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Abstract

Over a period of time spanning September 2008 to June 2010, the National Chamber of Freight Truck Transportation (CANACAR) and its members colluded to transfer increases in fuel prices directly to customers through the so-called "Fuel Price Adjustment Fee (FPAF)". This paper studies the impact of such anticompetitive practice in the evolution of prices and calculates the resulting impact on welfare. The methodology focuses on the statistical comparison between the observed behavior of prices and the counterfactual that would have been expected in the absence of this anticompetitive practice. The results are consistent with a statistically significant and measurable impact of the anticompetitive conduct on observed prices during the period of study.

Keywords: Competition law enforcement, collusion, ex post studies, freight transportation market.

JEL Classification: C22, D43, K21, L12.

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Content

1. Introduction

This paper examines the empirical evidence and measures the impact of an anticompetitive practice observed in the freight truck transportation industry in Mexico between 2008 and 2010. This anticompetitive practice was focused on the so-called Fuel Price Adjustment Fee (FPAF) through which the National Chamber of Freight Truck Transportation (CANACAR, by its acronym in Spanish) and its members colluded to transfer increases in fuel prices directly to customers. This analysis will be based solely on the study of price behavior due to the availability of data and the sample size. The goals of the study are:

i. To establish whether there is statistical evidence of a structural change in the evolution of the freight truck transportation price index during the period of the anticompetitive practice compared to the period during which such practice did not exist.
ii. To isolate and quantify the impact of the anticompetitive practice in the freight truck transportation price index. This will be done through a measure of anticompetitive prices markup.
iii. To propose and estimate measures of the impact on welfare from the anticompetitive practice.
iv. To study the explanatory power of the FPAF as a predictor of the anticompetitive prices markup index.

Each of the points above will be discussed in individual sections of this document. From now on, we will refer to the period of the anticompetitive practice as "collusive period" and the period when the practice was not observed as "non-collusive period".

2. The Case[1]

On November 13, 2008, the Federal Competition Commission (CFC) received a complaint against the National Chamber of Freight Truck Transportation (CANACAR) and its decision-making body, the National Executive Board (NEB), for probable collusive behavior.[2] [3] The complaint was that NEB of CANACAR agreed to issue a recommendation to its members to pass through to their costumers the increases applied by the Federal Government in fuel prices by the so-called "Fuel Price Adjustment Fee (FPAF)".

As part of the conduct, CANACAR released and tracked the implementation of FPAF through the publication of the agreement on its website and on another website built-in with the objective that the members abide by the recommendation. This agreement prevented companies from individually deciding whether or not to transfer the price increase to users totally or partially according to their cost structure, as would occur in competition conditions.

On June 3, 2010 the Board of the Commission found the economic agents under investigation guilty of collusive behavior specified under article 9 section I of the Federal Economic Competition Law (FECL), namely the subscription of contracts, agreements, arrangements or any other combination among competitors in order to raise or manipulate the price of the freight truck transportation services in the country. The Board of the CFC ordered to suspend immediately the practice and fined the CANACAR and involved economic agents for about 2 million USD.[4]

Sanctioned firms filed an appeal procedure before CFC against the decision issued on June 3, 2010. As a result of this procedure, the Board considered that the grievances claimed by the appellants were unfounded and inoperative, confirming the previous resolution on October 21, 2010.

[1] File DE-153-2008. Available in Spanish on: http://www.cfc.gob.mx:8080/cfcresoluciones/docs/Asuntos%20Juridicos/V76/9/1765469.pdf

[2] CFC was extinct on September 11, 2013, to be replaced by the Federal Economic Competition Commission (COFECE).

[3] The CANACAR is the leading association of freight carriers nationwide in 2008 had about 4,500, affiliates. At the time of the investigation five affiliated companies had representatives in the NEB.

[4] All dollar figures shown in the document are calculated using an exchange rate of 1 USD for 15 MXP.

3. Econometric analysis of structural change

The first part of the analysis focuses on determining whether there is evidence of structural change in the evolution and behavior of the freight truck transportation price index if we compare the collusive period against the non-collusion one. In general, the shift to a collusive behavior should be identifiable in data through a structural change. Before describing the model used in this section, related variables are defined in Table 1.

Table 1. Definition of used variables.

$Y_t =$	PPI (base June 2012=100, monthly). Generic price index for national market: Freight Truck Transportation (1461).
$X_{t lub} =$	PPI (base June 2012=100, monthly). Generic price index for national market: Oils and lubricants (1242).
$X_{t tire} =$	PPI (base June 2012=100, monthly). Generic price index for national market: Pneumatic tires for cars and trucks (1319).
$X_{t parts} =$	PPI (base June 2012=100, monthly). Generic price index for national market: Auto replacement parts (1438).
$X_{t dies} =$	PPI (base June 2012=100, monthly). Generic price index for national market: Diesel (1237).
$Z_t =$	Vector of indicative variables for each quarter.

Source: INEGI.
Note: Data collected covers the period: January 2004-October 2014.

The econometric analysis will be based on price behavior due to the data availability and the sample size. Variables of economic activity in the freight truck transportation sector (included in the Transportation National Surveys, by the National Institute of Statistics and Geography, INEGI by its acronym in Spanish) have annual frequency. Given the monthly frequency of price data and the fact that the analysis focuses on changes in prices, annual frequency variables had little predictive power and therefore were excluded from the analysis. For this study there is no more disaggregated (at a firm or city level) information available. However, as the results show, the price analysis is sufficient to identify a clear anticompetitive pattern and to establish a genuine measurement of impact on welfare and to estimate the magnitude of this impact.

3.1. Collusive period

The sample covers the period between January 2004 and October 2014. Henceforth the collusion period will be considered to cover from September 2008 to July 2010. Therefore, the period recognized in the file as collusive conduct is one more month longer.[5] This is done because the anticompetitive effects of the change in prices might be reflected even in July 2010. The rest of the sample will be referred to hereinafter as "non-collusive period". Also, denote:

$$\tau^{c}\{t: 09/2008 \leq t \leq 06/2010\},\ \tau^{nc}\{t: t \leq 08/2008 \text{ or } t \geq 07/2010\}$$

τ^{c} refers to the period of collusive conduct while τ^{nc} refers to the period of non-collusive behavior.

3.2. Econometric model

Let us group the following price series:

$$X_t = \left(X_t^{lub}, X_t^{tire}, X_t^{parts}, X_t^{dies}\right)$$

Due to the natural presence of a temporal trend in the price series, the econometric model used is based on the study of changes in prices. Let us define:

$$\Delta Y_t = Y_t - Y_{t-1}, \rightarrow \Delta X_t = X_t - X_{t-1}$$

As Figure 1 suggests, taking first differences eliminates the time trend of the price series of freight truck transportation and produces a time series with stationary characteristics, a requirement for the theoretical validity of our econometric analysis (see Hamilton (1994, Chapter 15)).

The analysis is based on the following model:[6]

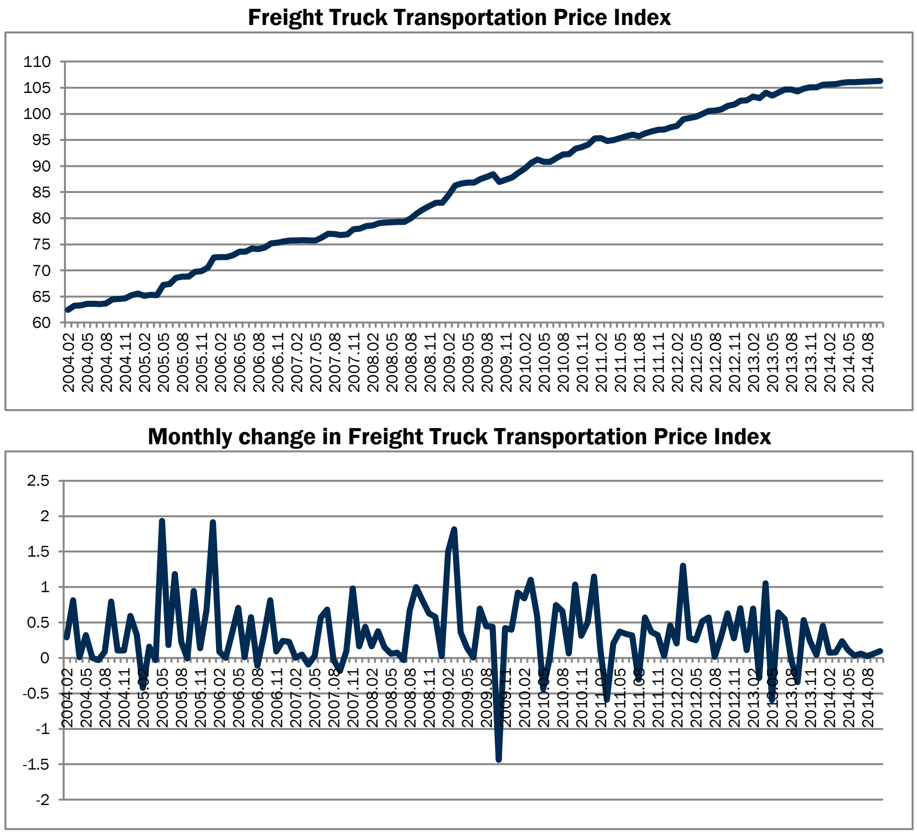
$$\Delta Y_t = \Delta X_t' \beta_1 + Z_t' \beta_2 + \varepsilon_t \tag{1}$$

β_1 and β_2 are coefficient vectors (with four elements each) to estimate. By focusing the econometric analysis on price changes, the presence of a temporal trend is eliminated and at the same time the potential problem of estimating a spurious regression is prevented (see Hamilton (1994, section 18.3)).

[5] CFC's resolution is dated June 2010, establishing the end of conduct. However, its impact on the monthly price change is reflected in July 2010 yet.

[6] This model is identical to a specification which includes an intercept and includes only 3 of the 4 indicative Z_t variables. Including an intercept plus all the variables in Z_t result, as is well known, in perfect multicollinearity, making it impossible to estimate the model parameters.

Figure 1. Level and monthly change in Freight Truck Transportation Price Index.



Source: Own elaboration using data from INEGI.

Prices contained in X_t include the most relevant observable components to explain the dynamics of prices in the freight truck transportation sector. The inclusion of quarterly dummies Z_t helps to control seasonal factors that explain prices variation.[7]

3.3. Econometric test for structural change

This method focuses on the "Chow test" (Chow (1960)), perhaps the most popular and well-known method to perform statistical tests of structural change. Assuming the model described in Equation (1), a structural change refers to a change in the value of β_1 and/or β_2 coefficients in the collusive period compared to the non-collusive period. Specifically, the goal is to analyze whether the original model (1) can be generalized as follows:

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[7] The conclusions of the econometric analysis presented in this paper remained intact if we use monthly indicator variables instead of quarterly.

$$\Delta Y_t = \begin{cases} \Delta X_t' \beta_1^{nc} + Z_t' \beta_2^{nc} + \varepsilon_t \text{ when } t \in \tau^{nc} \; (not\ collusive\ period), \\ \Delta X_t' \beta_1^{c} + Z_t' \beta_2^{c} + \varepsilon_t \text{ when } t \in \tau^{c} \; (collusive\ period). \end{cases} \quad (2)$$

We say that there is a structural change if $\beta_1^{nc} \neq \beta_2^{nc}$ or $\beta_2^{nc} \neq \beta_2^{c}$. Otherwise the structural change is rejected. The Chow test consists of the following steps:

i. Estimate model (1) using ordinary least squares for the whole sample, denoting the estimators as $(\hat{\beta}_1, \hat{\beta}_2)$ and the corresponding residual sum of squares as:

$$RSS = \sum_{t=1}^{T} \left(\Delta Y_t - \left(\Delta X_t' \hat{\beta}_1 + Z_t' \hat{\beta}_2 \right) \right)^2$$

ii. Estimate model (1) using ordinary least squares for the non-collusive period, denoting the estimators as $(\hat{\beta}_1^{nc}, \hat{\beta}_2^{nc})$ and the corresponding residual sum of squares as:

$$RSS^{nc} = \sum_{t \in \tau^{nc}} \left(\Delta Y_t - \left(\Delta X_t' \hat{\beta}_1^{nc} + Z_t' \hat{\beta}_2^{nc} \right) \right)^2$$

iii. Estimate model (1) using ordinary least squares for the collusive period, denoting the estimators as $(\hat{\beta}_1^{c}, \hat{\beta}_2^{c})$ and the corresponding residual sum of squares as:

$$RSS^{c} = \sum_{t \in \tau^{c}} \left(\Delta Y_t - \left(\Delta X_t' \hat{\beta}_1^{c} + Z_t' \hat{\beta}_2^{c} \right) \right)^2$$

iv. Build the Chow statistic:

$$Chow = \frac{\left(RSS - (RSS^{nc} + RSS^{c}) \right)/k}{(RSS^{nc} + RSS^{c})/(T_c + T_{nc} - 2k)}$$

where k is the number of parameters to estimate (8 in our case), T_c is the number of observations in the collusive period (23 in our case) and T_{nc} is the number of observations in the non-collusive period (106 in our case). Under the null hypothesis that does not exist structural change, the Chow statistic is distributed approximately as a random F variable with $k = 8$ degrees of freedom on the numerator and $T_c + T_{nc} - 2k = 113$ degrees of freedom on the denominator. The hypothesis that <u>does not exist</u> structural change is rejected if $Chow > F(1-\alpha; 8{,}113)$ where α is the chosen significance level and $F(1-\alpha; 8{,}113)$ refers to the critical value corresponding to a distribution $F_{8,113}$. For example, if the significance level is 5%, the hypothesis of no structural change is rejected if $Chow > 2.02$. The results in this case are included in Table 2.

Table 2. Results of the structural change test.

Statistical Chow	Critical value (α = 5%)	Test p-value
2.2576	2.0215	0.0281

Source: Own estimation.

From results in Table 2, it can be affirmed, with a certainty above 95% that structural change existed between the collusive period and the non-collusive one. The p-value indicates that this certainty is approximately 98%.

Having empirical evidence of the presence of a structural difference in the data between collusive and non-collusive period, the next section proposes a markup index to measure the impact on prices from the anticompetitive behavior.

4. Analysis of the freight truck transportation prices markup due to the collusive behavior

The most natural way to measure the impact of any anticompetitive practice in prices is through a counterfactual analysis. This consists on estimating what the price behavior would have been in the absence of the anticompetitive practice, and comparing this with the observed price behavior (see Whinston (2006, Chapter 2)). For this purpose, we used the results from the model estimated in the previous section. As before, $\left(\hat{\beta}_1^{nc}, \hat{\beta}_2^{nc}\right)$ denotes the least squares estimators of model (1) during the non-collusive period. Henceforth, let us define:

$$\underline{t^c} = \text{Beginning of the collusive period } (September, 2008),$$

$$\overline{t^c} = \text{End of the collusive period } (July, 2010),$$

Also, let us define:

$$\begin{aligned} \hat{\Delta} Y_t^{nc} &= \Delta X_t' \hat{\beta}_1^{nc} + Z_t' \hat{\beta}_2^{nc}, \\ \hat{Y}_{\underline{t^c}}^{nc} &= Y_{\underline{t^c}-1} + \hat{\Delta} Y_{\underline{t^c}}^{nc}, \\ \hat{Y}_t^{nc} &= \hat{Y}_{t-1}^{nc} + \hat{\Delta} Y_t^{nc}, \text{ for } \underline{t}^c + 1 \leq t \leq \overline{t}^c. \end{aligned} \tag{3}$$

$\hat{Y}_t^{nc}$, defined in Equation (3), represents the freight truck transportation price predicted by the model without collusion. In particular, for each period $t \in \tau^c$ (during the collusive period), $Y_t - \hat{Y}_t^{nc}$ measures (estimates) the counterfactual difference in prices in the absence of collusion.

4.1. Markup definition

Our measurement of impact on freight truck transportation prices due to the collusive conduct is the following:

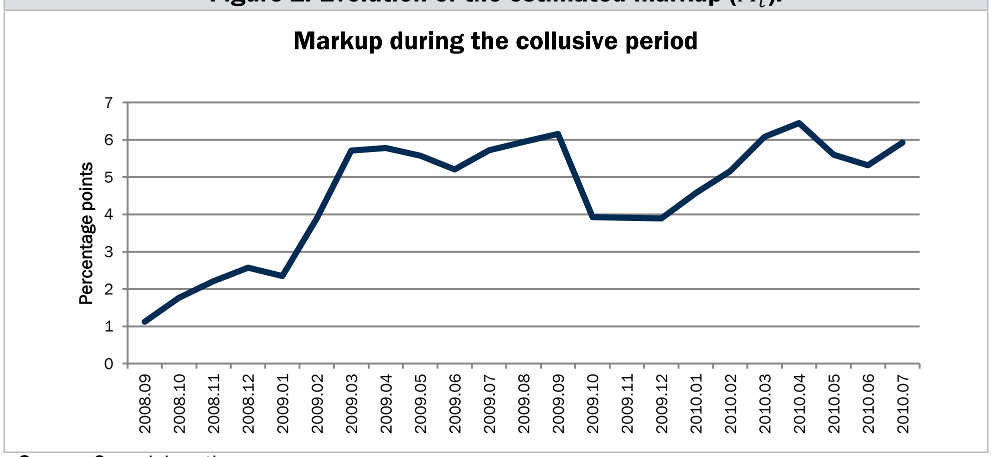
$$\widehat{M}_t = \frac{Y_t - \hat{Y}_t^{nc}}{\hat{Y}_t^{nc}} \qquad (4)$$

From now and then we will refer to this quantity as *markup index*, which must be interpreted as the percentage deviation between the expected price in the absence of collusion and the price actually observed. In the absence of collusive conduct, such difference would be approximately insignificant (in a statistical sense). A measure similar to (4) is analyzed, for example, in Block, Nold, and Sidak (1981).

4.2. Markup evolution during collusive period

As can be seen in Figure 2, the estimated markup $\widehat{M}_t$ had a positive sign all along the collusive period, which is consistent with what we would expect to observe as a result of an anticompetitive practice.

Figure 2. Evolution of the estimated markup ($\widehat{M}_t$).



Source: Own elaboration.

Table 3 summarizes the main statistical characteristics of the markup $\widehat{M}_t$. From our results we obtain the following:

i. The observed freight truck transportation price index was systematically higher than would have been expected in the absence of collusion.
ii. This difference is statistically significant, with a resulting markup of approximately 5% on average, and with a 95% of certainty it could have reached up to 7.67%.

5. Assessment of the impact of the collusive behavior

The nature of the available data prevents from estimating a demand function (see, for example, Oum, Waters, and Yong (1992) and Berry, Levinsohn, and Pakes (1995)) and from using the consumer surplus as a measurement of welfare loss (seer, for example, Davis and Garcés (2010, chapters 1, 8 and 10) or Whinston (2007)).

Table 3. Markup distribution characteristics $\widehat{M}_t$ (in percentage points)	
Average	4.56%
Standard deviation	1.58%
Minimum	1.12%
Median	5.18%
75^{th} percentile	5.73%
90^{th} percentile	6.04%
Maximum	6.45%
95% confidence interval	[1.45% , 7.67%]

Source: Own elaboration.

However, our data allows to identify, estimate and quantify the collusion impact on inflation on freight truck transportation prices. It is clear that inflation is a variable that affects the economy through the welfare of firms and of individuals (see Aiyagari, Braun, and Eckstein (1998)). Therefore, being able to isolate and estimate the impact of the collusive behavior in the freight truck transportation sector inflation provides a relevant measurement of impact on welfare. As done previously, the first and last collusion periods are defined as:

$$\underline{t}^c = September\ 2008 \qquad \qquad \bar{t}^c = July\ 2010$$

Let us define:

$$\Pi^c = \left(\frac{12}{24}\right)\left[\frac{Y_{\bar{t}^c} - Y_{\underline{t}^c - 1}}{Y_{\underline{t}^c - 1}}\right]$$

$$\widehat{\Pi}^{nc} = \left(\frac{12}{24}\right)\left[\frac{\hat{Y}^{nc}_{\bar{t}^c} - Y_{\underline{t}^c-1}}{Y_{\underline{t}^c-1}}\right]$$

Π^c represents the inflation (annually) observed in data between August 2008 and July 2010. $\widehat{\Pi}^{nc}$ represents the inflation that would have been expected in the absence of the collusive behavior. Our measurement of impact on welfare is defined by:

$$\widehat{W}^c = \Pi^c - \widehat{\Pi}^{nc} \qquad (5)$$

$\widehat{W}^c$ can be identified as an estimator of the inflationary increase as a result of the collusive behavior. In addition to presenting the estimated value of $\widehat{W}^c$, it is necessary to construct a confidence interval to have a more precise idea of the range of the impact of the collusive behavior on welfare. To this end, it is important to have a variance estimator for $\widehat{W}^c$. In order to derive the asymptotic variance of $\widehat{W}^c$, we may use the so-called Delta Method (see Hayashi (2000, chapter 2)) from econometrics. Let us define:

$$U_t = (\Delta X_t', Z_t')'$$

Conditional on price values $(Y_t\ , X_t)$ observed during the collusive period, an estimator of $Var\left(\widehat{W}^c\right)$ can be constructed in the following way:

$$\widehat{Var}\left(\widehat{W}^c\right) = \left[\sum_{t=\underline{t}_c}^{\bar{t}^c} \frac{U_t'}{Y_{\underline{t}^c-1}}\right] \widehat{Var}\left(\hat{\beta}^{nc}\right) \left[\sum_{t=\underline{t}_c}^{\bar{t}^c} \frac{U_t}{Y_{\underline{t}^c-1}}\right]$$

where $\widehat{Var}\left(\hat{\beta}^{nc}\right)$ is the estimator of the variance-covariance matrix of $\hat{\beta}^{nc}$. The variance estimator $\widehat{Var}\left(\hat{\beta}^{nc}\right)$ is constructed in our case following the Newey-West Method (Newey and West (1987)) which allows autocorrelation and heteroskedasticity in the residuals for Equation (1).[8] Using these results, a confidence interval of 95% for $\widehat{W}^c$ is constructed as follows:

$$\left[\widehat{W}^c - 1.96\sqrt{\widehat{Var}\left(\widehat{W}^c\right)}, \widehat{W}^c + 1.96\sqrt{\widehat{Var}\left(\widehat{W}^c\right)}\right]$$

The results are included in Table 4.

[8] By constructing the estimator, autocorrelation of third order among residuals of Equation (1) is allowed.

Table 4. Estimation of the inflationary impact derived from the collusive behavior (in inflation percentage points).

Observed value Π^c	Estimated value $\hat{\Pi}^{nc}$	Inflationary increment $\widehat{W}^c = \Pi^c - \hat{\Pi}^{nc}$	95% confidence interval for $\widehat{W}^c$
7.25%	4.05%	3.20%	[0.23% , 6.31%]

Source: Own elaboration.

Our results show that:

i. Observed inflation was 3.2 percentage points above what would have been expected in the absence of collusion. This is equal to a difference of 79%.
ii. The inflationary impact from the collusive conduct is statistically significant with 95% of certainty.

5.1. Evolution of annual inflation: comparison between observed behavior and counterfactual without collusion

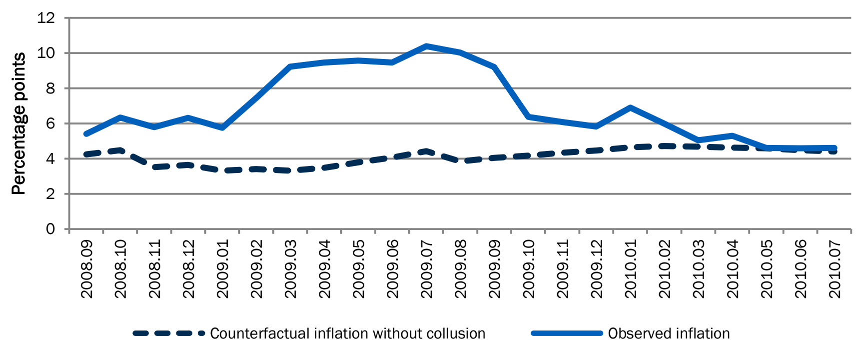
In order to complement the analysis and have a more complete picture of the inflationary impact of the anticompetitive behavior, we present a comparison of the behavior of the observed annual inflation against what we would have expected in the absence of collusion. Let us define:

$$\pi_t^c = \frac{Y_t - Y_{t-12}}{Y_{t-12}}, \qquad \hat{\pi}_t^c = \frac{\hat{Y}_t - \hat{Y}_{t-12}}{\hat{Y}_{t-12}}$$

π_t^c represents the observed annual inflation in the period (month) t, while $\hat{\pi}_t^c$ represents the inflation we would have expected in the absence of collusion. Figure 3 makes a comparison between the two quantities. From the information observed in Figure 3 we can obtain the following:

i. The observed inflation in freight truck transportation prices was systematically above expected inflation without collusion during the whole period when the anticompetitive practice was in effect.
ii. This discrepancy started from the beginning of the collusive period, being highlighted in the second half of 2009 and continuously decreasing towards the end of the period of collusion, when the CFC's resolution was approaching.
iii. The counterfactual difference estimated during 2009 was on average 4.34 percentage points of inflation, reaching up to 6.17 points in August 2009 (just one year after the anticompetitive practice have begun).

Figure 3. Observed inflation and counterfactual without collusion.



Source: Own elaboration.

5.2. An assessment of economic damages

A revenue comparison from services provided in the freight truck transportation sector during the collusive period, against the counterfactual revenue that would have been generated in the absence of collusion, provides an approximation of the direct economic impact of the anticompetitive practice.[9] Regarding industry-wide revenue measures in this industry, the most reliable and consistent source is the Annual Transport Surveys published by INEGI. These surveys include annual cumulative figures for revenue from providing freight truck transportation goods and services (general and specialized). This is the measure of revenue that will be used in this section, and it is denoted REV_A where A refers to year 'A'. To get an idea of the magnitude of this economic activity, in 2012 (the last year for which figures are available), the sector's revenues amounted to REV_A =8.3 billion USD. The available revenue figures have the disadvantage of being accrued annually (no monthly figures are available). However, if we assume that the real volume of activity (real sales) remained approximately constant during the period in question, the counterfactual revenue in the absence of collusion can be approximated as:

$$REV_A^{nc} = \left(\frac{\sum_{t \epsilon A} Y_t^{nc}}{\sum_{t \epsilon A} Y_t}\right) REV_A$$

[9] We will discuss below some of the indirect impacts that may result from anticompetitive practices in the freight truck transportation industry on other sectors of the economy.

where, as defined previously, Y_t^{nc} refers to the counterfactual price index in the absence of collusion. Therefore, it can be estimated the counterfactual revenue accrued during year 'A' as:

$$\widehat{REV}_A^{nc} = \left(\frac{\sum_{t\epsilon A}\hat{Y}_t^{nc}}{\sum_{t\epsilon A}Y_t}\right)REV_A$$

where $\hat{Y}_t^{nc}$ is estimated according to Equation (3) during the collusive period (September 2008 to July 2010) and $\hat{Y}_t^{nc}$ corresponds to Y_t during the rest of the sample. The monetary measure for the anticompetitive impact analyzed in this section is:

$$\begin{aligned} &\hat{M}_A = REV_A - \widehat{REV}_A^{nc} && \text{(Annual figure), for A = 2008, 2009, 2010.} \\ &\hat{M} = \hat{M}_{2008} + \hat{M}_{2009} + \hat{M}_{2010} && \text{(Accrued figure during collusive period).} \end{aligned} \quad (6)$$

In addition to estimating $\hat{M}_A$ and $\hat{M}$, it is convenient to construct confidence intervals for these measurements. It requires having an estimator of the corresponding variances. As done previously for $\widehat{W}^c$, it will be used the so-called Delta Method. Again, let us define:

$$U_t = (\Delta X_t', Z_t')'$$

As defined previously, $\underline{t}_c = September\ 2008$ and $\bar{t}_c = July\ 2010$ denote the start and end dates of the anticompetitive period in our study. $\hat{M}_A$ and $\hat{M}$ variances can be estimated as follows:

$$\widehat{Var}(\hat{M}_A) = \left(\frac{REV_A}{\sum_{r\epsilon A}Y_r}\right)^2\left(\sum_{\substack{t\geq\underline{t}_c\\ t\in A}}^{t\leq\bar{t}_c}\sum_{s=\underline{t}_c}^{t}U_s'\right)\widehat{Var}(\hat{\beta}^{nc})\left(\sum_{\substack{t\geq\underline{t}_c\\ t\in A}}^{t\leq\bar{t}_c}\sum_{s=\underline{t}_c}^{t}U_s\right)$$

and

$$\widehat{Var}(\hat{M}) = \left(\sum_{A=2008}^{2010}\left(\frac{REV_A}{\sum_{r\epsilon A}Y_r}\right)\sum_{\substack{t\geq\underline{t}_c\\ t\in A}}^{t\leq\bar{t}_c}\sum_{s=\underline{t}_c}^{t}U_s'\right)\widehat{Var}(\hat{\beta}^{nc})\left(\sum_{A=2008}^{2010}\left(\frac{REV_A}{\sum_{r\epsilon A}Y_r}\right)\sum_{\substack{t\geq\underline{t}_c\\ t\in A}}^{t\leq\bar{t}_c}\sum_{s=\underline{t}_c}^{t}U_s\right)$$

From here, confidence intervals with 95% statistical certainty are constructed simply as:

$$\left[\hat{M}_A - 1.96\sqrt{\widehat{Var}(\hat{M}_A)}, \hat{M}_A + 1.96\sqrt{\widehat{Var}(\hat{M}_A)}\right]$$

$$\left[\hat{M} - 1.96\sqrt{\widehat{Var}(\hat{M})}, \hat{M} + 1.96\sqrt{\widehat{Var}(\hat{M})}\right]$$

The results are presented in Tables 5 and 6.

Table 5. Estimation of the economic impact (million USD).

Period	Amount Estimated	95% confidence interval
2008	46.40	[14.53 , 78.33]
2009	345.73	[296.13 , 395.53]
2010	236.53	[213.67 , 259.40]
2008-2010	628.80	[546.47 , 711.13]

Source: Own elaboration.

Table 6. Estimation of the economic impact (as percentage of total industry revenue).

Period	Amount estimated	95% confidence interval
2008	0.643%	[0.201% , 1.085%]
2009	4.617%	[3.952% , 5.282%]
2010	3.050%	[2.755% , 3.345%]
2008-2010	2.798%	[2.432% , 3.165%]

Source: Own elaboration.

From results in Tables 5 and 6 we can state the following:

a. There is confirmation that the greatest impact of the anticompetitive behavior was recorded in 2009 because, unlike 2008 and 2010, such behavior was recorded during the whole 2009. Our estimated amount of economic damages through 2009 was 345.73 million USD and our results shows that with 95% certainty, that amount was at least 296.13 million USD.
b. Our estimated impact represents a relatively small proportion (about 3%) of revenues from the provision of services in the freight truck transportation sector. However, the magnitude of the economic activity in this sector results in a cumulative damage of about 628.80 million USD. With 95% certainty, our results indicate that the amount was at least 546.47 million USD. Even if we assume conservatively that only 10% of the firms included in the survey sample took part in the anticompetitive practice, the amount of estimated damage would be around 63 million USD.

The measurement presented here is an approximation of the direct impact of the anticompetitive behavior as it focuses exclusively on the freight truck transportation sector. The importance of freight truck transportation as a link between different economic sectors and geographic regions suggest that the macroeconomic impact is much greater. In the next section we will include a discussion of this wider impact.

5.3. Impact on other economic sectors

Freight truck transportation is a major input cost in many economic sectors. Therefore, anticompetitive behavior in this sector has implications that extend into many branches of economic activity. In this sense, the figures presented previously should be considered as a lower bound, a very conservative estimate of the damage caused to the economy as a result of the anticompetitive practice studied here.

Available data for this study preclude an accurate quantification of damages in other sectors of economic activity. However, we can draw on previous studies that apply largely to the case of the Mexican economy to get a rough idea of the impact of the freight truck transportation industry in costs and prices. Specifically we focus on the food industry for two main reasons:

i. Behavior of food prices is essential to the welfare of families in vulnerable circumstances.
ii. Due to its perishable nature, the food sector is particularly vulnerable to changes in freight truck transportation costs.

In this sense, the World Bank (Schwartz, Guasch, Wilmsmeier, and Stokenberga (2009)) prepared a working paper to study the impact of transportation costs in food prices in Latin America and the Caribbean. The main conclusions of this study are summarized below:

i. Logistics costs in Latin America and the Caribbean are between 16% and 26% of GDP and between 18% and 32% of the total value of primary goods. Transportation costs in the region constitute a relevant ratio of these logistical expenses.
ii. Increases in transportation costs are translated into increases in food prices towards the final consumer of about 15% and 25% (i.e. for each percentage point increase in transportation costs, final prices of food to the consumer increase between 0.15% and 0.25%).
iii. Fluctuations in transportation costs are the main cause of food prices volatility observed recently in the region.

Table 4 analyzes the impact of the anticompetitive conduct on the freight truck transportation price index inflation between September 2008 and July 2010. During that period, the cumulative inflation in the National Consumer Price Index for Food, Beverages and Tobacco was 10.54%. Extrapolating the elasticities estimated by the

World Bank and combining these figures with our results in Table 4, we estimate that, *caeteris paribus*, inflation in food prices in the absence of the anticompetitive practice in freight truck transportation would have been observed within the range of 8.45% and 9.29% instead of the 10.54% level. Given the proportion of Mexican families in vulnerable economic situations, the inflationary impact has significant social costs.

6. FPAF as markup predictor

At the center of the anticompetitive practice during the collusion was the Fuel Price Adjustment Fee (FPAF) through which CANACAR and its members colluded to transfer the increases in the price of fuel directly to their customers. In this section we study the statistical relationship between the markup $\widehat{M}_t$ and the FPAF. Since the collusive practice focused on the latter, we would expect FPAF to have predictive power to explain our markup measure $\widehat{M}_t$.

The first obstacle we face is the lack of information about the FPAF during the collusive period (September 2008 to July 2010). Public data about the FPAF until April 2009 can be found in CFC's case file.[10] Therefore, the first step in our analysis is to project the FPAF until July 2010. This projection was constructed based in the following autoregressive econometric model:

$$FPAF_t = \gamma_0 + \gamma_1 FPAF_{t-1} + \gamma_2 FPAF_{t-2} + v_t$$

The inclusion of intercept γ_0 helps to capture the temporal trends of the FPAF. Coefficients γ_1 and γ_2 capture the dynamic characteristics of this series. Parameters of the autoregressive model were estimated using available information about FPAF, and for periods after April 2009 the fee is projected using:

$$\widehat{FPAF}_t = \begin{cases} FPAF_t \text{ for } t \leq April\ 2009 \\ \hat{\gamma}_0 + \hat{\gamma}_1 FPAF_{t-1} + \hat{\gamma}_2 FPAF_{t-2} \text{ for } t = May\ 2009 \\ \hat{\gamma}_0 + \hat{\gamma}_1 \widehat{FPAF}_{t-1} + \hat{\gamma}_2 FPAF_{t-2} \text{ for } t = June\ 2009 \\ \hat{\gamma}_0 + \hat{\gamma}_1 \widehat{FPAF}_{t-1} + \hat{\gamma}_2 \widehat{FPAF}_{t-2} \text{ for } t \geq July\ 2009 \end{cases}$$

Our goal is to study the statistical relationship between markup $\widehat{M}_t$ and FPAF. Since the latter has a time trend factor (captured by coefficient $\hat{\gamma}_0$), it is necessary to remove any

[10] This information comes directly from CANACAR's website, where the FPAF was published monthly to members.

temporal trend in $\widehat{M}_t$ in order to remove the risk of a "spurious regression" (Hamilton (1994, Section 18.3)). For this purpose, we estimate the following regression first:

$$\widehat{M}_t = \delta_0 + \delta_1 t + \eta_t$$

and use:

$$\overline{M}_t = \widehat{M}_t - \left[\hat{\delta}_0 + \hat{\delta}_1 t\right]$$

$\overline{M}_t$ eliminates the temporal trend in markup $\widehat{M}_t$. Finally, we estimate the following regression for the collusive period:

$$\overline{M}_t = \theta_0 + \theta_1 \widehat{FPAF}_t + \theta_2 \widehat{FPAF}_t^2 + \theta_3 \widehat{FPAF}_t^3 + \epsilon_t \tag{7}$$

The determination coefficient (R^2 or “R-squared”) for regression (7) was 0.66. From this we know that through model (7), FPAF variations explain 66% of markup variations during the collusive period. This finding is consistent with the main role that FPAF played as a collusion instrument.

7. Conclusions and final results

We found empirical evidence of a statistically significant change in the dynamic structure of prices in the freight truck transportation industry during the collusive period (September 2008 to July 2010) compared with the non-collusive one.

Our index for measuring the impact on prices from the observed anticompetitive practice was a markup $\widehat{M}_t$ constructed as the percentage difference between the freight truck transportation price index observed in the data and the counterfactual price index expected in the absence of collusion.

The estimated markup $\widehat{M}_t$ had positive statistically significant sign during the whole collusion period, showing that the freight truck transportation price index in the data was systematically higher than the expected in the absence of the anticompetitive practice. This difference was statistically significant, with an average value of about 5% with 95% of certainty, and could have reach levels close to 8%.

As a measure of impact on welfare we used the comparison between the inflation rate in the freight truck transportation industry observed during the period of the anticompetitive practice and the inflation rate expected in the absence of such behavior. Specifically, the inflation rate (annualized) between September 2008 and July 2010 was analyzed. The analysis revealed that this difference was statistically significant, with an estimated value of 3.2 percentage points of annualized inflation. We also compared the evolution of the annual inflation rate for each month in that period and we found an inflationary impact of the anticompetitive practice in each of the months during the year, reaching this impact a maximum level of 6 percentage points of inflation in August 2009. Applying this annualized inflation to revenue figures for the provision of services in the freight truck transportation sector, we estimated that the revenue difference in monetary terms during the collusive period was about 630 million USD.

The figures described above are an estimate of the direct impact of the anticompetitive practice. Indirect costs reverberate throughout the economic sectors that require freight truck transportation as an intermediate input. Particular attention deserves the food sector due to the perishable nature of its products and its impact on household welfare. Extrapolating studies by the World Bank and combining them with our findings, we believe that, holding other factors constant, inflation of consumer prices in food during the September 2008--July 2010 period would have been in the range of 8.45% and 9.29%, in the absence of the anticompetitive practice. However, an inflation of 10.54% was observed. The proportion of Mexican families in vulnerable economic situations make this an economic impact with enormous social welfare implications.

Finally, we estimate that the Fuel Price Adjustment Fee (FPAF) explains about 66% of the variations in the markup $\widehat{M}_t$ during the collusive period. This is consistent with CFC's determination that the anticompetitive practice was based on the FPAF as the collusion instrument.

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