Master's Research Paper:
The Price Effects Due to an Increase in Market Share: Empirical Evidence from an Acquisition in Retail Gasoline Markets in Panama

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Abstract

This paper studies the price and quantity effects as well as the resulting deadweight loss due an increase in market share in retail gasoline markets. We employ both linear and nonparametric difference in difference techniques to make a causal inference about the effect an acquisition had on overall welfare. The model is estimated using panel data on retail sales in the Panamanian gasoline market. We estimate the effect for three different goods: diesel fuel, regular gasoline and premium gasoline. Our analysis provides robust evidence that the acquisition led to higher prices for regular gasoline which is the advertised price at retail stations.

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1 Introduction

Understanding the causal impact of mergers and acquisitions on an economy's welfare is essential to properly guide public policy on the topic. Empirical evidence has been gathered on a variety of industries to determine the impact that specific mergers have had on the broader market.[1] These studies have used various forms of retrospective merger analysis techniques to estimate the price effect caused by a reduction in competition levels implied by a merger between two competing firms. Retail gasoline markets have been at the forefront of the development of a large empirical literature on the retrospective analysis of mergers. This literature has found significant price impacts on both wholesale and retail prices which have negatively impacted consumers. However the body of research has shown that the results are not replicable across data sets and difficult to generalize to properly inform policy makers.

Generalizing the results from studying consummated mergers is hard due to the fact that these studies are not a random sample of all possible mergers. Up until now the literature on the impact of mergers in retail gasoline markets, has focused on two countries: the United States and Canada.[2] The ability to expand this literature to other markets has the potential to generate large returns for two reasons. First and foremost the focus of retrospective mergers on North American markets may give us no insight into how the same type of merger may affect less developed economies. Secondly the antitrust authorities in the United States and Canada may be better equipped to stop mergers that may negatively affect the economy. Thus if we were to look at the sample of

[1] For example the General Accounting Organization (2004), Hastings (2004), Hastings and Gilbert (2005), Taylor and Hosken (2007), Simpson and Taylor (2008), Chouinard and Perloff (2009), Taylor et. al (2010) and Houde (2013) have studied various mergers in the gasoline industry. These merger studies will be explained in detail in section 2.3 of the literature review. Additionally, Hunter, Leonard and Olley (2008) and Ashenfelter et al. (2009) review merger retrospective studies in not only the oil and gas industry, but also consumer products, railroads, airlines, banks and hospitals.

[2] The General Accounting Organization (2004), Hastings (2004), Hastings and Gilbert (2005), Taylor and Hosken (2007), Simpson and Taylor (2008), Chouinard and Perloff (2009), Taylor et. al (2010) have focused on mergers in the U.S. market, while Houde (2013) studied a merger in Quebec City. These mergers will be reviewed in depth in section 2.3 of the literature review.

consummated mergers in less developed economies we may be able to observe mergers that would not have been consummated in North America. This gives us a larger sample of mergers to study, which will allow a more realistic generalization of the results from merger retrospective studies.

To expand this body of research we use data from Panama to study the impact of the 2011 purchase of Royal Dutch Shell's (Shell) Panamanian operations by the retail gasoline distribution firm Petro Delta (Delta). Due to this purchase Delta's nationwide market share increased from 27.5 percent to 44.2 percent, an increase of nearly 17 percent. This increase in market share is substantial as at the time of the merger Delta and Shell had the first and second largest market shares in Panama, respectively. While local authorities approved the acquisition on the basis that it would generate cost savings and allow local retailers to better negotiate fuel prices, others worried that the rise in market share would enable Delta to raise retail gasoline prices. This paper seeks to infer the casual impact of the larger discontinuity in Delta's market share caused by the acquisition on consumer prices, quantity consumed and deadweight loss in the market for diesel fuel, regular gasoline and premium gasoline.

To get a causal estimate of the impact due to the gain in Delta's market share we will treat the merger as a natural experiment and employ a difference in difference estimator. Our empirical results show that the price effect was largest on the advertised price at retail gasoline outlets, regular gasoline prices. We found that the acquisition led to an increase in regular gasoline prices of 3.70-7.59 cents per gallon (cpg). This is of similar magnitude to Hastings' (2004) and implies that the merger had an economically significant negative impact on consumers.[3] For premium gasoline we found that the results not robust and are sensitive to the controls included in the model specification. The sole robust effect of the merger on the price of diesel fuel exists as a strong and

[3]The results in Hastings' (2004) was found not to be robust with less aggregate data by Taylor et al. (2010). On the other hand this study finds robust results while using less aggregate data.

statistically significant reduction in the price of this fuel. Thus the mergers effect was the opposite for diesel fuel as compared to regular gasoline. As diesel fuel is the only price not advertised at retail stations in Panama this is an interesting result. The quantity effect of the merger suggests that consumers switched from regular fuel to premium fuel as premium fuel prices became relatively less expensive. We find instances where deadweight loss is identified for regular gasoline when stations the competing stations were in close spatial proximity to one another, but this result is not fully robust to changes in the sample period used.

This paper contributes to the existing body of literature by expanding the sample of consummated mergers studied. Studying the impact of a merger in a previously unstudied economy gives insight into whether the results from developed countries are generalizable to less developed countries. Furthermore the addition of a study in a developing country allows us to observe the effects of mergers that may not have been approved by antitrust authorities in developed countries. These additions push the literature on mergers and acquisitions in retail gasoline markets towards a more representative sample. In addition to expanding the sample of mergers studied, this paper contributes to the literature by estimating the quantity effect of the merger. Due to data limitations, previous analyses have been unable to estimate the effect on quantities consumed. The quantity effect is important as it allows the researcher to calculate the deadweight loss caused by the merger. This paper aims to fill that gap by using the same retrospective merger analysis techniques to estimate the quantity effect alongside the price effect. Furthermore this paper, for the first time, compares how the treatment effect changes when different methods and assumptions for selecting the treatment group are employed.

The rest of the paper is organized as follows. Section 2 reviews the related retrospective merger analysis literature including previous studies from the gasoline industry. Then in section 3 we provide an overview of the Panamanian retail gasoline industry. In section 4 we describe the details of the acquisition and the impact on market shares in the Panamanian economy. Section 5 introduces the data used for our analysis and describes some of the spatial components of the market. Then the model for the retrospective merger analysis along with the estimation strategy is presented in Section 6. Finally a discussion of the empirical results is presented in section 7. The paper is concluded in section 8 where we also discuss possible extensions to the study. Further computational and data work are placed in the Appendix.

2 Literature Review

2.1 Purpose of Retrospective Merger Analysis

Retrospective merger analysis has been used by many researchers to identify the causal effect of consummated mergers. Ashenfelter et al. (2009) explains that the main goal of these studies is straightforward; to learn if prices changed as a result of the merger. A decrease in prices implies that the merger was efficient and benefited consumers. On the other hand a price increase implies that the increase in market power due to the merger harmed consumers. Ashenfelter et al. points out that there are three difficulties in determining the price effects of mergers and acquisitions.

The first difficulty arises because the calculation of the effect of the merger presumes knowledge of the counterfactual prices had the merger not occurred. Therefore the identification strategy used by the empirical researcher must define a reasonable estimate of what prices would have been in an industry without the merger. The second issue occurs as prices are often hard to measure in existing data sets and the choice of price can have important consequences on the results. For instance Taylor and Hosken (2007) show that whether one uses retail prices as opposed to wholesale prices can lead to different results. The last difficulty is that it is not always clear when the relevant time period in which the price effect of the merger would manifest itself is. The goal is to identify a time period sufficiently long enough to capture the price effect associated with the change in market structure but short enough to avoid contaminating effects from other market changes.

Finally Ashenfelter et al. posits that it is often hard to generalize the results even from a large number of retrospective studies. One reason for this, as noted by Carlton (2009) and Ashenfelter and Hosken (2008) is that only the price effects of consummated mergers can be studied and this is not a random sample of all possible studies. Furthermore Hunter et al. (2008) point out that even less obvious is those researchers are not likely to study a random sample of all cleared mergers. Researchers conducting retrospective studies have tended to focus on controversial marginal cases. Thus Hunter et al. state it is important to recognize that the results from merger retrospective studies are generally describing the competitive effects of the marginal merger, not the average cleared merger, let alone the average proposed merger. Furthermore they recognize that existing studies tend to focus on industries and countries where pricing data are readily available; mainly in the U.S. and on banking, airlines, oil and hospitals.

2.2 Types of Retrospective Merger Analysis

Using a reduced form pricing equation there are two dominant identification approaches used to estimate the price effects of a merger. The first, which is employed by The General Accounting Organization (GAO) (2004) and Chouinard and Perloff (2009) is to use explicit controls for the cost and demand factors as well as supply and demand shocks that affect prices independent of the merger. The major problem with this method is that a cost shock can easily complicated the ability of the researcher's econometric model to control for all factors affecting prices.

The second and more common reduced form approach is to treat the merger as a natural experiment and use some form of a Difference-in-Difference (DD) estimator. This method requires that outcomes are observed for two groups and two distinct time periods. The first time period is known as the pre-treatment period and the second period is known as the post-treatment period. The treatment in the case of a merger analysis is typically the date the merger was consummated. One of the two required groups is exposed to a treatment in the second time period but not the first period; this group is known as the treatment group. The second group is not exposed to the treatment in either time period; this group is known as the control group. In this estimators simplest form we take the average gain in the control group and subtract it from the average gain in the treatment group. The resulting difference is the DD estimate which describes the causal effect of the natural experiment.

A major difficulty with this method is identifying a control group to compare those affected by the merger against. Different researchers have used different control groups depending on the industry and specific merger they are studying. For instance Kim and Singal (1993) study a a number of mergers in the airline industry and use a market containing the same number of competitors pre-merger with no reduction in competition post-merger as a control group. Alternatively Hastings (2004) studies a single merger in retail gasoline stations in the Californian market. She uses gasoline stations located outside of a one mile radius of a competitor as a control group as they were deemed not to be in competition with the merging firm.

Another approach to retrospective merger analysis is to simulate a structural oligopoly model, known as the merger-simulation approach, which was pioneered by Baker and Bresnahan (1985). These simulations generate explicit predictions of the competitive effects of a merger and explicitly predict the price effect. The results rely on the estimation of a well-specified model of demand and supply which is a difficult task in spatially differentiated markets.

2.3 Examples from the Gasoline Industry

The oil and gas industry has provided the basis for several merger retrospective studies. The majority of the papers performing retrospective merger analysis in gasoline markets use the DD approach. However, the GAO and Chouinard and Perloff differ in that they use explicit controls to model cost and demand structures for a variety of separate mergers in the US. Houde (2013) studies a vertical merger in the Quebec City gasoline market and utilizes both a structural Hotelling-style model with spatial competition to explicitly predict the price effect and a DD approach to see if the reduced form model supports the results from the structural model. As a whole the literature studies both wholesale and retail gasoline prices[4] and focus on mergers in the U.S.; however Houde analyses changes in the Canadian market.

The body of empirical merger analysis for the gasoline industry can be placed into two broader categories: those examining multiple mergers on a broad set of markets and those examining a specific merger in a specified market. The first approach, employed by GAO and Chouinard and Perloff has been criticized by the latter. Simpson and Taylor (2008) explain that examining multiple mergers in multiple markets is poorly suited for the oil industry because they run the risk of incorrectly attributing a price fluctuation caused by the merger with a price fluctuation that was caused by a local supply or demand shock. Additionally Taylor and Hosken (2007) point out that for this methodology to be sound the researcher must infer that the price change is associated with a merger rather than other factors, a flawed approach when looking at many regions over a long time frame. Thus it is in their view that estimating the effect of a specific merger in a small number of markets allows the econometrician to better identify and account for local demand and supply shocks.

[4] Hastings and Gilbert (2004) and GAO (2004) study wholesale prices; Simpson and Taylor (2008), Hastings (2004) and Houde (2013) study retail prices; and Chouinard and Perloff (2007) and Taylor and Hosken (2007) study both retail and wholesale prices.

The literature in the second broader category began with Hastings (2004) study on the effects of the Atlantic Richfield Company's (ARCO) 1997 lease of 260 stations from the Thrift Oil Group (Thrifty), an independent retail gasoline chain. This study employed a DD estimator on a panel of station-specific prices to examine the price effect of the transaction at nearby competing stations. She focuses on the pure re-branding effect of the transaction and finds that retail prices increased by five cents per gallon at competing stations, a 50 percent increase in average retail margins. Furthermore Hastings explains her results through a preference structure of brand loyalty with heterogeneous consumer types. She posits that stations which were close competitors with an independent station, those with a low-share of brand loyal consumers, should have the largest price increase. To test her hypothesis empirically she divides her treatment group into three categories: high-share brand, mid-share brands and low-share brands. Her results provide supporting evidence that the price effect was largest for low-share brands and lowest for high-share brands.

Taylor et al. (2010) replicate Hastings' study using a different data set containing fleet card transactions which they aggregate by month. While Hastings data set provides a more representative sample of the retail gasoline market their data set is available at monthly intervals, compared to Hastings' data which was quarterly, and their data is available for a larger number of stations, for a longer period of time. They find a statistically significant result but of a much lower magnitude than the result Hastings found and is of very little economic significance. They also disaggregate their results into high, mid and low share brands but find no evidence that the price effects for low and mid brands are statistically different. Although they use a different dataset they find no reason that would explain the discrepancy between the results. This suggests the effect of the merger studied by Hastings is of a magnitude smaller than her estimates suggest.

Other studies in the literature focus more on vertical aspects of acquisitions. For instance Hastings and Gilbert (2005) examine The Oil and Shale Corporation's (Tosco) 1997 purchase of three refineries and 1100 gas stations. In this study the authors find some evidence that Tosco set higher wholesale prices in markets where its new retail assets competed most intensely with independent retailers. This suggests that in the presence of upstream market power, changes in the vertical market structure can lead to significant impacts on the upstream firms conduct and prices. Their study failed to examine the overall effect of the acquisition on retail gasoline prices and if the effect on wholesale prices translated into a negative impact for consumers.

Taylor and Hosken (2007) examine the impact of the 1998 joint venture between Marathon Oil Corporation (MAP) and Ashland Inc. on retail and wholesale rack prices in four cities; two in Kentucky and two in Virginia. While the joint venture they study led to significant changes in the market concentrations at both the wholesale and retail levels they do not find any statistically significant effects on retail prices. They do however find some evidence of higher wholesale prices following the joint venture but conclude that these higher prices, on net, did not cause retail prices to rise.

Simpson and Taylor (2008) estimate whether the acquisition of Ultramar Diamond Shamrock (UDS) by MAP led to an increase in retail prices. This acquisition increased both the share of terminal storage operated by MAP and the share of gasoline stations bearing the MAP name. This merger was also studied in the GAO's report but they come to a different result. Unlike the GAO study the authors find no evidence of a price increase, however the studies use different prices. The GAO study used wholesale rack prices while Simpson and Taylor use retail prices. As shown by Taylor and Hosken there is not perfect pass through between the prices so it is possible there was an effect on wholesale prices while retail prices remained unaffected. The two studies also use two different methodologies and Simpson and Taylor note that the GAO study did not account for a supply disruption in the year following the acquisition which could have seriously confounded their results.

The most recent study comes from Houde (2013) who estimates the price effect of Ultramar's purchase of Sunoco stations in the Quebec City gasoline market. Houde utilizes and compares both merger simulation methods with DD methods and finds that the reduced form estimates to a large extent validate the assumptions of the demand model. The DD strategy uses a control group defined similar to Hastings but instead uses driving times instead of distances. Houde advances that using driving times instead of distances implies that the elasticity of substitution between two products is not only a function of the distance between stations, but also their connectivity along the road and the direction of traffic flows. His reduced form estimates find an increase in retail margins of 4-11 percent, much less than the 50 percent increase found by Hastings but is still economically significant.

2.4 Importance of Replication in Economics

Hamermesh (2007) reviews three types of replications in academia and their importance in empirical research. The first type of replication is pure replication, defined as using the same sample, the same model and the same underlying population. This type of replication is important in economics to ensure that the results of empirical research were conducted correctly without any coding errors. The second type is statistical replication defined as using a different sample, the same model and the same underlying population. This is considered to be not very important by Hamermesh as only marginally relevant in economics. Lastly Hamermesh discuses scientific replication which is defined as using a different sample, a different population and a very similar - or identical - model. This form of replication comprises most of what economists view as replication.

Scientific replication is justified in economics because in non-experimental studies one cannot expect econometric results produced for one time period, or for one economy, to carry over to another. Underlying the importance of scientific replication is the dominance of American data in the study of economic phenomena. Hamermesh states that the rarity of scientific replication within studies may well arise from the extra data work required. In order to perform a within-study replication one must become familiar with a different dataset, often one that is not coded in English.

The importance of replication in merger retrospectives is grand. The prevailing literature reviewed thus far has achieved different results when replications are performed. For instance the differences between Hastings' and Houde's results suggest that there is a varying level of price effects due to retail gasoline mergers. Taylor et. al show the importance of estimating the effects using a variety of datasets, if possible, as the results may not be robust to the use of data available for a longer time frame, at higher frequencies. Additionally as noted by Ashenfelter et al. it is hard to generalize the results from a large number of studies due to the fact that the studies are not a random sample of all possible mergers.

Scientific replication is a major contribution of this paper to the literature as it allows the effects of an acquisition in a previously unstudied market to be compared to the existing literature. Studying the effects of mergers in less developed markets may lead to larger effects than developed markets due to the fact that the antitrust authorities are less equipped and often weaker than their counterparts in developed countries. Thus it is possible that mergers that would have not been cleared in the developed world may have been cleared elsewhere allowing for a broader sample of merger retrospective studies to be conducted. Only when the existing bulk of literature on mergers and acquisitions is representative of a larger sample can the results be generalized to properly inform policy makers.

3 Industry Overview

The retail gasoline market in Panama is very similar to other countries, however there are several notable differences. Typically a countries retail gasoline products are produced at a refinery, which buys oil at a world market price, and is then transported to a distribution center called a distribution rack or despatch center. In Panama there is no gasoline refinery as the last one, which was operated by Chevron, shut down in 2003. Panama currently imports each of its gasoline products from abroad and sells them at distribution centres within the country. There is one major distribution center in Panama, operated by Refpan who is vertically integrated with Chevron, which between 2004 and 2011 supplied about 70 percent of the domestic market. In general distribution centres sell two types of gasoline: branded and unbranded. Branded gasoline's have an additive mixed in before it is shipped to a retail station whereas unbranded gasoline's do not. Consequently in order to sell a specific brand of gasoline at a retail station, it must contain a brand specific additive.

There are four types of retail gasoline stations in operation globally. The first set of stations is known as branded stations, which sell a company specific branded gasoline at their retail outlets. Branded stations can operate as company-op stations where the refiner owns the station and an employee of the refiner manages the stations. The refiner sets the retail price directly and pays the employee a salary. They can also operate as lessee-dealer stations where the refiner owns the station and leases it to a residual claimant. The lessee is responsible for setting the retail price; however they are under contract to buy at the wholesale price the refiner sets for that station. Finally a branded station can be operated as a dealer-owned station. This is where the retailer owns the station property and signs a contract with a branded refiner to sell its brand of gasoline. Under this scenario the station displays the sign of the brand it is under contract to sell and must buy gasoline either directly from the refiner or through and intermediate supplier called a jobber. In contrast to branded stations the last type of retail gasoline station is known as an unbranded station, or an independent retailer. These stations sell unbranded gasoline and are free to market it as they wish.

Due to differences in the structure of branded gasoline stations there are various definitions of wholesale prices. If a station is operated as a company-op then their wholesale price is unobservable as it is set internally by the vertically integrated firm. Instead if the station operates as a lesee-dealer station the wholesale price is observable and is known as the Dealer Tankwagon Price (DTP). In practice a refiner could set the DTP price to reflect local market conditions, as small as a single station. As explained by Deck and Wilson (2004) this is known as zone pricing and is of major policy concern. Finally if a station is dealer-operated or independent the wholesale price is either the branded rack price or the unbranded rack price, respectively. These rack prices are the price paid by the company to the jobber and are the same for any jobber purchasing fuels at the distribution rack.

Finally the retail gasoline price is the final price at the point of sale to consumers at a retail station. The retail margin is usually calculated as the difference between the rack price and the retail price charged upon final transaction.[5] Retail prices differ depending on a variety of factors including the wholesale price paid, type of product sold, geographic location, additional station specific amenities provided and the level of local competition. In Panama there are a variety products sold including diesel products and gasoline with varying octane ratings. An octane rating is a standard measure of performance of motor fuel and a higher the octane number implies a higher quality product. The Panamanian Ministry of Industry and Commerce reports that stations in Panama sell gasoline with two octane ratings: 91 and 95, where an octane rating of 95 refers to premium gasoline. Additionally the Ministry of Industry and Commerce report the sale of three types of

[5] The real retail margin would be the difference between the specific wholesale price paid and the retail price; however Hastings (2004), Taylor et al. (2010) and Houde (2013) each use the rack price as the wholesale price to calculate retail margins.

diesel fuel: normal diesel, improved diesel and low sulphur diesel. However the sale of improved diesel was discontinued in June 2009 and was replaced with low sulphur diesel. This was mainly due to regulatory requirements based off the impact of high levels of sulphur in diesel fuels. By the end of 2010 the sale of normal diesel was phased out and the only retail diesel product for sale in Panama was low sulphur diesel.

Table 1 summarizes the usage of each retail fuel product between 2009 and 2012 at all retail stations across the country. As we can see from this table diesel products account for the largest share of all retail fuels, but their share of sales has been declining. One the other hand gasoline 95 accounts for the smallest share of all fuels, but their share has been increasing. Finally gasoline 91 accounts for roughly one third of all retail fuel sales and this number has, more or less, remained constant between 2009 and 2012.

Table 1: Percentage of Total Country Wide Retail Fuel Sales by Fuel Type

Product	2009	2010	2011	2012
All Diesel Products	47.20%	46.40%	46.40%	45.10%
Gasoline 95	19.70%	21.30%	21.50%	22.20%
Gasoline 91	33.10%	32.30%	32.10%	32.80%

Source: Ministry of Industry and Commerce, Panama. Author's Calculations.

4 Merger Details

After the 2008 financial crisis Shell, along with other major oil companies, began selling off their downstream assets in many smaller markets throughout the world. The economic downturn left little room for refining and marketing activities in small markets. Most major oil company's assets were up for sale, especially in the smaller Latin American countries. For instance in 2005 Shell had operations in 24 Latin American and Caribbean countries and by 2010 that number had been reduced to just six. Shell planned further reductions in Latin America after 2010 as they planned to maintain a presence in the retail gasoline sector in only three Latin American countries. Shell's departure from downstream operations in many Latin American countries was due to it reducing its exposure to low margin activities in a shift towards more profitable upstream operations.

Even countries like Panama, who was characterized by higher than average GDP growth in the region with oil consumption on a steady growth path, was ill suited to keep major oil companies in the country. This in part may be due to the fact the Panama had one of the highest levels of service stations per capita in Latin America and the Caribbean, making it highly competitive landscape and pushing down retail margins.

In the midst of their offloading of downstream assets, Shell sold both their Panamanian and Costa Rican retail stations to Delta, a fully Panamanian owned company. Delta is owned by the General Petroleum Company, an oil exploration and refining company. However since Delta purchases its retail fuels from Refpan's fuel distribution centre, within Panama, Delta simply operates as a distribution company and is not able to take advantage of its vertical integration.

The acquisition of Shell's Panamanian assets was originally announced on October 15th 2010. The deal was comprised of 68 Shell branded stations; 25 of which were company operated and another 43 which were branded locations operated by franchisees. The acquisition was subject to review by the Panamanian antitrust authorities, which approved the merger at the beginning of January. After the approval, the transaction was effective as of January 25th, 2011. Delta declared upon completion of the purchase that they do not plan to close any stations as a result of the transaction and that they will maintain the terms of contracts that were already in place with station managers.

Table 2 shows the market shares of each major retailer before the acquisition in Panama. From this we can see that Delta had the largest retail gasoline presence in Panama, while Shell was the second largest retail gasoline company. This implies that the purchase of Shell's assets by Delta generated a sharp discontinuity in the market share of Delta, a country wide increase of nearly 17 percent, which we can exploit to determine the price effect of the merger.

Table 2: Pre-Merger Market Share, by Company and Province

Province	Delta	Esso	Shell	Accel / Terpel	Texaco	Independents	Total Number of Stations
Bocas del Toro	28.6%	0.0%	14.3%	14.3%	14.3%	28.6%	7
Coclé	22.2%	14.8%	11.1%	11.1%	22.2%	18.5%	27
Colón	24.0%	4.0%	12.0%	20.0%	16.0%	24.0%	25
Chiriquí	24.4%	2.6%	23.1%	23.1%	6.4%	20.5%	78
Darién	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	1
Herrera	43.5%	4.3%	17.4%	13.0%	4.3%	17.4%	23
Los Santos	26.7%	0.0%	20.0%	6.7%	13.3%	33.3%	15
Panamá	28.3%	15.1%	15.1%	12.8%	16.4%	12.3%	219
Veraguas	26.1%	8.7%	21.7%	4.3%	17.4%	21.7%	23
Total	27.5%	10.3%	16.7%	14.4%	14.1%	17.0%	418

Source: Acodeco Merger Report; Information from the Panamanian national secretary of energy.
*Authors Calculations.

Delta used the opportunity of re-branding the image of the Shell stations to renew its image of Petro Delta and improve several of its own stations. The official contractual commitment to change Shell's brand gave Delta two years to complete the re-branding of Shell's stations, but by October 2011, 40 of the stations had been re-branded. Furthermore it was announced that the completion date for re-branding all the stations was set for May 2012. The length and staggered re-branding of Shell stations makes it difficult for us to test for the effects of re-branding, like in Hastings, but instead will allow us to test for the effects of change in ownership and an increase in market share.

5 Data

The data used in this study was provided by the World Bank's Latin America and Caribbean division. The World Bank facilitated the upgrading Panama's procurement system to an electronic system aimed at lowering corruption in the country. One of procurement contracts, awarded to Delta for the purchase of fuel for the government's fleet, was touted as saving large sums of government money. To track the success of this contract high frequency transaction data was recorded which tracked the prices and quantities sold to government officials at all of Delta's stations which accept fleet cards.

In total the dataset contained 2,042,327 transaction level observations for 36 stations from March 2009 until March 2012, however only 31 stations were actively participating in the fleet card program at the date of the merger, so 5 stations were dropped.[6] Thus this data set accounts for 7.4 percent of all retail stations in Panama and 27 percent of all Deltas stations before the merger. Table 3 compares the percentage of the total population of Deltas stations in each province to the percentage of our sample population in each province. This shows us that our date greatly under samples the population of all Delta stations in the province of Chiriqui and over samples in the provinces of Panama and Veraguas.

Furthermore, the data was merged with location data contained in Acodeco's (2010) merger report. The report contained geographic coordinates for each of Delta's and Shell's retail outlets prior to the merger. To utilize this data we imported the coordinates into the GIS software AcrMap which was used to plot and measure distances and drive times between stations. The first thing this data provided the ability to link each retail station to the city, town or rural locality it was located in. This provided more accurate clusters as the previous data only provided us with the province

[6]As these stations were all added to the fleet card program later on, or dropped early on, this only accounts for one-sixth of a percent of all transaction level data.

each station was located in. Additionally we were able to determine whether a station was located within the city centre, in the city outskirts or in a rural location.

After the data was imported into ArcMap we measured the nearest distance on a surface road between each Delta station and the nearest three Shell stations as well as the nearest three Delta stations using the programs measuring tool. Next we calculated the driving time to the nearest three stations, for each company, from each station, using drive-time polygons in ArcMap. To calculate driving times we incorporated road speed and road direction information contained on Google Maps websites into the analysis. Finally the calculated drive times and distances between stations, for each retail outlet, were merged to our existing dataset.

We measured the nearest Delta station to each Delta station to better understand the spatial organization of the Panamanian gasoline market. It is unlikely that Delta would place a station such that it would compete with another Delta station. This implies that we can use this information to find a reasonable competition radius for the Panamanian market. Table A3, in the appendix, reports summary statistics for distances and drive time to the nearest Delta station. Here we find that a reasonable competition radius is between 700 and 1300 meters, when using distances, and between two and four minutes, when using drive times. This data was then used to create control and treatment groups which is explained in more detail in Section 6.

As a station only has a price recording every time a government official fuelled up at that station the data was aggregated to reflect the average price paid in a given month. Using monthly data, we have observations for 22 time periods prior to the merger and 13 months afterwards. Wholesale prices as well as the locations of other retail gasoline companies in Panama, at the time of the merger, were unavailable.

Table 3: Number of Stations by Province, Total Population vs. Dataset

Province	Delta Owned Stations (Pre-Merger)	Delta Stations in Dataset	Percent of Pre-Merger Stations	Percent of Stations in Dataset
Bocas del Toro	2	0	1.74%	0.00%
Coclé	6	2	5.22%	6.45%
Colón	6	2	5.22%	6.45%
Chiriquí	19	2	16.52%	6.45%
Darién	0	0	0.00%	0.00%
Herrera	10	2	8.70%	6.45%
Los Santos	4	1	3.48%	3.23%
Panamá	62	19	53.91%	61.29%
Veraguas	6	3	5.22%	9.68%
Total	115	31	100.00%	100.00%

Source: Acodeco Merger Report; Information from the Panamanian national secretary of energy. *Authors Calculations.

The data collected tracked the purchase of three different goods: regular gasoline, premium gasoline and diesel fuel. Figure 1 displays local polynomial regressions for daily prices of each good and the average price of all goods combined. As expected we find that premium gasoline prices are the highest throughout the sample period, followed by regular gasoline and diesel prices. By the end of the time sample period the gap between diesel fuels and regular gasoline has shrunk. On the other hand the gap between regular gasoline and premium gasoline has increase making premium gasoline relatively more expensive. Table A.2 displays the standard deviation of these prices by year and discusses changes in the quality due to government regulations of these goods.

The dataset contains service stations in ten cities and two rural localities in a total of seven different provinces. Before any analysis was conducted observations with erroneous information were dropped from the dataset. As these observations only accounted for one tenth of a percent of the transaction level data it is unlikely that dropping these observations will bias the results.[7] Table

[7]Erroneous observations were defined as: missing price data (2119 observations), price data equalled 0 (115

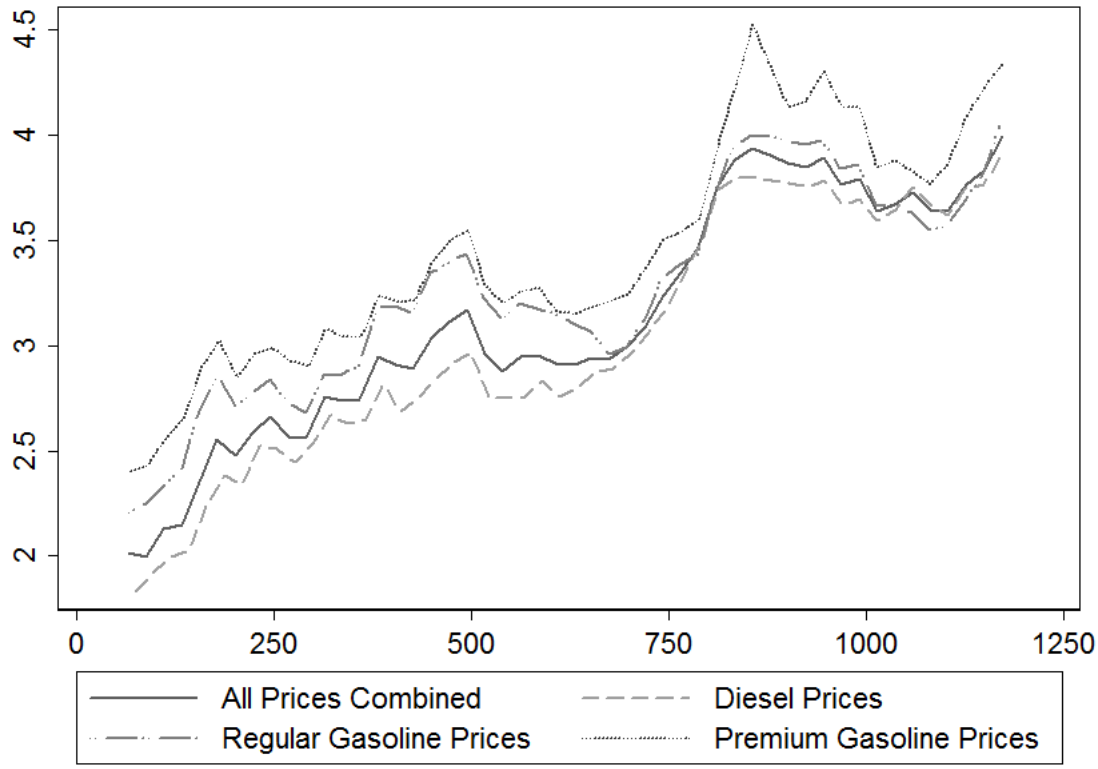

Figure 1: Daily Prices by Retail Fuel Type - Local Polynomial Regression

A.1 summarizes the number of service stations in each city, the average price per gallon paid for all retail fuels combined (PPG) by city in each year. From this table we can see that roughly 50 percent of all observed stations are located in Panama City while the rest are spread across the country.

Figure 2 displays spatial price differences over the time period analyzed in the Panamanian market. The three graphs in the left column display local polynomial regressions for the daily prices in Panama city, all cities less Panama city and the rural localities. The top, middle and bottom rows display the price trends for regular gasoline, premium gasoline and diesel fuel, respectively. The graph for regular gasoline shows us that in the first year of the data set towns and cities had the

observations), reported consumption and price was less than 0.5 gallons and greater than $5 simultaneously (156 observations), report prices above $6.5 (1 observation) and report prices below $1 (2 observations).

highest regular gasoline prices while rural localities had the cheapest. In year two this reverses and by the end of the year rural prices are highest while Panama City has the lowest prices. In year three there is a fast significant rise in prices and for the most part spatial price disparities return to the pattern found in year one. For premium gasoline that towns and cities less Panama City have the highest prices throughout the time period. In the beginning of the sample period rural localities have the lowest price but it alternates between Panama City and rural localities thereafter. For diesel fuels towns and cities have the highest prices throughout while rural localities have the lowest prices. Furthermore we can see that regardless of fuel type that each of these localities follow the same general trend.

The graphs in the column on the right of Figure 2 show the price trends for stations located within a city core, in a cities outskirts and rural localities. Regardless of price we see that whether the station is located in the city core or the outskirts has little impact on prices. However at times we do observe that the prices on the outskirts is slightly higher, but the difference is small. For regular fuel we observe that rural localities have the lowest prices in year one, the highest in year two and all are very close in the final months. This is the same pattern observed previously. For premium gasoline the trend is very similar. Finally for diesel fuel we find that rural prices are cheapest throughout the time series.

6 Methodology

In an ideal world, to estimate the causal effects of an increase in market share on retail prices, quantities and deadweight loss, the researcher would randomly assign station ownership at a random and representative sample of stations. Then the researcher could calculate the resulting change in local prices and quantities to explicitly identify a causal relationship. The purpose of random

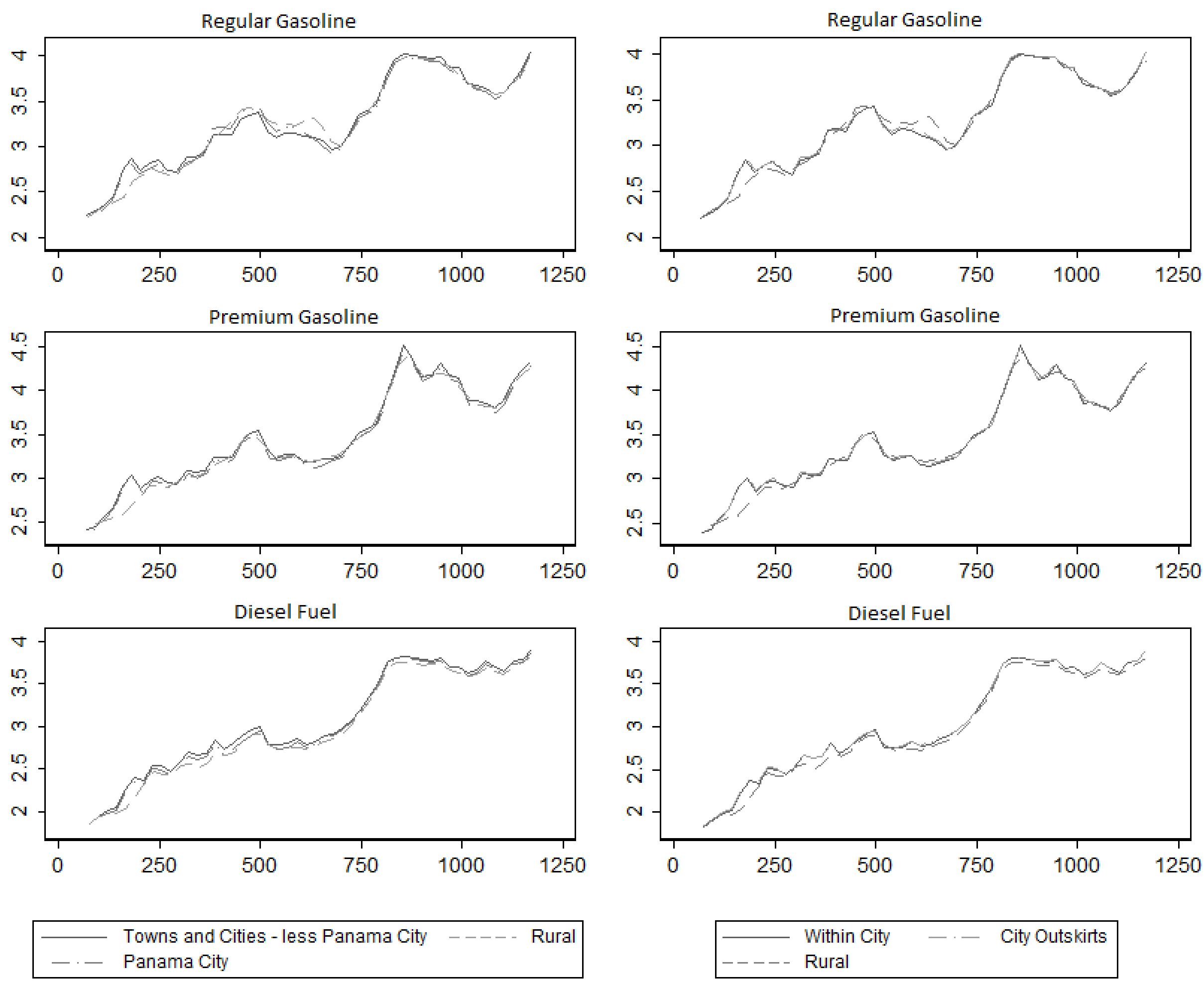

Figure 2: Daily Prices by Spatial Locality Type - Local Polynomial Regression

assignment to a representative sample of the population is to ensure that the change in market share is orthogonal to all other factors that determine retail gasoline prices.

In reality, random assignment of station ownership is not possible so we must instead exploit a natural experiment which caused a sharp, discontinuous change in the market share of a company. This discontinuity in market share occurred when Delta bought Shell's assets and the nationwide market share of Delta increased by 17 percent. Exploiting this natural experiment has obvious limitations and drawbacks. Most importantly, since the researcher has very little control over the situation, there is always the possibility that some other uncontrolled factor has an influence on the dependent variable. Since the characteristics and location of each station was determined before Delta's decision to purchase Shell's assets, it is reasonable to consider the loss of local competition with Shell as exogenous to a specific Delta stations pricing decision, conditioned on station specific characteristics. This allows us to dramatically reduce the omitted variable bias problem. Therefore the potential confounds can be controlled for when estimating the effects of a change in market share on retail prices.

In order to estimate the price, quantity and deadweight loss effects of the acquisition of Shell's assets by Delta, this paper conducts a difference-in-difference (DD) analysis similar to Hastings (2004) and Houde (2013). The identification strategy used relies on the notion that the merger between to retail store networks created a sharp change in the structure of local markets. In Hastings' case the acquisition implied the loss of independent retailers that once competed with the purchasing firm. Hastings' was able to exploit the change in market structure as a rebranding effect because the rebranding occurred almost immediately. In Houde's case rebranding took place over a two-year period, so instead he was able to exploit an immediate change in the vertical integration of the purchasing firm. Houde exploited the fact that the new upstream supplier was able to fully or partially control the retail price, through some form of wholesale price discrimination. This implied that the post-merger prices should be set less competitively. In the case of Delta's purchase of Shell's assets the immediate change was a sharp change in competition levels among Delta stations that locally competed with a Shell station prior to the merger. This allows us to exploit the effect of the change in ownership and loss in competition on prices.

Each model estimated in this paper is a form of a station specific effects model. The first model estimated uses station level prices, p_{st} as the dependent variable.

$$p_{ist} = \alpha_i s + \gamma T_{st} + \lambda C_t + \delta T_{st} C_t + \epsilon_{ist} \tag{1}$$

Equation one is the standard DD model where the subscripts stand for the specific fuel product price, the individual station and time period, respectively. Three specific fuel product prices are used: regular gasoline, premium gasoline and diesel fuel. Additionally the model is also estimated using an average of the three prices combined. We measure station specific prices as the average price observed for that good in each given month. The station specific effects are denoted in this equation by α_s while the idiosyncratic error is denoted by $epsilon_{st}$. The treatment group is denoted by T_{st} which is equal to 1 if the station is in the treatment group and is 0 otherwise. The variable C_t, tracks whether each Delta station is currently competing with a Shell station. This variable is equal to 1 before the acquisition and 0 after the transaction when the firms are no longer competing. The coefficient on the interaction term between the treatment group and competition dummy variables, δ, is the DD estimate for the causal impact of the acquisition.

The second model estimated is the same as the first, however it instead uses station level quantities q_{st} as the dependent variable.

$$q_{ist} = \alpha_i s + \gamma T_{st} + \lambda C_t + \delta T_{st} C_t + \epsilon_{ist} \tag{2}$$

We measure quantities as the total volume of sales in a given month for a given station. Estimating the effect of the acquisition on the quantity consumed will allow us to see if quantity reduced as price rose. If this is the case we will be able to calculate the deadweight loss in each specific product market.

The third model used in this paper replicates equation one with the addition of city-specific time trends to the list of controls.

$$p_{ist} = \alpha_{0is} + \alpha_{1is}t + \gamma T_{st} + \lambda C_t + \delta T_{st} C_t + \epsilon_{ist} \tag{3}$$

Here α_{1s} is a city-specific time trend coefficient multiplying the time trend variable, t. This model specification is a close replication to Hastings' (2004) model and Houde's (2013) model. This additional control allows for each city in the dataset to follow different trends in a limited but potentially revealing way. As pointed out by Angrist and Pischke (2009) DD estimation with these additional city-specific time trends are likely to be more robust and convincing.

The last model used replicates equation two while also controlling for city-specific time trends using the same method described in equation three.

$$q_{ist} = \alpha_{0is} + \alpha_{1is}t + \gamma T_{st} + \lambda C_t + \delta T_{st} C_t + \epsilon_{ist} \tag{4}$$

To designate which stations belong in the treatment group we use two different methods and then compare the results across these methods. The first procedure utilized to determine the treatment group selected stations based off their distances to competing stations. The distance between stations were measured by using the coordinate addresses of each gas station and finding the nearest distance on a surface road between each set of stations.[8] Using this method implies the elasticity of substitution between stations is a function of the road distance between them. This was the method employed by Hastings. The second method uses the amount of time it takes to drive from one station to another measured using road speeds and direction of traffic flow information.[9] Using

[8]Distance was measured as the nearest Manhattan (road) distance via the measuring tool in the ArcMap software by ESRI. The ArcMap software uses 2D Cartesian mathematics to calculate distances. Thus the distances reflect a projection of 3D data onto a 2D surface and does not take into account the curvature of the earth.

[9]Drive times were measured using drive-time polygons in the business analyst menu of the ArcMap software from ESRI. Drive times were calculated by incorporating road speeds and road direction information contained on Google

drive times implies that the elasticity of substitution between two stations is a function of not only the distance travelled but also the connectivity along the road, the direction of traffic flows, and the speed limit of the roadways. This is the method that Houde used in his analysis.

The next step in sorting the stations into treatment and control groups is to make an inference about which stations are to be deemed as competing with a Shell station based off their distance from or drive time to that station. Hastings used a distance of one mile for the Southern Californian market based off the reasoning that a company will not place a station within its own competition radius and that ARCO stations are located more than one mile apart. This does not seem like a feasible distance for the Panamanian data set as the cities studied are much smaller in geographic terms. In Table A3, in the Appendix, we summarize the distance and drive times, by percentile, between Delta stations to see if this is a reasonable distance to use for defining the treatment group. Roughly 10 percent of Delta's service stations are within 800m of other Delta stations. This implies that the relevant treatment radius in Panama is much smaller than that in Southern California. Additionally Houde uses a drive time radius of one half a minute in the Quebec City market, but the closest Delta stations to one another, in terms of driving time, are 2 minutes apart.

Due to the variation in the spatial organization of Panama's retail gasoline market in the different localities contained in the data set this paper will not claim that there is one perfect treatment radius. Additionally there is a clear discrepancy int he spatial organization of these markets when compared to previous studies so we can not use them as a guide in determining the optimal treatment radius. Instead we will use various treatment intensities and observe the sensitivity of the results to the choice of various treatment radii. Table 4 summarizes the different treatment intensities used for the analysis as well as the number of treatment and control stations at the varying

Maps websites. Drive times did not incorporate road traffic records as this was only available for Panama City and Colon, not the whole country.

distances and drive times. This table also displays how many treatment stations have more than one Shell station within the treatment radius, how many treatment stations have a Delta station within the treatment radius and how many control stations have a Delta station within the treatment radius. These additional statistics help build a picture of which treatment intensities best replicate whether or not a Delta station actually competed with a Shell station, or not, before the merger. For instance as we get over 1200 meters or 3 minutes more than 40 percent of the Delta stations in the sample had another Delta station within the treatment radius. This implies that using these distances to select the treatment group may be unreliable.

Table 4: Number of Treatment and Control Stations by Treatment Intensity

Treatment Intensity	# of Treatment Stations	# of Control Stations	# of Treatment Stations with multiple Shell stations	# of Treatment Stations with multiple Delta stations
400 meters	2	29	1	0
800 meters	7	24	1	3
1200 meters	11	20	2	7
1600 meters	18	13	3	13
2000 meters	24	7	7	18
1 min	4	27	1	0
2 min	9	22	2	3
3 min	17	14	4	9
4 min	20	11	9	16
5 min	25	6	9	19

The appropriateness of the DD estimator hinges upon three critical assumptions being satisfied. The principal identifying assumption is that there is an identical counterfactual trend in the treatment and control group. This assumption is known as common trend and in our case requires that price and quantity trends at retail gasoline stations in both the treatment and control groups would have been the same in the absence of the treatment. As we cannot observe true counterfactual trends in our data we rely on testing the validity of this assumption using pre-intervention data to show that the trends were similar before the treatment date. The second necessary assumption is that of common support. This assumption requires that the composition of the treatment and control group be similar in terms of observable and unobservable characteristics. The final identifying assumption required is that of no pre-treatment effects. Under this assumption we must ensure that the treatment group does not exhibit a change in outcomes prior to the implementation of the program.

Beyond the identifying assumptions needed to conduct a valid DD study, recent literature has focused on how to properly conduct inference with this class of estimators. Betrand, Duflo and Mullainathan (BDM) (2004) note that the standard estimation of DD estimators may give us incorrect standard errors since: the formulas rely on long time series, the dependent variables are typically highly positively serially correlated and the treatment dummy itself changes little over time. Furthermore, BDM show that in Monte Carlo simulations DD coefficients are estimated to be significant at the 5% level 45% of the time.

An initial solution to this problem is to cluster the standard errors at the group level and was first proposed by Moulton (1990). However this only solves part of the problem. With this type of estimator the cluster-robust standard error estimator converges to the true standard error as the number of cluster approaches infinity and Kezdi (2004) shows that 50 clusters is often close enough to infinity for accurate inference. However these fixes were shown by BDM to perform poorly. Instead they propose that the econometrician use a block bootstrap method which resamples clusters with replacement. Cameron et al. (2008) show that this method works well when the number of clusters is as low as six. However, Webb (2012) argues that this method only works well when the number of clusters is eleven or more.

Additionally BDM also show that the block bootstrap method produces significantly more reliable estimates of the standard errors than correcting for the serial correlation in the time series by incorporating an autoregressive error term. While some papers in the gasoline merger retrospective literature use cluster robust errors or try to correct for serial correlation by incorporating an autoregressive error component, none use the more efficient block bootstrap method. Due to the long series and high frequencies used in many of these papers this may imply that many of these papers have made type 1 errors. This paper attempts to improve upon these potential problems in conducting inference by estimating all of the above models using the block bootstrap method, when possible.

7 Results

This section, which will discuss the results from the above models, is split into two subsections. First we will analyse the results from each of our equations when they are estimated using distances as the definition for the treatment radius. Next we will analyse the results when using drive times and compare differences. Before we estimate our model we must first ensure we are making valid assumptions. To do this we first look to see if the common trend identifying assumption holds in our data. Then we have to ensure we correctly specify our econometric model.

This paper's research design allows for the econometric model to include station level fixed effects and city-time effects. For the fixed effects regression to be valid two criterion must be satisfied. First the data must reject the test of no fixed effects. If the data supports the test of no fixed effects then the pooled OLS estimator will be the most efficient estimator. If the data however rejects the test of no fixed effects then the fixed-effect estimator is only consistent when the unobservable station-specific effects are not distributed independently from the models observables. If the unobservable station-specific effects are distributed independently from observables then the random-effects model will be consistent. Thus, the fundamental issue is whether the individual effect is correlated with regressors. [10]

7.1 Distances

To ensure the common trend assumption holds we have plotted lowess regression lines for monthly prices for both our treatment and control groups in Figure 3. This figure defines treatment and control groups using the 800 meter treatment radius which was deemed relevant in the Panamanian data. The figure displays four graphs: one for all fuels combined, regular gasoline, premium gasoline and diesel fuel. The two vertical lines in these graphs refer to date the acquisition was announced and the date the acquisitions was completed, respectively. As we can see from the graph plotting all fuels combined, the prices in the treatment group were lower prior to the date of acquisition. After the completion of the acquisition these prices appear to be virtually the same. This is true for regular gasoline as well, however the change is more profound when just looking at this fuel. For diesel fuel and premium fuel this is not the case. For both of these fuels the prices in the treatment group are either on par with or above the prices in the control group with no change due to the acquisition date. These results imply that stations were only competing for customers based upon the price of regular gasoline, the advertised price at the station, prior to the merger. This is highlighted by the fact that it is the only price that is significantly cheaper for the treatment group than the control group before the acquisition. Therefore the only price that we should expect to find a treatment effect for is that of regular gasoline. The robustness of these results to the econometric model used for the regressions is checked in the Appendix where we instead use local polynomial regressions.

In Table 5, we estimate equation 1 and observe the price effect caused by the discrete change in Delta's market share after the acquisition. This table reports reports varying degrees of treatment

[10] This is tested using the Hausman test. We conducted F-tests and Hausman tests throughout this entire section and they support the fixed effects results in this sections tables. The results of the specification tests are available upon request.

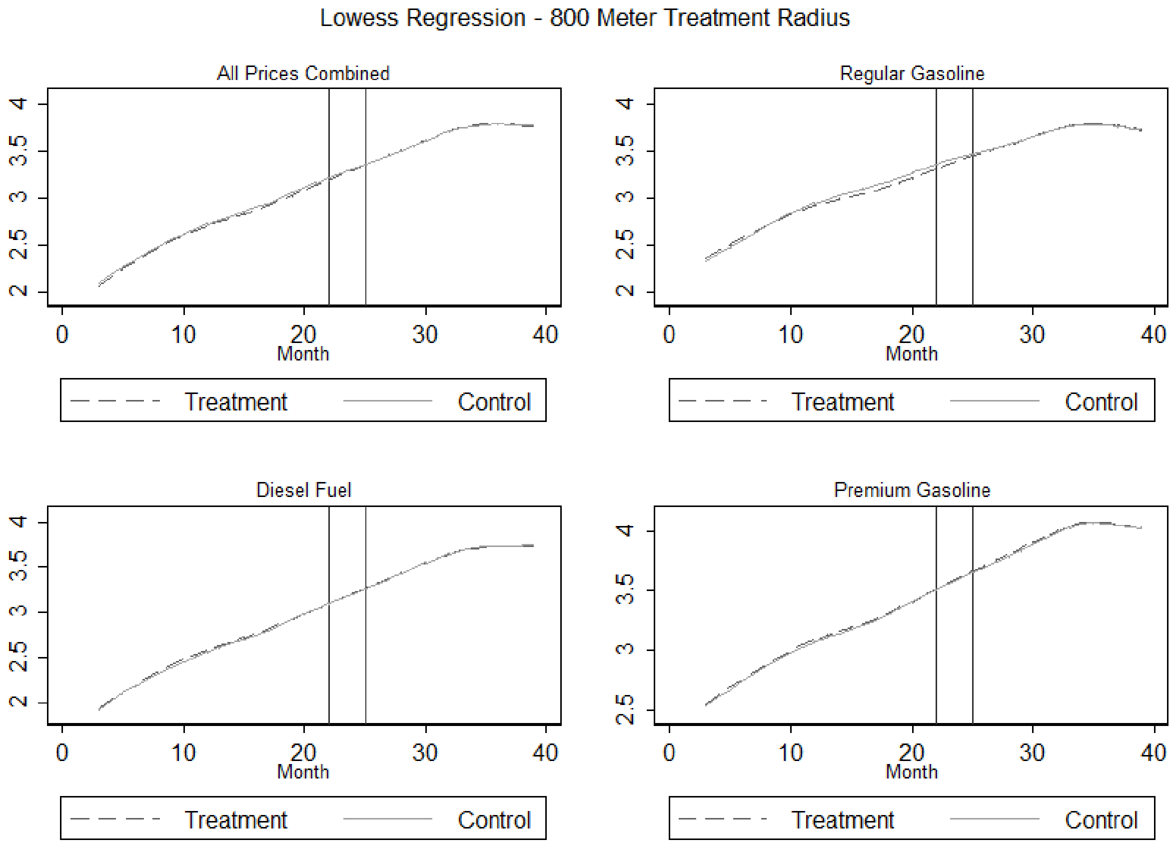

Figure 3: Common Trend Analysis - Distances

intensities to estimate the price effect of the merger. The closest treatment group contains stations within a 400 meter surface road distance. The treatment intensity then increases by intervals of 400 meters up until two kilometres. The distance of 1600 meters is roughly equal to one mile, the distance used by Hastings in her 2004 study of Californian retail gasoline markets. In addition to observing varying treatment intensities the table also reports the effects for two different sample periods: one period uses all the available data, the other uses data from 6 months before and after the treatment date.

Columns 1, 3, 5 and 7 report the effects the whole sample period for each treatment distance.

Column 1 reports the effects on the average of all three fuel types combined. Here we see that the merger increased prices by 5.73 cents per gallon (cpg) for the competition radius of 400 meters and that this result is significant at the 10 percent level. This result disappears as the competition distance increases and is insignificant by the time the competition radius reaches 800 meters. Column 3 shows the effects on the monthly average of diesel fuel prices. The effect on diesel fuel prices are found to be insignificant at each treatment distance. Column 5 displays the effect of the acquisition on average monthly price of regular gasoline, the retail price advertised at competing gasoline stations. At 400 meters the estimated effect is the highest, the purchase caused an increase of 6.26 cpg, and is significant at the 10 percent level. At 800 meters the estimated merger effect is an increase in prices of 5.10 cpg and is found to be significant at the 1 percent level. The effect then decreases to 3.70 cpg as the treatment radius increase to 1200 meters and becomes insignificant if the treatment increases any farther. Column 7 displays the estimated effect on premium gasoline prices. At 400 meters our model estimates an increase of premium gasoline prices of 3.22 cpg. As the treatment distance increases the results become insignificant. Thus, as expected, from the data presented in Figure 3, the price effect was largest for regular gasoline.

These results are comparable in magnitude to the effects found by Hastings in the Los Angeles and San Diego markets. However at a comparable distance to the one Hastings used, one mile, the effect of the merger is not statistically significant. One reason the relevant treatment distance is smaller is because there are differences in the spatial organization of the markets being studied in Panama compared to those studied in California. For instance the retail markets examined here are much smaller in total geographic size. San Diego is 3.5 times and Los Angeles is 4.7 times the geographic area, respectively, of the largest city studied in this data, Panama City which is 275 square kilometres. Additionally there are even smaller cities, townships and rural localities included in the Panama data. Thus it is logical that a significant effect is found in a competition distance that is much smaller than in Hastings study. This implies that the competition region in our data is much smaller than those used in previous studies conducted using North American data.

Columns 2, 4, 6 and 8 report the estimated effects using equation 1 for only one year of data for each treatment distance. In column 2 we see that the price effect on all prices combined is now significant at each treatment distance, except for 800 meters, however the effect is of a magnitude smaller than before. The estimated effect is now biggest at 1200 meters where the purchase led to an increase in average monthly prices of 2.89 cpg. Column 4 presents the results for diesel prices which, once again, show that there is no significant price effect for this fuel type. The estimated effect for regular gasoline, column 6, is now significant at each treatment distance but 400 meters. The estimated effect is now largest at 1200 meters where the merger led to an increase in average monthly prices of 7.44 cpg. This estimate is 19 percent larger than the largest estimate of the price effect when using the entire dataset. In column 8 we find that the only treatment distance where a price effect is realized for premium gasoline is at the 1200 meter distance. Here we find that the merge led to an increase of premium fuel prices of 1.72 cpg.

In Table 6, we estimate equation 2 and observe the quantity effect caused by the discrete change in Delta's market share after the merger. The quantity effect is estimated to see if there is a measurable deadweight loss caused by the merger in the Panamanian economy. It is important to note that our deadweight loss results are merely suggestive of the presence of deadweight loss due to the acquisition. We are not able to properly conduct a welfare analysis as one would need to have representative quantity data for the entire Panamanian retail gasoline industry, which we do not. This table reports the effects at the same treatment radii as Table 5. As before we also estimate the quantity effect for two different sample periods. This is done to see if the deadweight loss is robust to the sample period used.

Table 5: Price Effects of Merger by Fuel Type and Treatment Intensity

Distance		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		PPG of Combined		PPG of Diesel		PPG of Regular Gasoline		PPG of Premium Gasoline	
		2009-2012	1 year	2009-2012	1 year	2009-2012	1 year	2009-2012	1 year
400m	Conversion	-0.0573*	-0.0170*	-0.0261	-0.00357	-0.0626*	-0.0463	-0.0322**	-0.0151
		(0.0302)	(0.00885)	(0.0208)	(0.00681)	(0.0356)	(0.0308)	(0.0145)	(0.0148)
	Constant	3.761***	3.751***	3.700***	3.678***	3.780***	3.799***	4.047***	4.056***
		(0.0116)	(0.0125)	(0.0121)	(0.0106)	(0.0119)	(0.0116)	(0.0132)	(0.0118)
800m	Conversion	-0.0236	-0.0154	0.0147	0.00587	-0.0510***	-0.0530**	-0.000704	-0.00710
		(0.0208)	(0.00984)	(0.0319)	(0.00493)	(0.0177)	(0.0214)	(0.0267)	(0.00807)
	Constant	3.761***	3.751***	3.700***	3.678***	3.780***	3.799***	4.047***	4.056***
		(0.0117)	(0.0129)	(0.0124)	(0.0107)	(0.0107)	(0.0110)	(0.0143)	(0.0139)
1200m	Conversion	-0.00330	-0.0289***	0.0360	-0.000572	-0.0370**	-0.0744***	0.00731	-0.0172***
		(0.0232)	(0.0104)	(0.0337)	(0.00427)	(0.0183)	(0.0183)	(0.0312)	(0.00608)
	Constant	3.761***	3.751***	3.700***	3.678***	3.780***	3.799***	4.047***	4.056***
		(0.0108)	(0.0130)	(0.0122)	(0.0114)	(0.0115)	(0.0112)	(0.0126)	(0.0133)
1600m	Conversion	0.00333	-0.0134**	0.0181	0.00117	-0.0255	-0.0441*	-0.000532	-0.00862
		(0.0255)	(0.00653)	(0.0233)	(0.00332)	(0.0291)	(0.0248)	(0.0217)	(0.00933)
	Constant	3.761***	3.751***	3.700***	3.678***	3.780***	3.799***	4.047***	4.056***
		(0.0108)	(0.0113)	(0.0119)	(0.0106)	(0.0114)	(0.0111)	(0.0149)	(0.0130)
2000m	Conversion	-0.00395	-0.0223*	0.00745	-0.00297	-0.0336	-0.0711**	-0.00979	-0.0182
		(0.0394)	(0.0120)	(0.0435)	(0.00413)	(0.0433)	(0.0356)	(0.0420)	(0.0111)
	Constant	3.761***	3.751***	3.700***	3.678***	3.780***	3.799***	4.047***	4.056***
		(0.0111)	(0.0108)	(0.0120)	(0.0111)	(0.0102)	(0.0109)	(0.0134)	(0.0136)
Stations		31	31	31	31	31	31	30	30
Clusters		12	12	12	12	12	12	11	11
N		1,069	371	1,068	371	1,068	371	1,044	360

Note: Block bootstrap robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. For all regressions fixed effects tests and Hausman specification tests were conducted. The results from these tests are available upon request. Block bootstrapped errors were obtained using city level groups and were sampled with replacement. To make the tests valid at the 5 percent level 199 repetitions were used as suggested in Mackinnon and Davidson, 2004.

When using the whole sample period we find that there are no significant quantity effects on all fuels when combined statistics are used. In column 3 we see that there was a statistically significant increase in diesel fuels at 1200 meters. As there was no price effect for diesel fuel due to the purchase, the change in consumption must be caused by variation in other market prices. In column 5, we see a decrease in consumption of regular gasoline at a treatment distance of 400 meters in column 5. Since prices increased at this distance this implies there is a deadweight loss in the market for regular gasoline at a treatment distance of 400 meters. In column 7 we find several significant results for premium gasoline. At the closest treatment distance we find that the merger decreased consumption. As prices increased at this distance this leads to a deadweight loss in this market segment and treatment distance. When the treatment distance is increases, up to 1600 meters, we find that consumption increased although there was no price effect at these distances.

When we instead only use one year of the sample we find that there is an increase in identified effects however the magnitude of the effect tends to shrink. The majority of the treatment effects show that the acquisition led to an increase in quantity consumed, except the quantity effect for premium and regular gasoline at 400 meters negative. This is the same result we found when we used the whole sample period. This shows that, for the most part, the quantity effects are robust to time period selected for the estimation. However since the price effect at this treatment distance, for both of these products, was not robust to the time period selected we conclude that the identified deadweight loss is not robust to the sample period used.

One possibility that explains the increase in consumption when there was no price effect is that consumers expected future price shocks. As the regular fuel price is the one advertised, and this price increased due to the acquisition, consumers of premium gas and diesel fuel would of expected the same for their products as well. Thus they rationally choose to consume more now before the expected future price increase is to be realized. Another possibility which explains the increase in consumption of premium gasoline is due to the substitutability between premium and regular fuels. If consumers prefer premium fuel but the price differential between regular and premium fuel is too high, they will choose to consume regular fuel. However when the price of regular fuel increases by more than the price of premium fuel, this differential shrinks, causing some consumers to choose to use premium fuel as it is now, relatively, less expensive.

In Table 7 and Table 8 we test the robustness of our results by estimating equation 3 and 4, respectively, which add city-time effects. Table 7 displays the results for the estimation of equation 3. Overall, we find that there is a slight increase in price effects that are statistically significant as compared to table Table 5. We speculate that this occurs as people are more likely to drive slightly further within their own town to save money on gasoline but not to another town. For all fuels combined we no longer find that there was an effect at 400 meters, instead we do now find that the merger led to a price increase of 3.16 cpg at 1200 meters. For diesel fuels we find that the merger led to a decrease in prices at 400 and 800 meters of 1.99 cpg and 1.53 cpg, respectively. This implies that the merger was efficient for this type of fuel product in the Panamanian market. We now find a significant price effect for regular fuels up until a 1600 meter treatment radius. The price effect at 400 meters has gone down to 5.13 cpg, however the price effect has increased at all other treatment distances. At 1200 meters we now find that the merger led to an increase of 6.21 cpg for regular fuel. The results for premium gasoline when adding city-time effects show that the merger had no statistically significant effect on this products price. These results show us that the effect on premium fuel prices is not robust and is not a convincing result. On the other hand, the results for regular fuel prices are still significant at each treatment distance and the estimated effect is of a similar magnitude. This provides ample evidence that the acquisition did lead to an

Table 6: Quantity Effects of Merger by Fuel Type and Treatment Intensity

Distance		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Gallons of Combinedl)		Gallons of Diesel		Gallons of Regular Gasoline		Gallons Premium Gasoline	
		2009-2012	1 year	2009-2012	1 year	2009-2012	1 year	2009-2012	1 year
400m	Conversion	4,021	-61.44	543.3	-2,256**	2,926*	2,021*	551.8*	173.0*
		(2,741)	(587.2)	(947.9)	(892.0)	(1,728)	(1,070)	(299.7)	(103.8)
	Constant	28,345***	26,285***	18,900***	17,771***	6,517***	5,800***	2,928***	2,714***
		(2,009)	(2,143)	(1,553)	(1,910)	(932.0)	(1,044)	(819.3)	(697.6)
800m	Conversion	-2,994	-906.6	-2,102	-684.4	234.9	189.7	-1,127*	-411.9
		(3,398)	(1,379)	(1,499)	(645.2)	(1,637)	(1,156)	(667.5)	(317.5)
	Constant	28,371***	26,286***	18,915***	17,771***	6,521***	5,800***	2,936***	2,714***
		(1,867)	(2,059)	(1,397)	(1,831)	(1,073)	(1,110)	(793.1)	(704.0)
1200m	Conversion	-3,501	-1,351	-2,916*	-1,107*	182.6	148.4	-768.4**	-391.6
		(3,140)	(1,364)	(1,615)	(619.4)	(1,712)	(1,016)	(385.7)	(286.5)
	Constant	28,353***	26,284***	18,902***	17,770***	6,522***	5,800***	2,929***	2,714***
		(1,772)	(2,195)	(1,426)	(1,758)	(1,060)	(1,055)	(780.0)	(649.1)
1600m	Conversion	-2,924	-1,447	-2,344	-734.8	206.7	-249.0	-786.8***	-462.8***
		(2,756)	(983.3)	(1,776)	(841.1)	(959.8)	(552.8)	(290.0)	(116.4)
	Constant	28,353***	26,284***	18,902***	17,771***	6,522***	5,800***	2,929***	2,714***
		(1,798)	(2,246)	(1,501)	(1,718)	(1,094)	(1,055)	(781.7)	(700.9)
2000m	Conversion	329.1	-45.41	845.1	446.1	-99.72	-290.0	-416.3	-201.6*
		(4,517)	(694.7)	(2,573)	(681.9)	(1,500)	(726.2)	(359.5)	(109.1)
	Constant	28,352***	26,285***	18,900***	17,771***	6,522***	5,800***	2,929***	2,714***
		(1,914)	(2,003)	(1,537)	(1,878)	(1,082)	(1,064)	(773.4)	(687.5)
Stations		31	31	31	31	31	31	30	30
Clusters		12	12	12	12	12	12	11	11
N		1,069	371	1,068	371	1,068	371	1,044	360

Note: Block bootstrap robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. For all regressions fixed effects tests and Hausman specification tests were conducted. The results from these tests are available upon request. Block bootstrapped errors were obtained using city level groups and were sampled with replacement. To make the tests valid at the 5 percent level 199 repetitions were used as suggested in Mackinnon and Davidson, 2004.

economically significant price increase in the market for this product.

When we use only one year of data instead, we find that the results are very similar to Table 5, although we once again realize a slight increase in the number of statistically significant results. For all fuels combined we see two differences; we now estimate a significant effect at each treatment distance and the highest effect gone down to 2.68 cpg. This effect is still found at the same treatment distance of 1200 meters. For diesel fuels we find that the identified effects are statistically insignificant. This implies that the result that the merger was efficient for this product market is not robust. For regular fuel we now find that the price effect at 400 meters is now significant. Compared to Table 5 the largest price effect has shrunk to 6.96 cpg, however this effect is still larger than the results from the use of the whole sample period. Finally the results for premium gasoline are very similar, the only significant result is at the 1200 meter treatment distance; however the treatment effect has now gone down 1.30 cpg. Therefore the results from the addition of city-time effects mimic our previous results rather closely when only one year of data is used.

Table 8 reports the quantity effect estimated using equation 4. We again find that the addition of city-time effects led to an increase in the number of identified effects. The first notable difference is that we no longer identify any instances of deadweight loss for premium fuel. This creates doubt on the previously identified deadweight loss identified in this product market as it is not robust to the addition of city-time effects. However for regular fuel we now find that the deadweight loss identified at 400 meters is now robust to the sample period used. This provides strong evidence that the merger created deadweight loss in this product market. For diesel and premium gasoline markets we find that the quantity consumed increased due to the acquisition. Since we find that in some specifications the price of diesel fuel decreased due to the merger part of the increase in consumption can be attributed to the decrease in prices. However as the price decrease is not

Table 7: Price Effects, Controlling for City-Time Effects, of Merger by Fuel Type and Treatment Intensity

Distance		(1) PPG of Combined 2009-2012	(2) PPG of Combined 1 year	(3) PPG of Diesel 2009-2012	(4) PPG of Diesel 1 year	(5) PPG of Regular Gasoline 2009-2012	(6) PPG of Regular Gasoline 1 year	(7) PPG of Premium Gasoline 2009-2012	(8) PPG of Premium Gasoline 1 year
400m	Conversion	-0.0201	-0.0128**	0.0199**	-0.00181	-0.0513*	-0.0691**	0.00235	0.00502
		(0.0156)	(0.00577)	(0.00662)	(0.0133)	(0.0285)	(0.0251)	(0.00860)	(0.0143)
	Constant	2.621***	1.944***	2.467***	1.690***	2.850***	2.553***	3.133***	1.967***
		(0.0210)	(0.0239)	(0.0150)	(0.0146)	(0.0411)	(0.0659)	(0.0116)	(0.0183)
800m	Conversion	-0.0263	-0.0194**	0.0153*	0.00409	-0.0590*	-0.0532**	-0.00162	-0.00357
		(0.0168)	(0.00867)	(0.00722)	(0.00348)	(0.0268)	(0.0173)	(0.00861)	(0.00497)
	Constant	2.620***	1.944***	2.468***	1.690***	2.848***	2.552***	3.132***	1.967***
		(0.0219)	(0.0239)	(0.0148)	(0.0147)	(0.0428)	(0.0617)	(0.0118)	(0.0176)
1200m	Conversion	-0.0316**	-0.0268**	0.00467	0.00247	-0.0621***	-0.0565**	0.00273	-0.0130***
		(0.0118)	(0.0120)	(0.00843)	(0.00402)	(0.0195)	(0.0224)	(0.00548)	(0.00360)
	Constant	2.619***	1.945***	2.467***	1.690***	2.847***	2.553***	3.133***	1.967***
		(0.0215)	(0.0249)	(0.0148)	(0.0147)	(0.0424)	(0.0627)	(0.0118)	(0.0172)
1600m	Conversion	-0.0148	-0.0135**	0.00327	0.00215	-0.0436**	-0.0471***	0.00355	-0.00176
		(0.00900)	(0.00466)	(0.00680)	(0.00259)	(0.0196)	(0.0122)	(0.00619)	(0.00325)
	Constant	2.620***	1.945***	2.467***	1.690***	2.848***	2.553***	3.133***	1.967***
		(0.0217)	(0.0225)	(0.0150)	(0.0146)	(0.0440)	(0.0555)	(0.0119)	(0.0180)
2000m	Conversion	-0.00876	-0.0246**	0.00838	-0.00343	-0.0398	-0.0696**	0.0103	-0.00507
		(0.0156)	(0.0100)	(0.0127)	(0.00263)	(0.0265)	(0.0257)	(0.0133)	(0.00347)
	Constant	2.620***	1.945***	2.467***	1.690***	2.849***	2.553***	3.133***	1.967***
		(0.0217)	(0.0220)	(0.0151)	(0.0147)	(0.0436)	(0.0561)	(0.0122)	(0.0181)
Stations		31	31	31	31	31	31	30	30
Clusters		12	12	12	12	12	12	11	11
N		1,069	371	1,068	371	1,068	371	1,044	360

Note: Cluster robust standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. For all regressions fixed effects tests and Hausman specification tests were conducted. The results from these tests are available upon request. Block bootstrap errors were not used when controlling for city-time effects as there were insufficient observations in specific city-time blocks to compute bootstrap standard errors.

robust this can only explain part of the story. Thus, these results add additional support to the view that the consumption of premium fuel and diesel fuels went up due to substitutability and shocks to expectations, respectively.

7.2 Drive Times

We now replicate the results from the previous section using drive times between stations, instead of distances, to define our competition regions to see if our results are sensitive to the selection criterion used. As before we first check to ensure the common trend assumption holds. Figure 4 displays lowess regression lines for monthly prices for both our treatment and control groups. This main difference between this figure and Figure 3 is we now define treatment and control groups using the 2 minute drive time radius. We find the same results for each fuel type and this, once again, leads us to expect that the effects on regular gasoline will be highest. This implies the acquisition should have the largest impact on the advertised price at the station. Again, the robustness of these results to the econometric model used for the regressions is checked in the Appendix where we instead use local polynomial regressions.

Table 9 reports the results for the estimation of equation 1 using driving times. When the whole sample period is considered, columns 1, 3, 5 and 7, we notice a decrease in the amount of statistically significant price effects than when distances were used. When using the whole sample period and all fuels combined we we now find that there are no price effects due to the merger. We find zero effects on diesel prices, giving further evidence that the acquisition did not affect these prices. For regular gasoline we find price increases at 2, and 4 minute drive times of 5.36 and 4.56 cpg, respectively. These are slightly higher than the results previously found when using distances and comparable treatment intervals. Our model does not identify any price effects for premium gasoline using the whole sample.

Table 8: Quantity Effects, Controlling for City-Time Effects, of Merger by Fuel Type and Treatment Intensity

Distance		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Gallons of Combinedl)		Gallons of Diesel		Gallons of Regular Gasoline		Gallons Premium Gasoline	
		2009-2012	1 year	2009-2012	1 year	2009-2012	1 year	2009-2012	1 year
400m	Conversion	5,598**	-2,507***	-476.6	-3,671***	6,139**	1,414**	-64.80	-249.8
		(2,313)	(665.9)	(309.6)	(1,108)	(2,523)	(610.3)	(199.2)	(140.5)
	Constant	17,950***	17,710***	12,590***	13,971***	3,748***	2,259***	1,612***	1,481***
		(1,181)	(1,419)	(697.0)	(1,204)	(579.7)	(365.0)	(46.46)	(146.6)
800m	Conversion	-5,240	-2,386***	-3,231***	-1,100	-265.7	-556.0	-1,742**	-729.2***
		(3,417)	(750.6)	(913.6)	(839.1)	(2,283)	(1,163)	(679.3)	(234.8)
	Constant	17,771***	17,705***	12,488***	13,970***	3,727***	2,256***	1,556***	1,479***
		(1,620)	(1,628)	(817.9)	(1,524)	(781.8)	(446.4)	(168.3)	(192.8)
1200m	Conversion	-6,086**	-2,883***	-4,312***	-1,665**	-618.1	-530.9	-1,156***	-687.5***
		(2,401)	(679.9)	(752.0)	(599.5)	(1,630)	(827.1)	(326.9)	(164.4)
	Constant	17,666***	17,742***	12,398***	13,991***	3,708***	2,263***	1,560***	1,488***
		(1,632)	(1,785)	(861.8)	(1,592)	(793.3)	(460.7)	(129.4)	(202.7)
1600m	Conversion	-4,698**	-1,469	-3,748**	-942.2	25.64	-61.11	-976.4***	-465.7***
		(1,669)	(825.4)	(1,384)	(981.6)	(845.8)	(395.2)	(157.8)	(74.56)
	Constant	17,713***	17,722***	12,411***	13,980***	3,737***	2,258***	1,565***	1,484***
		(1,418)	(1,703)	(744.8)	(1,632)	(805.6)	(372.6)	(79.38)	(187.7)
2000m	Conversion	-4,458***	-368.1	-2,511*	309.8	-1,078	-446.7	-869.1***	-231.2***
		(1,341)	(265.3)	(1,184)	(666.1)	(724.5)	(699.6)	(138.6)	(52.44)
	Constant	17,784***	17,714***	12,504***	13,973***	3,698***	2,259***	1,582***	1,482***
		(1,450)	(1,645)	(705.1)	(1,582)	(819.4)	(356.5)	(81.63)	(150.9)
Stations		31	31	31	31	31	31	30	30
Clusters		12	12	12	12	12	12	11	11
N		1,069	371	1,068	371	1,068	371	1,044	360

Note: Cluster robust standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. For all regressions fixed effects tests and Hausman specification tests were conducted. The results from these tests are available upon request. Block bootstrap errors were not used when controlling for city-time effects as there were insufficient observations in specific city-time blocks to compute bootstrap standard errors.

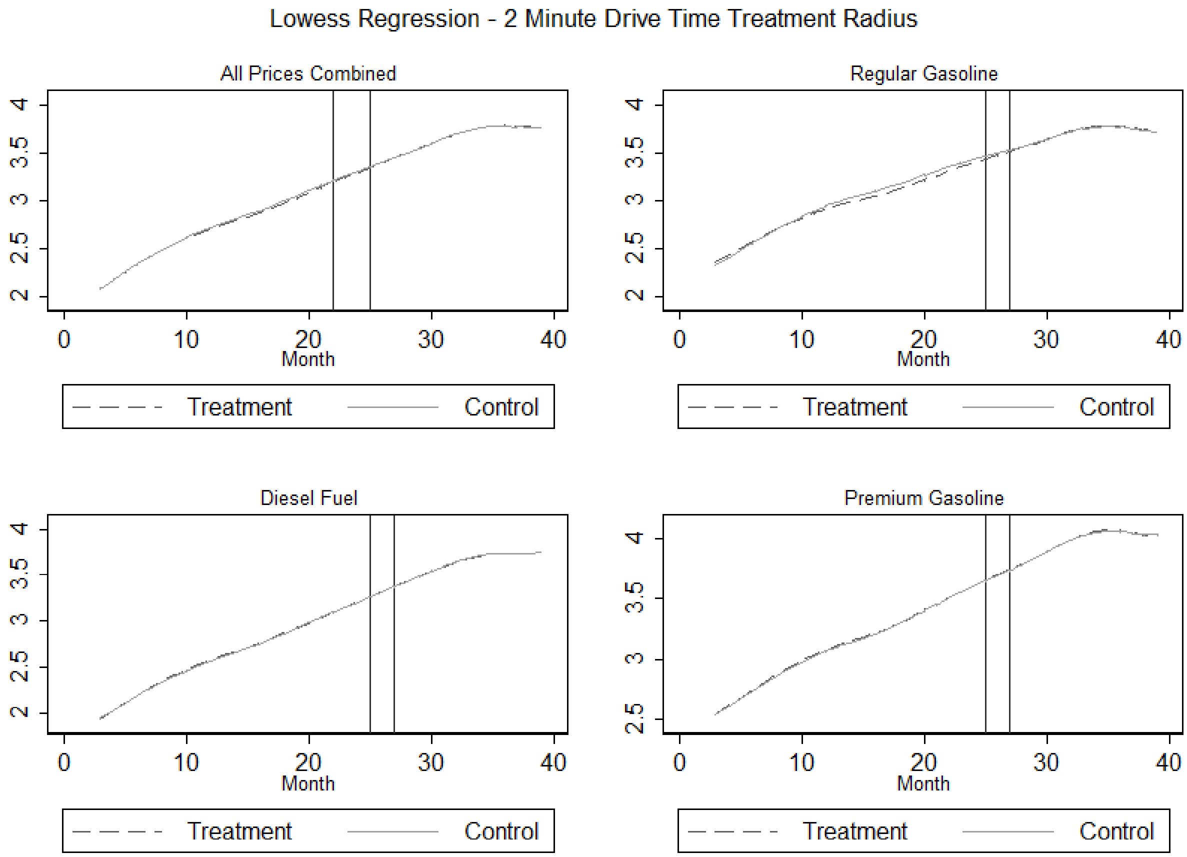

Figure 4: Common Trend Analysis - Distances

When we use only one year of the sample period as in columns 2, 4, 6 and 8 of Table 9, we identify more treatment effects. For all fuels combined we find significant effects at drive times up until 4 minutes, excluding 2 minutes. The largest identified treatment effect is found when the drive time between stations is 4 minutes. The price effect at this treatment radius is 3.16 cpg. Once more, there is no price effect for diesel fuels. For regular gasoline we find a price effect at each treatment radius. The largest estimated treatment effect is an increase in prices of 6.64 cpg and is found at a 5 minute drive time between stations. However this effect is only significant at the 10 percent level, while the rest of the results for regular fuel are significant at the 1 or 5 percent level. For premium fuel we find a significant effects at 2 and 3 minute drive time radii of 1.75 and 1.45 cpg, respectively.

Comparing these results to those when distances were used shows us that the overall pattern of identified treatment effects is the same. The treatment effect is still highest for regular gasoline and the is no evidence that the merger affected diesel prices. However there are slight differences. When using distances we are able to identify more statistically significant treatment effects. Also when estimating the price effect on regular gas the range of the estimated price increase drops from 3.70-7.44 cpg to 4.56-6.64 cpg. This implies that when we expand our definition of the elasticity of substitution between stations we slightly dampen the magnitude and variability of the estimated causal effect.

The results from estimating equation 2 using drive times are presented in Table 10. The first thing to notice about this table is that it reports less significant results than found in Table 6 when distances were used. For all fuels combined and diesel fuel we find no quantity effect, whether we use the whole sample or one year. For regular gasoline we find a negative quantity effect when the treatment radius is 1 minute and one year of data is used. Additionally when the treatment radius is 2 minutes we find a negative quantity effect regardless of the sample used. This implies that we are able to estimate deadweight loss in the market for regular fuel when the merging retail stations are within a 2 minute drive time of one another. For premium fuel we find that there was a negative quantity effect when the stations were only 1 minute apart and this result is robust to the length of the sample used. For distances further out, we find that there was a positive quantity effect on premium fuel. This, again, supports the theory of substitutability between regular and premium fuel.

In Table 11 and Table 12 we test for the robustness of these results by adding in city-time effects

Table 9: Price Effects of Merger by Fuel Type and Treatment Intensity

Distance		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		PPG of Combined		PPG of Diesel		PPG of Regular Gasoline		PPG of Premium Gasoline	
		2009-2012	1 year	2009-2012	1 year	2009-2012	1 year	2009-2012	1 year
1min	Conversion	-0.00104	-0.0211**	0.0240	0.000387	-0.0107	-0.0519**	0.0200	-0.0168
		(0.0316)	(0.00956)	(0.0379)	(0.00554)	(0.0348)	(0.0248)	(0.0373)	(0.0108)
	Constant	3.761***	3.751***	3.700***	3.678***	3.780***	3.799***	4.047***	4.056***
		(0.0107)	(0.0127)	(0.0124)	(0.0115)	(0.0107)	(0.0106)	(0.0127)	(0.0134)
2min	Conversion	-0.0307	-0.0209	-0.00193	0.00357	-0.0536***	-0.0575***	-0.0117	-0.0175**
		(0.0195)	(0.0129)	(0.0204)	(0.00484)	(0.0179)	(0.0197)	(0.0215)	(0.00864)
	Constant	3.761***	3.751***	3.700***	3.678***	3.781***	3.799***	4.047***	4.056***
		(0.0125)	(0.0120)	(0.0125)	(0.0121)	(0.0111)	(0.0106)	(0.0140)	(0.0131)
3min	Conversion	-0.0232	-0.0308**	0.0201	-0.00164	-0.0366	-0.0616*	0.00146	-0.0145*
		(0.0266)	(0.0140)	(0.0419)	(0.00452)	(0.0240)	(0.0316)	(0.0446)	(0.00879)
	Constant	3.761***	3.751***	3.700***	3.678***	3.780***	3.799***	4.047***	4.056***
		(0.0108)	(0.0124)	(0.0118)	(0.0107)	(0.0109)	(0.00984)	(0.0127)	(0.0138)
4min	Conversion	-0.0379	-0.0316**	0.00335	-0.00161	-0.0456*	-0.0604**	-0.00912	-0.0134
		(0.0300)	(0.0133)	(0.0453)	(0.00340)	(0.0262)	(0.0264)	(0.0434)	(0.00979)
	Constant	3.761***	3.751***	3.700***	3.678***	3.780***	3.799***	4.047***	4.056***
		(0.0112)	(0.0114)	(0.0121)	(0.0107)	(0.0110)	(0.0112)	(0.0139)	(0.0130)
5min	Conversion	-0.00249	-0.0213	-0.000443	-0.00353	-0.0287	-0.0664*	-0.0162	-0.0188
		(0.0332)	(0.0136)	(0.0403)	(0.00413)	(0.0419)	(0.0360)	(0.0444)	(0.0122)
	Constant	3.761***	3.751***	3.700***	3.678***	3.780***	3.799***	4.047***	4.056***
		(0.0114)	(0.0124)	(0.0113)	(0.0108)	(0.0115)	(0.0110)	(0.0141)	(0.0138)
Stations		31	31	31	31	31	31	30	30
Clusters		12	12	12	12	12	12	11	11
N		1,069	371	1,068	371	1,068	371	1,044	360

Note: Block bootstrap robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. For all regressions fixed effects tests and Hausman specification tests were conducted. The results from these tests are available upon request. Block bootstrapped errors were obtained using city level groups and were sampled with replacement. To make the tests valid at the 5 percent level 199 repetitions were used as suggested in Mackinnon and Davidson, 2004.

Table 10: Quantity Effects of Merger by Fuel Type and Treatment Intensity

Distance		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Gallons of Combinedl)		Gallons of Diesel		Gallons of Regular Gasoline		Gallons Premium Gasoline	
		2009-2012	1 year	2009-2012	1 year	2009-2012	1 year	2009-2012	1 year
1min	Conversion	1,030	1,492	-1,242	-584.6	1,931	1,720***	340.6*	357.0**
		(2,151)	(1,523)	(1,259)	(1,288)	(1,193)	(618.5)	(175.6)	(175.1)
	Constant	28,354***	26,285***	18,899***	17,771***	6,525***	5,800***	2,929***	2,714***
		(1,987)	(1,940)	(1,561)	(1,876)	(989.0)	(1,004)	(778.2)	(668.9)
2min	Conversion	-385.1	449.7	-1,393	-718.7	1,590*	1,476***	-581.9**	-307.5
		(2,364)	(741.6)	(1,458)	(644.3)	(951.8)	(526.1)	(260.4)	(236.4)
	Constant	28,355***	26,285***	18,912***	17,772***	6,510***	5,800***	2,933***	2,714***
		(1,991)	(2,349)	(1,578)	(1,649)	(1,078)	(1,058)	(745.6)	(712.4)
3min	Conversion	-2,100	-1,499	-1,582	-465.9	197.4	-660.9	-715.4*	-372.3**
		(3,190)	(970.8)	(1,883)	(503.1)	(1,409)	(891.2)	(370.2)	(159.9)
	Constant	28,354***	26,284***	18,903***	17,771***	6,522***	5,800***	2,929***	2,714***
		(2,109)	(2,183)	(1,744)	(1,800)	(1,112)	(944.4)	(784.2)	(714.8)
4min	Conversion	2,054	-342.3	1,102	215.8	1,390	-194.8	-437.5	-363.4**
		(3,081)	(889.5)	(2,018)	(708.8)	(1,385)	(672.9)	(346.5)	(163.0)
	Constant	28,345***	26,285***	18,897***	17,771***	6,517***	5,800***	2,930***	2,714***
		(1,678)	(2,208)	(1,392)	(1,773)	(1,040)	(1,070)	(790.4)	(647.2)
5min	Conversion	2,083	591.5	1,848	790.5	503.8	-61.38	-269.0	-137.7
		(4,059)	(855.1)	(1,881)	(720.9)	(1,362)	(571.1)	(269.4)	(88.49)
	Constant	28,348***	26,285***	18,897***	17,771***	6,521***	5,800***	2,929***	2,714***
		(1,761)	(2,365)	(1,676)	(1,801)	(1,072)	(1,020)	(799.6)	(699.8)
Stations		31	31	31	31	31	31	30	30
Clusters		12	12	12	12	12	12	11	11
N		1,069	371	1,068	371	1,068	371	1,044	360

Note: Block bootstrap robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. For all regressions fixed effects tests and Hausman specification tests were conducted. The results from these tests are available upon request. Block bootstrapped errors were obtained using city level groups and were sampled with replacement. To make the tests valid at the 5 percent level 199 repetitions were used as suggested in Mackinnon and Davidson, 2004.

into our model. Table 11 and Table 12 model price effects and quantity effects, using equation 3 and 4, respectively, with the competition regions defined by the drive time between retail stations. When adding city time effects to our estimating equation we find that there is an increase in the amount of statistically significant results. We find that when using all fuels combined the acquisition led to an increase of 3.30-3.95 cpg at drive times between 2 to 4 minutes. When using only one year of the sample we identify an increased number of treatment effects for all fuels combined. We now find a significant result at each treatment radii however the range of the effect has gone down to 2.85-3.43 cpg. When we estimate the effect for diesel fuels we find that, when the whole sample is used, the merger led to a price decrease of 2.05 cpg. While this is not robust to the sample period, this result supports the findings of a negative price effect on diesel fuel which was found in earlier model specifications. Like in Table 7, when we estimate the effects on regular fuel prices using a one year time frame we identify a price effect at each drive time. For regular fuels we once again find that the merger caused significant price increases. When using the entire sample period we find that the merger led to a price increase of 4.77-5.64 cpg at drive times between 2 and 4 minutes. This is comparable to the results found in Table 7 and adds robustness to the result that the merger increased the price of regular gasoline. Overall the price effect has gone up from Table 7. The price effect of the merger when including city time effects is now between 6.29 cpg and 7.59 cpg compared to a range of 5.19-6.64 cpg when city time effects were not included. For premium fuel a negative price effect is identified when the whole sample period is used. We find that at drive times of 1 and 3 minutes the merger decreased prices by 1.78 cpg and 1.37 cpg, respectively. However when we use only one year of data this result disappears. In fact, when we use one year of data we find that the merger caused prices to increase by 0.7-1.69 cpg. This casts doubt on the result that the merger was efficient for this product market.

For the quantity effects which are presented in Table 12, we now identify more significant treatment

Table 11: Price Effects, Controlling for City-Time Effects, of Merger by Fuel Type and Treatment Intensity

Distance		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		PPG of Combined		PPG of Diesel		PPG of Regular Gasoline		PPG of Premium Gasoline	
		2009-2012	1 year	2009-2012	1 year	2009-2012	1 year	2009-2012	1 year
1min	Conversion	-0.0149	-0.0312***	0.0205***	0.00371	-0.0233	-0.0759***	0.0178*	-0.00836
		(0.00842)	(0.00675)	(0.00513)	(0.00423)	(0.0174)	(0.00883)	(0.00824)	(0.00915)
	Constant	2.620***	1.944***	2.468***	1.690***	2.849***	2.553***	3.133***	1.967***
		(0.0218)	(0.0225)	(0.0150)	(0.0148)	(0.0431)	(0.0579)	(0.0118)	(0.0182)
2min	Conversion	-0.0330*	-0.0316**	0.00536	0.00209	-0.0564**	-0.0677***	-0.00628	-0.0169**
		(0.0168)	(0.0108)	(0.00940)	(0.00321)	(0.0234)	(0.0163)	(0.00853)	(0.00546)
	Constant	2.620***	1.944***	2.467***	1.690***	2.849***	2.552***	3.132***	1.967***
		(0.0229)	(0.0217)	(0.0149)	(0.0146)	(0.0446)	(0.0554)	(0.0118)	(0.0187)
3min	Conversion	-0.0363**	-0.0338**	0.0125	0.00215	-0.0543*	-0.0754***	0.0137*	-0.00700**
		(0.0157)	(0.0123)	(0.00739)	(0.00312)	(0.0277)	(0.0161)	(0.00711)	(0.00288)
	Constant	2.618***	1.945***	2.468***	1.690***	2.847***	2.553***	3.134***	1.967***
		(0.0227)	(0.0247)	(0.0148)	(0.0148)	(0.0451)	(0.0596)	(0.0118)	(0.0175)
4min	Conversion	-0.0395**	-0.0343**	0.00800	0.000425	-0.0477*	-0.0629***	0.0107	-0.00404
		(0.0174)	(0.0150)	(0.00766)	(0.00286)	(0.0254)	(0.0196)	(0.00756)	(0.00303)
	Constant	2.620***	1.945***	2.467***	1.690***	2.849***	2.553***	3.133***	1.967***
		(0.0227)	(0.0222)	(0.0149)	(0.0147)	(0.0446)	(0.0556)	(0.0117)	(0.0179)
5min	Conversion	-0.00450	-0.0285*	0.00987	-0.00400	-0.0285	-0.0700**	0.0131	-0.00294
		(0.0193)	(0.0137)	(0.0159)	(0.00326)	(0.0304)	(0.0309)	(0.0171)	(0.00468)
	Constant	2.620***	1.945***	2.467***	1.690***	2.849***	2.553***	3.133***	1.967***
		(0.0218)	(0.0205)	(0.0151)	(0.0148)	(0.0439)	(0.0522)	(0.0123)	(0.0181)
Stations		31	31	31	31	31	31	30	30
Clusters		12	12	12	12	12	12	11	11
N		1,069	371	1,068	371	1,068	371	1,044	360

Note: Cluster robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. For all regressions fixed effects tests and Hausman specification tests were conducted. The results from these tests are available upon request. Block bootstrap errors were not used when controlling for city-time effects as there were insufficient observations in specific city-time blocks to compute bootstrap standard errors.

effects than we did in Table 10. For all fuels combined we find a positive quantity effect when the drive time is 3 minutes, whether the whole sample or just one year is used. For diesel fuel we identify a positive quantity effect, when the whole sample is used, for drive times of 1, 2, and 3 minutes. At the 1 minute drive time this shows consumers are behaving rationally as we estimated a decrease in prices for this specification. When estimating the treatment effect for regular fuel we find a negative quantity effect at 1 and 2 minute drive time, when one year of the data is used. This provides additional evidence that the acquisition led to a negative impact on the consumer as this once again implies there is identifiable deadweight loss in the market for this product. The identification of deadweight loss is robust to the addition of city-time effects however it is not robust to the sample used. When examining the quantity effect for premium fuels using drive times between and equal to 2 and 5 minutes we find a positive quantity effect, regardless of the data sample used. As with the result from diesel fuels, when the whole sample and a 3 minute drive time is used, this shows consumers are behaving rationally as prices decreased at this specification. For the most part, however these results, once again, support substitutability between regular and premium fuel.

We find that overall there are subtle differences in the results when we change our criterion for selecting the treatment group. When estimating prices or quantities we find that less significant treatment effects when using drive times compared to distances. As seen above when we estimate add city-time effects to the estimation we observe an increase in the treatment effects found. For drive times we find that this result is less profound. The results for diesel fuel are, for the most part, the same when we use drive times instead of distances. In both cases we only find a significant result when city-time effects are added to our list of controls and the whole sample period is used. We find that when we use drive times the value of the price decrease increases slightly to 2.05 cpg from 1.53-1.99 cpg. For regular gasoline we find that the use of drive times increases the range of the price effect from 3.70-7.44 cpg to 4.56-7.59 cpg. Furthermore we are able to estimate more instances of deadweight loss in the market for regular gasoline when using drive times instead of distances. When using distances we find that the deadweight loss estimated is robust to the addition of city-time effects, but only when the whole sample is used. However, when using drive times we find that the estimated deadweight loss is robust to the addition of city-time effects regardless of the sample used. The results for premium gasoline changes more substantially than the other fuels when we use drive times instead of distances. Notably, when we use distances we find that in one of the specifications the acquisition caused deadweight loss but when we use drive times we find that there is a specification where the acquisition led to an efficient price decrease. Due to the ambiguity of these results we conclude that the finding of both the deadweight loss and the price decrease for premium gasoline is not robust nor is it a convincing result.

8 Conclusion

Being able to determine the impact mergers and acquisitions have on economic welfare is pivotal to inform public policy and competition law. This paper evaluates a merger in Panama and shows that in this particular gasoline market the price effect of an acquisition is strongest on the advertised price as this is the price companies compete on prior to the deal. In this case the advertised price is regular gasoline. Our results show that the acquisition led to an increase in prices of 3.70-7.59 cpg. The causal effect is found to be robust to varying controls in the estimating equation, treatment intensities, sample periods and assumptions on the distance between stations in determining treatment and control groups. We are able to estimate deadweight loss for this product market when stations the competing stations were in close spatial proximity to one another, but this result is not fully robust to changes in the sample period used. Furthermore our findings of deadweight loss are suggestive as we do not have the necessary data required to perform a complete welfare analysis. We also found compelling evidence that consumers are inclined to increase their consumption

Table 12: Quantity Effects, Controlling for City-Time Effects, of Merger by Fuel Type and Treatment Intensity

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Gallons of Combinedl)		Gallons of Diesel		Gallons of Regular Gasoline		Gallons Premium Gasoline	
Distance		2009-2012	1 year	2009-2012	1 year	2009-2012	1 year	2009-2012	1 year
1min	Conversion	906.6	1,914	-2,287***	-265.1	2,915	1,837***	279.2	341.4
		(2,308)	(1,877)	(683.2)	(1,529)	(1,873)	(218.6)	(190.0)	(270.6)
	Constant	17,963***	17,717***	12,527***	13,974***	3,817***	2,261***	1,620***	1,482***
		(1,380)	(1,666)	(662.7)	(1,576)	(769.9)	(388.1)	(36.52)	(140.6)
2min	Conversion	-710.7	31.96	-1,865**	-1,005	1,838	1,535***	-683.5***	-498.1***
		(1,447)	(489.2)	(839.9)	(672.6)	(1,046)	(197.0)	(135.7)	(106.1)
	Constant	17,924***	17,713***	12,553***	13,970***	3,773***	2,265***	1,598***	1,479***
		(1,425)	(1,642)	(689.7)	(1,653)	(819.0)	(396.2)	(97.07)	(191.1)
3min	Conversion	-4,335*	-1,872***	-2,900***	-617.4	-303.9	-834.8	-1,131***	-419.3***
		(1,996)	(601.1)	(755.7)	(581.2)	(1,292)	(887.5)	(284.5)	(116.9)
	Constant	17,681***	17,726***	12,419***	13,978***	3,718***	2,264***	1,545***	1,484***
		(1,482)	(1,737)	(806.5)	(1,596)	(767.5)	(436.9)	(130.4)	(208.4)
4min	Conversion	-87.78	-226.8	-365.0	184.3	978.3	-48.55	-701.1**	-362.5**
		(2,281)	(736.5)	(1,489)	(722.0)	(989.7)	(731.6)	(258.9)	(149.4)
	Constant	17,936***	17,714***	12,584***	13,973***	3,753***	2,258***	1,599***	1,483***
		(1,417)	(1,652)	(680.4)	(1,575)	(850.1)	(373.7)	(80.45)	(177.5)
5min	Conversion	-2,193	914.7	-1,489	912.0	-136.9	109.7	-567.4***	-107.1***
		(1,951)	(605.8)	(1,788)	(1,064)	(502.6)	(610.1)	(106.4)	(23.42)
	Constant	17,878***	17,710***	12,550***	13,971***	3,732***	2,257***	1,596***	1,481***
		(1,408)	(1,613)	(677.1)	(1,532)	(824.5)	(387.0)	(67.35)	(147.9)
Stations		31	31	31	31	31	31	30	30
Clusters		12	12	12	12	12	12	11	11
N		1,069	371	1,068	371	1,068	371	1,044	360

Note: Cluster robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. For all regressions fixed effects tests and Hausman specification tests were conducted. The results from these tests are available upon request. Block bootstrap errors were not used when controlling for city-time effects as there were insufficient observations in specific city-time blocks to compute bootstrap standard errors.

of premium gasoline if the price relative to regular gasoline decreases. However we did not find robust price effects on premium gasoline. For diesel fuels we find that a sole robust effect which was that the merger caused a price decrease. This result is not robust to varying controls in the estimating equation nor is it robust to varying sample periods. This provides strong evidence that retail gasoline outlets do compete for customers based advertised price, in this case, regular gasoline.

These findings are consistent with the findings of Hastings' (2004) and Haode (2013) as we find that the causal effect of the merger is of economic significance. However our results are not consistent with the findings of Talyor et al. (2010) who found that Hastings' results were not robust to the use of a different dataset available at monthly intervals as opposed to quarterly. In comparison we are able to report a robust causal effect using monthly data. One reason we are able to identify a robust and economically significant effect is due to differences in the strength of antitrust authorities between Panama and the North American economies previously studied. Antitrust authorities are better equipped in North America to identify and stop mergers which may negatively affect the economy. Therefore mergers that are allowed in Panama may not have been consummated in North America and are likely to have a larger causal effect on retail prices.

Due to the differences in our results when we employ different methods and assumptions for choosing the treatment and control groups further research needs to be done to see how changing these assumptions would impact the results of previous studies. Properly creating treatment and control groups and understanding the differences between different selection techniques is needed to ensure retrospective mergers are conducted with a level of consistency. Additionally expanding the literature on retrospective mergers to developing countries is a necessary step in creating a representative sample of all possible mergers. This is because mergers that competition authorities may not allow in the developed world may occur in developing economies. Only when a broad set of mergers and acquisitions have been studied can the results be generalized to inform policy makers for future deals. Therefore additional retrospective merger research is still needed in developing countries.

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A Appendix

Table A1 shows the number of stations and mean yearly prices by city in our data set. Here we can see that in all active years, prices for the rural locality in the Veraguas province were the lowest in the sample followed by the city of Aguadulce. Additionally prices were highest in Panama City and the city of David. Price variations, measured by the standard deviation of prices at the transaction level were highest in the first two years and began to fall thereafter.

Table A2 summarizes the average PPG of each retail fuel type individually for each year of the dataset. As expected premium gas prices are the highest in each year. Diesel prices are cheapest in the first three years, but by 2012 diesel was more expensive the regular gasoline. Part of this change in price levels may be attributable to the change in diesel products in the Panamanian market place mentioned before. This is in part echoed by the fact that, overall, diesel prices had the largest standard deviation out of all retail fuel types.

Table A3 displays summary statistics, by percentile, for the distance and drive time to the nearest Delta station from a Delta station. Here we see that the nearest Delta station to another Delta station is 700 meters. Furthermore ten percent of the sample has a Delta station within 800 meters and fifty percent of the sample has a Delta station within 1300 meters. Based off the assumption that it is unlikely that Delta would place a station within its own competition radius this provides evidence that a reasonable treatment radius is between 700 and 1300 meters when using distances. For drive times we find that the nearest Delta station is a two minute drive. Furthermore we find that ten percent of the sample has Delta stations located within a two minute drive and fifty percent of the sample has a Delta station located within a four minute drive. This provides evidence that a reasonable treatment radius for drive times is between two minutes and four minutes.

Table A1: Number of Stations and Mean Yearly Prices by City

City	Province	Number of Service Stations	PPG 2009	PPG 2010	PPG 2011	PPG 2012
Aguadulce	Panama	1	$2.44	$2.85	$3.61	$3.69
			(0.28)	(0.32)	(0.24)	(0.18)
Chitre	Herrera	2	$2.49	$2.93	$3.74	$3.83
			(0.29)	(0.27)	(0.23)	(0.16)
Colon	Colon	2	$2.47	$2.93	$3.70	$3.78
			(0.30)	(0.33)	(0.23)	(0.17)
David	Chiriqui	2	$2.51	$2.98	$3.77	$3.88
			(0.30)	(0.23)	(0.22)	(0.17)
La Cabima	Panama	1	$2.41	$2.96	$3.69	$3.75
			(0.33)	(0.42)	(0.20)	(0.15)
La Chorrera	Panama	2	$2.47	$2.95	$3.72	$3.78
			(0.29)	(0.35)	(0.23)	(0.16)
Panama	Panama	15	$2.52	$2.99	$3.73	$3.80
			(0.31)	(0.35)	(0.25)	(0.19)
Parque Porras	Los Santos	1	$2.48	$2.95	$3.72	$3.77
			(0.30)	(0.31)	(0.22)	(0.17)
Penonome	Cocle	1	$2.46	$2.93	$3.70	$3.79
			(0.30)	(0.28)	(0.23)	(0.17)
Rural Airport	Panama	1		$2.94	$3.72	$3.79
				(0.24)	(0.22)	(0.16)
Rural Highway	Veraguas	1		$2.76	$3.56	$3.65
				(0.21)	(0.19)	(0.13)
Santiago	Veraguas	2	$2.48	$2.92	$3.70	$3.80
			(0.28)	(0.24)	(0.22)	(0.15)
Total		31	$2.50	$2.96	$3.72	$3.80
			(0.30)	(0.32)	(0.24)	(0.18)

Note: Standard deviations are in brackets below. Standard deviations are calculated using the transaction level data in each year. Author's Calculations.

Table A2: Yearly Mean Prices by Retail Fuel Type

Product	2009	2010	2011	2012	Total
Diesel	$2.37	$2.84	$3.66	$3.76	$3.11
	(0.25)	(0.17)	(0.19)	(0.11)	(0.57)
Gas (Octane Level 91)	$2.69	$3.16	$3.75	$3.75	$3.36
	(0.21)	(0.49)	(0.22)	(0.18)	(0.53)
Gas (Octane Level 95)	$2.88	$3.27	$4.00	$4.11	$3.56
	(0.20)	(0.23)	(0.30)	(0.18)	(0.53)
All Retail Fuels Combined	$2.50	$2.96	$3.72	$3.80	$3.22
	(0.30)	(0.32)	(0.24)	(0.18)	(0.58)

Note: Standard deviations are in brackets below. Standard deviations are calculated using the transaction level data in each year. Author's Calculations.

Table A3: Summary Statistics for Distance and Drive Time to the Nearest Delta Station

	Distance to Nearest Delta Station (meters)	Drive Time to Nearest Delta Station (seconds)
Mean	2748	261
Standard Deviation	4179	207
Min	700	120
Max	21800	1200
	Percentiles	
1%	700	120
5%	700	120
10%	800	120
25%	1000	180
50%	1300	240
75%	3000	300
99%	21800	1200

Figures A1 and A2 are testing to see if the common trend assumption holds for distances and drive times, respectively, using local polynomial regressions. To be comparable to the graphs examining the common trend using a lowess regression the same treatment radii are used. The same general result as found with the lowess regressions holds here: the treatment and control groups exhibit the same trends prior to the merger. The only good where the treatment group price is lower prior to the acquisition is, again, regular gasoline. The main difference here is that when using this econometric specification it appears the treatment group price increases to be on par with the control group on the announcement date not on the merger completion date.

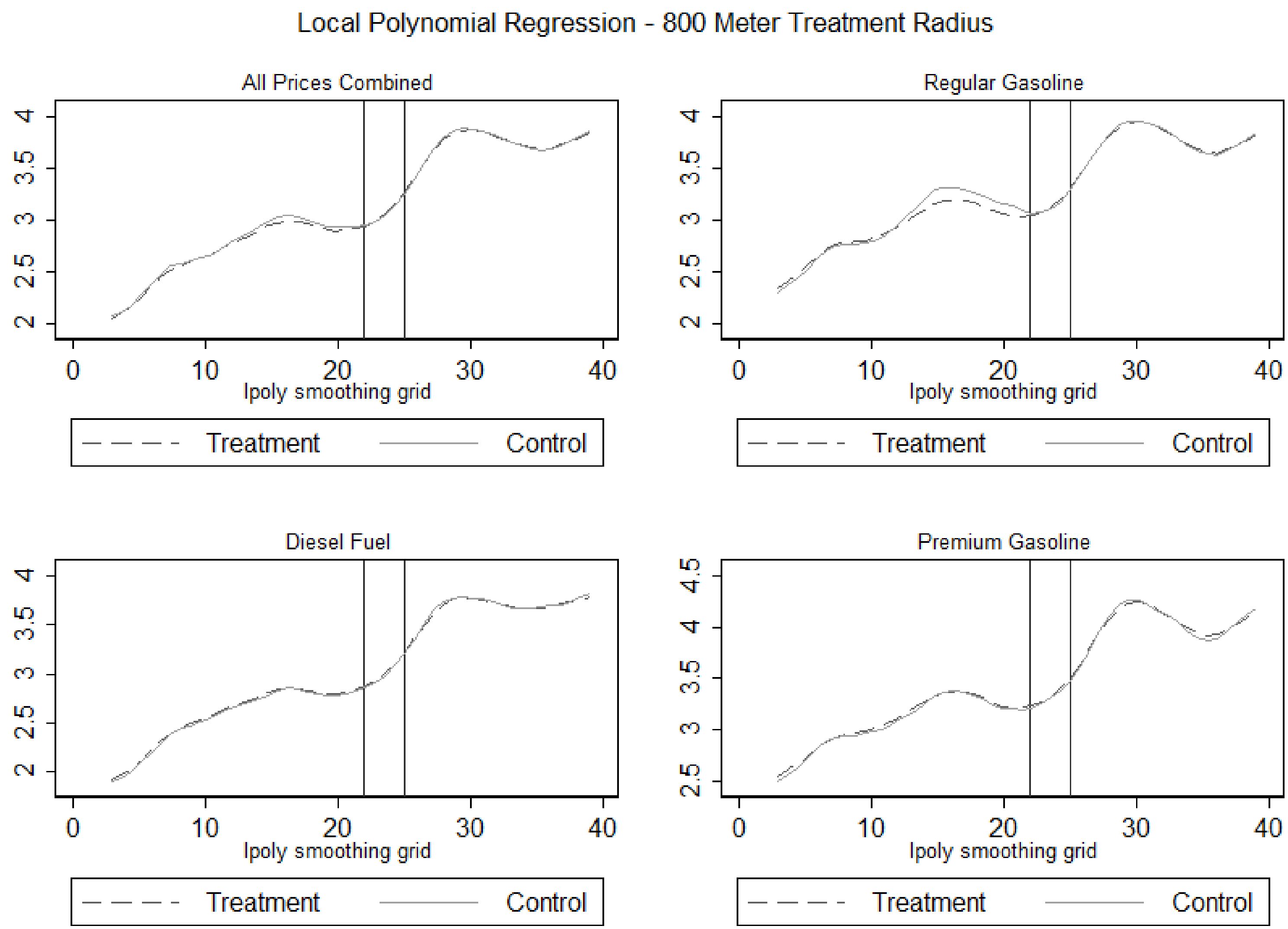

Figure A1: Common Trend Analysis - Distances

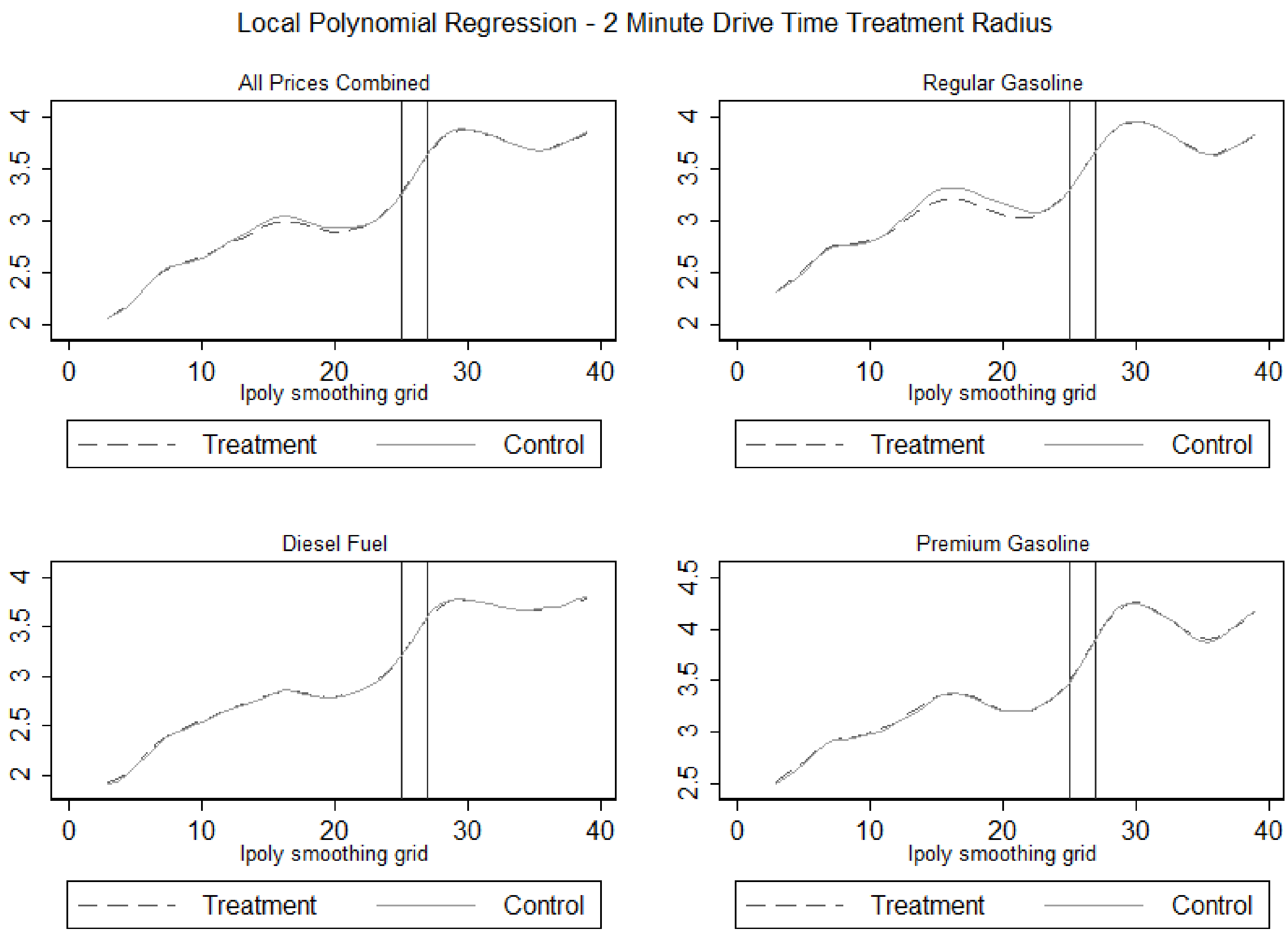

Figure A2: Common Trend Analysis - Distances