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Tax Pass-Through in Gasoline and Diesel Fuel: The 2003 Washington State Nickel Funding Package Increase

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I. Introduction

This paper considers the pass-through of a previously unexamined increase in excise taxes on gasoline and diesel fuel that were part of Washington State's Nickel Funding Package of 2003. Although there is disagreement on whether pass-through is complete, earlier studies of gasoline taxes have consTc0ether

II. Literature on Tax Pass-Through Gasoline Taxes

Tax pass-through is the rate of price increase to consumers per unit of tax imposed. Under perfect competition, the pass-through has an upper bound of one and is determined by the

prices in other northeast metropolitan locations, assuming seasonal and state fixed effects and six-month pre and post event windows. Barron, Blanchard and Umbeck find a consumer pass-through of about two-thirds.[4] They conclude that rising costs at refineries absorbed most of the remaining the tax decrease. They also find that retailers' revenue per gallon increased by a very small (but statistically insignificant) amount, an effect possibly reflecting rising marginal costs at retail.

Doyle and Samphantharak (2008) use daily, station-specific retail prices to analyze temporary moratoria in Indiana and Illinois of a 5% ad valorem gasoline tax in 2000. They present several specifications beginning with a simple DID comparison with neighboring states, which controls for terminal rack wholesale prices and zip-code level demographic variables are subsequently added. Applying pre and post-tax event windows of seven days, their results indicate that about 70% of the tax reduction was passed on to consumers with 80 to 100% of an increase being passed on. They also observevel de565idþ-.001Brtax quick dai

on wholesale prices might suggest that wholesale markets may not be competitive. Under this assumption that wholesale supply is (locally) perfectly elastic, they see evidence of less than full pass-through in one of three tax change regressions**.**

Finally, Alm, Sennoga and Skidmore (2009) analyze a panel of state-level, monthly data for the 50 U.S. states between 1984 and 1999. Estimating a reduced form model with demand and cost shifters and with state and time (monthly) fixed effects, they find a state excise tax pass-through of nearly 100% across all states, with slightly lower pass-through in more rural states. Arguing that retail markets in more urbanized states are likely to be more competitive, the authors attribute the somewhat lower pass-through rate in rural states to weaker retail competition.[5] Across all states, they find that tax changes are fully passed through in the first month of the change though they observe statistically significant second month effects in medium and highly urbanized states.

In sum, recent studies present broadly consistent results about the incidence of state gasoline taxes. Gasoline taxes are mostly borne by consumers. Evidence for over-shifting is limited. Tax pass-through appears to take place quickly. Quick pass-through of tax changes is consistent with Duffy-Deno (1996), EIA (1999), EIA (2003), and Lewis and Noel (2010), all of which find relatively quick pass-through of changes in wholesale gasoline prices to retail prices. Previous studies agree less whether incomplete pass-through is cost or competition related.

[5] Alm et al. observe that pass-through was greater for medium urbanized states than for highly urbanized states, a finding inconsistent with a view that highly urbanized states should have the highest pass-through, at least if demand were approximately linear. The authors also found some evidence of over shifting for medium urbanized states. Attributing incidence effects to competition differences across states requires assuming that there is no correlation between state urbanization and state-level supply elasiticities.

III. Industry Background

Washington State's Puget Sound was the home of five refineries in 2003. These refineries typically ran close to capacity during the first half of the 2000s.[6] Washington State and Oregon consumed most of their output, though some Puget Sound gasoline and diesel went to California or was exported, particularly to nearby Canada.

The north to south flow on the Olympic and Kinder Morgan pipelines dominated the bulk distribution infrastructure of western Washington State and western Oregon. Olympic carried gasoline and diesel from the Puget Sound refineries to product terminals to the south, including those serving the relatively populated areas of Seattle, Tacoma and Olympia. Olympic connected to the Kinder Morgan pipeline at Vancouver, WA. The Kinder Morgan line ran south to serve Oregon terminals in Portland, Salem and Eugene. Olympic was generally at capacity south of Tacoma during the 2000s. Ocean barge shipments to Portland from Puget Sound supplemented shipments on Olympic. Shipments from California and foreign refineries into Portland also added to shipments from Puget Sound.[7] Imports from foreign refiners (mostly gasoline) occurred primarily during higher demand summer months.[8]

The logistics of bulk distribution in the more sparsely populated eastern parts of Washington State and Oregon presented a different picture. No pipeline crosses the Cascades. Instead, river barges on the Columbia are the main source of supply. Gasoline and diesel were

[6] Washington State Attorney General's Office, *2007-08 Gas Price Study*, 2008, available at,

loaded into barges at Portland terminals or directly from ocean-going vessels landed in Portland. Pasco, WA was the primary destination for these barges. Gasoline and diesel barged to Pasco could also be injected into the Chevron pipeline for shipment northeast to Spokane.

Refineries in the Rockies also served eastern Washington and Oregon. The Yellowstone pipeline carried gasoline and diesel to Spokane and east Central Washington State from refineries in Billings, Montana. The first leg of the Chevron pipeline connected Pasco and Spokane terminals to Salt Lake City refineries. Generally, terminals in the east were located at greater distances from refineries (or points of marine landings) compared to terminals in western Washington State and western Oregon.

Washington State had nearly 3,100 gasoline retail outlets in the early 2000s. Less than half of the stations sold retail diesel. Differences in local competition, wages, land values, wholesale prices and transportation costs from terminals and other factors resulted in contemporaneous price differences across retailers. Like gasoline and diesel retailing elsewhere, price differences among stations were often significant even within a small geographic area.[9]

The entry of hypermarkets since the late 1990s is a notable feature of gasoline and diesel retailing in Washington State. Hypermarkets refer to retailers such as Costco, Walmart, Fred Meyer and Safeway that add fuel pumps at their retailing. Hypermarkets outlets sell five to ten times more gasoline than the typical gasoline station, have lower construction and operating costs, and typically offer lower prices. Hypermarkets sold about six percent of retail gasoline sales in the United States by late 2002.[10] Hypermarket entry into Washington State as of 2002

[9] For an analysis of retail gasoline price differences Washington State between 2000 2007, see the WA AG Gas Study at 41-47. This study found six statistically significant variables explaining retail price differences: population per station, area wages, vehicles per station, property value, tank truck transportation costs, and percent of hypermarkets in the area.

[10] Federal Trade Commission, Bureau of Economics, "The Petroleum Industry: Mergers, Structural Change and Antitrust Enforcement", (2004) at 235-236, available at, http://www.ftc.gov/sites/default/files/documents/reports/petroleum-industry-mergers-structural-change-and-

was well above the national average, accounting for approximately 13.9 percent of gasoline sales in Washington State. Oregon hypermarket volume at the time was closer to the national average, accounting for 6.3 percent of statewide gasoline sales.[11]

Washington State's excise taxe

does not preclude possible wholesale effects of the tax. We measure short run demand and supply sensitivity. This short run would be long enough for non-capital adjustments by consumers (e.g. changed driving patterns) and sellers (e.g. changed refinery runs, changed geographic allocation of product, changed retail hours), but not long enough for significant capital-related adjustments (e.g. more fuel efficient vehicles, refinery reconfigurations, retailer entry or exit). We use three and six month periods around the tax change to measure pass-through.

We believe wholesaling in the Pacific Northwest was approximately competitive. This would imply no change in wholesale prices due to the tax change. No Washington State refiner was large enough for unilateral market power to be plausible. Significant departures from marginal cost pricing would require coordination among the state's five refiners. In addition to the challenges in achieving and maintaining coordination among the five, shipments from California, from refineries in the Rockies and from foreign refineries would present significant obstacles to anticompetitive coordination.[14]

We assume that gasoline and diesel retailing is differentiated, spatially and by brand, and that departures from marginal cost pricing are limited by entry and rival repositioning. We assume that retailer-level, short run demand elasticities vary according to the extent of localized competition raising the possibility of differing pass-through rates.[15]

[14] The FTC's 2006 competitive assessment of U.S refining, including West Coast refining, found no evidence of

Our basic estimating equation is:

(1)

Where P_T

recognize that OLS remains unbiased and consistent in the presence of autocorrelation and uses standard errors corrected for heteroscedasticity and autocorrelation in the underlying data.

Taylor and Hosken (2007) take an alternative approach and model the autocorrelation using the Prais-Winsten correction. This approach should be more efficient. Kreisle (2013) shows that under some statistical circumstances common to gasoline and diesel price data, modeling the autocorrelation in this way tends to perform better and comes closer to estimating the true relationship than using OLS with corrected standard errors. Here we report results using the Prais-Winsten correction. Results under the alternative approach, OLS with Newey-West standard errors (which we do not report) are similar however.[17]

Price data comes from the Oil Price Information Service (OPIS).[18] Rack prices consist of terminal-average daily price quotes of unbrande

Table 1 provides descriptive statistics for (unbranded) wholesale prices by terminal location for gasoline and diesel. Annual average rack gasoline prices by location for 2003 varied

V. Empirical Results

Inspection of the raw gasoline retail price data for Washington State overall suggest a nearly immediate impact of the tax change.[20] Figure 1 shows daily average gasoline prices in Washington State, less the price in Oregon, controlling for station level fixed effects, in the

to Oregon over the period, but also affected relative retail prices within Washington State.[22] The mere existence of hypermarkets in differing degrees in treatment and control markets would not frustrate identification if their price effects were time-invariant, but this was not the case.

Washington State publishes data on underground fuel tanks. These data show the ongoing hypermarket entry in 2002 and 2003.[23] The leading urban locations of Seattle, Spokane, and Vancouver had most of this hypermarket entry. In particular, more than a third of the state's hypermarkets were in the Seattle Metropolitan Statistical Area (MSA) and more than half were in the Seattle Combined Statistical Area ("CSA").[24]

A comparison of retail gasoline prices in the Seattle CSA to those the rest of the state in 2002 and 2003 illustrates the impact of hypermarket entry. Figure 2 shows the monthly price difference in gasoline between the Seattle CSA and the rest of Washington, controlling for station level fixed effects. Seattle CSA prices fell relative to the rest of the state over the period. Seattle gasoline was more expensive by two to six cpg in early 2002 but by the end of the year, gasoline in Seattle was several cents cheaper than gasoline in the rest of the state. The same seasonal pattern occurred in 2003, but the average annual difference between Seattle and the rest of the state is roughly a penny per gallon lower compared to 2002. Similar comparisons (which we do not report) indicate that Seattle CSA retail gasoline and diesel prices also fell relative to Oregon prices over the period, though the trend in diesel was weaker.

To mitigate the confounding effects from hypermarket entry, we re-estimate equation (1) removing from the sample those parts of Washington State and Oregon with significant

[22] y8.48 154.8 (y8.48 .06-iCSA t)9sest

no case can full pass-through be rejected. Not only is there no difference in the estimated pass-through across the categories, but there also does not seem to be a pattern, i.e. the rank order of pass through is not the same for any of the products or windows.

VI. Discussion

West Coast refiners were generally operating close to capacity in the early 2000s, and the tax increase occurred right at the peak of summertime demand. Under these circumstances the tax increase might be expected to reduce wholesale prices owing to diminishing returns.

On the other hand, the reduction in quantity demanded due to the tax increase was small and probably unlikely to have much of an impact upon marginal supply costs once geographic reallocation of product is considered. Washington State daily average gasoline consumption was approximately 170 thousand barrels per day ("MBD") in 2003. Full pass-through to consumers of the Nickel Package tax would increase pump prices by about three percent. Assuming a gasoline demand elasticity of -0.2, this price increase would decrease Washington State demand by about 1 MBD. By comparison, total gasoline production in 2003 for the five Puget Sound refineries was approximately 292 MBD, and other refiners also supplied the Pacific Northwest to some extent. Any reduced demand for gasoline and diesel in Washington State could most likely be accommodated by slightly reduced imports into the Pacific Northwest, perhaps in conjunction with slightly increased expor

diesel to gasoline pass-through of is not surprising—the demands for both products are highly inelastic and the costs of producing and distributing the two products are similar.

Full pass-through is also consistent with our expectation about retail-level short run cost elasticities within the quantity range relevant to the tax change. Assuming a statewide reduction in demand of about 1MBD, a significant impact upon marginal costs at the retail level seems unlikely. A reduction of 1 MBD of gasoline is equivalent to 42,000 gallons per day. Washington State had about 3,100 gas stations in the early 2000s. Given a daily statewide reduction of 42,000 gallons, the average gas station would see a reduction in sales of just fewer than 14 gallons per day, or about less than one vehicle visit per day. Such a small quantity reduction also seems unlikely to significantly affect costs at the margin of tank-wagon deliveries from product terminals.

Consequently, any differences in pass-through at the station level in our framework of differentiated retail competition would be driven by differences in station level demand elasticities. We examined for near border effects based on the notion that stations close to the borders would be more constrained in increasing prices than others in the state. We find no significant differences in pass-through for retailers located close to the Canadian, Idaho and Oregon borders compared to other Washington retailers.

The absence of a pass-through differential near the Canadian border is not surprising. Gasoline prices on the Canadian side (the greater Vancouver area) averaged more than 40 cpg greater than nearby Washington State stations in the first half 2003, while Canadian diesel was about 25 cpg greater than that available just across the border in Washington State. Canadian stations were very likely a weak constraint on the pass-through by close to border Washington stations. Pre-tax price differentials are less persuasive as explanation for an absence of

differential pass-through effects for Washington stations on the Oregon and Idaho borders since the price differences were much smaller that the differences with Canada.[27]

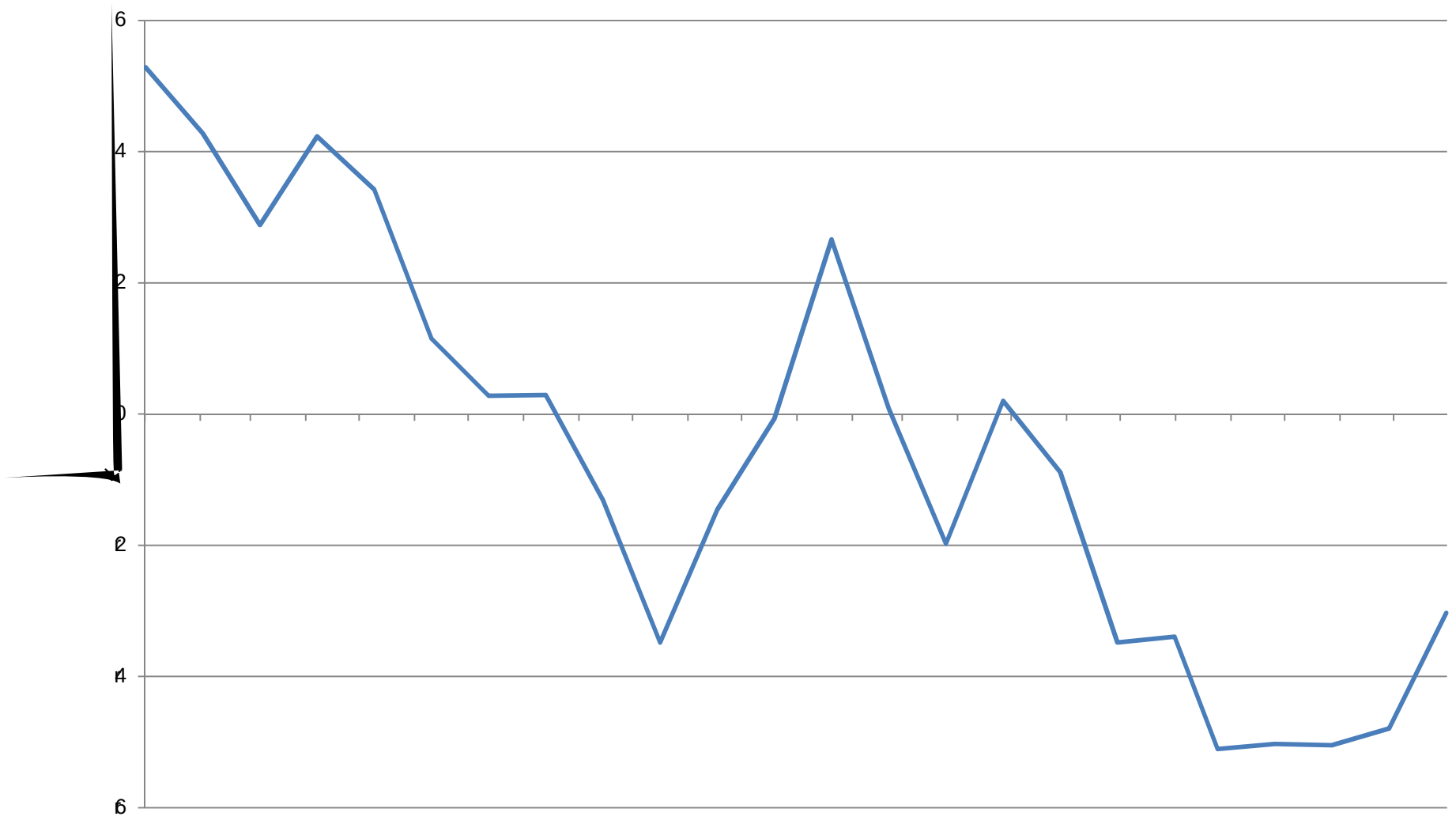
Conceivably the absence of pass-through differentials for Washington border stations might be attributed to the rural nature of these border areas, such as low demand density or limited road connections to neighboring states, factors which would limit the diversion of demand. Yet arbitrage across at least the Washington/Oregon border appeared to robust enough to increase significantly gasoline and diesel prices at Oregon stations adjacent to the Washington border. This effect in Oregon, however, dissipated somewhat further away from the border.[28]

We found no strong evidence that localized competitive conditions matter to pass-through. Full-pass through cannot be rejected for any of the categories of stations or that the estimated pass-through was different by competitive category.

The expansion of hypermarkets in Washington State complicated in identifying pass-through. The hypermarket areas of Washington State comprise over half of the station observations for gasoline and diesel prices. By eliminating the hypermarket area observations, due to the changes in retail competition in those areas, the size of the standard errors on the pass-through estimates increased.[29] Given the changing face of gasoline and diesel retailing, e.g. the increasing importance of convenience stores and the entrance of hypermarkets, any estimation using multiple regions where retailing may have evolved differently is problematic. This suggests that researchers should exercise caution in using sizeable panels of data in this or similar industries.

[27] While first half 2003 prices for Washington State border stations averaged 7.5 cpg below nearby Oregon border stations, diesel was cheaper on the Oregon side by 0.5 cpg. We have no station-specific price data for Idaho, but we note that first half 2003 gasoline prices at Washington Stations near the Idaho border were about a penny cheaper that state level average Idaho average, while diesel was cheaper in Idaho by about 5 cpg.

[28]



This is the difference, Seattle less the rest of Washington, in the average station price by month controlling for station level fixed effects.

Table 1 - Descriptive Statistics Wholesale (Rack) Prices - 2003

	Gasoline	Diesel

TABLE 3 - Wholesale (Rack) Gasoline & Diesel Pass-Through

Sample	Pre/Post	Gasoline	Obs	Diesel	Obs
Table 1 Treatment/Control Racks	3 Month	2.25	269	1.58	275
		(2.45)		(1.50)	
Table 1 Treatment/Control Racks	6 Month	0.13	547	0.87	553
		(1.63)		(1.25)	
Table 1 East/West WA Racks	3 Month	0.39	197	-1.62	200
		(1.84)		(1.29)	
Table 1 East/West WA Racks	6 Month	0.67	397	-0.43	400
		(1.20)		(0.99)	

Estimates of in Equation (1) H0 : B_2=0, no pass-through

Daily once a week data. Control variables include week and rack fixed effects.
Standard errors in parentheses

TABLE4 - Station Specific Retail Gasoline & Diesel Pricing

Sample	Pre/Post	Gasoline	Obs	Diesel	Obs
All Stations WA/OR	3 Month	3.27**	43,826	4.08**	10,807
		(0.19)		(0.28)	
All Stations WA/OR	6 Month	2.75**	85,003	2.54**	20,325
		(0.14)		(0.24)	

Estimates of in Equation (1) H0 : B_2=5, full pass-through

Daily once a week data. Control variables include week and station fixed effects.
Standard errors in parentheses
** Reject Full Pass-Through at 95% confidence level

TABLE 5 - Station Specific Retail Gasoline & Diesel Pricing - Non-Hypermarket Areas

Sample	Pre/Post	Gasoline	Obs	Diesel	Obs
Non - Hypermarket Areas (WA/OR)	3 Month	4.75	18,707	5.27	5,430
		(0.28)		(0.38)	
Non - Hypermarket Areas (WA/OR)	6 Month	5.00	36,779	3.49	10,645
		(0.21)		(0.89)	

Estimates of in Equation (1) H0 : B_2=5, full pass-through

Daily once a week data. Control variables include week and station fixed effects.
Standard errors in parentheses
** Reject Full Pass-Through at 95% confidence level

TABLE 6 - Station Retail Gasoline & Diesel Price-Washington State near Borders

Sample	Pre/Post	Gasoline	Obs	Diesel	Obs
WA Stations Near CND vs Rest of WA Stations	3 Month	1.46 (1.76)	8,693	2.57 (4.81)	2,349
WA Stations Near CND vs Rest of WA Stations	6 Month	0.93 (2.27)	17,387	-3.04 (4.06)	4,615
WA Stations Near ID vs Rest of WA Stations	3 Month	1.09 (1.64)	11,116	-3.73 (5.97)	2,720
WA Stations Near ID vs Rest of WA Stations	6 Month	0.91 (1.24)	22,282	-2.97 (5.44)	5,367
WA Stations Near OR vs Rest of WA Stations	3 Month	-2.31 (2.46)	8,693	-1.96 (2.52)	2,349
WA Stations Near OR vs Rest of WA Stations	6 Month	-0.65 (1.86)	17,387	-0.71 (2.52)	4,615

Estimates of in Equation (1) H0 : B_2=0, equal pass-through

Daily once a week data. Control variables include week and station fixed effects.
Standard errors in parentheses

TABLE 7 - Station Retail Gasoline & Diesel Price-Oregon near Border

Sample	Pre/Post	Gasoline	Obs	Diesel	Obs
OR Stations Near WA Border vs Rest of OR Stations	3 Month	0.43 (1.03)	13,752	10.86** (3.23)	3,739
OR Stations Near WA Border vs	6 Month	2.91**	26,489	3.10**	7,198

TABLE 8 - Station Retail Gasoline Pass-Through by Number of Competitors

Sample	Pre/Post	Group	Gasoline	Obs	Diesel	Obs
Non - Hypermarket Areas (WA/OR)	3 month	1	4.84	17,512	7.03	3,820
			(0.49)		(1.32)	
		2	5.01		7.10	
			(0.51)		(1.42)	
		3	5.24		7.37	
			(0.49)		(1.62)	
		4	4.69		5.33	
			(0.47)		(1.30)	
Non - Hypermarket Areas (WA/OR)	6 month	1	5.08	35,662	6.59	7,904
			(0.46)		(1.35)	
		2	4.95		7.17	
			(0.47)		(1.46)	
		3	5.20		7.38	
			(0.46)		(1.68)	
		4	4.82		4.81	
			(0.43)		(1.35)	

Estimates of in Equation (1) H0 : B_2=5, full pass-through

Daily once a week data. Control variables include week and station fixed effects.
Standard errors in parentheses