Integration and Behavior in the U.S. Winter Market for Fresh Tomatoes

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Abstract

Alternative hypotheses of market integration in the U.S winter market for fresh tomatoes were evaluated using a dynamic model of spatial price adjustment. The results showed that while Florida and Mexico were integrated in the same market, a price change in one area was not instantaneously reflected in the other Lagged effects were important with long-run integration being supported for both Florida and Mexico and short-run integration for Mexico. However, the information flow, while relatively efficient, was not symmetric. Florida was found to be dominant in the price formation process with Mexico responding to changes in the Florida price.

Key Words: Florida, market integration, Mexico, pricing, tomatoes

Uniformity of price for a homogeneous good, net of transfer costs, has conventionally been used as a measure of market integration. This concept is still widely applied, but it has become increasingly recognized that prices at spatially separate points may depart from uniformity for several reasons. These include information lags; asymmetric information flow; risk and market interventions of various kinds. Accordingly, markets for a homogeneous commodity may not be integrated instantaneously. Integration may take place over the longer term after prices have had time to adjust.

Empirically, the concern with the sphere of the market has found expression in efforts to validate the law of one price (LOP) in international trade or to establish market integration in specific commodity markets. This is done by examining the degree of comovement of prices at spatially separate points. Within a market, prices at different points are influenced by the same supply and demand forces and, consequently, should move together over time.

Most of the early studies of the LOP or market integration used static price correlations. Two spatially separate areas were considered to be in the same market if the degree of correlation between two price series tended to unity. This approach, which employed price series expressed in levels or as price changes, suffered from several shortcomings (Ravallion, 1986; Ardeni, 1990; Goodwin and Schroeder, 1991). In particular, the dynamic nature of spatial price adjustment was ignored or possibly misrepresented. Other problems related to simultaneity bias (since one of the prices was considered exogenous) and bias from omitted variables. Besides, even though markets may in fact be segmented, two (or more) price series may move together if they are linearly affected by another variable, leading to incorrect inferences concerning market integration.

Recently, a number of studies have employed methods which address the problems associated with the static approach. Ravallion (1986) extended the static bivariate model into a dynamic framework which explicitly recognized that

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integration may not take place instantaneously and allowed for local influences on prices. Cointegration approaches (Ardeni, 1990; Baffes, 1991; Goodwin and Schroeder, 1991) were used to capture the dynamic properties of time series data. Goodwin and Schroeder (1990) employed a rational expectations model which took into account simultaneity, price expectations and serial correlation.

The empirical results on the LOP and market integration have been mixed. Earlier studies suggest that the incidence of market integration is quite low. More recently, Ravallion (1986) failed to find support for market integration in Bangladesh rice markets. Goodwin and Schroeder (1990) found that regional cattle markets in the U.S. were less than fully integrated. Evaluating two sub-periods, integration was rejected in five out of ten markets in each case. The same authors (1991) also found limited cointegration of regional cattle prices. Baffes (1991) obtained results generally favorable to the LOP for several commodities in international trade. Ardeni (1990), on the other hand, was unable to support the LOP empirically. In general, when the LOP or market integration was not supported, it was suggested that this was due to market inefficiency arising from impediments to trade (e.g., risk, tariffs and subsidies, communications difficulties, institutional factors) or to significant transportation costs.

The objectives of this paper are to test alternative hypotheses of market integration between Florida and Mexico in the U.S. winter market for fresh tomatoes and to make inferences regarding market behavior. Measurement of market integration provides basic information on the dynamics of price movement in the market and can yield useful insight into the likely behavior of these two supply areas in the market. Given that these suppliers comprise virtually the entire market and the homogeneity of the product, a high degree of pricing interdependence is expected to characterize their relationship on the market. Market behavior in such circumstances may range from intense rivalry to possible collusion (Cochrane, 1957). Many studies (e.g., Ravallion) have dealt primarily with food staples in developing countries where information and transportation facilities are poor. In recent studies on cattle markets (Goodwin and Schroeder 1990, 1991), risk is a significant factor. In contrast to previous studies, this paper provides an opportunity to examine market integration in a context of more developed information and transportation systems and relatively limited risk. On a priori grounds, therefore, a higher degree of market integration is anticipated.

The next section of the paper provides information on important aspects of the marketing of fresh tomatoes in the U.S. winter market, drawing the implications for informational efficiency and market integration. Following that, the market integration model is outlined along with the hypothesis tests. Reduced-form equations are derived and used to highlight some implications of the model. Granger causality tests are then described. Finally, the results are presented and evaluated.

Background

The U.S. market for fresh winter tomatoes is served almost entirely by Florida and Mexico. These areas consistently accounted for over 95 percent of the market over the 1980/81-1989/90 period during the months December to April. The relationship between tomato producers in Florida and Mexico has often been characterized by intense competition. Sustained expansion of Mexican vegetable exports and the consequent loss of market share by Florida to Mexico led producers in Florida to seek protection from the U.S. government beginning at the end of the 1960s and continuing throughout the 1970s. These efforts included the institution of a marketing order regulation which stipulated dual sizing requirements for mature-green and vine-ripened tomatoes respectively, and the filing of anti-dumping petitions in 1978 and 1979.

While Florida producers failed to obtain protection, this episode led Mexico to adopt a system of export controls which, in part, had the effect of reducing its position in the market. However, since this policy of export restraint is based on varying quality and maturity requirements, Mexico has the ability to increase fresh tomato exports to the U.S. market at short notice by diverting supplies from its domestic market. For instance, during the freeze in Florida in January 1986, Mexican tomato shipments increased 16 percent over the previous week (Buckley et al., 1986).

Production and marketing activities in Florida and Mexico are relatively concentrated. The two industries are dominated by small groups of large farmers. Most of the produce marketed is handled by a few U.S. distributors who are at the center of the marketing system (Emerson, 1986). Marketing channels within the U.S. are essentially the same for Florida and Mexico. However, Mexico faces significant transportation and other marketing costs (e.g., export and import taxes) to enter the market. Given the similarity in marketing channels within the U.S., the most significant price competition takes place at the U.S. shipping point (Nogales, Arizona, South and Central Florida).

Concentration in the industry and the pivotal position of the distributors are conducive to rapid information dissemination throughout the market and are thus expected to be factors favorable to market integration. On the other hand, the higher marketing and transportation costs faced by Mexico should negatively affect integration in the longer term. Notwithstanding Mexico's policy of supply restraint, its potential to respond quickly to production shortfalls can positively influence market integration in the short run.

The Model

Tests of market integration are conducted on the basis of the dynamic model proposed by Ravallion (1986) adapted for present purposes. The model was developed to deal with trade between a central market and a set of local markets. It was assumed that trade with the central market dominated local price formation. The model does, however, allow for the possibility of local markets influencing each other and the central market depending on their size and can thus be applied in a situation where prices are jointly determined.

Faminow and Benson (1990) show how the model can be used in an oligopolistic setting where each firm's price depends on the prices set by other firms. This was done by considering all market pair relationships. The U.S. winter market for fresh tomatoes can be modelled as an oligopoly. Given the market shares of Florida and Mexico, prices received by each are expected to have some influence on those received by the other.

The following simultaneous equation model was estimated by two-stage least squares in restricted and unrestricted forms:

$$P_t^f = \delta + \sum_{i=1}^{2} \beta_i P_{t-i}^f + \sum_{j=0}^{2} \gamma_j P_{t-j}^m + \sum_{k=1}^{2} \alpha_k Q_{t-k}^f + \varepsilon_t. \tag{1}$$

$$P_t^m = \delta' + \sum_{i=1}^{2} \beta_i' P_{t-i}^m + \sum_{j=0}^{2} \gamma_j' P_{t-j}^f + \sum_{k-1}^{2} \alpha_k' Q_{t-k}^m + \varepsilon_t' \tag{2}$$

where P^f and P^m represent prices and Q^f and Q^m represent quantities of Florida and Mexico respectively. The number of price lags included in the model was determined on the basis of F-tests conducted at the 95 percent confidence level. In the determination of lag length, the number of observations was held constant while the lag length was successively increased. The equations which were selected were subsequently evaluated for serial correlation using Ljung-Box Q-statistics. Calculated test statistics of 42.78 and 35.06 for Florida and Mexico respectively were smaller than the critical value of 49.802, indicating that serial correlation was not a problem. Thus little information remained in the residuals of both equations.

Multicollinearity is often encountered when estimating unrestricted models of the type used in the analysis. However, the restriction which tests long-run integration involves all the price variables. This alleviates much of the multicollinearity danger (Ravallion, 1986). If long-run integration is not rejected, it can be imposed and more powerful tests of segmentation and short-run integration obtained.

Based on the above model, the following hypotheses are tested:

(a) *Market segmentation*
Florida:

$$H_o: \ \gamma_j = 0; \quad (j = 0,...,2) \tag{3}$$

Mexico:

$$H_o: \ \gamma_j' = 0; \quad (j = 0,...,2) \tag{4}$$

(b) *Strong short-run market integration*
Florida:

$$H_o: \gamma_0 = 1; \ \beta_i = 0; \ \gamma_i = 0 \ ; \ (i,j = 1,2) \tag{5}$$

Mexico:

$$H_0: \ \gamma_0' = 1; \ \beta_i' = 0; \ \gamma_i' = 0; \ (i,j = 1,2) \tag{6}$$

(c) *Weak short-run integration*
Florida:

$$H_0: \ \gamma_0 = 1; \ \sum_{i=1}^{2}\beta_i + \sum_{j=1}^{2}\gamma_j = 0 \tag{7}$$

Mexico:

$$H_0: \ \gamma_0' = 1; \ \sum_{i=1}^{2}\beta_i' + \sum_{j=1}^{2}\gamma_j' = 0 \tag{8}$$

(d) *Long-run Integration*
Florida:

$$H_0: \ \sum_{i=1}^{2}\beta_i + \sum_{j=0}^{2}\gamma_j = 1 \tag{9}$$

Mexico:

$$H_0: \ \sum_{i=1}^{2}\beta_i' + \sum_{j=0}^{2}\gamma_j' = 1 \tag{10}$$

Market segmentation implies that prices received by one supply area do not influence those received by the other. Short-run integration may exist either in strong or in weak form. In the strong form, a price increase in one area is immediately passed on to another area with no lagged effects. In the case of weak short-run integration lagged effects are present but their influence disappears on average. Long-run integration implies that a price change at one point is fully reflected over time in prices at another point so that in the long run both prices move in tandem even though they may depart from each other in the short run. The market integration tests were conducted in both directions to take account of simultaneity and to gauge the extent of symmetry in the market relationship between Florida and Mexico.

The reduced-form equations for the market integration model are as follows:

$$\begin{aligned} P_t^f = {} & \frac{\delta+\gamma_0\delta'}{1-\gamma_0\gamma_0'} + \frac{\beta_1+\gamma_0\gamma_1'}{1-\gamma_0\gamma_0'}P_{t-1}^f \\ & + \frac{\beta_2+\gamma_0\gamma_2'}{1-\gamma_0\gamma_0'}P_{t-2}^f + \frac{\gamma_1+\gamma_0\beta_1'}{1-\gamma_0\gamma_0'}P_{t-1}^m \\ & + \frac{\gamma_2+\gamma_0\beta_2'}{1-\gamma_0\gamma_0'}P_{t-2}^m + \frac{\gamma_0\alpha_1'}{1-\gamma_0\gamma_0'}Q_{t-1}^m \\ & + \frac{\gamma_0\alpha_2'}{1-\gamma_0\gamma_0'}Q_{t-2}^m + \frac{\alpha_1}{1-\gamma_0\gamma_0'}Q_{t-1}^f \\ & + \frac{\alpha_2}{1-\gamma_0\gamma_0'}Q_{t-2}^f + \frac{\gamma_0\varepsilon_t'\varepsilon_t}{1-\gamma_0\gamma_0'} \end{aligned} \tag{11}$$

$$\begin{aligned} P_t^m = {} & \frac{\delta'+\gamma_0'\delta}{1-\gamma_0\gamma_0'} + \frac{\beta_1'+\gamma_0'\gamma_1}{1-\gamma_0\gamma_0'}P_{t-1}^m \\ & + \frac{\beta_2'+\gamma_0'\gamma_2}{1-\gamma_0\gamma_0'}P_{t-2}^m + \frac{\gamma_1'+\gamma_0'\beta_1}{1-\gamma_0\gamma_0'}P_{t-1}^f \\ & + \frac{\gamma_2'+\gamma_0'\beta_2}{1-\gamma_0\gamma_0'}P_{t-2}^f + \frac{\gamma_0'\alpha_1}{1-\gamma_0\gamma_0'}Q_{t-1}^f \\ & + \frac{\gamma_0'\alpha_2}{1-\gamma_0\gamma_0'}Q_{t-2}^f + \frac{\alpha_1'}{1-\gamma_0\gamma_0'}Q_{t-1}^m \\ & + \frac{\alpha_2'}{1-\gamma_0\gamma_0'}Q_{t-2}^m + \frac{\gamma_0'\varepsilon_t+\varepsilon_t'}{1-\gamma_0\gamma_0'} \end{aligned} \tag{12}$$

These give prices for Florida and Mexico as functions of all predetermined variables and the structural parameters. These equations were estimated and served to clarify conclusions of the tests of hypotheses. They also highlight implications of the structural model, an important one being its consistency with the rational expectations hypothesis. Agents in the market make their decisions rationally and prices at each shipping point are determined taking into account all available information.

Recently, Fackler (1993) criticized all previous approaches to evaluating spatial market integration on conceptual grounds. He contended that it was not enough to state that (observed) prices moved together over time without taking cognizance of the underlying fundamentals, namely, excess demands and transport rates. In particular, he highlighted that, while shifts in excess demand saw prices at two separate points moving together, an exogenous shift in the transport rate caused prices to move in opposite directions. He argued that nothing could be said about market integration based on a comparison of price changes at separate points unless it is known what caused these changes.

The concern about the incorporation of fundamentals and, specifically the transportation rate, can be addressed econometrically by treating the observed prices as being subject to measurement error. Measurement error in the dependent variable poses no real problem. Measurement error in the explanatory variables, however, will lead to inconsistent ordinary least squares (OLS) estimates. An instrumental variable estimator will satisfactorily address this problem and give consistent estimates. Two-stage least squares is an instrumental variable estimator and accordingly, the concern raised by Fackler is adequately handled in the present estimation process. The concern about capturing excess demand as a fundamental element driving market integration is also to some extent addressed by the inclusion in the model of lagged quantity variables for each supply area.

Fackler also highlighted what he considered to be certain specific shortcomings of the Ravallion approach. These criticisms related mainly to the tests of short-run market integration. In particular, the test of strong short-run integration was considered too strong, justifiable only under the assumption that transport rates are white noise, and that of weak short-run integration was too weak. The test of long-run integration was not specifically criticized and this appears to be essentially the same as that proposed by Fackler within the context of a vector autoregression approach.

The implications of the above criticisms for the Ravallion approach can be examined on the basis of the reduced-form equations. For example, if strong short-run integration is presumed, then $\gamma_0=1$ in the structural model for Florida. This implies that γ'_0 could not equal unity. Otherwise, the completeness condition would not be met and no market equilibrium solution would exist. Implicit in the Ravallion approach, therefore, is the view that strong short-run integration is a limiting restriction which is not expected to be satisfied symmetrically in practice. Recall that a critical premise of this approach was that markets were not expected to be instantaneously integrated with integration likely to be more of a longer term phenomenon.

Imposing the market integration restrictions on the structural parameters in terms of the reduced forms reveals that market integration, whether short-run or long-run, requires only that all available information be used in the price formation process. Segmentation requires that only lagged own-price values and the corresponding quantities be utilized. However, a specific advantage of the Ravallion model is that it allows a direct estimate of the parameter on the current price explanatory variable (γ_0 and γ'_0) in each model.

Causality Tests

Granger causality tests, as applied in Bessler and Brandt (1982), were conducted to support conclusions regarding price leadership made on the basis of the market integration tests. These tests were based on the following OLS regressions:

$$P_t^f = \alpha_{10} + \sum_{j=1}^{r} \alpha_{1j} P_{t-j}^f + \varepsilon_{1t} \tag{13}$$

$$P_t^f = \alpha_{20} + \sum_{j=1}^{r} \alpha_{2j} P_{t-j}^f + \sum_{k=1}^{s} \beta_{2k} P_{t-k}^m + \varepsilon_{2t}. \tag{14}$$

where ε_{1t} and ε_{2t} are white noise residuals. Similar equations were specified for Mexico. The causality tests were carried out in both directions with an F-statistic. The null hypothesis of no causality (H_0: $\beta_{21} = \beta_{22} = ... = \beta_{2s} = 0$) is rejected for suitably large values of the test statistic. Instantaneous causality was evaluated by comparing, on the basis of an F-statistic, the sum of squared errors of (14) with those of the following OLS regression equation:

$$P_t^f = \alpha_{30} + \sum_{j=1}^{r} \alpha_{3j} P_{t-j}^f + \sum_{k=0}^{s} \beta_{3k} P_{t-k}^m + \varepsilon_{3t} \tag{15}$$

The use of equations (13)-(15) requires that values of r and s be large enough to remove substantial serial correlation (Bessler and Brandt, 1982). The F-statistic may be seriously overvalued if substantial serial correlation is present. The causality tests were done with two and four lags and all the regression equations were symmetric in lags.

Data

Weekly data on shipping-point prices and quantities of fresh tomatoes supplied by Florida and Mexico are used in the analysis. The data covered the period 1979/80-1988/89 for the months January to May. Prices are expressed in current terms on a common unit basis of twenty-five pounds. The data are taken from various issues of *Marketing Florida Fresh Fruits and Vegetables* and *Marketing Mexico Fresh Fruits and Vegetables* respectively, published by the Agricultural Marketing Service of the USDA. U.S. shipping-point prices (Nogales, Arizona and South and Central Florida) are used because the most significant competition between Florida and Mexico takes place at this point and also in an attempt to capture strategic changes in prices and quantities by the supplying areas.

In estimating the various models used in the analysis, all of which involved lags, gaps were left in the data set between seasons to ensure that there was no carry-over of information. Stationarity tests were conducted on the price series using the augmented Dickey-Fuller unit root test (Dickey and Fuller, 1979, 1981). Up to four lags and 146 observations were used in these tests. The results, presented in Table 1, suggest that the price series were stationary. The calculated test statistics were consistently above the critical values (see Engle and Yoo, 1987; p. 157) at the 90 percent and 95 percent levels of confidence. The null hypothesis is accordingly rejected in both instances. The usual regression techniques could therefore be applied.

Results and Implications

The results of the estimation of the unrestricted market integration models are given in Table 2. The model fits the data better in the case of Florida with an adjusted R^2 of 0.81 compared with 0.66 for Mexico. Since the models are essentially the same and are symmetric in lags, factors outside the model which are peculiar to Mexico may be important in explaining this difference. As indicated earlier, major differences between Florida and Mexico lie in the fact that there was greater intervention in the production and marketing of fresh tomatoes and a higher incidence of marketing and transportation costs in the case of Mexico. A priori, these factors work against integration and informational efficiency. The unrestricted adjusted R^2 values can be used to capture distance-decay effects (Faminow and Benson, 1990) where these values decline with distance and the number of intermediate points. Mexico's higher transportation and marketing costs are reflected in this criterion. The adjusted R^2 for Mexico is smaller than that for Florida indicating less informational efficiency on the part of Mexico. This evidence suggests an asymmetric information flow in the market.

The coefficient on the current price of the other supply area was statistically significant in each model. This suggests that current prices in each supply area influence each other. However, the marked difference in the absolute size of the relevant parameter estimates provides further evidence of the lack of symmetry in the information between shipping points. The coefficient on the current Florida price in the Mexican model is statistically equal to unity which indicates that a change in the Florida price is very quickly reflected in the Mexican price. The corresponding coefficient in the Florida model is statistically different from one suggesting lower immediate responsiveness of the current Florida price to changes in the contemporaneous Mexican prices. It is also clear that lagged prices are important in explaining the

Table 1. Tests for Nonstationarity on Price Series for Florida and Mexico

Number of Lags	Test Statistics[a]	
	Florida	Mexico
0	-3.21[b]	-4.52[b]
1	-3.69[b]	-4 07[b]
2	-3.45[b]	-3.52[b]
3	-4.33[b]	-3.53[b]
4	-4.26[b]	-3.65[b]

[a] Critical values are 2.81 (5 percent) and 2.58 (10 percent) for 100 observations and 2.88 (5 percent) and 2.57 (10 percent) for 200 observations

[b] Denotes statistically significant estimates.

Table 2. Results of Unrestricted Market Integration Model

Parameter Estimates	Florida	Mexico
Intercept (δ, δ')	1.294 (0 709)[a]	0.346 (0.934)
β_1, β'_1	0.755[b] (0.085)	0.373[b] (0.087)
β_2, β'_2	-0 111 (0.086)	0.135 (0.105)
γ_0, γ'_0	0.614[b] (0.121)	1.042[b] (0.252)
γ_1, γ'_1	-0.238[b] (0.102)	-0.636[b] (0.262)
γ_2, γ'_2	-0.081 (0.065)	0.076 (0.120)
α_1, α'_1	-0 000000767 (0 000000512)	-0.00000211[b] (0.000000709)
α_2, α'_2	0 000000418 (0.000000553)	0.00000147[b] (0.000000674)
Adj. R^2	0.81	0.66

[a] Standard errors are in parentheses below each of the parameter estimates.

[b] Denotes statistically significant estimate at the 95 percent confidence level.

respective current prices. In addition, the lagged Mexican quantities enter significantly in explaining the Mexican current price. This fact, together with the change in sign between periods may be indicative of Mexico's supply restraint policy which adjusts quantities to achieve a certain price objective. This means that lagged Mexican quantities have an indirect impact on the Florida current price.

F-statistics for the market integration hypotheses tests are presented in Table 3. The results do not support segmentation at shipping-point with regard to supplies of fresh tomatoes to the U.S. winter market. The market segmentation hypothesis is rejected in both instances suggesting that Florida and Mexico are in the same market. Strong short-run integration, at the other extreme, is also not supported. This confirms that lagged effects are important. Weak short-run integration is rejected for Florida but cannot be rejected for Mexico. This indicates that Mexico responds in the short term to a change in Florida prices. Florida, on the hand, does not appear to respond significantly to

Table 3. F-Statistics for Market Segmentation and Integration Tests

Variable[a]		Segmentation[b]	Integration		
Dependent	Independent	$\gamma_j = 0$	Strong short-run[c] $\gamma_0=1;\beta_i=\gamma_j=0;$ $i,j=1,2,$	Weak short-run[d] $\gamma_0=1;$ $\sum_{i=1}^{2}\beta_i+\sum_{j=1}^{2}\gamma_j=0$	Long-run[e] $\sum_{i=1}^{2}\beta_i+\sum_{j=0}^{2}\gamma_j=1$
P^F_t	P^M_t	12.02[f]	22 10[f]	5.27[f]	1.42
P^M_t	P^F_t	15.68[f]	8.79[f]	0.072	0.03

[a] P^F_t - Florida price; P^M_t - Mexican price
[b] $F(3,168) = 2\ 659$
[c] $F(5,168) = 2.268$
[d] $F(2,168) = 3\ 050$
[e] $F(1,168) = 3.898$
[f] Denotes statistically significant at the 95 percent confidence level. This test indicates that the null hypothesis is rejected.

Table 4. Results of Estimation of Reduced Forms

Variables	Parameter Estimates	
	Florida	Mexico
Intercept	8 045[b] (1 579)[a]	8.689[b] (2.008)
P^F_{t-1}	0.900[b] (0 112)	0.300[b] (0.142)
P^F_{t-2}	0 066 (0.110)	0.145 (0.140)
P^M_{t-1}	-0.046 (0.089)	0.326[b] (0.113)
P^M_{t-2}	-0.186[b] (0.085)	-0.058 (0.109)
Q^F_{t-1}	-0.00000153[b] (0.00000061)	-0.00000162[b] (0.00000077)
Q^F_{t-2}	-0.000000357 (0.00000075)	-0.000000332 (0.00000096)
Q^M_{t-1}	-0.00000245[b] (0.00000071)	-0.00000466[b] (0.00000091)
Q^M_{t-2}	-0.000000640 (0.00000068)	0.000000814 (0.00000086)
Adj. R^2	0.75	0.58

[a] Standard errors are in parentheses below each of the parameter estimates.
[b] Denotes statistically significant estimates at the 95 percent confidence level.

a change in the Mexican price in the short run. The restriction of long-run market integration was not rejected for both Florida and Mexico. The evidence therefore suggests that shipments of fresh tomatoes are integrated in the same market in the long run. A change in price by either supplier is fully reflected over time in the prices of the other.

These results indicate that although spatial price adjustment did not take place within one time period, each supplier does respond to the price and supply variations of the other. Florida appears to be the price leader with its current prices depending significantly on their own past values. This conclusion is premised on the fact that short-run integration (both versions) was rejected in the case of Florida. Notwithstanding its apparent leadership position, Florida is closely integrated with Mexico in the long run.

Mexico is integrated with Florida in both the short term and the long term. Weak short-run integration suggests that Florida prices are a significant factor determining the Mexican price even in the short term. This is consistent with the expectation of a relatively rapid response on the part of Mexico given its supply restraint policy described earlier. The above together with the result that the short-run restriction is rejected for Florida and long-run integration supported is indicative of underlying competition in the market (Faminow and Benson, 1990) with Mexico closely following Florida's pricing initiatives.

The estimated coefficients of the reduced-form equations are presented in Table 4. The results show that the current Florida price is significantly influenced by its own price the previous period. The second lag of the Mexican price is a statistically significant influence on the current Florida price. However, the size of this coefficient is considerably smaller than that of Florida's price the previous period. This confirms that the Florida price is much more dependent on its own past values than on past Mexican prices although Mexican prices are eventually taken into account.

All lagged quantities are negatively related to the current Florida price in keeping with expectations. Relatively high quantities in the recent past put downward pressure on prices. However, only the first lagged quantities of both Florida and Mexico are statistically significant. It is noteworthy that there is information contained in past quantities which are not contained in past prices, indicative of a less than fully efficient market.

Previous period prices for both Florida and Mexico significantly affect the current Mexican price. However, the influence on the current Mexican price of first lagged prices for Florida and Mexico are about the same. This is unlike the situation with the current Florida price. Again lagged effects decrease with time. As was the case with the Florida model, first lagged quantities of both supply areas affect the current Mexican price negatively and significantly.

The reduced-form equation explains 75 percent of the total variation in the Florida current price and 58 percent in the case of the Mexican price. While the reduced form represents a better explanation of the current Florida price, the results suggest that, in both instances, important factors may have been omitted. The significance of transportation and other marketing costs in the case of Mexico have already been mentioned. In addition, the contemporaneous influence of each price on the other is evidently a relevant factor.

The results of the causality tests are given in Tables 5 and 6. These indicate a one-way causal relationship in which Florida prices cause Mexican prices. This finding provides additional support for the conclusion that Florida is the price leader on the market. Instantaneous causality is also indicated suggesting a relatively efficient information flow in the market (Adamowicz, Baah and Hawkins, 1984). However, these tests confirm that the information flow is asymmetric. These results lend support to the conclusions drawn on the basis of the integration tests. Although Florida and Mexico belong to the same market, Florida appears to be dominant in the price formation process.

Conclusions

This study evaluated the extent of spatial integration in the U.S. winter market for fresh tomatoes. From the results, implications were drawn regarding the market behavior of Florida and Mexico. One major conclusion is that Florida and Mexico are integrated in the same market. Long-run integration is supported for both Florida and Mexico while short-run integration is indicated for Mexico. These results suggest that while price changes in one area are not instantaneously diffused to the other, those changes will eventually be reflected in the prices of the other area. The second major conclusion is that the information flow between shipping points is relatively efficient indicative of reasonably efficient arbitrage. This information flow, however, is asymmetric. This study did not attempt to isolate reasons for this lack of symmetry but Mexico's distance from the market and consequently, significant transportation and marketing costs, are likely contributing factors.

Table 5. One-Way Granger Causality Tests

Florida → Mexico		Mexico → Florida	
Lags[a]	F-Statistic	Lags[a]	F-statistic
2	3 75[b]	2	2.49
4	3 02[b]	4	1.34

[a] Critical values for 2 and 4 lags are $F_{0\ 05}(2,170) = 3.05$ and $F_{0\ 05}(4,146) = 2.43$ respectively.
* Denotes restriction is statistically significant.

Table 6. Instantaneous Granger Causality Tests

Florida ↔ Mexico	
Lags[a]	F-Statistic
2	98.12[b]
4	88.87[b]

[a] Critical values are $F_{0.05}(1,169) = 3.89$ for the model with 2 lags and $F_{0\ 05}(1,145) = 3.91$ for the model with four lags respectively.
[b] Denotes restriction is statistically significant.

Thirdly, Florida appears dominant in the price formation process pursuing a relatively independent pricing policy in the short term with Mexico responding to changes in the Florida price.

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