand.

- The inventory ratio is the one period lagged normalized weekly PADD inventory divided by the monthly expected PADD demand. (weekly, PADD)

- The same monthly PADD expected demand is used for each week in the month.

Estimation Method

- The model estimation included rack fixed effects, which were implemented by demeaning the data by rack location.

- The XTGLS command in STATA was used to estimate feasible generalized least squares (GLS) for panel data. The used GLS estimator accounted for a common (single) autocorrelation coefficient for all racks and a separate error variance for each rack, and a covariance between each set of racks.

Estimation Method

- Endogeneity – "Since two of the explanatory regressors in the price equations might be endogenous – Inventory Ratio and Utilization Rates-we test for their endogeneity using the Hausman (1978) specification test." (GAO, 126)

- If exogeneity of the variables was rejected, GAO used a two step estimation procedure with instrumental variables.

- Instrumental variables were used in the unbranded conventional merger analysis, unbranded CARB merger analysis, the unbranded conventional price concentration analysis for the entire country, the branded conventional price concentration analyses for PADDs I-III and PADDs IV-V, and the unbranded price concentration analysis for CARB.

Mergers Examined

1. Tosco-Unocal (1997) – PADD V
2. UDS-Total (1997) – PADD II-IV
3. Marathon-Ashland (1998) – PADD I-III
4. Shell-Texaco I(Equilon) (1998) – PADD II-V
5. Shell-Texaco II(Motiva) (1998) – PADD I-III
6. BP-Amoco (1998) – PADD I-III
7. MAP-UDS (1999) – PADD II
8. Exxon-Mobil (2000) – PADD I,III

Merger Results

- "GAO's econometric modeling shows that the mergers GAO examined mostly led to higher wholesale gasoline prices in the second half of the 1990's. GAO's analysis shows that the majority of the eight specific mergers examined –…- resulted in higher prices of wholesale gasoline in the cities where the merging companies supplied gasoline before they merged. " (GAO Report, page 10)

- The effects of the mergers varied depending on gasoline formulation.

Results – Merger Study (Conventional)

Table 15: Effects of Mergers on Conventional Wholesale Gasoline Prices (1994-2000)

Merger	Geographic region	Estimates are obtained using data for		Estimated change in price margin (cents per gallon)
		premerger period	postmerger period	
UDS-Total	PADD II, III, IV	2/3/94–9/30/97	10/1/97–1/31/98	
Branded				- 0.89^c
Unbranded				- 1.25^c
Marathon-Ashland	PADD I, II, III	2/3/94–1/4/98	1/5/98–6/30/98	
Branded				0.70^c
Unbranded				0.39^c
Shell-Texaco I	PADD II, III, IV, V	2/3/94–1/31/98	2/1/98–12/30/98	
Branded				0.99^c
Unbranded				1.13^c
Shell-Texaco II	PADD I, II, III	1/5/98–6/30/98	7/1/98–12/30/98	
Branded				- 1.77^c
Unbranded				- 1.24^c
BP-Amoco	PADD I, II, III	7/1/98–12/30/98	12/31/98–2/29/00	
Branded				0.40^c
Unbranded				0.97^c
MAP-UDS	PADD II	12/31/98–12/12/99	12/13/99–12/31/00	
Branded				1.38^c
Unbranded				2.63^c
Exxon-Mobil	PADD I, III	12/31/98–2/29/00	3/1/00–12/31/00	
Branded				3.71^c
Unbranded				5.00^c

(GAO Report, p.132)

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Results – Merger Study (Reformulated)

Table 16: Effects of Mergers on Reformulated Wholesale Gasoline Prices (1995-2000)

| Merger[a] | Geographic region[b] | Estimates are obtained using data for | | Estimated change in price margin (cents per gallon) |
		premerger period	postmerger period[c]	
Marathon-Ashland	PADD I, II	3/2/95–1/4/98	1/5/98–6/30/98	
Branded				0.71[d]
Unbranded				0.86[d]
Shell-Texaco II	PADD I, III	1/5/98–6/30/98	7/1/98–12/30/98	
Branded				- 0.39[e]
Unbranded				0.09
BP-Amoco	PADD I, II	7/1/98–12/30/98	12/31/98–2/29/00	
Branded				0.55
Unbranded				0.40
Exxon-Mobil	PADD I, III	12/31/98–2/29/00	3/1/00–12/31/00	
Branded				1.61[d]
Unbranded				1.01[e]

(GAO Report, p.133)

Results – Merger Study (CARB)

Table 17: Effects of Mergers on CARB Wholesale Gasoline Prices (1996-2000)

Merger	Geographic region	Estimates are obtained using data for		Estimated change in price margin (cents per gallon)
		premerger period	postmerger period	
Tosco-Unocal	PADD V	5/16/96–4/10/97	4/11/97–1/31/98	
Branded				6.87
Unbranded				-1.58
Shell-Texaco I	PADD V	4/11/97–1/31/98	2/1//98–12/31/00	
Branded				- 0.69
Unbranded				-0.24

(GAO Report, p.134)

Price-Concentration Regions and Formulations Examined

1. Conventional Gasoline – PADD I-V (February 1994 – December 2000)

2. Reformulated Gasoline – PADD I-III (February 1995 – December 2000)

3. CARB Gasoline – PADD V (May 1996 – December 2000)

Price Concentration Results

- "For market concentration…. GAO's econometric analysis shows that increased market concentration resulted in higher wholesale gasoline prices. Prices for conventional gasoline increased by less than one-half cent per gallon for branded and unbranded gasoline." (GAO Report, page 10)

- "The wholesale prices increased by about 1 cent per gallon for boutique fuel sold in the East Coast and Gulf Coast regions between 1995 and 2000 and by over 7 cents per gallon in California between 1996 and 2000." (GAO Report, page 10-11)

Results–Price Concentration (Conventional)

Table 18: Effects of Market Concentration on Conventional Wholesale Gasoline Prices (1994-2000)

All regions[a]	Market concentration (HHI)			Estimated change in wholesale price margin due to increase in HHI (cents per gallon)[b]
	1994	2000	Increase in HHI	
Branded	803	1101	298	0.15[c]
Unbranded	803	1101	298	0.33[c]
Geographic area				
Eastern United States (PADDs I, II, III)				
Branded	773	1090	317	0.25[c]
Unbranded	773	1090	317	0.10
Western United States (PADDs IV, V)				
Branded	1032	1180	148	0.56[c]
Unbranded	1032	1180	148	1.29[d]

(GAO Report, p.136)

Results–Price Concentration (Reformulated and CARB)

Table 19: Effects of Market Concentration on Wholesale Prices of Boutique Fuels (1995-2000)

	Market concentration (HHI)			Estimated change in price margin due to increase in HHI (cents per gallon)[b]
	1995	2000	Increase in HHI	
Reformulated wholesale gasoline: 1995-2000[a]				
Branded	1,237	1,477	240	0.98[c]
Unbranded	1,237	1,477	240	0.89[c]
CARB reformulated wholesale gasoline: 1996-2000[d]	1996	2000		
Branded	965	1,267	302	7.19[c]
Unbranded	965	1,267	302	7.94[c]

(GAO Report, pp.137)

Summary of Report

- "GAO's econometric analyses indicate that mergers and increased market concentration generally led to higher wholesale gasoline prices in the United States from the mid-1990's through 2000. Six of the eight mergers GAO modeled led to price increases, averaging 1 cent to 2 cents per gallon. GAO found that increased market concentration, which reflects the cumulative effects of mergers and other competitive factors, also led to increased prices." (GAO, executive summary)