Is the Local Basis Really Local?

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Practitioners Abstract

Conventional wisdom suggests the local cash – futures basis is determined from local supply and demand conditions. However, it may be the case that local elevators look to other locations, such as terminal locations, and adjust for transportation differentials when determining the basis for their particular market. If so, certain grain marketing locations (e.g., export and interior terminal locations) may play an important role in discovering and ultimately determining the basis for other local markets. This hypothesis is examined for the #2 yellow corn basis at various export terminal (Gulf; Toledo), river terminal (Illinois River; Omaha) and interior (S. Central Illinois; N. Central Iowa; Denver) locations. Specifically, if the basis calculated at one market location is found to lead the basis at another market location, then this suggests that the leading market plays a role in determining the basis for the other market. The findings suggest that corn basis calculated at the export terminal markets of Toledo and the U.S. Gulf, as well as the Illinois River, may indeed provide valuable information in determining the basis for other river terminal and interior locations.

Introduction

The key price relationship in grain marketing is the basis, typically defined as cash-futures price. Grain market participants routinely quote the basis when engaging in grain market transactions, and there is little dispute as to the importance of basis relationships in guiding commodity inventories through the supply chain (Tilley and Campbell; Tomek and Robinson). Understanding the behavior of the local basis is also critical in designing and implementing grain marketing and risk management strategies (Tomek and Peterson).

For storable commodities, such as corn, the difference between local cash and futures prices reflects the market determined price of storage for a particular market location, encompassing physical storage costs, quality differentials, and transportation costs from the local cash market to a par delivery point. While conventional wisdom suggests that basis is determined at the local market level, it may be the case that grain elevators look to other locations, such as terminal locations, and make adjustments for transportation differentials when determining the basis for their particular market location. Given this, certain grain market locations may play an important role in discovering and determining the basis for other markets.

Some evidence exists to support this idea. In examining how soybean basis levels respond to barge rate shocks and other supply and demand disruptions, McKenzie found that for Arkansas soybean markets, Gulf basis shocks cause simultaneous movements in the Memphis basis. McKenzie also found that Memphis basis shocks influence the basis for Arkansas Delta locations (Little Rock). However, basis shocks at Little Rock did not transmit to Memphis, suggesting a dominant price discovery role for Memphis. Similarly, Haigh and Bessler find that Illinois grain prices are highly influenced by both barge freight markets and Gulf export markets. Indeed, these studies suggest that the basis determined at certain locations, such as the Gulf, may lead the basis for other, namely interior, locations. If this is the case, then one or more dominant markets may play a critical role in discovering and determining the basis relative to other markets, suggesting that basis may not be completely independently determined at the local level.

Therefore, the overall objective of this research is to determine if one or more market locations play a dominant role in discovering and ultimately determining the basis for #2 yellow corn. In doing this, we concentrate on the examination of the nearby basis for corn at various terminal locations (export and river terminals) and geographically dispersed interior locations. Using a bi-variate Granger Causality framework, if the basis for one market location is found to lead another, then the leading market is said to play a role in discovering and ultimately determining the basis of the other market.

This research provides insight into the relationships between corn basis calculated at alternative market locations. Indeed, while a sizeable body of literature exists examining the factors effecting the basis for grains (Garcia and Good; Naik and Leuthold) and basis forecasting (Taylor, Dhuyvetter, and Kastens; Jiang and Hayenga), little is known about the relationships between basis realized at various market locations throughout the grain marketing system. The results of this research should be of interest both to professionals working in the grain industry, as well as academics. Indeed, if the basis at one or more market locations is found to play a dominant role in discovering the basis for other geographically disperse locations, this has important implications for basis forecasting efforts. Most importantly, however, this research adds to the body of literature on the basis and basis relationships – a topic of inquiry that needs further attention (Tomek).

The remainder of the paper is presented as follows. First, the methods and data used in this research are presented. Next, the results of the Granger Causality tests are discussed, followed by summary and conclusions, implications, and suggestions for further research.

Methods and Data

Issues of price discovery, in particular the question of whether prices at one market location lead those of another, are often examined using a Granger Causality framework. For example, Oellermann and Farris test the lead-lag relationships between live cattle spot prices and live cattle futures prices in order to determine if the spot or futures market is the center of price discovery. Similarly, Koontz, Garcia, and Hudson examined the spatial nature of price discovery for live cattle by examining lead-lag relationships between various spot markets for live cattle, and between the live cattle futures market and these spot markets. Given that the basis for storable commodities is indeed a price, namely the market determined price of storage for a particular market location, we follow the Granger Causality framework of Oellermann and Farris and Koontz, and Garcia, and Hudson to determine if particular market locations play a dominant role in discovering and determining the #2 yellow corn basis for other locations.

For corn basis calculated at two different market locations, market X and market Y, the bi-variate Granger test for causality between X and Y used is (Hamilton, p. 302):

(1) $$Y_t = \alpha + \sum_{i=1}^{m} \lambda_i Y_{t-i} + \sum_{j=1}^{n} \theta_j X_{t-j} + w_t$$

where, *m* and *n* represent the lag lengths for Y_t and X_t respectively, and w_t is a random disturbance term (Pindyck and Rubinfeld; Granger). The null hypothesis that X_t does not lead Y_t, or more formally that X_t does not Granger cause Y_t, is examined by testing the restriction that $\theta_j = 0$ for all *j* using a Wald chi-square statistic. That is, if the null hypothesis is rejected, then it can be said that the basis at market *X* does indeed lead the basis at market *Y*, thus playing a role in discovering the basis for market *Y*.

Weekly (Friday) nearby basis (cash – nearby futures) for #2 yellow corn is calculated for the following export terminal, river terminal, and interior elevator locations. In cases where a Friday price is not available, the corresponding Thursday price, or the immediately following Monday price is used. Export terminal locations include the U.S. Gulf and Toledo (on the river). River terminal locations are for the Illinois River (N. of Peoria) as well as Omaha, and interior locations include S. Central Illinois, N. Central Iowa, and Denver, Colorado. Cash price data are provided by the USDA Agricultural Marketing Service (AMS) for each of these market locations. In creating the cash price series for each market, an average of the high and low cash bid reported for the day is calculated. Nearby Chicago Board of Trade corn futures prices are used are in creating the nearby basis series, with futures contract rollover occurring on the last trading day of the month prior to the contract delivery month to avoid using prices during the delivery period. For instance, for April 22, 2005, the futures price used is taken from the May 2005 contract, but for April 29, 2005, the July 2005 futures price is used. Both the cash and futures price data span from January 1996 through December 2005, resulting in 523 weekly basis observations for each of the market locations.

Results

To keep the analysis tractable, causality relationships are examined between basis calculated at export terminal and river terminal locations, river terminal and interior elevator locations, and between export terminal and interior elevator locations. For each pair of causality tests identified, the causality is tested both ways (e.g., *X* does not cause *Y*, and *Y* does not cause *X*) in order to determine direction of causality, or if causality is simultaneous. Results of Augmented Dickey Fuller tests (ADF) indicate that each of the basis series are stationary, therefore the causality tests are run using basis levels. Equation (1) is estimated using OLS, with the optimal lag structure determined by estimating all models for lag values of i = 1 to 12 and j = 1 to 12. The model that minimizes Akaike's information criteria (AIC) is then used in the causality regression (Beveridge and Oickle). Serial correlation in the relationship is tested using a Lagrange multiplier test, and heteroskedasticity is tested for using White's test. Given that each of the original models estimated exhibited heteroskedasticy, White's heteroskedastic consistent covariance estimator is used to correct the covariance matrix. Results are presented in tables 1 through 3. For each table, the first column illustrates the lead-lag null hypothesis, the second column reports the optimal lag length of the estimated model determined by the minimization of

AIC, and the third column reports the p-value from the Wald chi-square statistic testing the null hypothesis that *X* does not lead *Y*.

Do Export Terminal Basis Lead River Terminal Basis?

Table 1 presents the first set of results examining the lead-lag relationships between basis calculated at export terminal and river terminal locations. The null hypothesis that Gulf basis does not cause Illinois River, as well as the null that Illinois River does not cause Gulf, are both rejected at the 5% level (p-values = 0.0100 and 0.0013 respectively). This finding suggests that a simultaneous feedback relationship exists between these two markets in that the corn basis at each location likely assimilates or impounds information that may be available at the other. In other words, neither market plays a dominant role in determining the basis for the other market. However, another story is told when considering the lead-lag relationships between Gulf and Omaha. The null hypothesis that Gulf does not cause Omaha is rejected (p-value = 0.0004), while there is failure to reject the null that Omaha does not cause Gulf (p-value = 0.2699). Thus, it appears that the Omaha corn basis does consider basis information from the Gulf, such that Gulf basis information may be used to discover the Omaha basis.

Interestingly, however, corn basis calculated at Toledo is found to lead the basis at both the Illinois River and Omaha. The null hypotheses that Toledo does not cause Illinois River, and that Toledo does not cause Omaha, are both rejected soundly at the 5% level. As well, when the causality relationship is reversed in each case, there is a failure to reject the null. At least in considering these specific lead-lag relationships, Toledo appears to provide a role in discovering the basis at both the Illinois River and Omaha river terminal locations.

Do River Terminal Basis Lead Interior Basis?

One of the primary motivations of this research is to determine if interior or local elevators take clues from terminal markets in determining local corn basis. Therefore, this set of causality tests examine the lead-lag relationships between basis calculated at river terminal and interior locations. Table 2 (panel A) presents results from the Granger Causality tests examining if the Illinois River basis does not cause S. Central Illinois, N. Central Iowa, and Denver basis, and subsequently that each of these interior location's basis do not cause Illinois River. Interestingly, there is a simultaneous causality relationship between Illinois River basis and S. Central Illinois, as well as Illinois River and N. Central Iowa. Therefore, neither the Illinois River terminal or interior locations play a dominant role in discovering corn basis at their respective locals. Rather, the corn basis at each location likely reflects important information that is also critical in determining the basis at the other market. This is not surprising given the size, importance, and number of grain elevators in both S. Central Illinois and N. Central Iowa AMS reporting areas. The null hypothesis that Illinois River basis does not lead basis calculated at Denver is rejected at the 5% level (p-value = 0.0034), while there is a failure to reject the null (p-value = 0.3027) when this relationship is reversed. Since Denver is not located in a major corn producing region, it is not surprising that the corn basis at the Illinois River is found to lead that of Denver especially given the importance of the Illinois River as a grain merchandising hub and par delivery point for Chicago Board of Trade corn futures. Clearly in this case, corn basis at the Illinois River is important in determining the basis for Denver.

The results from testing the null hypothesis that Omaha basis does not lead the basis at the interior locations of S. Central Illinois, N. Central Iowa, and Denver (table 2 panel B) show that there is a failure to reject the null in each case (p-values = 0.2314, 0.4641, and 0.2924 respectively). However, it is somewhat surprising that Omaha does not lead Denver given the geographic proximity of Denver to Omaha relative to Denver and the Illinois River. A reversal of the causality relationships show that basis at S. Central Illinois actually leads that of Omaha. This finding is likely due to the importance of S. Central Illinois as a production region. Neither N. Central Iowa or Denver are found to lead Omaha.

A final pair of causality tests are conducted to determine if one or the other river terminal locations examined play a dominant role in discovering the corn basis relative to each other (table 2 panel C). Given the previous results, it is not surprising that the null hypothesis that Illinois River does not cause Omaha is rejected at the 5% level (p-value = 0.0008). A reversal of the null shows that Omaha does not cause Illinois River basis (p-value = 0.2808). Therefore, when considering the basis at these two river terminal locations, evidence suggests that the Illinois River basis leads that of Omaha. Indeed, this result, combined with the lead-lag relationships found between the river and interior locations examined, confirm to a certain degree the importance of the Illinois River basis in discovering the basis for local or interior locations.

Do Export Terminal Basis Lead Interior Basis?

Examining the causality relationships between export terminal and interior locations provides the broadest test as the relationships here bypass the river terminal. Indeed, examining these pair-wise relationships is a natural progression from the other relationships examined previously. Table 3 (panel A) reports the results from testing the lead-lag relationships between Gulf and interior locations. The null hypothesis that Gulf does not cause N. Central Iowa is rejected at 5% level (p-value = 0.0026). The null that Gulf does not cause Denver is also rejected (p-value = 0.0122). Reversing the order of causality in each of the above cases results in a failure to reject the null at the 5% level (p-values = 0.1298 and 0.0962 respectively). Therefore, based on these results, it appears that Gulf basis plays an important role in discovering the corn basis for both the N. Central Iowa and Denver locations. Interestingly though, when considering the causality relationships between Gulf and S. Central Illinois, no relationship was found. There is a failure to reject the null hypothesis that Gulf does not cause S. Central Illinois, as well as the null that S. Central Illinois does not cause Gulf.

Table 3 (panel B) presents results where the export terminal is designated as Toledo. The null hypothesis that Toledo basis leads S. Central Illinois is rejected (p-value = 0.0000), as well as the null that S. Central Illinois leads Toledo (p-value = 0.0105). This evidence suggest that there is simultaneous feedback, and that basis information at both this export and interior location are important in the discovery of the basis at the other location. This result is very different than the finding for Gulf / S. Central Illinois that shows no causality occurring in either direction. The null hypothesis that Toledo does not cause N. Central Illinois is rejected (p-value = 0.0000), while there is a failure to reject the null that N. Central Illinois does not cause Toledo (p-value = 0.4453). Results are the same when considering the lead-lag relationship between Toledo and Denver, as well as a reversal of causality (Denver does not cause Toledo). Thus, the Toledo corn basis leads the corn basis at both N. Central Illinois and Denver locations, again suggesting an important role for Toledo in discovering the basis for these two interior locations.

While both the Gulf and Toledo corn basis appear to play an important role in discovering the basis at the interior locations, it may be the case that one of the export terminal locations plays a greater role in basis determination than the other. To consider this, we test the null hypothesis that Toledo does not cause Gulf, and also reverse this relationship (table 3 panel C). Interestingly, the null hypothesis that Toledo does not cause Gulf is rejected (p-value = 0.0082), and there is a failure to reject the null that Gulf causes Toledo (p-value = 0.1505). Therefore, Toledo basis leads that of the Gulf basis. This suggests that at a minimum that, when considering the corn basis at both these export terminal locations, Toledo may play a dominant role in discovering the basis for other locations relative to the information provided by the Gulf basis.

The results presented in tables 1 through 3 present some initial evidence as to the role that certain market locations play in discovering the basis for other markets. While it is well known that basis is indeed a local concept – reflecting the market determined price for storage for specific location – evidence presented here suggests the corn basis at one or more dominant market locations may indeed influence the corn basis at other market locations. Figures 1 and 2 provide a graphical summary of the results presented in tables 1 to 3. Red arrows indicate one-way causality, while blue arrows indicate a simultaneous causal relationship. From these figures, two important findings are clarified. First, the Toledo corn basis appears to play an important role in discovering the basis for a number of important market locations, including the Gulf, Illinois River, Omaha, and each of the interior locations examined. Second, considerable basis information is transmitted through the Illinois River to other markets. Namely, there is a simultaneous causality relationship between Gulf and Illinois River, and between the Illinois River and S. Central Illinois, and Illinois River and N. Central Iowa. As well, basis at the Illinois River leads both the Denver interior location, as well as the Omaha terminal, but Illinois River basis does not lead Toledo. Indeed, while export terminal locations either lead (Toledo) or have a simultaneous relationship (Gulf) with the Illinois River, interior elevators are likely to look to the Illinois River in forming their basis quotes. Third and finally, Omaha does not play an important role in discovering the basis for any of the locations examined. Omaha corn basis does not lead the basis of any of the examined locations, and furthermore lags that of the Illinois River, export terminal locations, and S. Central Illinois. Therefore, the results indicate that the Omaha corn basis is influenced by more dominant market locations.

Summary, Conclusions, and Implications

This research provides an initial investigation into the lead-lag relationships of corn basis calculated at different market locations in order to determine if the basis at one or more markets play a dominant role in discovering the basis for other locations. The lead-lag relationships are examined using bi-variate Granger Causality tests. Causality relationships are tested between export terminal locations and river terminal locations, between river terminal and interior locations, and between export terminal and interior locations.

So, based on the results of this research, is the local basis really local? Yes, but perhaps not totally. By the theoretical definition of basis for storable commodities – the market determined price or cost of storage for a particular location – basis is indeed a local concept. Our findings do suggest, however, that the corn basis at certain market locations may play an important role in discovering the basis for other locations. That is, grain merchandising operations, elevators, and users of corn are likely to take cues from important grain markets, namely Toledo, Gulf, and Illinois River, in developing basis quotes for their specific location. Therefore, markets such as Toledo, Gulf, and Illinois River, likely play an important role in discovering the basis for other markets. This is idea is probably best illustrated and most obvious when considering the causal relationships between Denver corn basis and the export and river terminals examined. Since Denver is clearly not in the corn belt, elevators, merchandisers, and users of corn in the Denver AMS reporting region are likely to look to a major grain marketing location, such as the Illinois River, to serve as a benchmark in determining the local basis, and then adjust for local market conditions.

An interesting result of this research is the dominant role that Toledo is found to play in discovering the basis for other locations. Indeed, considering the flow of causality from Toledo to other markets (Figures 1 and 2), the evidence suggests that the Toledo export terminal market plays a critical role in discovering the corn basis for other markets. Interestingly, Toledo is found to lead both Gulf and Illinois River locations, which have also been found to lead other terminal and interior locations. Given the direction of causality found, the Illinois River and Gulf locations may serve as points of transmission of basis information originating from Toledo.

This research represents only an initial investigation into corn basis relationships among disperse geographic markets. There are many avenues for future research. First and foremost, a further examination into the role that Toledo plays in discovering the basis for other markets is warranted. Indeed, the finding that Toledo plays such an important role is a bit counterintuitive given the quantity of grain shipped out of Toledo relative to the Gulf export market. However, Toledo was a major Chicago Board of Trade corn futures delivery point prior to 2000 when all corn delivery points were re-designated to certified elevators on the Illinois River. As well, Toledo is a major export terminal for corn shipped to Rotterdam, Netherlands. It may be the case that the Toledo corn basis is influenced by the Rotterdam basis, a major export destination for U.S. corn, with this information then transmitted through Toledo to other markets. Furthermore, additional market locations should be examined, especially additional river terminal locations (e.g., St. Louis) and a broader set of interior locations. Since AMS cash price data for interior locations such as S. Central Illinois represent a survey of local elevator bids, different elevators may develop their basis quotes in different ways. Namely, some elevators may look to (say) the Illinois River basis and make the necessary adjustments, while other elevators may determine their basis differently. Therefore, testing the basis causality relationships between major export or river terminal markets and basis determined at individual county elevators would be an interesting and important extension to this research. Also, while the evidence presented here suggests that the Toledo corn basis leads several of the alternative market locations examined, the impact of this causality is not known. For instance, while Toledo is found to lead interior locations such as N. Central Iowa, it may be that elevators in the region do not look directly to Toledo per se, but to closer locations such as the Illinois River. Conducting in-depth interviews with elevator operators may help in better understanding how basis is determined for various markets.

This research is important from both an academic and practical perspective. First, the notion that the local basis simply follows a dominant basis location, baring minor adjustments (e.g., transportation and quality differentials), has considerable ramifications for how applied economists should approach modeling and forecasting the basis. For instance, many prior basis forecasting models may be misspecified due to an important omitted variable which proxies the behavior of the basis at the leading market. Recently, it has been suggested that economists move away from explicitly predicting prices, and focus attention on forecasting basis (Brorsen and Irwin). That is, price forecasts can be formulated using prevailing futures prices and the expected basis (Kastens, Jones, and Schroeder). Indeed, accurate and meaningful basis forecasts are critical in developing successful risk management and marketing strategies (Tomek and Peterson). Furthermore, this research should be of interest to farmers and extension economists given that posted county prices for loan deficiency payments are calculated based on cash prices at terminal market locations. Most importantly, however, this research adds to the body of literature examining basis behavior – an important and needed avenue of inquiry for agricultural economists (Tomek; Tomek and Peterson).

Table 1. Granger Causality Tests: Export Terminal and River Terminal Locations

Null Hypothesis (X does not cause Y)[1]	Lag Structure (m,n)	p-value
Gulf does not lead Illinois River	1,11	0.0100
Illinois River does not lead Gulf	3,11	0.0013
Gulf does not lead Omaha	4,11	0.0004
Omaha does not lead Gulf	11,2	0.2699
Toledo does not lead Illinois River	11,9	0.0000
Illinois River does not lead Toledo	11,1	0.6955
Toledo does not lead Omaha	4,11	0.0000
Omaha does not lead Toledo	11,1	0.3605

[1] Causality test is of the form $Y_t = \alpha + \sum_{i=1}^{m} \lambda_i Y_{t-i} + \sum_{j=1}^{n} \theta_j X_{t-j} + w_t$ where the lag structure specified for each OLS regression is m,n. Y_t and X_t are defined are the nearby basis for the respective location, where basis is defined as cash – nearby futures. The p-value is from a Wald chi-squared test of the null hypothesis that *X* does not cause *Y* ($\theta_j = 0 \ \forall \ j$). Rejection of the null hypothesis suggests that *X* does indeed lead *Y*. Each of the models is estimated using White's heteroskedasticity consistent estimator.

Table 2. Granger Causality Tests: River Terminal and Interior Locations

Null Hypothesis (X does not cause Y)[1]	Lag Structure (m,n)	p-value
Panel A:		
Illinois River does not cause S. Central Illinois	11,2	0.0006
S. Central Illinois does not cause Illinois River	1,12	0.0161
Illinois River does not cause N. Central Iowa	7,11	0.0010
N. Central Iowa does not cause Illinois River	1,11	0.0002
Illinois River does not cause Denver	7,10	0.0034
Denver does not cause Illinois River	11,12	0.3027
Panel B:		
Omaha does not cause S. Central Illinois	11,4	0.2314
S. Central Illinois does not cause Omaha	4,11	0.0000
Omaha does not cause N. Central Iowa	11,4	0.4641
N. Central Iowa does not cause Omaha	4,11	0.1917
Omaha does not cause Denver	7,4	0.2924
Denver does not cause Omaha	9,3	0.3576
Panel C:		
Illinois River does not cause Omaha	4,10	0.0008
Omaha does not cause Illinois River	11, 4	0.2808

[1] Causality test is of the form $Y_t = \alpha + \sum_{i=1}^{m} \lambda_i Y_{t-i} + \sum_{j=1}^{n} \theta_j X_{t-j} + w_t$ where the lag structure specified for each OLS regression is m,n. Y_t and X_t are defined are the nearby basis for the respective location, where basis is defined as cash – nearby futures. The p-value is from a Wald chi-squared test of the null hypothesis that X does not cause Y ($\theta_j = 0 \ \forall \ j$). Rejection of the null hypothesis suggests that X does indeed lead Y. Each of the models is estimated using White's heteroskedasticity consistent estimator.

Table 3. Granger Causality Tests: Export Terminal and Interior Locations

Null Hypothesis (X does not cause Y)[1]	Lag Structure (m,n)	p-value
Panel A:		
Gulf does not lead S. Central Illinois	11,4	0.2685
S. Central Illinois does not lead Gulf	4,11	0.3308
Gulf does not lead N. Central Iowa	2,11	0.0026
N. Central Iowa does not lead Gulf	3,11	0.1298
Gulf does not lead Denver	7,10	0.0122
Denver does not lead Gulf	11,4	0.0962
Panel B:		
Toledo does not lead S. Central Illinois	11,9	0.0000
S. Central Illinois does not lead Toledo	9,11	0.0105
Toledo does not lead N. Central Iowa	11,9	0.0000
N. Central Iowa does not lead Toledo	9,10	0.4453
Toledo does not cause Denver	7,10	0.0118
Denver does not cause Toledo	12,12	0.3982
Panel C:		
Toledo does not cause Gulf	3,11	0.0082
Gulf does not cause Toledo	9,11	0.1505

[1] Causality test is of the form $Y_t = \alpha + \sum_{i=1}^{m} \lambda_i Y_{t-i} + \sum_{j=1}^{n} \theta_j X_{t-j} + w_t$ where the lag structure specified for each OLS regression is m,n. Y_t and X_t are defined are the nearby basis for the respective location, where basis is defined as cash – nearby futures. The p-value is from a Wald chi-squared test of the null hypothesis that *X* does not cause *Y* ($\theta_j = 0 \ \forall \ j$). Rejection of the null hypothesis suggests that *X* does indeed lead *Y*. Each of the models is estimated using White's heteroskedasticity consistent estimator.

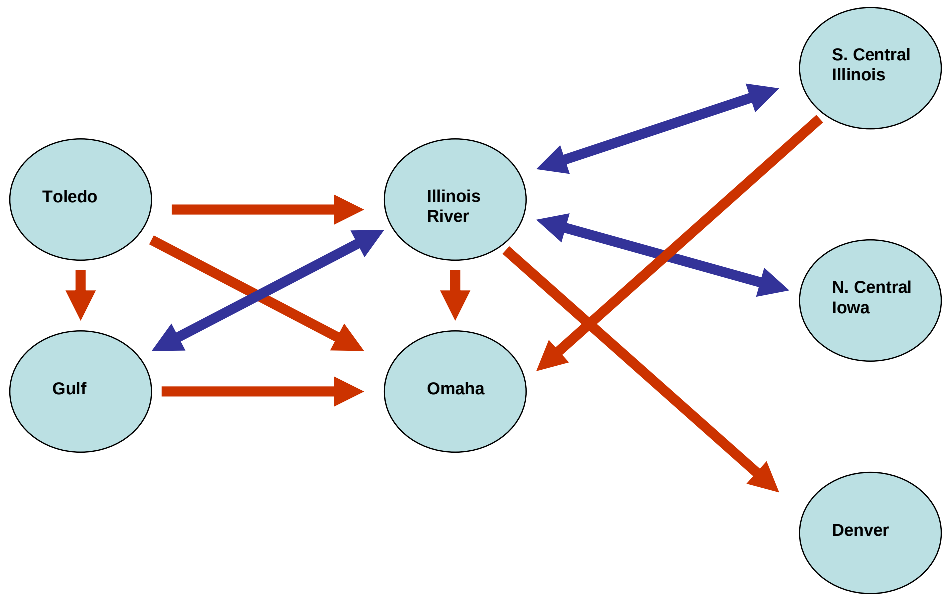

Figure 1. Summary of Causality Relationships: Gulf / River Terminals; River Terminals / Interior Locations

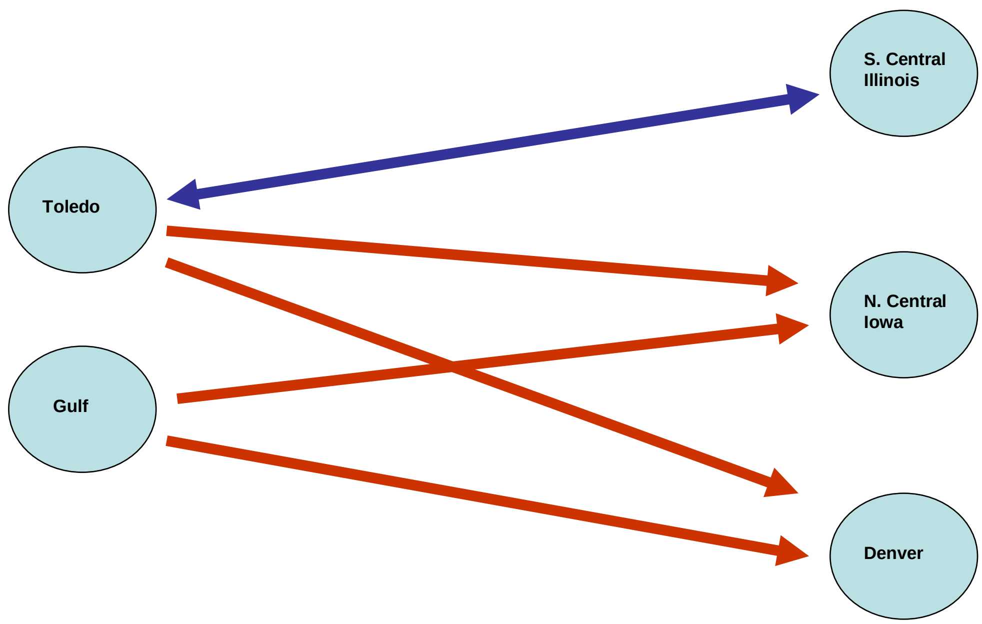

Figure 2. Summary of Causality Relationships: Gulf / Interior Locations

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