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Weekday with Low Prices: Evidence on Daily Seasonality of Foods, Beverages and Tobacco Prices*

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Abstract: In this document we analyze the evidence of daily seasonality found in the weekly price variations of food, beverages, and tobacco in the Metropolitan Area of Mexico City. Our research is based on the daily price quotes of 2,724 goods, collected by Banco de México for the Consumer Price Index (CPI), in 434 commercial establishments between March 2009 and June 2010. We identify the weekday with the lowest weekly variation in prices, and find that it differs across products, types of commercial establishment, and supermarket chains. Moreover, we find that such a “day of the week” effect increases the volatility of the weekly variations of price quotes. These results establish the “day of the week” among the distinct characteristics of a price, a fact that must be taken into account while preparing calendars for CPI data collection.

Keywords: Daily prices, retail sales, seasonal price patterns, dynamic pricing policies, CPI methodologies.

JEL Classification: B4, D4, L16, L81.

Resumen: En este documento se analizan los indicios de estacionalidad diaria encontrados en las variaciones semanales de los precios de alimentos, bebidas y tabaco en el Área Metropolitana de la Ciudad de México. La investigación se basa en las cotizaciones diarias de los precios de 2,724 productos específicos, recopiladas por el Banco de México para el cálculo del Índice Nacional de Precios al Consumidor (INPC), en 434 establecimientos comerciales entre marzo de 2009 y junio de 2010. El análisis identifica el día de la semana con menores variaciones en los precios y muestra que éste presenta diferencias por producto, tipo de establecimiento, y cadena de supermercado. Asimismo, se encuentra que este efecto “día de la semana” aumenta la volatilidad de las variaciones semanales de los cotizaciones de precios. Los resultados sitúan al “día de la semana” entre las características definitorias de un precio, lo que debe ser tomado en consideración durante la preparación de los calendarios para recoger la información base de los índices de precio.

Palabras Clave: Precios diarios, descuentos de minoristas, patrones estacionales de precios, políticas dinámicas de determinación de precios, metodologías del índice de precios al consumidor.

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1. Introduction

Theoretically, a “commodity” is a good or a service completely specified in terms of its physical characteristics, as well as the place and time of its availability. Thus, goods that have the same physical features, but are available at different times or in distinct places are different products, since their role or economic purpose is different (Debreu, 1959). Nevertheless, it is common in practice to omit the time dimension within the description of goods; mainly due to the “time aggregation” prevailing in the data (Mas-Collel et al., 1995). For instance, the price of tomato is usually not stated as the price on Monday in supermarket Z, but as the price during a given fortnight or month in supermarket Z.

The time dimension is often neglected within the definitions of merchandise or products included in the reference basket for the Consumer Price Index (CPI) calculation. In particular, statistical bureaus in charge of compiling price indices tend not to distinguish among the prices of the same good collected on different days of the week. The Consumer Price Index Manual (2004), the main reference for consumer price index compilers worldwide, just briefly mentions the existence of goods that are subject to a “day of the week” effect. Thus, international practice does not usually consider the day of the week as a relevant characteristic of goods within its information reccompilation for statistical purposes. In the case of the Mexican Consumer Price Index (CPI), until October 2010, weekdays were only considered relevant for price quotes of tourist services and cinema tickets.

However, the industrial organization literature found, mostly for the U.S. economy, that weekly price variations of many goods differ considerably across weekdays due to price markdowns (There are no similar previous studies for the Mexican economy). This suggests that price variations are subject to a certain type of daily seasonality. The omission of the time dimension within the definition of CPI price
quotes, even though it does not affect the average level of prices, may induce price
index volatility as changes over time estimated with quotes collected on different
weekdays are assigned to the same good.¹

The aim of this paper is to contribute to the industrial organization and price
statistics literature by analyzing the evidence on daily seasonality found in the weekly
changes of foods, beverages and tobacco prices in the Mexico City Metropolitan Area
(MCMA). The analysis is based on the price quotes of the Mexican CPI collected by
Banco de México, which represent an extensive database regarding the number of
establishments, products and the time period, as compared to the international literature.

The methodology used in this study consists in the estimation of transition
matrices for the weekly price changes. These matrices allow identifying the weekday
with the lowest ratio of price increases to price reductions, as well as the weekday on
which the lowest percentage price change was observed. Tests are applied to the
resulting differences among weekdays in order to determine their statistical
significance. Furthermore, a linear regression of weekly changes of fruit and vegetable
prices is estimated to approximate the contribution of daily seasonality to the volatility
of the price index.

The results seem to confirm the existence of a “day of the week” effect on foods,
beverages and tobacco prices in the MCMA. The pattern of price changes throughout
the week varies across products, commercial establishments and supermarket chains.
This result seems to be new in the industrial organization literature, since previous
studies usually focused on the analysis of monthly prices of a product or a small product
group in a given type of establishment. Also, to our knowledge this issue has not been
addressed empirically in the price indices literature.

¹ However, time aggregation has been shown to affect the estimates of price changes in chained indices
computed using scanner data, as in de Haan and van der Grient (2011) and Ivancic et al. (2011).
In particular, the analysis reveals that weekly variations of fruit and vegetable prices present a “smile” or “V” shape, i.e., high price changes at the beginning and the end of the week, and low price changes during the week. Price changes of livestock products present a “W” pattern throughout the week. In the case of beverages and tobacco, the size of price variations diminishes as the weekend approaches, although these differences are not statistically significant. The pattern of price changes in supermarkets during a week has a “smile” shape, while other establishment types present a “slide” shape. Finally, in the case of fruit and vegetables, the “day of the week” with the lowest price increase changes across supermarket chains. It is noteworthy that the regression analysis indeed confirmed that a price compilation scheme that neglects the “day of the week” effect leads to an increase in the volatility of some fruit and vegetable price indices that have a high CPI weight.

This study has also implications for public policy in three dimensions: first, for the design of price statistics by indicating the need of incorporating the day of the week into the CPI price collection calendar; second, for the knowledge required by central banks about the volatility of the price index that is used to approximate the evolution of population’s living costs and, thus, for the evaluation of the economy’s price stability; and third, for the design of a country’s competition policy, as daily seasonality of prices is only possible in an environment where commercial establishments are able to exert certain market power.

The document is structured as follows: Section 2 reviews the literature on price markdowns on given weekdays as observed in the U.S. economy and their impact on the frequency and magnitude of price changes. Section 3 presents the data used in this study, as well as the empirical strategy applied for the estimation of the “day of the week” effect. Section 4 presents and discusses the main results. Section 5 concludes
with some final considerations. For readers’ convenience, tables and graphs with the results are presented at the end of the document.

2. Literature

The industrial organization literature that deals with price markdowns (i.e. the sales of goods at a reduced price) includes empirical studies that focus on the existence of daily seasonality in price changes. The economic rationality behind markdowns is that, given retailers’ ability to exert certain market power, daily price changes are a price discrimination strategy that allows retailers to extract higher consumer surplus. The literature mostly analyzes the pattern of price changes in supermarkets in the United States.\(^2\) In this context, the evidence presented by Warner and Barsky (1995) and Pesendorfer (2002) stands out. The former analyze the daily prices of 8 durable goods in 17 establishments located in Ann Arbor, Michigan, during the period of November 1, 1987 to February 29, 1988, and find a “day of the week” effect: the prices of durable consumption goods decline as Friday approaches, and then increase again reaching their maximum on Monday. Pesendorfer analyzes daily ketchup prices in supermarkets in Springfield, Missouri, between 1986 and 1988, and finds a “Wednesday” effect, since most price markdowns are recorded on that day. The empirical approach followed by these authors is in general conventional and based on mean comparisons or econometric estimations of simple price variation models.

Previous research analyzing food price markdowns in supermarkets in general concluded that they are frequent, include many goods simultaneously and explain a high fraction of price changes of perishable goods. Hosken and Reiffen (2004), using a monthly BLS database, analyze 20 product categories over 5 years and find that between 20 to 50 percent of the variation around the mode of prices are explained by

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\(^2\) In general, the European studies on retail sale prices basically deal with the degree of their variability rather than the pattern they follow throughout the week (see footnote 3).
temporary price markdowns. Li et al. (2006) report similar results for the case of avocado, lettuce and packaged salads, in a weekly price sample of 20 retail stores in 6 U.S. cities between January 1998 and December 1999. In turn, Richards (2006) documents that the number of fresh fruit and livestock products included in price markdowns is usually high, based on the analysis of a weekly price sample collected during 2 years in 4 supermarket chains in Los Angeles, California.

In sum, the economic literature on price markdowns seems to emphasize the “day of the week” effect in the case of durable goods and processed food, while in the case of fresh food the analysis seems to highlight the high share of price changes that the markdowns explain. In contrast, and due to the special sample characteristics, in this document we study the “day of the week” effect on prices of the foods, beverages and tobacco group, especially emphasizing fruit and vegetables. For the Mexican case, there are no previous studies like the one presented here.3

The Consumer Price Index Manual (2004), as mentioned before, recognizes the existence of prices that are subject to a “day of the week” effect, although it is just a brief reference concerning cinema entrance tickets. Despite the existing evidence pointing to a “day of the week” effect on prices of goods with a CPI weight higher than recreational services, compilers and evaluators of price indices have generally disregarded this phenomenon. Regarding this, in the evaluation exercises of price statistics denominated the Report on the Observance of Standards and Codes (ROSC), carried out by the International Monetary Fund the specification of the data recollection day is not one of the dimensions taken into account. Thus, in international practice the

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3 The study of daily seasonality in the price changes of processed and unprocessed food, and its relation to price markdowns, seems to be more relevant given the findings reported in Nakamura and Steinsson (2008) indicating that there is much less seasonality in the monthly frequency of sales of these products than in other major groups, like apparel and household furnishings. Likewise, Abe and Tonogi (2010) used scanner data to estimate the difference in the degree of flexibility of prices based on daily and monthly data, including and excluding sales prices, in general merchandise stores and supermarkets of Japan between 1988 and 2005, but did not study the seasonality of price variations throughout the week.
weekday is usually not considered within the data collection programs. In the case of the Mexican CPI, until October 2010 the day of the week was only considered in reference to the price quotes of tourist services and cinema tickets.

3. Data and Methods

3.1 CPI Micro Data

Given the availability of data for the MCMA, the results obtained in the industrial organization literature can be extended in three dimensions: the variety of products, the type of establishments and the number of observations. Thus, we will study the effect of price markdowns on price dynamics in the MCMA and examine if they are characterized by a daily seasonal pattern that should be taken into account in CPI compilation procedures.

The analysis presented in this paper is based on the CPI micro database elaborated by Banco de México’s General Economic Research Directorate. In this case, only the price quotes of foods, beverages and tobacco items of the MCMA are considered, since it is the only location in Mexico where daily information for this subset is collected (the price of each item and the day of recompilation is registered once a week).

The sample includes 2724 items collected in 434 different establishments (Tables 1 and 2). We exclude (chained) rotating goods, since they modify their characteristics (establishment, brand, weight, etc.). The analysis covers the period from the first week of March 2009 to the fourth week of June 2010. It was chosen due to the data availability and was limited by the calendar of handing over the responsibility of the CPI calculation from Banco de México to INEGI.4

In this sample, fruit and vegetables prices are the most flexible ones: on average 45.9 percent of products in this group changed their price every week (Graph 1), as

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4 The National System of Statistical and Geographical Information Law established that INEGI would be in charge of compiling the CPI starting from July 15, 2011.
compared to 27.4 percent of products in the whole foods, beverages and tobacco group. Among the livestock products, processed foods, beverages and cigarettes, the percentage of goods that registered a price change each week was even lower (17.9, 13.4 and 10.8 percent, respectively, Graph 1).5

3.2 Transition Matrices

Based on the calculation of transition matrices for price variations between the week \( h \) and week \( h+1 \), two measures of daily seasonality of weekly price changes were analyzed: the ratio of price increases to price reductions, and the average weekly percentage change of prices. In the first case, transition matrices allow identifying the day of the week with the lowest number of goods with price increases relative to the number of goods with price reductions, as compared to the prices registered in the previous week. In the second case, the matrices allow detecting the weekday with the lowest average weekly percentage change of prices.

Table 3 shows the transition matrices for the goods in the foods, beverages and tobacco group of the CPI in the MCMA. The cells of matrix (a) display the ratio of price increases to price reductions for each weekday, with respect to the prices observed during the previous week. The results discussed in Section 4 refer to the last row of the matrix (denominated Total), where the ratio is reported for each weekday irrespective of the day of the previous week. The cells of matrix (b) report the average weekly percentage change in prices observed on each weekday, as compared to those of the

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5 The result referring to the higher flexibility of fruit and vegetable prices in relation to prices of other goods is similar to the findings reported for other countries. Costa Dias et al. (2008), using micro data for consumer price index in Portugal in the period 1992-2001, found a frequency of average monthly price changes of 47.2 percent for unprocessed food, 23.9 for processed food and 14.4 percent for beverages and tobacco. Nakamura and Steinsson (2008), using CPI micro data of the United States for the period 1988-2005, found an average monthly frequency of 39.5 percent for unprocessed foods and 25.5 percent for processed foods (besides, they found that excluding price markdowns, the median frequency of price changes was halved). Finally, Ellis (2009) analyzed the weekly sales of 240 supermarkets in England between 2005 and 2008 and found that, on average, 60.0 percent of the prices of 10 product categories changed every week, while this frequency was 40.4 percent when fresh foods were excluded.
previous week. Note again that the results discussed in Section 4 refer to the cells of the last row, where this variation is presented with respect to the weighted average of the previous week prices.

In both cases, the matrices corresponding to each subgroup of goods are calculated using the observations from the total sample, so that the reported daily seasonality pattern of prices corresponds to the average weekly price dynamics observed during the study period.\(^6\) It is noteworthy that there are no observations for Sundays, since no price quotes for the CPI are collected on that weekday.

3.3 Statistical Tests
The daily pattern of weekly price changes corresponds, as already mentioned, to the last row of the transition matrices, registering the weekly price change for each day regardless of the day of the previous week. Daily seasonality is found if this pattern is nonlinear, i.e., if observed weekly price changes are statistically different across the weekdays. Therefore, in addition to the transition matrices, Section 4 discusses the results of two hypothesis tests: the conventional \(t\)-test for equal means and the Mann-Whitney non-parametric U-test for equal medians. The first test is estimated assuming that the samples of each weekday are randomly and independently obtained from the respective populations; that the observations have a normal distribution; and that variances do not differ between populations. The Mann-Whitney U-test is used since it is an acceptable option when the assumptions underlying the parametric \(t\)-test are not

\(^6\) Additionally, this allowed us to leave out of the discussion the correlation between the frequency of price changes and the level of inflation, studied by Nakamura and Steinsson (2008), and the relationship between the extent of price discounts and the business cycle, analyzed by Coleman and De Veirman (2011).
met. A detailed discussion of these tests can be found in Wackerly et al. (2002) and Siegel (2005).7

3.4 Volatility Estimation

The presence of daily seasonality in the price quotes of the foods, beverages and tobacco group, together with a price collecting procedure that does not contemplate the weekday as one of the features defining a good, certainly leads to an upward bias in the volatility of weekly price changes.

In order to quantify the contribution of the “day of the week” effect to the volatility of weekly price changes in the fruit and vegetable group in supermarkets (the product group with the most pronounced daily seasonality pattern), we estimate an econometric model similar to that used in Warner and Barsky (1995).

In this specification, price reductions correspond to negative values of the coefficient \( \gamma(i) \) in the regression \( \log[p(t)]*100 = \alpha + \beta*t + \sum \gamma(i)*D(i) + \epsilon(t) \), where \( \log[p(t)]*100 \) is the weekly price change in percent of the item under study; \( i = 1, \ldots, 4 \) indicates the weekday (Monday to Thursday, Fridays are omitted since their effect is captured by the constant); \( D(i) \) is a dummy for weekday \( i \); and \( t = 1, \ldots, 315 \) is the number of weekly price observations.8 Price quotes collected on Saturdays are omitted in this regression analysis (and there are no observations for Sundays). All regressions

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7 It should be noted that here we discuss only the results of statistical tests for the differences across weekdays in the average weekly price change. We estimated a \( z \)-test for the differences across weekdays in the ratio of price increases to price reductions. The null hypothesis of equal ratios on Mondays and Wednesdays, and on Wednesdays and Fridays was rejected for the set of products in the foods, beverages and tobacco group, as well as in the fruits and vegetables group. However, given that the test was less reliable for other groups of products, and that an alternative non-parametric test was not found in this case, these results are not reported here.

8 The daily series \( p(t) \) of each item was calculated as follows: first, we identified the products of each item group for which prices were collected on Monday of the second week in the sample period; second, we computed the ratio between the price of each of these specific products and their price observed during the previous week; and third, we computed the geometric mean of these ratios in order to obtain the first observation of the series. The remaining observations of \( p(t) \) were obtained by repeating these three steps for all weekdays (excluding Saturdays and Sundays) during the reference period.
control for serial autocorrelation in error terms and coefficients’ standard errors are corrected for heteroscedasticity.

Finally, the contribution of the “day of the week” effect to the volatility of weekly price changes is derived from the regression equations, which under general assumptions approximately equals: $\Phi \gamma(i)^2$, where $0 < \Phi < 1$ and $\Phi = \{\text{var}[D(i)] / \text{var} [\log(p(t)]*100\}$.  

4. Results

This section presents the daily pattern of weekly price changes, as well as the ratio of price increases to price reductions for each weekday with respect to the average of the previous week. The results are shown as follows: first, the price pattern according to the type of good: fruit and vegetables, processed food, livestock products, beverages and tobacco; second, the price pattern according to the type of good and the type of establishment: supermarket, public market and specialized stores (e.g., tortillería, fruit store, liquor store, etc.); third, the price pattern of fruit and vegetables in different supermarket chains (six supermarket chains are considered, labeled from “A” through “F” in order to maintain the confidentiality of the data).

4.1 Daily Seasonality by Type of Good

For products in the group of foods, beverages and tobacco, the ratio of price increases to price reductions and the weekly percentage price change follow a “smile” or “V” pattern throughout the week –with the lowest value being achieved on Wednesday in both cases (Graph 2). Thus, on that day, for every 100 price reductions we observe 96 price increases, while on Monday and Friday we observe 114 and 113 price increases,

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9 The first assumption is that the stochastic properties of the regression error are the classical ones and that the regression can be estimated with ordinary least squares; the second assumption, and more important for the calculation of the contribution of the daily seasonality to the volatility of weekly price changes, is that the sum of the covariances between $\gamma(i)$ and $\gamma(j)$, for all $j$, is very small, and can thus, for practical reasons, be neglected.
respectively (Graph 2a). Additionally, while on Wednesday the average weekly price variation is 0.34 percent, on Monday and Friday it is 0.82 and 0.83 percent (Graph 2b). The tests of equal means ($t$-test) and equal medians (Mann-Whitney non-parametric U-test) of average weekly price changes on Mondays and Fridays, with respect to Wednesdays, are rejected, thus indicating that the pattern found is statistically significant.

The pattern of daily seasonality is even more pronounced in the case of fruit and vegetables; the lowest price variations are also observed on Wednesdays (Graph 2): for every 100 price reductions on average there are 88 price increases; on Mondays and Fridays the latter figure is 110 and 114, respectively (Graph 2a). Likewise, while on Wednesdays the average weekly price change of fruit and vegetables is 0.51 percent, on Mondays and Fridays this figure is 1.56 and 1.78 percent (Graph 2b). The tests of equal means and medians of average weekly price changes of fruit and vegetables on Mondays and Fridays with respect to Wednesdays are rejected.

The magnitude of the “day of the week” effect is lower for the prices of processed foods as compared to those of the foods, beverages and tobacco group (Graph 2). In the case of processed foods the tests of equal means and medians of average weekly price changes on Mondays and Fridays, as compared to Wednesdays, in general could not be rejected.

In the case of livestock products, both measures of the “day of the week” effect exhibit a “W” shape, reaching their lowest values on Tuesdays and Fridays (Graph 3a and 3b). The test of equal means ($t$-test) of weekly price changes of these goods on Mondays with respect to Tuesdays and Fridays is rejected. The test for equal medians (Mann-Whitney non-parametric U-test) is rejected for the variations on Mondays and Fridays.
In the case of beverages and tobacco, the number of price reductions dominate price increases on Mondays (Graph 3a), although the average weekly price change reaches a minimum value on Saturdays (Graph 3b); however, the differences observed in price changes between weekdays are not statistically significant in this case.

4.2 Daily Seasonality by Type of Good and Type of Establishment

The pattern of daily seasonality of average weekly price changes varies among establishment types (supermarket, public markets and specialized stores) for the group of foods, beverages and tobacco products, as well as for the subgroup of fruit and vegetables. In the case of livestock products such a difference was not observed among commercial establishment types.

The “V”-shaped pattern of daily seasonality, with the average weekly price change being lowest on Wednesdays, is still observed when the foods, beverages and tobacco group sample is restricted to supermarket price quotes only (Graph 4a); the same is true for fruit and vegetables (Graph 4b). In the first case, the average weekly price change estimated for Wednesdays is 0.12 percent, while on Mondays and Fridays it is 0.96 and 1.18 percent, respectively; in the case of fruit and vegetables, the “V”-shaped pattern is more pronounced: the change corresponding to Wednesday is -0.17 percent, as compared to 1.80 and 2.78 percent on Monday and Friday. For both the foods, beverages and tobacco group and the fruit and vegetables subgroup, the tests of equal means (t-test) and equal medians (Mann-Whitney non-parametric U-test) of average weekly price changes in supermarkets on Mondays and Fridays, as related to Wednesdays, are rejected.

The pattern of daily seasonality found in the price quotes of both the foods, beverages and tobacco group, and the fruit and vegetable subgroup, collected in public markets and specialized stores, differs from the one observed in the price quotes
collected in supermarkets: the average weekly price variation declines throughout the week and, in general, reaches its lowest value on Fridays; thus, the daily seasonality pattern is shaped like a “slide” (Graph 4a and 4b). In public markets, the average weekly price variation of foods, beverages and tobacco, and of fruits and vegetables is on average 0.18 and 0.31 percent on Fridays, while on Mondays it is 0.87 and 1.57 percent, respectively. In both cases, these differences are statistically significant (in the t-test for equal means and in the non-parametric U-test of equal medians). Although this pattern is also observed in specialized stores, the average weekly price variations on Mondays and Fridays do not differ significantly.

In contrast, the daily pattern of average weekly price variations of livestock products do not differ with the type of establishment (remember from the previous section that these changes follow a “W” shape during the week, Graph 5a). Nevertheless, the statistical significance of these patterns is lower as compared to that found in the case of fruit and vegetables. The tests of equal means and medians of price changes of livestock products are rejected when comparing price variations on Monday and Friday in supermarkets, and on Wednesday and Thursday in public markets; while for specialized stores, these tests are not rejected.

Finally, the average weekly price changes of processed foods in supermarkets exhibit a daily seasonality pattern that is opposite to that observed in public markets and specialized stores (Graph 5b). While in supermarkets, the mentioned changes are lowest on Tuesdays and highest on Thursdays, respectively; in public markets and specialized stores they reach their maximum and minimum levels on these days. In general, this pattern is found to be statistically significant in the three types of establishment.
4.3 Volatility of Fruit and Vegetable Price Changes in Supermarkets

The regression analysis allowed us to estimate the “day of the week” effect on the volatility of average weekly price changes of fruit and vegetables items collected in supermarkets on Wednesdays. The group for which this effect was found to be statistically significant has a CPI weight of 1.98 percentage points, and it is composed of the following products: avocado, zucchini, tomato, apple, melon, orange, nopal, potato, papaya, pineapple, banana, watermelon, green tomatoes and carrots (Table 4). In contrast, the group of fruit and vegetables, for which the effect was not statistically significant has a CPI weight of 1.67 percentage points. The difference is partially derived from the sample composition. Finally, according to the regression coefficients estimated, price markdowns account for less than 10 percent of the volatility of average weekly price variations (Table 4).

4.4 Daily Seasonality of Fruit and Vegetables by Supermarket Chain

Even though the average weekly variations of fruit and vegetable prices in supermarkets exhibit a statistically significant “day of the week” effect on Wednesdays, this particular result is mainly due to greater participation of some supermarket chains in the data sample analyzed here. This is apparent when we estimate the “day of the week” effect on fruit and vegetable price variations for each of the six supermarket chains in the sample (to maintain confidentiality of data, these chains are denominated “A” through “F”).

The “day of the week” effect is observed on Wednesdays in supermarkets “A”, “B” and “C”, on Thursdays in supermarket “D”, on Fridays in supermarket “E”, and on Tuesdays in supermarket “F” (Graphs 6, 7 and 8). The tests of equal means (t-test) and equal medians (Mann-Whitney non-parametric U-test) are rejected, indicating that the patterns of daily seasonality are statistically significant.
5. Final Considerations

The aim of this document is to contribute to the industrial organization and price index literature by analyzing the daily seasonality of weekly price changes of foods, beverages and tobacco in the Mexico City Metropolitan Zone (MCMA). This paper seems to be the first in the literature that uses daily CPI price quotes for the estimation of daily seasonality of consumer prices. It also seems to be one of the first studies that, given the number of observations and the coverage of goods and establishments in the CPI sample, estimates the “day of the week” effect by type of good, type of commercial establishment and supermarket chain.

The results of this study confirm that the weekday (as well as the type of establishment where the prices are collected) is a feature of the goods in the foods, beverages, and tobacco group in the MCMA that is relevant for CPI collection. The magnitude of the “day of the week” effect is more pronounced in the prices of fruits and vegetables with respect to the rest of the products considered, and in the prices collected in supermarkets as compared to the rest of the establishments. In both cases, the average weekly price changes present a “smile” or “V” pattern, since these variations are high at the beginning and the end of the week, but low in the middle of the week (the exact day when prices exhibit their lowest price change varies among supermarket chains).

The results presented in this document suggest that, in order to increase the accuracy of price statistics, the “day of the week” effect should be considered in two instances: first, the day when price quotes are levied should be determined when specifying the goods and services included in the index sample; and second, the data sample should be diversified, i.e. include data from different days, since the dynamics of prices may change depending on the clientele that the establishments cater for. The additional result regarding the distribution of the discount days throughout the week
among different commercial chains suggests that some of the retailers apply a price discrimination strategy among their clients.\footnote{These results are complementary to those recently published in the literature on the construction of price indices, although they are derived from different research objectives and from the analysis of distinct sources of data and price indices. Particularly, they are related to those in Nakamura et al. (2011), de Haan and van der Grient (2011), and Ivancic et al. (2011), that emphasized the implications of pricing dynamics, especially of temporary sales, for the measurement of inflation. The first of the referred papers also highlighted retail characteristics as crucial determinants of heterogeneity in pricing dynamics, in addition to the product features usually mentioned in literature.}

This evidence of daily seasonality of CPI price quotes is also a contribution to the studies of frequency and magnitude of price changes and their determinants. This paper emphasizes the effect of price markdowns (a price discrimination strategy among different types of consumers) on the frequency and magnitude of price changes throughout the week, while in the literature it has generally been dealt with monthly price changes, relating them to the general conditions of the price formation process.

To conclude, it is worth mentioning that the results obtained in this research allowed Banco de México’s General Economic Research Directorate to adjust its price quotes recollection program in November 2010. The procedures revised by Banco de México were made available to INEGI, the institution being in charge of the CPI calculation since the second fortnight of July 2011.

References


Table 1  
Collected CPI Items by Type of Establishment in the Mexico City Metropolitan Area  
1st week of March 2009 to 4th week of June 2010

<table>
<thead>
<tr>
<th>Establishment</th>
<th>Fruit and Vegetables</th>
<th>Meats and Egg</th>
<th>Processed Foods</th>
<th>Beverages and Tobacco</th>
<th>Total</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warehouse club</td>
<td>3</td>
<td>0</td>
<td>29</td>
<td>5</td>
<td>37</td>
<td>1.4</td>
</tr>
<tr>
<td>Public market</td>
<td>453</td>
<td>213</td>
<td>202</td>
<td>1</td>
<td>869</td>
<td>31.9</td>
</tr>
<tr>
<td>Supermarket</td>
<td>535</td>
<td>196</td>
<td>649</td>
<td>71</td>
<td>1451</td>
<td>53.3</td>
</tr>
<tr>
<td>Street market</td>
<td>79</td>
<td>12</td>
<td>9</td>
<td>0</td>
<td>100</td>
<td>3.7</td>
</tr>
<tr>
<td>Convenience store</td>
<td>23</td>
<td>4</td>
<td>13</td>
<td>5</td>
<td>45</td>
<td>1.7</td>
</tr>
<tr>
<td>Specialized store</td>
<td>29</td>
<td>17</td>
<td>155</td>
<td>21</td>
<td>222</td>
<td>8.1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1122</strong></td>
<td><strong>442</strong></td>
<td><strong>1057</strong></td>
<td><strong>103</strong></td>
<td><strong>2724</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: Banco de México.

Table 2  
Number of Establishments in the Sample

<table>
<thead>
<tr>
<th>Establishment</th>
<th>Number of Different Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warehouse club</td>
<td>1</td>
</tr>
<tr>
<td>Public market</td>
<td>180</td>
</tr>
<tr>
<td>Supermarket</td>
<td>24</td>
</tr>
<tr>
<td>Street market</td>
<td>26</td>
</tr>
<tr>
<td>Convenience store</td>
<td>8</td>
</tr>
<tr>
<td>Specialized store</td>
<td>195</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>434</strong></td>
</tr>
</tbody>
</table>

Source: Banco de México.
Table 3
Transition Matrices: Foods, Beverages and Tobacco Prices
Weekly averages, 1st week of March 2009 to 4th week of June 2010

<table>
<thead>
<tr>
<th>Week h</th>
<th>M</th>
<th>T</th>
<th>W</th>
<th>T</th>
<th>F</th>
<th>S</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>1.08</td>
<td>0.94</td>
<td>0.98</td>
<td>1.30</td>
<td>NA</td>
<td>1.15</td>
<td>1.03</td>
</tr>
<tr>
<td>T</td>
<td>1.52</td>
<td>1.03</td>
<td>0.82</td>
<td>1.16</td>
<td>0.87</td>
<td>1.10</td>
<td>1.05</td>
</tr>
<tr>
<td>W</td>
<td>1.39</td>
<td>1.50</td>
<td>0.98</td>
<td>1.37</td>
<td>1.55</td>
<td>NA</td>
<td>1.19</td>
</tr>
<tr>
<td>T</td>
<td>1.43</td>
<td>NA</td>
<td>1.23</td>
<td>0.93</td>
<td>1.09</td>
<td>1.52</td>
<td>1.06</td>
</tr>
<tr>
<td>F</td>
<td>0.98</td>
<td>0.88</td>
<td>NA</td>
<td>1.14</td>
<td>1.10</td>
<td>1.14</td>
<td>1.05</td>
</tr>
<tr>
<td>S</td>
<td>1.10</td>
<td>1.06</td>
<td>NA</td>
<td>NA</td>
<td>1.07</td>
<td>NA</td>
<td>1.08</td>
</tr>
<tr>
<td>Total</td>
<td>1.14</td>
<td>1.05</td>
<td>0.96</td>
<td>1.08</td>
<td>1.13</td>
<td>1.24</td>
<td>1.08</td>
</tr>
</tbody>
</table>

Source: Authors’ calculation with data from Banco de México.
NA: No transitions available.

Table 4
“Day of the Week” Effect on Fruit and Vegetable Prices in Supermarkets (Wednesdays)
Average price reduction and contribution to the volatility of weekly price changes
In percent
1st week of March 2009 to 4th week of June 2010

<table>
<thead>
<tr>
<th>Item</th>
<th>Price reduction</th>
<th>Contribution to volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avocado</td>
<td>4.3 **</td>
<td>3.6</td>
</tr>
<tr>
<td>Zucchini</td>
<td>4.4 *</td>
<td>1.5</td>
</tr>
<tr>
<td>Tomato</td>
<td>6.3 ***</td>
<td>2.5</td>
</tr>
<tr>
<td>Apple</td>
<td>2.7 *</td>
<td>1.5</td>
</tr>
<tr>
<td>Melon</td>
<td>4.4 **</td>
<td>2.2</td>
</tr>
<tr>
<td>Orange</td>
<td>5.3 **</td>
<td>3.5</td>
</tr>
<tr>
<td>Nopal</td>
<td>4.7 ***</td>
<td>4.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Price reduction</th>
<th>Contribution to volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potato</td>
<td>4.1 ***</td>
<td>5.2</td>
</tr>
<tr>
<td>Papaya</td>
<td>7.2 ***</td>
<td>8.6</td>
</tr>
<tr>
<td>Pineapple</td>
<td>4.2 **</td>
<td>2.1</td>
</tr>
<tr>
<td>Banana</td>
<td>5.3 **</td>
<td>6.2</td>
</tr>
<tr>
<td>Watermelon</td>
<td>2.7 *</td>
<td>1.5</td>
</tr>
<tr>
<td>Green tomatoe</td>
<td>2.4 *</td>
<td>0.7</td>
</tr>
<tr>
<td>Carrot</td>
<td>3.3 *</td>
<td>1.7</td>
</tr>
</tbody>
</table>

1/ Statistical significance at the 10 % (*), 5 % (**) and 1 % (***) level.
Source: Authors’ calculation with data from Banco de México.
Graph 1

Price Changes by Type of Good

Average in percent
1st week of March 2009 to 4th week of June 2010

1/ The graph shows the average percentage of goods in the sample that exhibit a price change each week.

Source: Authors’ calculation with data from Banco de México.

Graph 2

“Day of the Week” Effect on the Number and Magnitude of Price Changes

1st week of March 2009 to 4th week of June 2010

a) Price Increase to Price Reduction Ratio

b) Weekly Price Change

In percent

Source: Authors’ calculation with data from Banco de México.
Graph 3
“Day of the Week” Effect on the Number and Magnitude of Price Changes
1st week of March 2009 to 4th week of June 2010

a) Price Increase to Price Reduction Ratio

b) Weekly Price Change
In percent

Source: Authors’ calculation with data from Banco de México.

Graph 4
Weekly Price Change by Product Group and Type of Establishment
In percent, 1st week of March 2009 to 4th week of June 2010

a) Foods, Beverages and Tobacco

b) Fruits and Vegetables

Source: Authors’ calculation with data from Banco de México.
Graph 5
Weekly Price Change by Product Group and Type of Establishment
In percent, 1st week of March 2009 to 4th week of June 2010

(a) Livestock Products

(b) Processed Foods

Source: Authors’ calculation with data from Banco de México.

Graph 6
“Day of the Week” Effect on the Number and Magnitude of Fruit and Vegetable Price Changes, by Supermarket Chain
1st week of March 2009 to 4th week of June 2010

(a) Price Increase to Price Reduction Ratio

(b) Weekly Price Change
In percent

Source: Authors’ calculation with data from Banco de México.
Graph 7
“Day of the Week” Effect on the Number and Magnitude of Fruit and Vegetable Price Changes, by Supermarket Chain
1st week of March 2009 to 4th week of June 2010

a) Price Increase to Price Reduction Ratio

b) Weekly Price Change
In percent

Source: Authors’ calculation with data from Banco de México.

Graph 8
“Day of the Week” Effect on the Number and Magnitude of Fruit and Vegetable Price Changes, by Supermarket Chain
1st week of March 2009 to 4th week of June 2010

a) Price Increase to Price Reduction Ratio

b) Weekly Price Change
In percent

Source: Authors’ calculation with data from Banco de México.