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Do Regions Matter for the Behavior of City Relative Prices in the U. S.?

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Abstract: This paper examines the importance of regions in the relative price behavior across the U.S. cities. Results indicate that average relative price variability is significantly lower if the cities belong to the same region. However, after controlling for distance, relative price variability (measured by standard deviation of relative prices) increases significantly if cities are in the West and relative price variability (measured by standard deviation of relative price changes) decreases if they are in the Northeast. Further, relative price variability increases significantly if at least one city is located either in the South or in the West. The likelihood of relative price convergence increases if cities belong to the South and it decreases if at least one city belongs to the West.

Keywords: City Relative Price, Price Variability, Convergence, Region Dummy

JEL Classification Number: E31, R19

1. Introduction

The behavior of relative prices across the U.S. cities has been the focus of a relatively recent literature. In a pioneering work, Engel and Rogers (1996) use consumer price index (CPI) data for 14 categories of consumer items in 14 U. S. cities between 1978 and 1994 to show that there is substantial variation in prices of similar goods in different cities. More recently, Cecchetti *et al.* (2002) and Chen and Devereux (2003) use aggregate price data for different cities across the U.S. over a long period of time starting in 1918 to find evidence of convergence among city relative prices.[2] This literature has been primarily motivated by the law of one price or the Purchasing Power Parity (PPP) hypothesis. In this paper, we examine the importance of regions of the United States (Northeast, Midwest, South, and West) for the behavior of city level relative prices by asking three questions.[3]

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[2] Carrion-I-Silvestre *et al*. (2004) and Sonora (2005) study relative price convergence for Spanish and Mexican cities, respectively.

[3] We follow the regional divisions defined by the U.S. Census Bureau and used by the Bureau of Labor Statistics (BLS) for their regional price indices.

First, do relative prices between two cities located in the same region behave differently than cities located in different regions? Second, does any of the four regions have any specific implications for the relative price behavior? Finally, are there any significant differences in the effect of distance on the relative price behavior by regions?

Our results indicate that average relative price variability is significantly lower if the city pairs associated with a relative price series belong to the same region. However, after controlling for the effect of distance, relative price variability – measured by standard deviation of relative prices - increases significantly if both cities are in the West and relative price variability – measured by standard deviation of relative price changes - decreases if they both are in the Northeast. Further, relative price variability increases significantly if at least one city is located either in the South or in the West. We find that the likelihood of relative price convergence increases if both cities belong to the South, and decreases if at least one city belongs to the West. Finally, distance appears to increase relative price variability and to lower the likelihood of relative price convergence if at least one city is located in the South.

The rest of the paper is organized as follows. Section 2 describes the data and the empirical methods. In Section 3, we present the empirical results. Section 4 summarizes and concludes.

2. Data and Empirical Methods

We obtain annual Consumer Price Index (CPI) data for 17 major cities in the U.S. for the period between 1918 and 2007 from the Bureau of Labor Statistics (BLS).[4] For all possible pairs of cities, we construct 136 independent relative price series. The relative price in city *i* relative to city *j* is calculated as follows:

$$r_t^{ij} = p_t^i - p_t^j \tag{1}$$

where r_t^{ij} is the logarithm of the relative price in city *i* vis-à-vis city *j*, p_t^i is the logarithm of CPI in city *i* and p_t^j is the logarithm of CPI in city *j*. *t* indexes time with $t = 1, 2, 3, \ldots, T$, and i, j index cities with $i, j = 1, 2, \ldots, N$.

We examine the time series behavior of relative prices in two ways. First, we measure year-to-year relative price variability by calculating standard deviation of r_t^{ij} and its first difference. Second, we conduct Augmented Dickey-Fuller (ADF) test on each relative price series to determine its stochastic trending properties. Note that in the PPP literature,

[4] The cities are: Atlanta, Boston, Chicago, Cincinnati, Cleveland, Detroit, Houston, Kansas City, Los Angeles, Minneapolis, New York, Philadelphia, Pittsburgh, Portland, San Francisco, Seattle, St. Louis.

rejection of the unit root null is considered evidence in support of the convergence in relative prices.

To capture the effects of regions on the behavior of relative prices we introduce several dummy variables. As mentioned earlier, we divide the U.S. into four regions: Northeast, Midwest, South, and West. According to this classification, Boston, Philadelphia, Pittsburgh, and New York belong to the Northeast; Chicago, Cincinnati, Cleveland, Detroit, Kansas City, Minneapolis, and St. Louis belong to the Midwest; Atlanta and Houston belong to the South, and Los Angeles, Portland, San Francisco, and Seattle belong to the West. The region dummies are defined as follows:

REG = 1 if both cities in a relative price pair belong to the same region; 0 otherwise
REGNE = 1 if both cities belong to the Northeast; 0 otherwise
REGMW = 1 if both cities belong to the Midwest; 0 otherwise
REGSO = 1 if both cities belong to the South; 0 otherwise
REGWE = 1 if both cities belong to the West; 0 otherwise
NE = 1 if at least one city in a relative price pair belongs to the Northeast; 0 otherwise
MW = 1 if at least one city belongs to the Midwest; 0 otherwise
SO = 1 if at least one city belongs to the South; 0 otherwise
WE = 1 if at least one city belongs to the West; 0 otherwise

To examine if there are 'region effects' in the relative price behavior, we estimate various specifications of the following cross-section regression model:

$$y_i = \beta_o + \beta_1 RD_i + \beta_2 X_i + \varepsilon_i \quad (2)$$

where y_i is the dependent variable that could be one of the following: standard deviation of relative prices, standard deviation of relative price changes, and one *minus* the *p*-value of ADF test. The first two variables reflect average year-to-year relative price variability and, therefore, may be referred to as short-run relative price behavior measures. In contrast, the third variable reflects the stochastic trending properties and may be called a long-run relative price behavior measure. RD_i is a vector (scalar) of region dummy variables that belong to the set: {*REG*, *REGNE*, *REGMW*, *REGSO*, *REGWE*, *NE*, *MW*, *SO*, *WE*} and X_i is a vector (or scalar) of other independent variables. *i* indexes relative price series and $i = 1, 2, \ldots, 136$.

3. Results

3.1. Regressions with Region Dummies Only

In Table 1, we present results from regressions of relative price behavior measures on various region dummies. The coefficients reported in columns 1 and 4 indicate that the average relative price variability is significantly smaller if the city pairs belong to the same region than if they had belonged to different regions. However, there are important differences by the regions to which they belong. For example, if both cities are in the

Northeast, the standard deviation of relative prices is lower, on an average, by 1.41. Similarly, standard deviation of relative price changes is lower by 0.33 if both cities belong to the Northeast, but only by 0.07 if they both belong to the South. Furthermore, if at least one of the cities is located in the West, standard deviation of relative prices goes up by 1.45 and that of relative price changes, by 0.26.

Table 1: Regression Results with Region Dummies

Dependent variable	**Standard deviation of relative prices**			**Standard deviation of relative price changes**			**1-*p*-value of ADF test**		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
REG	-0.70***			-0.14***			0.07		
	(0.21)			(0.03)			(0.05)		
REGNE		-1.41***			-0.33***			0.00	
		(0.32)			(0.05)			(0.12)	
REGMW		-0.76***			-0.10**			0.07	
		(0.22)			(0.04)			(0.06)	
REGSO		-0.57***			-0.07***			0.23***	
		(0.14)			(0.02)			(0.03)	
REGWE		0.21			-0.09			0.09	
		(0.51)			(0.08)			(0.08)	
NE			0.22			0.07*			-0.04
			(0.23)			(0.04)			(0.06)
MW			0.29			0.16***			-0.09
			(0.29)			(0.04)			(0.07)
SO			0.47*			0.08*			0.04
			(0.25)			(0.04)			(0.06)
WE			1.45***			0.26***			-0.18**
			(0.27)			(0.04)			(0.07)
Adjusted R-squared	0.05	0.06	0.21	0.10	0.14	0.27	0.00	-0.02	0.06

Note: White heteroskedasticity-consistent standard errors are in brackets. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10 % level. An intercept term is included in the regressions.

That 1- *p*-value of the ADF test is higher suggests that the likelihood of rejecting the null of unit root in relative price is higher. However, only if both cities belong to the South, 1- *p*-value goes up significantly (by 0.23). There is a significant decline in 1 – *p*-value if at least one city belongs to the West.

3.2. Regressions with Distance and Region Dummies

In the city relative price literature, transportation costs - which are often proxied by distance - are shown to have some significant effect on the relative price behavior across cities. For example, Engel and Rogers (1996) report that the distance between cities explains a significant amount of variation in prices of similar goods in different cities. Parsley and Wei (1996) too find that prices in cities located far apart converge slower than do prices in cities located closer. We now, therefore, include distance (in logarithm) in our regression model.[5] Note that cities belonging to the same region (for example, Los Angeles and Seattle) are not necessarily closer in distance than are cities belonging to different regions (for example, Pittsburgh and Cleveland).

The results from these specifications are reported in Table 2. First five columns of Table 2 report results from various specifications of the regression model of standard deviation of relative price on distance and region dummies. Distance has positive and mostly significant effect on the standard deviation of relative prices. A significant positive coefficient of the region dummy in column (1) indicates that for the same distance, city pairs located in the same region have higher standard deviation of relative prices, which seems counter-intuitive. However, when we introduce separate dummies for cities being in the same region for each of the four regions, the coefficient is significantly positive only for cities in the West. When we include the dummy variable for cities being in the same region along with separate dummies for at least one city being in the Northeast, Midwest, and South, we find the coefficients to be negative and statistically significant for the Northeast and Midwest. In columns (4) and (5), we introduce interaction terms between the region dummies and distance. The results reported in column (4) indicate that when the two cities are located in two different regions, as mean distance increases by 1%, mean standard deviation increases by 0.99. But if they are located in the same region, the increase in standard deviation due to distance is smaller (0.99 – 0.33 = 0.66). Furthermore, the estimated coefficients for the dummy for at least one city being in the South and its interaction with distance turn out to be statistically significant (column 5).[6]

Columns (6) - (10) report results from regressions of standard deviation of relative price changes on distance and region dummies. Distance has a positive significant effect under all specifications. If the city pairs are located in the Northeast, variability in relative price changes goes down significantly. Further, when we control for the fact that cities are in the same region relative prices involving at least one city either from the Northeast or from the South have significantly lower standard deviation of relative price changes than do relative prices involving at least one city from the West.

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[5] We obtain data on distances between cities from http://www.mapquest.com/ and http://www.infoplease.com

[6] Because the region dummies and their interactions with distance are highly correlated and therefore the coefficients are estimated less precisely, we also conduct tests of joint significance of the region dummies and the interaction terms. Since results do not add much, we do not report the *F*-test results.

Table 2: Regression Results with Distance, Region Dummies and Interactions

	Standard deviation of relative prices					Standard deviation of relative price changes				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
LDIST	0.92***	0.88***	0.60***	0.99***	0.50	0.14***	0.13***	0.13***	0.14***	0.16*
	(0.14)	(0.15)	(0.19)	(0.17)	(0.55)	(0.02)	(0.02)	(0.03)	(0.03)	(0.09)
REG	0.39*		-0.37	2.47		0.03		-0.02	-0.05	
	(0.22)		(0.41)	(1.85)		(0.04)		(0.06)	(0.34)	
REGNE		0.03					-0.12**			
		(0.30)					(0.05)			
REGMW		0.28					0.06			
		(0.25)					(0.05)			
REGSO		-0.07					0.00			
		(0.12)					(0.02)			
REGWE		0.98*					0.03			
		(0.52)					(0.07)			
NE			-0.65*		-0.93			-0.06*		-0.05
			(0.35)		(2.40)			(0.04)		(0.40)
MW			-0.55*		-0.21			0.04		0.38
			(0.33)		(2.17)			(0.04)		(0.38)
SO			-0.48		-6.69**			-0.07*		-0.40
			(0.32)		(3.16)			(0.04)		(0.44)
WE					2.31					0.23
					(3.26)					(0.44)
REG×LDIST				-0.33					0.01	
				(0.29)					(0.05)	
NE×LDIST					0.12					0.00
					(0.37)					(0.06)
MW×LDIST					0.04					-0.04
					(0.34)					(0.06)
SO×LDIST					0.95**					0.05
					(0.48)					(0.07)
WE×LDIST					-0.25					-0.03
					(0.44)					(0.06)
Adjusted R-squared	0.24	0.24	0.24	0.24	0.25	0.31	0.33	0.36	0.31	0.35

Note: White heteroskedasticity-consistent standard errors are in brackets. *** indicates significance at the 1% level,** at the 5% level and * at the 10 % level. An intercept term is included in the regressions.

Table 2 continued

	1 – *p*-value of ADF test				
	(11)	(12)	(13)	(14)	(15)
LDIST	-0.09***	-0.10***	-0.04	-0.12***	0.15
	(0.03)	(0.03)	(0.05)	(0.04)	(0.12)
REG	-0.04		0.10	-1.04**	
	(0.06)		(0.11)	(0.45)	
REGNE		-0.16			
		(0.12)			
REGMW		-0.05			
		(0.07)			
REGSO		0.18***			
		(0.03)			
REGWE		0.00			
		(0.10)			
NE			0.10		0.48
			(0.09)		(0.48)
MW			0.04		1.15**
			(0.08)		(0.57)
SO			0.19**		2.55***
			(0.08)		(0.71)
WE					0.19
					(0.61)
REG×LDIST				0.16**	
				(0.07)	
NE×LDIST					-0.08
					(0.08)
MW×LDIST					-0.19**
					(0.09)
SO×LDIST					-0.36***
					(0.11)
WE×LDIST					-0.05
					(0.09)
Adjusted R-squared	0.03	0.02	0.06	0.04	0.10

Columns (11) - (15) report the regression results for 1 – *p*-value of the ADF tests. Distance has mostly significant negative effects on 1 – *p*-value. That is, as distance between cities increases, the strength of the evidence of convergence in relative prices weakens. The results further indicate that the likelihood of convergence in relative price increases significantly if at least one city is in the South. When the same region dummy is interacted with distance, the estimated coefficient for the region dummy is negative and for the interaction term is positive and both are statistically significant. Overall, the evidence of relative price convergence will strengthen if the city pairs are in the same region. Interactions with individual region dummies reveal that if at least one city is located either in the Midwest or in the South, as distance increases the strength of the evidence of convergence in relative prices significantly weakens.

4. Conclusions

In this paper, we examine the 'region effects' on the behavior of relative prices across 17 U.S. cities. First, we find that relative prices between two cities located in the same region behave differently than cities located in different regions. For example, average relative price variability – measured by standard deviation of relative prices and of relative price changes - is significantly lower if the city pairs belong to the same region. However, after controlling for the effect of distance, relative price variability – measured by standard deviation of relative prices - increases if both cities are in the West, and relative price variability – measured by standard deviation of relative price changes - decreases if they both are in the Northeast. Furthermore, the strength of the evidence of relative price convergence increases if both cities belong to the South and this result is robust irrespective of whether we control for distance or not. Second, if at least one city is located either in the South or in the West, relative price variability increases significantly. The likelihood of convergence in relative prices decreases if at least one city belongs to the West. Finally, distance appears to increase relative price variability if at least one city is located in the South and to lower the likelihood of relative price convergence if at least one city is located in the Midwest or in the South.

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