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Universidad Autónoma del Estado de México
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Price-Level-Convergence of Food Baskets in Mexican Cities: Inflation-Targeting and PPP

ALFONSO MENDOZA-VELÁZQUEZ* Y ALEJANDRO RONDERO-GARCIA**

ABSTRACT

We investigate relative price convergence under Inflation Targeting in Mexico from January 2010 to March 2018. A panel of 46 rural and urban cities shows half-lives ranging from 0.70 to 3.10 months. We find an increase in the speed of convergence during the period of U.S. monetary normalization. We also find a positive response of price variation to measures of distance and a slower speed of adjustment between cities of greater distance, suggesting that transportation costs are not necessarily a barrier to arbitrage opportunities. While univariate tests suggest that not all cities converge to the same long-run trend, panel unit root tests accounting for cross-sectional dependence favor the relative convergence of food prices. Beta convergence estimates suggest disparities in the cost of food baskets.

Keywords: PPP, baskets of food, monetary policy, inflation targeting.

JEL Classification: E31, E52, E58, F31.

RESUMEN

Convergencia de precios y niveles de las canastas de alimentos en las ciudades mexicanas: fijación de metas de inflación y PPP

Se investigó la convergencia de precios relativos bajo metas inflacionarias en México desde enero de 2010 hasta marzo de 2018. Un panel de 46 ciudades rurales y urbanas muestra vidas medias que van de 0.70 a

* Center for Research and Economic Intelligence (CIE)-UPAEP, Mexico. Email: alfonso.mendoza@upaep.mx.

** Center for Research and Economic Intelligence (CIE)-UPAEP, México. Email: alejandro.rondero1995@gmail.com.

3.10 meses. Se encontró un aumento en la velocidad de convergencia durante el periodo de normalización monetaria de EE. UU. También se encontró una respuesta positiva de la variación de precios a las medidas de distancia y una menor velocidad de ajuste entre las ciudades con mayor distancia, lo que sugiere que los costos de transporte no son necesariamente una barrera para las oportunidades de arbitraje. Si bien las pruebas univariadas sugieren que no todas las ciudades convergen en la misma tendencia a largo plazo, las pruebas panel de raíz unitaria que tienen en cuenta la dependencia transversal favorecen la convergencia relativa de los precios de los alimentos. Las estimaciones de convergencia beta sugieren disparidades en el costo de las canastas de alimentos

Palabras claves: paridad poder de compra, canastas de alimentos, política monetaria, metas inflacionarias.

Clasificación JEL: E31, E52, E58, F31.

INTRODUCTION

While there is ample evidence of long-run Purchasing Power Parity (PPP) in countries that follow an Inflation Targeting (IT) monetary regime (Ding and Kim, 2012; Lothian, 1998; Papell, 2002; Taylor, 2003; Taylor and Taylor, 2004), few studies in emerging countries examine the relationship between the monetary regime and convergence of prices. Several authors argue that IT regimes provide higher levels of accountability and transparency of monetary policy that limits the variability of inflation and real exchange rates in the long run (Ding and Kim, 2012; Svensson, 2000; Mishkin and Schmidt-Hebbel, 2007).

There is also scarce evidence of long-run PPP in middle-income countries under Inflation Targeting framework. Some recent exceptions are Yazgan and Yilmazkuday (2016), who investigated the monetary regime and price level convergence across regions in Turkey finding slower price convergence during the low-inflation-IT-period. García-Cintado *et al.* (2016) identify a sound IT monetary policy and the process of globalization as the main factors explaining inflation convergence in Spain. Alin *et al.*, (2017) studied Romania and reported a positive long-term relationship between interest and exchange rates under inflation targeting. These authors argue that raises in the price levels

due to greater interest rates and reduced money demand can affect real exchange rates in the long term when prices are fully flexible, which is consistent with the PPP theory.

Fullerton and Varella Mullick (2013) noted that transitory disturbances could explain deviations from PPP, such as financial and monetary shocks (see also Rogoff, 1996). Taylor (2000) also noted that the effect of exchange rates to price movements under a given monetary regime depends on the persistence of inflation rates: the more persistent inflation is, the less exchange rate movements are perceived as transitory by agents and the more firms might respond adjusting prices (Ca'Zorzi, Hahn and Sánchez, 2007). Some authors have suggested that incomplete exchange rate pass-through to prices may prevent PPP from holding (Ca'Zorzi, Hahn and Sánchez, 2007). In turn, Dornbusch (1987) argued that incomplete pass-through could be the result of firms operating in non-competitive markets and their lack of price adjustment.

While PPP is compatible with pronounced short-term volatility in real exchange rates, it also implies that deviations should be transitory during periods when wages and prices are sticky (Fullerton and Varella Mullick, 2013). Monetary shocks put pressure on nominal exchange rates and may induce real exchange rate variability under nominal price stickiness.

Despite the relevance of the monetary policy regime on price convergence, the possible association between the monetary regime, interest rates and price formation at the regional level has not attracted sufficient attention in the literature. This paper investigates the relationship between monetary policy regime and interest rate targets with regional price-level convergence in Mexico from 2010 to 2018. Our sample begins in 2010, in the aftermath of the financial crisis, when the U.S. monetary stance affected the policy reactions of central banks towards monetary easing. This is a period in Mexico when the IT regime is already fully operational under floating exchange rates and with credible central bank autonomy. Interest rate targets not only signal monetary policy stances to the market but also shift the whole interest rate term structure (Aportela, Ardavín, and Cruz, 2001), affecting aggregate demand and hence prices (Taylor, 1995).

We examine two sub-periods of monetary stances adopted by the Banco de México reacting to U.S. monetary policy and exchange rate changes: decreasing interest rate targets, from the beginning of the sample to

the end of 2014 and, increasing interest rate targets, adopted in anticipation of the monetary policy normalization in the U.S to the end of 2018. Decreasing (increasing) interest rate targets during the first period depreciated (appreciated) the local currency (Mexican Peso), lowering-down (pushing-up) aggregate supply and finally affecting local prices (Copelman and Werner, 1995; Baqueiro, Díaz de León and Torres, 2003; Calvo and Reinhart, 2002). Hence, while interest rates changes have surely affected prices effectively, it is worthwhile asking whether such interest rate decreases and increases, as well as the actual monetary stances by Banxico, could have affected inflation rates and also price convergence, and persistence at the city level.

In addition to providing evidence on whether the monetary stance can affect the convergence of prices and persistence at the regional level in middle-income economies, this paper contributes to the literature by investigating convergence in a panel data framework allowing for the possibility of cross-sectional dependence. As a by product to analysts of food poverty, we provide the costs of basic baskets of food by cities in Mexico. The costs of basic baskets of food in this study are fully consistent with the method employed by the CONEVAL (National Council for the Evaluation of Social Development Policy). We calculate the price of rural and urban baskets of foods for a sample of the 46 cities in Mexico with information on prices as collected by the National Institute of Geography (INEGI). Using food basket prices, instead of the Consumer Price Index (CPI) to investigate price convergence, as other studies propose, can be useful to inform on whether cities in Mexico really share a common poverty line and whether they do converge (see Fullerton and Varella-Mollick, 2013; Vargas-Tellez, 2008; Robertson *et al.*, 2009). Deviations from price convergence may indicate that poverty thresholds wander off, and the fight on poverty should take into account specific regional and location features. Food is a good with a high level of homogeneity and tradability. Therefore we should also expect a relatively fast rate of convergence.

We divide the rest of the article into four sections. Section 2 presents the literature review on the convergence of prices at the city level under inflation targeting. Section 3 describes the prices employed at the city level for the construction of baskets of food following the methodology by CONEVAL, as well as presenting the results on convergence and the speed of convergence, distinguishing the two periods of mone-

tary stance in the aftermath of the financial crisis of 2008. The results include univariate tests, panel data techniques and the speed of convergence. The last section presents a discussion and a conclusion.

1. BRIEF LITERATURE REVIEW

There is some evidence favoring long-run Purchasing Power Parity (PPP) in countries that follow an Inflation Targeting (IT) monetary regime (Ding and Kim, 2012; Lothian, 1998; Papell, 2002; Taylor, 2003; Taylor and Taylor, 2004). IT regimes provide high levels of accountability and transparency of monetary policy that limit the variability of inflation and real exchange rates in the long run and could affect the finding of convergence (Ding and Kim, 2012; Svensson, 2000; Mishkin and Schmidt-Hebbel, 2007).

However, the literature barely explores the relationship between the convergence of prices and monetary policy regimes in emerging markets. Some recent exceptions are the works by Yazgan and Yilmazkuday (2016), who investigated the monetary regime and price level convergence across regions in Turkey and find slower price convergence during the low-inflation-IT-period, combined with faster convergence in inflation rates. Alin *et al.* (2017) also reported a positive long-term relationship between interest and exchange rates under Inflation Targeting in Romania. These authors argue that raises in the price levels due to greater interest rates and reduced money demand can affect real exchange rates in the long term, when prices are fully flexible, which is consistent with the PPP theory. Winkelried and Gutierrez (2015) investigate the dynamic relation among regional inflations in Peru and test the relative version of PPP convergence.

In Latin America Arruda *et al.* (2018) have recently studied price convergence in the cities of Brazil, and find slow speed of convergence due to trade and bureaucratic barriers, market failures, and changes in the composition of price indexes. These authors also report differences of speed between tradable and non-tradable goods. González (2020) studies regional price dynamics in Argentina and reports evidence in favor of price convergence employing a basket of food and price indexes. The use of a total basket of food is an attempt to approximate the cost of living that reflects disparities in regional poverty. Iregui and Otero (2011) test the Law of One Price in Colombia, a country

with high regional heterogeneity often associated with the geographic characteristics of the country. These authors find that food markets are integrated in the main cities, while a weaker is found analyzing smaller and less populated cities.

Recent research has questioned the feasibility of adopting inflation targets to curbing inflation in developing countries, where the contribution of food prices to headline inflation is generally higher than in advanced economies (Surya, 2017). Coleman (2010) noted that different rates of food price convergence (persistence) could imply sub-optimality of certain monetary policies, including inflation targeting; not all regions can experience the same policy effect. For instance, García-Hiernaux and Guerrero (2015) find that European monetary policy does not affect price level trends of tradable and non-tradable goods equally for all EMU members. Nagayasu (2011) found that in a monetary union not only the average inflation differs significantly across regions, but regional inflation also responds differently to common economic and monetary factors; these authors report some evidence of convergence by subgroups of regions. In contrast, Seongman (2017) suggests that monetary policy shocks should be common to all regions within a country, irrespective of the base region.

Convergence and greater market integration stated by PPP should enhance the ability of locations to cope with monetary shocks in nominal prices and the price levels (García and Guerrero, 2015). However, the response of price levels to economic shocks is usually far from homogeneous, weakening the effectiveness of monetary policy to affect regional price levels. The multiplicity of prices within a country could prevent PPP from holding and from reaching the targets of inflation. Regional inflation persistence gaps could cause long-run real interest rate differentials, leading to losses of relative competitiveness under targeting framework. Taylor (2000) finds that the effect of floating exchange rates under IT to price movements depends on the persistence of inflation rates: the more persistent inflation is, the less exchange rate movements are perceived as transitory by agents and the more firms might respond adjusting prices (Ca'Zorzi, Hahn and Sánchez, 2007).

The prediction of PPP that price levels of an identical basket of goods measured in a common currency should be equal among regions or economic areas depends on the type of monetary regime. Economic policy actions condition the evidence in favor of PPP, which is proof

of high trade and integration of markets (Tasic, 2007; Cecchetti, Mark and Sonora, 2002; Gómez, and Rodríguez, 2011, 2012 and Nenna, 2001). For instance, Gómez and Rodríguez (2011; 2012; 2013) argue that monetary policy can create an inefficient distribution of productive resources when deviations of PPP are present (Hernández, López and Rodríguez, 2015). Deviations from PPP and slow price convergence could come from trade inefficiencies, artificial and non-artificial barriers and also form economic policy (Monge and Winkleried, 2008; González and Rivadeneyra, 2004; Tasic, 2007). Monge and Winkleried (2008) identify monetary, fiscal and exchange rate policy stances as significant factors for price adjustment that can also affect PPP from holding in the long run, affecting the degrees of market integration. García-Cintado *et al.* (2016) study the process of inflation convergence in Spain under Inflation Targeting. These authors suggest that the success of this regime also relies on a strong fiscal policy that is able to provide support to IT under cyclical fluctuations. Overall, these authors identify the globalization and a sound monetary policy as the main causes of convergence in Spain.

Several studies that have focused on exploring price convergence at the city level have reported a high degree of price convergence mainly due to greater homogeneity (among them Cecchetti, Mark, and Sonora, 2002; Gómez and Rodríguez, 2011, 2013; Hernández, López and Rodríguez, 2015). While the effects of the nominal exchange rate, trade, and non-trade barriers are attenuated completely at the regional level, transportation costs, non-tradable goods, and differences in productivities could cause of PPP deviations (Cecchetti, Mark, and Sonora, 2002). Winkelried and Gutierrez (2015) argue that the notion of price level differentials is more consistent with the weak version of PPP, that states that once the effects of transitory regional shocks fade away, the inflation in two cities should converge to an equilibrium rate, regardless of whether the shocks exert permanent discrepancies on the price levels.

Using panel unit-root tests on Mexican cities over the period 1982-2000 Sonora (2005) found evidence in favor of regional prices stationarity and price convergence. Gómez and Rodríguez (2013) examined 35 cities in Mexico for the period 1982-2012 and found evidence of convergence with a half-life of 5 to 6 years (depending on the type of good). These authors report a half-life of 5.6 years for the group of food, drinks, and tobacco. An earlier study by Gómez and Rodríguez (2011) for the cities in Mexico

found that cities converge within their own regions (Northern border, Northeast and Northwest), except for the cities in the south region of the country. They suggest that cities in Mexico share common regional features and price convergence in the long run.

The latest study by Gómez and Rodríguez (2013) considers other forms of stationarity accounting for structural breaks, time trends and random walks. The authors conclude that cities converge to a common price with a half-life of 6 years, a much lower process of adjustment that they found before accounting for breaks, trends and unit roots. Hernández, López and Rodríguez (2015) examine price converge of 15 cities relative to Mexico City from 1979 to 2011 and find evidence in favor of the PPP. Such finding however does not hold when the structural breaks are accounted for.

There are several studies on price convergence of food, among them González and Rivadeneyra (2004) and Monge and Winkleried (2008). For some, food is a highly tradable and homogenous good that shows a faster rate of price convergence than any other good (Haidar, 2011; Monge and Winkleried, 2008; De Masi and Koen, 1996), while for others, such as Tasic (2007), who explores convergence of food in Balkan countries, food price convergence is slow. But despite the various studies on price convergence of food at the city or regional level, in our view there is no sufficient research investigating the price convergence of baskets of foods. A couple of contributions are Gluschenko (2011), who estimates very high speed of convergence with an average half-life of 2 months for the cost of a basket of food in Russia, and Massi and Koen (1996), who employed a basket of 19 Russian staples, considered a minimum food consumption standard in and compare it with a similar basket in the U.S. and France.

At the same time, very few studies have considered the role of the monetary policy framework, such as Inflation Targeting, particularly in studies of food regional price convergence (Winkelried and Gutierrez, 2015 analyzed IT and the impact of monetary shock in Peru). At the regional level there are few studies investigating the relation between the monetary regime and convergence in middle income economies. We aim to fill this gap in the literature of price convergence of food at the city level and investigate the role of monetary stances for a middle income country under Inflation Targeting monetary framework. This assessment becomes highly relevant for policy analysis due to the crucial

role these baskets of food play in Mexico as a threshold in the definition and measurement of poverty. Assessing city price convergence for baskets of food might help distinguish whether regions in Mexico really share a common poverty line. Deviations from price convergence may not only indicate that markets are not fully integrated, but also that poverty thresholds wander off and hence the fight to end poverty should instead be designed to take into account specific regional and location features.

2. ESTIMATION MODELS

In order to investigate long run price convergence among Mexican cities, we now test whether real exchange rates are stationary, first, following a standard Dickey-Fuller framework (Cecchetti *et al.*, 2002; González and Rivadeneyra, 2004), and then, using standard panel data approaches to increase the power of the stationarity tests (Gómez and Rodríguez, 2011). Demeaning the relative price series might not be enough to ensure cross-sectional independence, hence we implement also the unit root test by Pesaran (2007) to test for cross sectional dependence, which augments Dickey-Fuller regressions with cross section averages of lagged levels and first-differences of the individual relative price series.

2.1. Univariate approach to unit-root testing

We test for unit roots in the baskets of foods for each of the 45 cities in Mexico, setting the Metropolitan Area of Mexico City (MAMC) as the numeraire city. The log real exchange rate between city i and MAMC in time t is defined as $q_{it} = \ln(P_{it}/P_{0t})$, where P_{it} is the price of the basket of foods. The Augmented Dickey-Fuller (ADF) underlying model is

$$\Delta q_{it} = \alpha_i + \beta_i q_{it-1} + \theta t + \sum_{j=1}^{k_1-1} \delta_{ij} \Delta q_{it-j} + u_{it} \quad (1)$$

Under the null of unit-root ($H_0: \beta_i = 0$) the prices of basic baskets of foods between city i and the numeraire city are divergent. Nenna (2001) argues that these tests depend to a large extent on the specification of the model, the selection of lags and the inclusion of a deterministic trend. However, Cecchetti, Mark, and Sonora (2002) argue that PPP

theory does not include a deterministic trend, while Monge and Winkelried (2008) consider a linear trend would incorporate the differences in the quality of products between cities and differences in the levels of productivity between tradable and non-tradable sectors.

2.2. Unit roots with Panel data

Some authors have found a high sensitivity of results to the choice of the numeraire city, *e.g.*, Chmelarova and Nath (2010) in her study of price convergence U.S. cities. Choosing a numeraire city becomes irrelevant in a panel data set. Using panel data eliminates the disadvantages associated with choosing a numeraire city in univariate analysis.

To overcome the lack of power shown by univariate unit-root tests, we first employ the panel procedure of Levin, Lin, and Chun (2002) regarded in the literature as a natural extension of the Dickey-Fuller (1981) test (Bornhorst, 2003). The LLC test considers pooling cross-section time-series data for testing the unit root hypothesis. A second approach to test unit roots in panel data is proposed by Pesaran (2007), who augments the basic ADF framework with cross-section averages of lagged levels and first differences of time series. This test acknowledges that cross-sectional independence is not warranted by merely demeaning the series before application of the unit root tests. Pesaran (2007) also argues that panel unit root tests can spuriously favor the PPP hypothesis when there is significant cross-section dependence.

The underlying model by Pesaran is:

$$y_{it} = (1 - \varphi_i)\mu_i + \varphi_i y_{i,t-1} + u_{it}, \quad i = 1, \dots, N; t = 1, \dots, T \quad (2)$$

where $y_{i,0}$ has a given density function with a finite mean and variance. The error term is

$$u_{i,t} = \gamma_i f_t + \varepsilon_{i,t} \quad (3)$$

in which f_t is an unobserved common effect and i, t is an individual-specific (idiosyncratic) error. Pesaran (2007) proxies the common factor f_t by the cross-section mean of $y_{i,t}$, *i.e.*, $\bar{y}_t$, and its lagged values $\bar{y}_{t-1}, \bar{y}_{t-2}, \dots$ for N sufficiently large, in which case $u_{i,t}$ is serially uncorrelated and sufficient to filter out the effects of the unobserved common

factor f_i . The Cross-sectionally augmented DF regression proposed by Pesaran is the following:

$$\Delta y_{i,t} = a_i + b_i y_{i,t-1} + c_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + e_{i,t} \quad (4)$$

Pesaran provides asymptotic cross-sectional ADF and Im, Pesaran and Shin (2003), (IPS) test statistics and critical values for specifications including intercepts, trends, individual-specific intercepts and models with incidental linear trends.

2.3. Modeling convergence

We complement the analysis with a Barro type model to investigate Price relative convergence further employing the following specification:

$$\ln\left(\frac{P_{it}}{P_{i,t-1}}\right) = \alpha + \beta \ln(P_{i,t-1}) + \rho_i + \sigma_t + \varepsilon_{it} \quad (5)$$

Where $\ln(P_{it})$ is the natural logarithm of the cost of the rural or urban basket, in the city i in the period t , α is the intercept, ρ_i are the city fixed effects, σ_t are the time fixed effects and ε_{it} is the error term. Ultimately, if the price convergence exists, it is expected to get a negative β . This type of convergence informs whether Mexican cities with lower prices present greater price increments. Fixed effects (ρ_i and σ_t) control for unobserved heterogeneity and point to a relative rather than absolute convergence of basic food baskets prices.

3. DATA AND ESTIMATION RESULTS

We calculate the cost of the basket of food of a representative consumer for each city in Mexico following the methodology employed for the national basket of food by the National Council for the Evaluation of Public Policy (CONEVAL). We employ the same food components and consumption quantities as the national basket but attaching the specific food prices adjusted monthly for each City using specific Consumer Price Indexes published by the National Institute for Geography and Statistics (INEGI) in Mexico. The dynamics of individual prices in each city drive the differences in the cost of the basic basket of food for each city and not the differences in consumption (for which there is no publicly available information for the period under analysis). As

in CONEVAL, we also make a distinction between rural and urban areas to acknowledge the differences in population size, lifestyle, and income between both areas. We calculate the cost of rural and urban food baskets for each city.

INEGI publishes monthly price indexes for specific foods for each of the main 46 Cities in Mexico. CONEVAL provides the initial consumption weights obtained from the National Income and Expenditure Survey (ENIGH). CONEVAL is an independent institution in charge of measuring poverty in Mexico and employs the cost of a national average basket of food, together with other social constraints, as a threshold to distinguish people living in poverty condition. People whose wages are below this threshold (known as poverty line) live in food poverty, and those who also face two or more social constraints (education, health, etc.), are identified as living in extreme poverty. CONEVAL calculates the average price of food baskets in Mexico, only at the national level. There is no calculation of the costs for baskets of food at the city or state levels, nor at the urban or rural levels. In this study, we fill this gap by providing calculations of baskets of food at the city level following the methodology by CONEVAL very closely.

The calculation of rural and urban baskets of food at the City level has many advantages: 1) food baskets are composed of highly homogeneous and tradable goods; 2) the analysis at the city level eliminates the barriers present in international comparisons; 3) the distinction between rural and urban baskets allows us to investigate whether price convergence in both areas also have common economic, social and political factors (Tasic, 2007).

Table 1 presents the maximum and minimum annualized growth rates of prices for baskets of food at the city level per year. The first panel (rural cities) shows that during 2010 Tlaxcala's price growth rate was the highest reaching 6.83%, while Huatabampo's growth rate was the lowest, experiencing a deflation of -0.49%, a range of 7.32%. The second panel of the table (urban cities) also shows that, again, Tlaxcala's growth rate was the highest in 2010 with an annualized rate of 12.54%, compared with the lowest rate in Iguala (-0.58%), a difference of 13.12% in that year. The costs of food baskets are highly volatile as shown by the last column in the table with ranges going from 5.39% in León Guanajuato to 23.95% in San Andrés Tuxtla, Veracruz.

The behavior of relative prices by the city reveals different patterns of convergence. While some cities show negative or positive trends, as well as different degrees of non-stationarity (Cuernavaca, Cd. Jiménez and Mexicali, among others); the majority of cities show patterns consistent with stationarity and possibly structural breaks (graphs available from authors, not included to save space). The convergence properties of the series will be studied further in the following sections.

TABLE 1
RURAL AND URBAN BASKETS OF FOOD, ANNUAL INFLATION RATES

Period	Maximum	City	Minimum	City	Range
Rural					
Jan-Dec, 2010	6.83%	Tlaxcala	-0.49%	Huatabampo	7.32%
Jan-Dec, 2011	15.09%	Iguala	-0.64%	San Andrés Tuxtla	15.73%
Jan-Dec, 2012	11.19%	Tehuantepec	0.84%	Tijuana	10.35%
Jan-Dec, 2013	9.26%	Matamoros	-0.70%	Tijuana	9.96%
Jan-Dec, 2014	8.65%	Tijuana	2.22%	Ciudad Jiménez	6.43%
Jan-Dec, 2015	8.75%	Tepatitlán	0.38%	Ciudad Juárez	8.37%
Jan-Dec, 2016	9.77%	Tepatitlán	-1.29%	Villahermosa	11.06%
Jan-Dec, 2017	12.78%	Matamoros	5.33%	Ciudad Jiménez	7.46%
Jan-Mar, 2018	1.92%	Campeche	-4.61%	León	6.53%
Urban					
Jan-Dec, 2010	12.54%	Tlaxcala	-0.58%	Iguala	13.12%
Jan-Dec, 2011	21.86%	Iguala	-2.09%	San Andrés Tuxtla	23.95%
Jan-Dec, 2012	13.04%	Tehuantepec	0.33%	Tijuana	12.71%
Jan-Dec, 2013	8.42%	Matamoros	0.97%	Tijuana	7.44%
Jan-Dec, 2014	10.82%	Tehuantepec	1.08%	Tulancingo	9.75%
Jan-Dec, 2015	7.33%	Iguala	-2.48%	La Paz	9.80%
Jan-Dec, 2016	7.99%	Tepatitlán	-0.89%	Iguala	8.89%
Jan-Dec, 2017	14.50%	Matamoros	2.05%	Ciudad Jiménez	12.45%
Jan-Mar, 2018	1.69%	Campeche	-3.70%	León	5.39%

Source: own elaboration.

3.2 SOURCE ESTIMATION RESULTS

3.2.1. Convergence and persistence: Univariate Unit Root Tests

Table A.1 shows the estimations statistics for studentized coefficients from univariate ADF tests for both rural and urban baskets of food,

respectively. The test statistics reject the null hypothesis of unit roots in 25 of the 45 rural cities considered at 90% level (from Ciudad Jimenez to Chihuahua); in 21 cities at the 95% level (from Ciudad Jimenez to Villa Hermosa) and in 13 cities at the 99% level (from Ciudad Jimenez to Monclova). In contrast, the unit root hypothesis is rejected in 18 urban cities at the 90% (second plot from Ciudad Jimenez to Durango), 12 cities at 95% (from Ciudad Jimenez to Querétaro) and six cities at the 99% level (from Ciudad Jimenez to Acapulco). These results reveal evidence of stationarity in the cost of basic baskets of food in both rural and urban for some cities at high levels of confidence.

These unit-root tests yield approximate measures of persistence in relative price movements which are computable from the quantity $\rho_i = \beta_i + 1$ (Cecchetti, Mark, and Sonora, 1998). We use Kendall's formula (1954) to adjust these unit root values for rural and urban food baskets, respectively. The majority of the point estimates in both rural and urban cases are $\rho_i > 0.60$. The average $\bar{\rho}$ of the rural food basket is $\bar{\rho} = 0.769$ and for the urban food $\bar{\rho} = 0.816$. Hence, while deviations from PPP across cities for the rural basket of food are relatively less persistent than the urban basket of food, deviations from PPP across cities in Mexico are not too large implying low persistence: the half-live of a disturbance for the rural food basket is $h = 2.639$ months, while the half-live of urban food baskets is $h = 3.409$ months, respectively. We investigate next whether changes in the monetary policy stance in Mexico affect the rates of convergence.

The monetary stance of Banco de México and price convergence

The U.S. output contraction in 2008 and the financial crisis spread to Mexico in 2009. This has been the biggest fall of U.S. GDP in more than six decades (2.6%) and the contagion to the Mexican economy had a negative impact, similar to the one experienced during the Tequila crisis in 1995 (8.9% in annual terms), although this time the crisis to Mexico was driven by the contraction of Mexican exports. The MXN Peso/USD exchange rate devalued from MXN 10.00/USD to more than MXN 15.00/USD at the beginning of August 2008.

During the first semester of 2009, Banco de México faced the prospects of contraction adopting a rather steep reduction of interest rates, from 8.25% in January to 4.5% in July. The new rate remained in that level until March 2013, when Banxico cut interest rates even more,

first in March by 50 basis points (from 4.50% to 4.00%) and then in September by 25 basis points more. Another 25 basis points were cut in October, reducing interest rates at 3.5% in 2013 (Carstens, 2015; Rojas and Rodriguez, 2017). It was until June 2014 that Banco de México cut interest rates from 3.50% to 3.00%, despite the increased public investments and the clear signs that the Fed was preparing to normalize its monetary policy (Rojas, 2015). The Mexican economy remained weak after the crisis, but interest rates remained low until the end of 2015, after when they started to rise once more following the normalization of the U.S. monetary policy.

The ease of monetary policy in Mexico during the first part of the sample (2009-2015) was also encouraged by the steep Quantitative Easing in the U.S. To cope with the crisis; the Fed kept interest rates at 0.00% between 2009 and 2015, the lowest funds rate possible. The Fed increased the fund rate 50 basis points on December 17, 2015, and 15 basis points more a year after, on December 15, 2016. The Fed rate increased three times during 2017, and four times during 2018, up until the fund rate reached 2.50%, coinciding with a steady U.S. growth expectation. The prospect of higher Fed fund rates was in part the reason for the reversal of monetary policy stance by Banco de Mexico from the beginning of 2016. The continuous interest rate increases announcements and actual raises by the Federal Reserve System anticipated the steep increases in the funding rate in Mexico.

Monetary policy stance changes and unit roots

In this work, we investigate whether changes in the monetary stance by the Banco de México, *i.e.*, monetary easing vs. tightening, have affected the convergence of prices and the speed of convergence. Formal structural break tests indicate a significant breakpoint in December 2014 in both the funding rate by Banco de México and the MXN/USD exchange rate. This coincidence of structural break dates between the exchange rate and the funding rate is not surprising. Target interest rates respond to fed moves and capital outflows, not only to contain potential inflationary pressures but also to revert Peso depreciation (Banco de México, 2014). Hence, to investigate the behavior of convergence before and after the structural break, we decided to divide the study into two sub-periods: from January 2010 to November 2014 (Period 1) and from December 2014 to March 2018 (Period 2). With this approach, we aim

to examine the effect of the change in monetary policy stance, before and after the break date, on the price convergence of baskets of food among Mexican cities.

Figure 1 shows studentized coefficients for (A) rural and (B) urban baskets of food for the full sample (continuous line) and the two sub-periods: monetary easing (squares) and monetary tightening (triangle). In the case of the rural (urban) basket of foods, during the monetary easing period (see squares), 19 (15) out of 45 cities reject the unit-root hypothesis at a confidence level of 90%; 14 (8) out of 45 cities reject the null at a 95% confidence level, and only 5 (3) of the 45 cities can reject the unit root with a 99% confidence level. On the other hand, during the monetary tightening period (see triangles), 21 rural (13 urban) of 45 cities reject the null hypothesis of unit root at a confidence level of 90%, 13 (8) of 45 cities reject unit root at 95% and 5 (2) of the 45 at 99% of confidence. The analysis by sub-periods for rural (urban) cities presents slightly more cases of cities with unit roots, *i.e.*, divergence, than when we consider the whole sample. It is also interesting to observe more cities with divergent behavior in the monetary tightening period, *i.e.*, a lower number of cities showing a rejection of the unit root, suggesting that the new monetary tightening environment of rising interest rates is associated with greater price divergence.

Our estimations (Table A.2 in the appendix) show that the average rho during the monetary easing period was $\bar{\rho}=0.711$ (urban $\bar{\rho}=0.763$), with a half-life of $h=2.965$ ($h=4.268$) months. The average persistence is lower in the monetary tightening period $\bar{\rho}=0.616$ ($\bar{\rho}=0.671$) with a half-life of $h=2.335$ (2.634) months. We observe a faster rate of convergence of shocks in the second period, when funding rates started to increase, compared to the monetary easing period. Tests for the difference of γ 's between period 1 and 2 show a significant reduction of persistence (faster rate of convergence) in 9 out of 45 rural cities, while one city (Villahermosa), shows a significant increase of persistence. In other words, the change of monetary policy stance by Banco de México seems positively associated with a greater speed of convergence.

All in all, as indicated by univariate Augmented Dickey-Fuller tests, the monetary policy change (tightened stance from December 2014) affected convergence in two ways: first, the number of divergent cases increased and, second, the speed of convergence increased compared

to the monetary easing period. Divergent cases would play in favor of adopting baskets of foods that are specific to every city, as their costs would tend to differ from the average cost of a common basket in the long term. In turn, the fast mean rate of convergence could imply that prices are somewhat flexible and sensitive to monetary policy shocks in the short run.

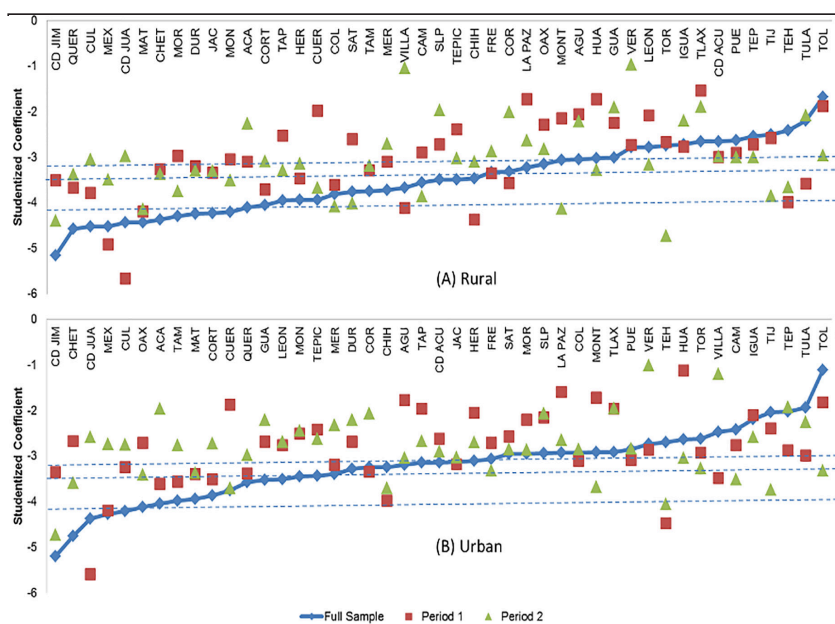
3.2.2. Relative Price Convergence: Unit Roots Tests with Panel data

Table 2 below shows panel unit root estimations employing the test by Levin, Lin and Chun (2002) (LLC) described in equation (4) for both urban and rural baskets of food for the whole sample period, as well as for the periods before and after the change in the monetary stance of December 2014. While univariate tests provide some evidence in favor of stationarity, using panel data tests, we can reject the hypothesis of divergence for the whole period and also for both sub-periods of monetary stance. The high speed of convergence measured by ρ is confirmed; the half-life in all scenarios is between 2 and five months approximately. The monetary tightening stance period presents a higher speed of convergence than the monetary easing period, particularly for the rural basket.

Our panel results reject the hypothesis of unit root for all real exchange rates among Mexican cities overall and by sub-periods. Relative prices in the whole sample are not persistent showing half-lives of less than 3.65 months; the costs of baskets of food in individual cities converge back to the national average cost of food baskets at a fast rate.

The fast rates of convergence in the food reported our study is not rare. Blanco, González, and Fullerton (2006) find, for instance, quick adjustments for relative prices for eight separate menu items with half-lives varying between 0.7 and 3.1 months. A more extensive sample in Fullerton *et al.* (2009) with 32 goods confirms these findings. During the Mexican Peso crisis, Robertson *et al.* (2009) estimated lower half-lives under flexible than under fixed exchange rates and found a rapid convergence. Some cities that are closer together such as Chihuahua and Ciudad Juárez present some of the fastest rates of convergence,

FIGURE 1
STUDENTIZED COEFFICIENTS (T-RATIOS) FOR RURAL FOOD BASKET



Source: own elaboration.

but it doesn't seem to be a pattern related to closeness as described by Cecchetti *et al.* (2002).

Now, to account for the possibility of cross-sectional dependence and to avoid spuriously favoring the PPP, we employ the test for cross-sectional dependence by Pesaran (2004) to find whether cross-sectional units are independent. Results in table 3 indicate rejection of the null of independence in both rural and urban prices whole samples with average absolute values of correlations $\hat{\rho}=0.643$ and $\hat{\rho}=0.501$, very high values, also found on the subsamples. After confirming the high level of cross-section dependence, we test for unit roots following the approach by Pesaran (2007) described in section 2.2 above. Table 4 below shows that when accounting for cross-sectional dependence in all samples and subsamples, with and without trends, the tests reject the hypothesis of unit roots in favor of relative price convergence. While most of the tests did not reject the null of unit roots without deterministic trends (see left panel of the table), Pesaran (2007) test did reject divergence in favor of

relative price convergence. Several authors have noted that a deterministic trend is inconsistent with PPP; a significant deterministic trend would negate the theory. Excluding a linear deterministic trend is also consistent with unit root testing (Amara and Papell, 2006; and Canarella *et al.*, 2014). Nonetheless, we also run panel unit root tests with a deterministic trend with a battery of tools and found a clear rejection of divergence in favor of relative PPP. Hence, overall, we find a clear

TABLE 2
LLC TEST*, RURAL AND URBAN BASKETS

	τ	p-value	$\rho=\beta+1$	Adjusted ρ	Adjusted Half-life
Rural Basket					
Full^a	-10.957	0.000	0.775	0.809	3.262
Period 1^b	-8.159	0.000	0.734	0.788	2.913
Period 2^c	-5.223	0.000	0.668	0.743	2.329
Urban Basket					
Full^a	-8.709	0.000	0.827	0.827	3.654
Period 1^b	-10.036	0.000	0.724	0.724	2.143
Period 2^c	-4.368	0.000	0.719	0.720	2.106

Notes: * Levin, Lin, and Chun (2002) test. a. Full period: 2010:01-2018:03. b. Period 1: 2010:01-2014:11; c. Period 2: 2014:12-2018:03

TABLE 3
PESARAN TEST OF CROSS-SECTION DEPENDENCE

	Rural Food Basket				Urban Food Basket			
	With trend and autoregressive terms		Without trend and no autoregressive terms		With trend and autoregressive terms		Without trend and no autoregressive terms	
	Pesaran	Average	Pesaran	Average	Pesaran	Average	Pesaran	Average
Full ^a	162.93***	0.543	301.83***	0.942	128.10***	0.427	297.34***	0.929
Period 1 ^b	121.66***	0.552	237.62***	0.952	95.79***	0.435	236.21***	0.956
Period 2 ^c	106.54***	0.524	126.68***	0.623	82.191***	0.405	94.34***	0.464

*, *** denote rejection at the 0.01 and 0.10 significance levels respectively. a. Full period: 2010:01-2018:03. b. Period 1: 2010:01-2014:11; c. Period 2: 2014:12-2018:03. d. Pesaran (2004) test. e. Average rho.

TABLE 4
PANEL UNIT ROOT TESTS

Sample	Without trend					With trend				
	LLC ^d	IPS ^e	ADF Fisher ^f	PP Fisher ^f	Pesaran ^g	LLC ^d	IPS ^e	ADF Fisher ^f	PP Fisher ^f	Pesaran ^g
<i>Rural Basket Food</i>										
Full ^a	2.26	9.68	12.16	6.84	-3.67*	-10.96*	-13.25*	74.61	231.78*	-3.75*
Period 1 ^b	-0.49	8.10	41.09	7.22	-3.18*	-8.16*	-8.87*	40.52	111.24***	-3.26*
Period 2 ^c	3.45	8.95	1.96	5.10	-3.03*	-5.22*	-6.54*	30.31	174.35*	-3.32*
<i>Urban Basket Food</i>										
Full ^a	2.47	10.61	14.90	9.57	-3.33*	-8.71*	-9.26*	65.04	170.21*	-3.39*
Period 1 ^b	0.72	9.31	27.55	9.55	-3.93*	-10.04*	-8.85*	75.32	104.37	-3.11*
Period 2 ^c	5.70	10.61	6.40	5.22	-2.76*	-4.37*	-0.05*	32.14	193.23*	-3.09*

*, *** denote rejection at the 0.01 and 0.10 significance levels respectively. a. Full period: 2010:01-2018:03. b. Period 1: 2010:01-2014:11; c. Period 2: 2014:12-2018:03. d. Levin, Lin, and Chun (2002) test. LM, Pesaran, and Chin (2003) test. f. Choi (2007) Fisher tests. g. Pesaran (2007) test.

rejection of divergence in favor of relative PPP when accounting for cross-sectional dependence.

As an additional test to rule out the possibility of our convergence conclusions be due to structural changes, we include in this study Bai and Carrion-i-Silvestre (2009) tests. Such test employs an iterative procedure that allows to test mean shifts, trend shifts and also constant and trend. Such shifts can occur in different dates and cities for different magnitudes. The factor approach employed by this method permits a differential impact in each city. Table 5 below presents the results on the three versions of this test: constant and trend; mean shifts and

trend shifts. We confirm the rejection of unit roots in favor of H1: $|\rho| < 0$ which adds to the evidence of convergence found so far. The estimation algorithm did not detect any structural change. The next section explores whether distance can explain the rates of convergence.

TABLE 5
PANEL UNIT ROOT TEST STATISTICS WITH STRUCTURAL BREAKS AND CROSS-SECTION
DEPENDENCE

Model	Basket	Test	Value
Mean shift	Rural	Z	-1.532
		P_m	5.596
		P	170.731
	Urban	Z	-1.733
		P_m	3.497
		P	141.947
Trend shift	Rural	Z	-5.667
		P_m	17.215
		P	330.037
	Urban	Z	-4.414
		P_m	9.957
		P	230.523

Notes: The 1%, 5% and 10% critical values for the standard normal distributed Z and P_m statistics are 2.326, 1.645 and 1.282, while the critical values for the chi-squared distributed P statistic are 71.201, 62.830 and 58.641, respectively.

3.2.3. The determinants of cost convergence

One goal of this study is to explain the relatively fast rates of convergence reported in the previous section. We follow the standard approach of investigating whether transportation costs, usually approximated by distance, are determinants of exchange rate convergence between cities (Engle, 1993; Engel and Rogers, 1997; Parsely and Wei, 1996). Table 6 presents the estimations of the average impact to convergence measures from changes in the $\ln$ and double $\ln$ of distance (second panel), between a given city ' i ' and the Metropolitan Area of Mexico City (numeraire) for rural cities. The volatility of log exchange rate is measured by the standard deviation of $SD(q_{it})$ in the first row of each panel and by the variance of $V(q_{it})$ in the second row of each panel in the table. We also employ the range $R(q_{it})$ and the variation coefficient $VC(q_{it})$ as measures of volatility. All these cases confirm that, albeit the weak response, rural cities farther apart show higher volatility of rela-

tive prices: a percentage increase of real distance is weakly associated with greater relative price variation —see $SD(\Delta q_{it})$ and $V(\Delta q_{it})$. Urban cities show some evidence that distance is related to the lower volatility of relative prices, as indicated by $V(qit)$ in ln and double ln.

Table 6 also shows estimates of the association between ρ , τ ratios and *half-lives* with relative distances. All these measures suggest that the speed of adjustment in both rural and urban cities is slower among cities of greater distance. The responses in the two exercises and the fast rate of adjustment may suggest that transportation costs in rural cities are not necessarily a barrier to arbitrage opportunities across cities in Mexico.

By sub-periods of monetary policy stance we confirm significant and positive effects of real distance with the measures of price variation in rural cities, but only during the first period of monetary easing (not shown to save space): rural cities farther apart show a higher volatility of relative prices. We also find that the speed of adjustment of the prices of baskets of food in rural cities was slower between cities of greater distance.

3.2.4. Relative Beta Price Convergence

The estimation results from equation (6) are presented in table 7 below. All the estimated β 's are negative and significant indicating that price convergence is present in all cases, *i.e.*, cities with low costs show greater price increments. Rural baskets present relatively higher speed of convergence than urban baskets. Urban baskets in the sub-period of December 2014-March 2018 show positive but non-significant estimates. Rural and urban baskets show that fixed effects are important features in the process of convergence. The highest rates of convergence are shown during the period January 2010-November 2014, while time fixed effects are less relevant during January 2010-November 2014 and more relevant during the second part of the sample, December 2014 - March 2018.

TABLE 6
DISTANCE AS A REGRESSOR OF CONVERGENCE VOLATILITY, 2010-2018

Dependent variables	Independent variable			
	ln(real distance)	Adjusted R ²	ln(road distance)	Adjusted R ²
$SD(q)$	6.94×10^{-4}	-0.012	7.95×10^{-4}	-0.009
$V(q)$	2.43×10^{-5}	-0.016	2.91×10^{-5}	-0.012
$R(q)$	0.007	0.03	0.008	0.036
$CV(q)$	-88.014	-0.001	-91.469	-0.007
$\hat{\rho}$	-0.029*	0.058	-0.031**	0.066
τ	-0.289**	0.100	-0.311**	0.113
h	-0.730**	0.098	-0.792**	0.113
$SD(\Delta q)$	0.001**	0.087	0.001**	0.093
$V(\Delta q)$	$2.11 \times 10^{-5**}$	0.069	$2.25 \times 10^{-5**}$	0.077
$R(\Delta q)$	0.007	0.026	0.007	0.034
$CV(\Delta q)$	199.645	-0.023	411.704	-0.022
Double ln's				
$SD(q)$	0.002	-0.020	0.003	-0.017
$V(q)$	7.05×10^{-5}	-0.021	1.10×10^{-4}	-0.019
$R(q)$	0.039	0.018	0.044	0.024
$CV(q)$	-468.049	-0.005	-497.261	-0.005
$\hat{\rho}$	-0.175*	0.063	-0.199**	0.075
τ	-1.719**	0.107	-1.948***	0.125
h	-4.517**	0.116	-5.149***	0.136
$SD(\Delta q)$	0.005**	0.074	0.006**	0.080
$V(\Delta q)$	$1.14 \times 10^{-4*}$	0.058	$1.27 \times 10^{-4**}$	0.065
$R(\Delta q)$	0.037	0.018	0.044	0.026
$CV(\Delta q)$	1080.977	-0.023	2471.4	-0.023

Notes: *, ** and *** denote significance at the 1, 5, and 10% levels respectively. $SD(q)$ and $V(q)$ are standard deviation and variance of monthly percent changes in log real exchange rates (q). $R(q)$ is the range and $CV(q)$ the coefficient of variation. Univariate ADF regressions provide the estimates of ρ , τ , and half-life.

Overall, the result of regional conditional convergence in Mexico is consistent with the findings of González (2020) who studied price convergence of total basic baskets in the provinces of Argentina and also found evidence of disparities at the regional level. As with their results, we also find that not including fixed time effects the rate of convergence slows down significantly. The impact revealed by half-lives is evident.

TABLE 7
RELATIVE BETA PRICE CONVERGENCE

Rural Basket			Urban Basket		
January 2010 March 2018					
β^a	-0.061***	-0.225***	β	-0.064***	-0.200***
City fe ^b	Yes	Yes	City fe	Yes	Yes
Time fe ^b	No	Yes	Time fe	No	Yes
Half-life ^c	11.013	2.719	Half-life	10.480	3.106
January 2010 - November 2014					
β^a	-0.265***	-0.272***	β	-0.259***	-0.264***
City fe ^b	Yes	Yes	City fe	Yes	Yes
Time fe ^b	No	Yes	Time fe	No	Yes
Half-life ^c	2.251	2.183	Half-life	2.312	2.261
December 2014 March 2018					
β^a	-0.020***	-0.275***	β	-0.009	-0.213***
City fe ^b	Yes	Yes	City fe	Yes	Yes
Time fe ^b	No	Yes	Time fe	No	Yes
Half-life ^c	34.310	2.155	Half-life	76.669	2.894

*** Significant at the 99% level. a. Estimate from equation (6). b. fe=fixed effects. c. Half-Life= $-\ln(0.5)/\ln(1+\beta)$.

Vaschuck (2013) argue that the lack of evidence in favor of the Law of One Price implies the presence of regional imbalances, a bad resources allocation and differences in the cost of living, which should be accounted for in the assignment of federal transfers aiming to compensate for the levels of poverty. As with the case of Argentina we also believe that regional disparities reflect themselves on price differences and the cost of living in the cities of Mexico.

4. DISCUSSION

This paper investigates the relationship between monetary policy stance changes and regional price-level convergence of baskets of food at the city level in Mexico from 2010 to 2018. The sample covers a phase of consolidation of Inflation Targeting that is further divided into two sub-periods: declines of interest rates targets from January 2010 to December 2014 and increases of interest rates targets from January 2015 to March 2018, respectively. We investigate whether deviations from PPP and changes in persistence can be attributed to monetary

policy shocks (Rogoff, 1996; Taylor, 2000). Dornbusch (1976) assumes price stickiness of goods in the short-run, but the flexibility of prices in the long-term, allowing prices to adjust towards a new equilibrium. Mishkin (2007) also foresees that greater interest rates would devalue investment portfolios for households, which in turn can constrain wealth, consumption, aggregate demand, and price formation. We have searched for evidence on the effect of monetary policy on price convergence and the rate of convergence.

This study contribution to the literature on convergence is twofold: first, we investigate the costs of food in middle-income countries under IT framework to examine the sensitivity of food prices to monetary policy and, second, the ample testing of convergence takes into account the possibility of cross-sectional dependence allowing for unknown mean and trend shifts. With respect to the first the IT framework, the results are clearly showing that interest rates have effective control of inflation and this is reflected in the time evolution of food costs both rural and urban.

Our work investigates the case of a middle-income economy in the wake of the financial crisis of 2008. We focus on a particular basket of food widely employed as a benchmark to measure poverty in Mexico. The study employs data on the cost of baskets of food as nationally provided by the National Council for the Evaluation of Social Development Policy (CONEVAL). In our study, the cost is calculated at the city level which makes it more relevant to monetary policymakers that monitor the behavior of aggregate inflation, but also to other branches of government aiming to fight poverty (Ceccetti, Mark and Sonora, 2002).

The univariate tests provide mixed results. Several prices of baskets of food do not reject the unit root hypothesis, while some others converge at relatively fast rates. From the estimations, we obtain a fast rate of convergence of baskets of food between 3 to 5 months for both rural and urban cities in Mexico. The change of monetary stance from reducing target rates to increasing target rates raised the number of divergent cases and also increased the rate of convergence. We believe that more divergent cases would indicate that the adoption of individual baskets of food by the city would be more realistic to measure poverty than following the average national basket of food. However, panel unit root tests accounting for the strong cross-section dependence can

reject unit roots in favor of price convergence. The fast rate or reversion (between 0.7 and 3.1 months) suggests that food prices, and baskets of food, in particular, are not sticky but somewhat more flexible and sensitive to monetary policy shocks in the short run. This result supports the idea that food is good with a high level of homogeneity and tradability, hence the relatively fast rate of converge while Obstfeld and Roggoff (2000) find that PPP half-life deviations in industrial economies last longer (three to five years), Cheung and Lai (2000) report half-lives less than three years in developing countries.

Some authors find stronger support for long-run PPP in data samples dominated by monetary shocks than in samples dominated by real shocks such as discoveries of natural resources (Cheun and Lai, 2000). Other studies also find high rates of convergence, very similar to our estimates. González and Rivadeneyra (2004) have shown that agriculture prices and food present stronger rates of price convergence (of about 3.3 months or less); Fullerton et al. (2009) reports deviations from the law of one price for low and high volatility panels of cities between 3 and 4 months, while Robertson *et al.* (2009) reported 6 to 7 months for general US-Mexico goods. Gluschenko (2006) estimates an average half-life of 2 months for the cost of a basket of food in Russia; Monge and Winkered (2008) tested the PPP in baskets where food is an important factor in a sample of 25 Peruvian cities and found relatively high price convergence, with a convergence speed of less than a year in a period from 1996 to 2003. Using index prices, Gómez and Rodríguez (2012) report that 23 cities do not converge to the numeraire cities in Mexico for a sample period before Inflation Targeting was fully-fledged.

We find that the speed of adjustment of the prices of baskets of food in rural cities was slower between cities of greater distance, particularly during the first period of monetary easing stance in rural cities. An additional analysis of conditional beta convergence shows price convergence is present in all cases, *i.e.*, cities with low costs show greater costs increments. Rural baskets present relatively higher speed of convergence than urban baskets. These results reveal evidence of disparities at the regional level, which policy makers should take care to avoid adverse effects on food security and local levels of poverty. This type of convergence suggests that food costs may increase faster than the implementation of policies to fight food poverty.

Contrary to González (2020) and Vaschuck (2013) who find lack of evidence in favor of the Law of One Price, convergence in this study implies a degree of balance in the costs of food across cities, similar costs of living overall and certain degree of resource allocation. Differences in the cost of living tend to close and the assignment of federal transfers, aiming to compensate for the levels of poverty, can help to speed up such process. As with the case of Argentina (González, 2020) we also believe that regional disparities reflect themselves on price differences and the cost of living in the cities of Mexico. However, there may be other factors such as food systems and macroeconomic variables explaining the convergence of costs in addition to social inequalities. This study suggest that monetary policy stances have promoted the convergence of costs.

Our work has some limitations. As it happens with other studies, *i.e.*, Ceccetti et al. (2002), we did not examine the effect of real wage productivity differentials due to lack of data available at the city level. There can also be other factors that explain the convergence and the speed of convergence in Mexico that is related to the monetary policy stance, such exchange rates. Fullerton and Varella Mollick (2013) consider that the principal source of price divergence is likely to come from the monetary policy framework and in particular from currency fluctuations.

Future work could emphasize the impact of social and cultural factors that affect the price convergence directly (Monge and Winkeried, 2008; Tasic, 2007). For instance, criminal activity, robbery and insecurity might delay the process of adjustment of real exchange rates because delinquency creates income differences and hence, differences of inflations (Monge and Winkeried, 2008). Some other cultural determinants that could be explored are bureaucratic difficulties and corruption (Tasic, 2007), that might discourage international trade and negatively impact the reversion of prices. Finally, we have tested the possibility of structural breaks in the level and trend of relative prices and the results confirm convergence. This last result can motivate the study of particular forms of non-stationarity, including catching-up or lagging behind processes, as proposed by Gómez-Saldivar and Ventosa-Santaulària (2012).

CONCLUSION

The study of convergence in food baskets at the regional level for middle-income countries has relevant policy implications that range from the conduct of monetary policy to the fight against extreme poverty. Food costs in Mexico converge rapidly and are sensitive to monetary policy shocks in the short run. Food costs show a high level of homogeneity and tradability, yet the convergence in rural areas is slower. Accounting for cross sectional dependence, regional income disparities may underlie this finding. The fight against food poverty should take into account these salient features in the design of federal transfers, implementation of social programs and to plan the food system.

REFERENCES

- Alin, Andrieş & Căpraru, Bogdan & Ihnatov, Iulian & Tiwari, Aviral Kumar (2017), "The relationship between exchange rates and interest rates in a small open emerging economy: The case of Romania", *Economic Modelling*, Elsevier, vol. 67(C), p.p. 261-274.
- Amara J, Papell DH (2006). "Testing for purchasing power parity using stationary covariates", *Appl Financ Econ* 16:29-39.
- Aportela, Ardaín and Cruz (2001), "Comportamiento histórico de las tasas de interés reales en México, 1995-2001". *Documento de investigación*, 2001-05, Dirección General de Investigación Económica, Banco de México.
- Arruda, EF., Castelar, I., Barboza, D., Barbosa, R. (2018), "Price convergence, reversal speed and purchasing power parity: Stylized facts for Brazilian cities", *Economía*, 19(2), 219-235.
- Bai, J., & Carrion-I-Silvestre, J. L. (2009), "Structural Changes, Common Stochastic Trends, and Unit Roots in Panel Data", *Review of Economic Studies* 76, 471-501.
- Baqueiro, A., Díaz de León, A. & Torres, G. (2003), "Temor a la flotación o a la inflación. La importancia del «traspaso» del tipo de cambio a los precios". *Documento de Investigación*, No. 2003-02, Dirección General de Investigación Económica, Banco de Mexico.
- Bernard, A.B. & S. N. Durlauf (1995). "Convergence in international output", *J Appl Econom*, 10 (2): 97-108. 10.1002/jae.3950100202.
- Bernard, A.B. & S. N. Durlauf (1996), "Interpreting tests of the convergence hypothesis", *J Econom*. 71 (1): 161-173. 10.1016/0304-4076(94)01699-2.
- Bornhorst, F. (2003), "On the Use of Panel Unit Root Tests on Cross-Sectionally Dependent Data: an Application to PPP", *EUI Working Paper*, ECO/2003/24.
- Blanco-González, L., and Fullerton Jr, T. M. (2006). "Borderplex menu eviden-

- ce for the law of one price”, *Economics Letters*, 90, 28–33.
- Ca' Zorzi, Michele, and Hahn, Elke, and Sanchez, Marcelo (2007), “Exchange Rate Pass-Through in Emerging Markets”, *ECB Working Paper*, No. 739.
- Calvo, G. & Reinhart, C. (2002), “Fear of Floating”, *Quarterly Journal of Economics*, 117(2), pp. 379-408.
- Canarella, Giorgio & Stephen Miller & Stephen Pollard (2014), "Purchasing Power Parity Between the UK and Germany: The Euro Era", *Open Economies Review*, Springer, vol. 25(4), pages 677-699, September.
- Carstens, A. (March, 2015). La banca preparada ante una gran oportunidad de desarrollo. En S. R. Ortega (Chairman), 78 *Convención Bancaria*. Conference held in the Asociación de Bancos en México, Acapulco, México.
- Cecchetti, S., Mark, N., & Sonora, R. (2002), “Price Index Convergence Among United State Cities”, *International Economic Review* Vol.43, 1081-1099.
- Cheung Y-W, Lai KS (2000), “On cross-country differences in the persistence of real exchange rates”, *Journal of International Economics*, 50(2):375–397.
- Chmelarova, V., & Nath, H. (2010), “Relative price convergence among US cities: Does the choice of numeraire city matter?”, *Journal of Macroeconomics*, Vol. 32, 405–414.
- Choi, I. (2001), “Unit root tests for panel data”, *Journal of International Money and Finance* 20: 249-272.
- CONEVAL (2012). Construcción de la Líneas de Bienestar Consejo Nacional de Evaluación de la Política de Desarrollo Social. *Documento metodológico*, México, D.F. CONEVAL, 2012.
- Copelman, M. & Werner, A. M. (1995), The monetary transmission mechanism in Mexico. International Finance. *Discussion Papers*, No. 521. Board of Governors of the Federal Reserve System.
- De Masi, P., & Koen, V. (1996), “Relative Price Convergence in Russia”, *Staff Papers - International Monetary Fund*, Vol. 43, No. 1, 97-122.
- Ding, Hui & Kim, Jaebeom (2012). "Does inflation targeting matter for PPP? An empirical investigation", *Applied Economics Letters*, vol. 19(18), pages 1777-1780.
- Dornbusch, R. (1976), “Expectations and exchange rate dynamics”, *Journal of Political Economy*. 84(6), pp. 1161-1176.
- Dornbusch, Rüdiger, (1987), “Exchange Rates and Prices”, *American Economic Review*, 77, issue 1, p. 93-106
- Engel, C. (1993), “Real Exchange Rates and Relative Prices? An Empirical Investigation”, *Journal of Monetary Economy*, vol. 32, num. 1, pp. 35-50.
- Engel, C.; Hendrickson, M.; Rogers, J. (1997), “Intranational, Intracontinental, and Interplanetary PPP”, *Journal of the Japanese and International Economies*, 11, pp. 480-501.
- Evans P, Karras G. (1996). “Convergence revisited”, *J Monet Econ.*; 37: 249-265.10.1016/S0304-3932(96)90036-7.
- Fullerton Jr, T. M., Fierro, K. P. and Villalobos, E. (2009). “Cross-border restaurant price and exchange rate interactions”, *North American Journal of*

- Economics and Finance*, 20, 281–8.
- Fullerton, T.M., Varella-Mollick (2013), “Border region panel evidence on PPP deviations”, *Applied Economics* 45, 2175–2182.
- García-Hiernaux, Alfredo y Guerrero, David E. (2015), “Price-Level Convergence in the Eurozone”, *Working Paper* 1505, Instituto Complutense de Análisis Económico, Universidad Complutense de Madrid
- García-Cintado, A.C., Romero-Ávila, D. & Usabiaga, C. (2016), “The economic integration of Spain: a change in the inflation pattern”, *Lat Am Econ Rev* 25, 1.
- Gluschenko, C. (2011), “Price convergence and market integration in Russia”, *Regional Science and Urban Economics*, 21, pp. 160–172.
- Gómez, M. (2009), “La Paridad del Poder de Compra: Una Revisión Crítica”, *Revista Nicolaita de Estudios Económicos*, Vol. IV, 89–112.
- Gómez, M., & Rodríguez, J. (2011), “Convergencia de Precios al Interior de las Regiones de México”, *INCEPTUM*, Vol. VI, No. 11, 413 - 423.
- Gómez, M., & Rodríguez, J. (2012), “Convergencia de Precios en las Ciudades de México: Una aplicación con pruebas de raíz unitaria que toman en cuenta cambios estructurales”, *INCEPTUM*, Vol. VII, No. 13, 127–154.
- Gómez Aguirre, M., & Rodríguez Chávez, J. C. (2013). “Cambio estructural y convergencia de precios entre las principales ciudades de México”, *Econo-Quantum*, 10(1), 59–75. <https://doi.org/10.18381/eq.v10i1.157>.
- Gómez-Zaldívar, M. and Ventosa-Santaulària, D. (2012), “Regional output convergence in México”, *Latin american journal of economics*, 49(2), pp. 217–236.
- González, M., & Rivadeneyra, F. (2004), “La ley de un solo precio en México: un análisis empírico”, *Gaceta de Economía*, Vol. 10, Núm. 19, 91–115.
- González, FA. (2020), “Regional price dynamics in Argentina (2016–2019)”, *Regional Statistics*, 10(2), 83–94.
- Haidar, J. (2011). “Currency Valuation and Purchasing Power Parity”, *World Economics*, Vol. 12, No. 3, 1–12.
- Harrod, R. (1933). *International Economics*, Londres: Nisbet y Cambridge University Press.
- Hernández, I., López, F., & Rodríguez, D. (2015), “El Principio de Paridad del Poder de Compra en el nivel de ciudades en México”, *Análisis Económico*, Vol. XXX, 75, 8–28.
- Im K, Pesaran H, Shin Y. (2003), “Testing for unit roots in heterogeneous panels”, *Journal of Econometrics* 115: 53–74.
- Iregui, A., Otero, J. (2011), “Testing the law of one price in food markets: evidence for Colombia using disaggregated data”, *Empirical Economics*, 40, 269–284.
- Kendall M. G. (1954), “Note on the Bias in the Estimation of Autocorrelation”, *Biometrika*, 41, 403–404.
- Levin, A., C.-F. Lin y C.-S. J. Chu (2002), “Unit Root Test in Panel Data: Asymptotic and Finite-Sample Properties”, *Journal of Econometrics*, 108 (1), 1–24.

- Lothian, J. R., and Taylor, M. P. (1997), "Real exchange rate behavior", *Journal of International Money and Finance*, 16, 945–54.
- Masi, Paula and Koen, Vincent (1996), "Relative price convergence in Russia", *IMF Staff papers*, 43(1), pp. 97-122.
- Medina, L., & Noriega, A. (2001), "Evidencia Empírica sobre la Paridad del Poder Adquisitivo en México", *Acta Universitaria*, Vol. 11, No. 3, 33-38.
- Mishkin, F. S., and Schmidt-Hebbel, K. (2007), "Does inflation targeting make a difference?", *NBER Working Paper*, No. 12876, NBER, Cambridge, MA.
- Monge, Á., & Winkelried, D. (2008). PPC y Convergencia de Precios: Un Análisis para las ciudades de Perú. *Ensayos sobre Política Económica*, Vol. 27, No. 58, 56-104.
- Nagayasu, Jun (2011). "Heterogeneity and convergence of regional inflation (prices)", *Journal of Macroeconomics*, 33(4), pp.711-723
- Nenna, M. (2001), "Price Level Convergence among Italian Cities: Any Role for the Harrod-Balassa-Samuelson Hypothesis?", *Working Paper*, No. 64, 1-24.
- Obstfeld, Maurice, and Kenneth Rogoff (2000). The Six Major Puzzles in International Macroeconomics: Is There a Common Cause? *NBER Working Papers*, 7777, National Bureau of Economic Research.
- Papell, D. (2006), "The panel purchasing power parity puzzle", *Journal of Money, Credit, and Banking*, 38, 447–67.
- Parsley, D.; Wei, S. (1996), "Convergence to the Law of One Price without Trade Barriers or Currency Fluctuations", *Quarterly Journal of Economics*, vol. 111, num. 4, pp. 1211-1236, 1996.
- Pesaran, M. H. (2004), "General diagnostic tests for cross-section dependence in panels. The University of Cambridge, Faculty of Economics", *Cambridge Working Papers in Economics* No. 0435.
- Pesaran, M. H. (2007), "A simple panel unit root test in the presence of cross-section dependence", *Journal of Applied Econometrics*, 22: 265-312.
- Quah D. (1993), "Galton's fallacy and tests of the convergence hypothesis", *Scand J Econ.*; 95:427-443.10.2307/3440905
- Robertson, R., Kumar, A. and Dutkowsky, D. (2009), "Purchasing power parity and aggregation bias for a developing country: the case of Mexico", *Journal of Development Economics*, 90, 237–43.
- Rogoff, K. (1996), "The purchasing-power-parity puzzle", *Journal of Economic Literature*, 34, 647–68.
- Rojas, M. (2015b), "El debate de las causas de la crisis financiera de Estados Unidos del 2008 ¿Fue adecuada la respuesta del FED?", *Perspectivas*, 9(1), pp. 29-53.
- Rojas-Miranda, M. and Rodríguez-Medina, O. (2017), "Two cycles of monetary easing in Mexico: 2009 and 2013-2014", *Clío América*, 11(22), pp. 205-218
- Roos, M. (2003), "Regional price levels in Germany", *European Regional Science Association*, 1-27.
- Samuelson, P. (1964), "Theoretical Notes on Trade Problems", *Review of Economics and Statistics*, 46, 145-154.

- Seongman, Mon (2017), "Inter region Relative Price Convergence in Korea", *East Asian Economic Review*, 21(2), pp.123-46
- Sonora, Robert J. (2005), "City CPI Convergence in Mexico", *Review of Development Economics*, 9(3), pp. 359-367.
- Surya, A. M. (2017). "The impact of inflation targeting framework on food price inflation: evidence from developing economies", *Journal of Governance & Regulation*, 6(4), 53-60
- Svensson, L. E. O. (2000), "Open economy inflation targeting," *Journal of International Economics*, 50, 155-83.
- Tasic, N. (2007), "Food Price Convergence and Trade in the Balkans", *Eastern European Economics*, Vol. 45, No. 2, 6-22.
- Taylor, J. (1995), "The monetary transmission mechanism: an empirical framework", *Journal of Economic Perspectives*, 9(4), pp. 11-26.
- Taylor, J. (2000), "Using monetary policy rules in emerging market economies", in G. Ortiz (Governador), *Stabilization and Monetary Policy: The International Experience*. Conference held in Banco de Mexico, Mexico City.
- Taylor, Mark Peter (2003), "Purchasing Power Parity", *Review of International Economics*, Vol. 11, pp. 436-452.
- Taylor, A. M. and Taylor, M. P. (2004), "The purchasing power parity debate", *Journal of Economic Perspectives*, 18, 135-58
- Vargas-Téllez (2008), "Purchasing power parity across Mexican cities: a panel data analysis", *Applied Economics*, 40:22, 2891-2899.
- Yazgan, M.E., and Yilmazkuday, H. (2016), "High versus low inflation: implications for price-level convergence", *Empirical Economics*, 50, pp. 1526-1563.
- Yilmazkuday, Hakan (2013), "Inflation targeting, flexible exchange rates, and inflation convergence", *Applied Economic*, 45 pp. 593-603.
- Winkelried, Diego & José Enrique Gutierrez (2015), "Regional inflation dynamics and inflation targeting. The case of Peru", *Journal of Applied Economics*, *Universidad del CEMA*, vol. 18, pages 199-224.

TABLE A.1
AUGMENTED DICKEY-FULLER ESTIMATIONS: RURAL AND URBAN BASKETS.

City	Rural Food Basket					Urban Food Basket						
	β_0	t	Trend	Lag	Adjusted p^*	Half-Life ²	β_0	t	Trend	Lag	Adjusted p^*	Half-Life ²
Acapulco	0.369***	-4.10	-0.0005**	-0.157	0.660	1.670	-0.305***	-4.05	-0.0008***	-0.161	0.726	2.166
Aguascalientes	0.182***	-3.04	-0.0007**	0.047	0.853	4.356	-0.187***	-3.20	-0.0001***	-0.071	0.948	4.196
Campeche	0.354***	-3.55	-0.0001*	0.220**	0.676	1.768	0.133***	-2.42	-0.0002	0.012	0.803	6.821
Ciudad Acuña	0.169***	-2.65	-0.0001	-0.154	0.866	4.829	-0.183***	-3.14	-0.0002	0.034	0.852	4.323
Ciudad Jiménez	0.446***	-5.15	-0.0003***	0.146	0.581	1.276	-0.049***	-5.20	-0.0003***	0.084	0.578	1.264
Ciudad Juárez	0.377***	-4.43	-0.0001	0.124	0.652	1.620	-0.171***	-4.38	-0.0001***	0.120	0.658	1.657
Colima	0.278***	-3.81	-0.00001	0.105	0.754	2.455	-0.169***	-2.92	-0.0003	0.056	0.866	4.829
Córdoba	0.217***	-3.31	-0.0008**	0.038	0.817	3.426	-0.206***	-3.25	-0.0007	0.034	0.828	3.676
Cortazar	0.316***	-4.05	-0.0001**	-0.084	0.715	2.065	-0.307***	-3.87	-0.0009*	-0.064	0.724	2.147
Cuernavaca	0.369***	-3.93	-0.0003***	-0.063	0.725	2.157	-0.255***	-3.75	-0.0003***	-0.008	0.778	2.757
Culiacán	0.369***	-4.52	-0.0009**	0.135	0.660	1.670	-0.356***	-4.22	-0.0001***	0.064	0.674	1.754
Chetumal	0.379***	-4.36	-0.0008	-0.131	0.650	1.609	-0.365***	-4.75	-0.0001**	-0.250**	0.664	1.695
Chihuahua	0.236***	-3.47	-0.0001**	0.075	0.797	3.059	-0.217***	-3.25	-0.0002***	0.044	0.817	3.426
Durango	0.346***	-4.24	-0.0001***	0.105	0.684	1.824	-0.214***	-3.29	-0.0001***	0.080	0.820	3.491
Ensenada	0.267***	-3.32	-0.0005	-0.091	0.765	2.591	-0.246***	-3.07	-0.0008*	-0.151	0.787	2.893
Guadalajara	0.289***	-3.01	-0.0006**	-0.019	0.834	3.827	-0.253***	-3.53	-0.0001**	0.064	0.780	2.786
Hermosillo	0.289***	-3.94	-0.0009**	0.113	0.743	2.330	-0.207***	-3.11	-0.0007*	-0.074	0.827	3.652
Huatabampo	0.184***	-3.02	-0.0007	0.024	0.851	4.291	-0.146***	-2.64	-0.0001*	-0.010	0.890	5.947
Iguala	0.166***	-2.72	-0.0004	0.025	0.869	4.952	-0.102**	-2.19	-0.0002	0.055	0.935	10.365
Jacón	0.376***	-4.23	-0.0001**	0.068	0.653	1.626	-0.186***	-3.13	-0.0005*	0.184*	0.849	4.227
La Paz	0.192***	-3.22	-0.0009*	0.137	0.843	4.047	-0.138***	-2.93	-0.0009	0.261**	0.898	6.458
León	0.167***	-2.77	-0.0004	-0.015	0.868	4.910	-0.244***	-3.51	-0.0006	0.077	0.789	2.925
Mérida	0.358***	-4.43	-0.0001**	0.130	0.672	1.741	-0.288***	-3.95	-0.0001**	0.122	0.744	2.341
Mexicali	0.320***	-3.72	-0.0001***	-0.001	0.711	2.030	-0.354***	-3.40	-0.0001**	0.047	0.779	2.771
Mora	0.355***	-4.52	-0.0002***	0.177*	0.675	1.761	-0.343***	-4.27	-0.0002***	0.122	0.687	1.846
Monclova	0.337***	-4.20	-0.00006	0.089	0.693	1.892	-0.249***	-3.45	-0.0003	-0.018	0.784	2.846
Monterrey	0.186***	-3.05	-0.0002	0.05	0.849	4.227	-0.158***	-2.92	-0.0001	0.077	0.878	5.310
Morelia	0.394***	-4.29	-0.0001***	-0.027	0.634	1.523	-0.204***	-2.95	-0.0001**	0.074	0.830	3.725
Oaxaca	0.213***	-3.14	-0.0008**	-0.06	0.821	3.513	-0.324***	-4.12	-0.0002***	0.103	0.707	1.996
Puebla	0.164***	-2.62	-0.0007**	-0.151	0.871	5.037	-0.184***	-2.85	-0.0001***	-0.116	0.851	4.291
Querétaro	0.396***	-4.57	-0.0006*	-0.044	0.632	1.513	-0.228***	-3.57	-0.0006	0.043	0.805	3.205
San Andrés Tuxtla	0.301***	-3.75	-0.0006*	-0.023	0.730	2.205	-0.195***	-2.96	-0.0005	0.022	0.839	3.962
San Luis Potosí	0.261***	-3.49	-0.0008**	-0.022	0.771	2.672	-0.180***	-2.94	-0.0008*	-0.032	0.855	4.423
Tampico	0.269***	-3.74	-0.0001**	0.104	0.763	2.566	-0.313***	-3.99	-0.0001**	0.105	0.718	2.092
Tehuacan	0.373***	-3.94	-0.0001**	-0.083	0.656	1.645	-0.224***	-3.15	-0.0006	-0.004	0.810	3.282
Tehuantepec	0.149***	-2.41	-0.0003	-0.135	0.887	5.775	-0.181***	-2.70	-0.0004	-0.109	0.854	4.389
Tepetitlán	0.118***	-2.53	-0.0001*	0.203**	0.919	8.188	-0.084***	-2.03	-0.0009**	0.184*	0.954	14.673
Tepic	0.243***	-3.49	-0.0006	0.065	0.790	2.941	-0.225***	-3.44	-0.0006**	0.125	0.809	3.262
Tijuana	0.133***	-2.5	-0.0004	-0.004	0.903	6.821	-0.085***	-2.04	-0.0001	-0.008	0.953	14.345
Tlaxcala	0.148***	-2.65	-0.0001	-0.332***	0.888	5.831	-0.171***	-2.91	-0.0001*	-0.316***	0.864	4.750
Toluca	0.106*	-1.67	0.000001	-0.413***	0.931	9.723	-0.052	-1.11	0.0001	-0.444***	0.987	52.277
Torresón	0.174***	-2.74	-0.0009*	-0.04	0.861	4.636	-0.152***	-2.62	-0.0008	-0.053	0.884	5.611
Tulancingo	0.133***	-2.20	-0.0007	0.017	0.903	6.821	-0.111**	-1.93	-0.0001	-0.011	0.923	8.645
Veracruz	0.190***	-2.77	-0.0005	-0.144	0.845	4.105	-0.183***	-2.74	-0.0006	-0.104	0.852	4.323
Villahermosa	0.329***	-3.68	-0.0006*	0.006	0.701	1.955	-0.168***	-2.47	-0.0002	-0.09	0.867	4.869

*We reject the null hypothesis at 10%. **We reject the null hypothesis at 5%. ***We reject the null hypothesis at 1%.

1 We use Kendall's formula (1954) for adjustment:

2 The half-life is:

TABLE A.2

AUGMENTED DICKEY-FULLER ESTIMATIONS RURAL BASKETS BY SUBPERIOD.

Table A.2 Augmented Dickey-Fuller estimations rural baskets by subperiod.

City	Subperiod (Jan 2010-Nov 2014)					Subperiod (Dic 2014-Mar 2018)						
	V_i	t	Trend	Lag	Adjusted p^*	Half-Life ²	V_i	t	Trend	Lag	Adjusted p^*	Half-Life ²
Acapulco	0.378***	-3.09	-0.00005	-0.179	0.671	1.735	-0.368**	-2.26	-0.00007	-0.083	0.704	1.978
Aguascalientes	-0.174**	-2.05	-0.00007	-0.081	0.885	5.671	-0.218**	-2.20	-0.00001	0.199	0.866	4.804
Campeche	0.324***	-2.89	-0.0002**	-0.047	0.727	2.177	0.857***	-3.86	0.0005*	-0.035	0.179	4.043
Ciudad Acaña	0.342***	-3.00	-0.00006	-0.142	0.708	2.011	-0.292***	-2.98	0.0004***	-0.03	0.786	2.880
Ciudad Juárez	0.398***	-3.50	-0.0002**	0.049	0.650	1.607	0.646***	-4.39	0.00002*	0.361**	0.406	0.768
Ciudad Juárez	-0.801***	-5.66	-0.0004***	0.338**	0.226	0.466	-0.335***	-2.97	0.00002*	0.062	0.740	2.301
Colima	0.473***	-3.60	0.0001***	0.063	0.571	1.236	0.473***	-4.08	-0.000004	0.463***	0.592	1.320
Córdoba	0.447***	-3.57	0.00007	0.115	0.598	1.348	-0.224*	-2.00	-0.00005	0.14	0.859	4.568
Cortazar	-0.470***	-3.70	-0.00001	0.028	0.574	1.248	0.471***	-3.08	-0.00005	-0.023	0.594	1.329
Cuernavaca	-0.169*	-1.98	-0.0002***	-0.316**	0.890	5.960	-0.698***	-3.67	-0.0005***	0.256	0.350	0.660
Culiacán	-0.423***	-3.78	-0.00009	0.183	0.623	1.466	-0.434***	-3.04	0.00001	0.121	0.633	1.518
Chetumal	-0.386***	-3.26	-0.0002*	0.035	0.662	1.681	-0.467***	-3.36	-0.00007	0.329**	0.598	1.348
Chihuahua	0.581***	-4.36	-0.0008***	0.183	0.457	0.886	0.406***	-3.09	-0.00002	0.262	0.664	1.690
Durango	-0.318***	-3.20	-0.0002**	0.179	0.734	2.238	-0.535***	-2.89	-0.0002	0.111	0.525	1.075
Fresnillo	-0.425***	-3.35	-0.0002**	0.032	0.621	1.456	-0.419***	-3.27	0.0002**	-0.094	0.650	1.607
Guadaluajara	-0.205**	-2.24	-0.00005	0.02	0.852	4.339	-0.207*	-1.90	-0.00008	-0.012	0.877	5.303
Hermosillo	-0.424***	-3.46	-0.0002**	0.113	0.622	1.461	-0.455***	-3.13	0.0001	0.310*	0.611	1.406
Huatabampo	-0.184*	-1.72	-0.0001	-0.083	0.874	5.166	-0.397***	-3.27	-0.0001	-0.066	0.673	1.752
Iquala	-0.274***	-2.77	0.0003*	0.092	0.780	2.788	-0.222**	-2.19	-0.0003**	-0.064	0.861	4.644
Jacona	-0.443***	-3.34	-0.0002**	-0.062	0.602	1.367	-0.435***	-3.30	-0.00001	0.315*	0.632	1.513
La Paz	-0.128*	-1.72	-0.0000001	-0.003	0.933	10.040	-0.269**	-2.62	-0.0001	0.251	0.811	3.305
León	-0.166**	-2.08	-0.0001	-0.024	0.893	6.147	-0.509**	-3.16	0.0001	0.152	0.553	1.169
Mamoras	0.519***	-4.19	0.0002**	0.184	0.522	1.068	-0.527***	-4.14	0.0007***	0.267*	0.533	1.103
Mérida	-0.363***	-3.10	-0.0002**	-0.063	0.686	1.842	-0.380***	-2.70	0.00002	0.104	0.692	1.879
Mexicali	-0.644***	-4.91	-0.0008***	0.332**	0.391	0.738	-0.538***	-3.49	-0.0004	0.256	0.522	1.065
Monclova	-0.338***	-3.05	-0.00007	0.104	0.713	2.046	-0.498***	-3.50	0.0003*	0.137	0.565	1.213
Monterrey	-0.207**	-2.14	-0.0001	0.049	0.850	4.273	-0.530***	-4.13	0.0002**	0.259*	0.530	1.093
Morelia	-0.328***	-2.97	-0.00009	-0.019	0.723	2.138	-0.723***	-3.74	-0.0002**	0.066	0.323	0.613
Oaxaca	-0.215**	-2.28	-0.0001	-0.084	0.842	4.027	-0.409***	-2.82	-0.0003	0.052	0.660	1.670
Puebla	-0.264***	-2.90	-0.0002***	-0.182	0.790	2.946	-0.480***	-2.99	0.00002	-0.085	0.584	1.289
Querétaro	-0.324***	-3.67	-0.00006	0.125	0.727	2.177	-0.656***	-3.37	-0.0003	-0.010	0.395	0.746
San Andrés Tuxtla	-0.239**	-2.60	-0.00004	0.060	0.817	3.422	-0.790**	-4.01	-0.0000008	0.144	0.251	0.501
San Luis Potosí	-0.258***	-2.71	-0.00009	-0.014	0.797	3.049	-0.300*	-1.96	-0.00004	-0.042	0.778	2.754
Tampico	-0.370***	-3.28	-0.0003**	0.142	0.679	1.790	-0.491***	-3.18	0.00006	0.249	0.572	1.242
Tapachula	-0.294**	-2.52	-0.0001	-0.185	0.759	2.512	-0.574***	-3.28	-0.00007	0.090	0.483	0.952
Tehuantepec	-0.581***	-3.98	-0.0007***	0.048	0.457	0.886	-0.632***	-3.66	0.0008***	0.421	0.660	1.670
Tepatlán	-0.205***	-2.71	-0.00009	0.236*	0.852	4.339	-0.362***	-3.00	0.0008***	0.340**	0.711	2.031
Tepic	-0.194**	-2.38	-0.00006	0.128	0.864	4.739	-0.420***	-3.02	-0.0001	-0.022	0.649	1.600
Tijuana	-0.222**	-2.57	-0.0004**	0.087	0.835	3.831	-0.501***	-3.85	-0.0001	-0.070	0.561	1.201
Tlaxcala	-0.115	-1.53	-0.00005	-0.389***	0.947	12.716	-0.261*	-1.89	-0.0001	-0.257	0.819	3.480
Toluca	-0.218*	-1.87	-0.0001	-0.378***	0.839	3.941	-0.583***	-2.96	0.0002**	-0.108	0.473	0.927
Torreón	-0.268***	-2.66	-0.0003**	0.124	0.786	2.881	-0.764***	-4.72	0.0004***	0.088	0.279	0.543
Tulancingo	-0.427***	-3.58	-0.0004***	0.145	0.619	1.446	-0.239**	-2.08	0.0001	0.051	0.843	4.061
Venustiano	-0.262**	-2.73	-0.0002	-0.038	0.792	2.980	-0.151	-0.96	0.0000001	-0.368**	0.938	16.194
Villahermosa	-0.501***	-4.11	-0.0001	0.222	0.541	1.129	-0.132	-1.04	0.00007	-0.353**	0.958	16.771

*We reject the null hypothesis at 10%. **We reject the null hypothesis at 5%. ***We reject the null hypothesis at 1%.

1 We use Kendall's formula (1954) for adjustment:

2 The half-life is: