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Transition in Russia: It's Happening

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Comments Welcome

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Abstract

Working with 110 pairs of time series of state and market commodity prices in Russia, we search for signs of transition in Russia from a command to a market economy. Beginning with inter-city comparisons of state and market prices, we find that differences in the levels of these prices have gradually diminished following the 1992 Big Bang, that market/state price ratios have become increasingly uniform across cities, and that the volatility of innovations to these ratios has decreased dramatically. Further, we find widespread evidence within cities that state and market prices are co-integrated, and that market prices are causally prior to state prices, in the sense of Granger (1969). Finally, we find widespread evidence of co-integration and causality between state and market prices across cities. These findings suggest that, despite obstacles posed by resistant local governments, mafia activity and poor infrastructure, Russia's efforts to implement economic reforms have generated tangible results: the transition to a market economy appears to be well underway.

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Transition in Russia: It's Happening

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I. Introduction

In January of 1992, the federal government of Russia began the implementation of a series of reforms dubbed the "Big Bang" which were intended to bring market forces more fully to bear in determining economic activity: federally sponsored price subsidies and controls operational in the former Soviet Union were phased out or eliminated. The practical impact of these reforms remains questionable. Immediately following the Big Bang, many local governments ignored federal policy and maintained price controls in state-run stores which remained under their jurisdiction, and which continue to be operational today.[1] Indeed, federal law in some cases allowed local governments to choose between price liberalization or the maintenance of price controls (although federal subsidies to local governments who chose the latter option were withdrawn). Also, the Big Bang gave rise to powerful local mafias that, often in concert with local government officials, have attempted to take advantage of price liberalization by blocking entry into existing markets or collecting extortion rent, thus distorting trade flows and prices in various markets. Finally, the poor state of Russia's communication and transportation systems has imposed additional limitations on the ability of firms and individuals to effectively respond to market signals. Thus, a successful transition to a market economy was far from assured by the implementation of Russia's Big-Bang reforms.

Working with 110 pairs of time series of state and market food prices (five food types across 25 cities, with 15 missing pairs), we look for signs that market forces are playing an important role in determining the behavior of prices in post-Big-Bang Russia. Our analysis focuses on the relationship between state and market prices within cities, and on the interaction of these prices across cities. It is divided into three parts. First, we explore the evolution of the relationship between state and market prices within cities following the Big Bang. We find that differences in the levels of these prices have gradually diminished, that market/state price ratios have become increasingly uniform across cities, and that the volatility of disturbances to market/state price ratios has decreased dramatically. These results suggest that resistance to economic reforms encountered at the local level has diminished in importance over time: state price subsidization seems to have subsided, and movements in state and market prices have

[1]While many state-run stores have been nominally privatized following the Big Bang, local governments have often maintained effective control of these stores, a point we elaborate on below.

come to exhibit far greater correspondence. Second, we seek to further characterize the nature of the interaction between state and market prices within cities by conducting co-integration and Granger (1969) causality tests. We find widespread evidence in favor of co-integration, hence disturbances to market/state price ratios are generally characterizable as transitory. We also find widespread evidence that market prices are causally prior to state prices, suggesting that state prices are responsive to changes in market conditions, as represented by innovations to market prices. There are also many cases in which state prices are causally prior to market prices, or in which feedback exists between the two series, suggesting instances in which the state has a statistically quantifiable degree of market power. In only a limited number of cases do we fail to detect at least unidirectional causality between state and market prices. Third, we seek to assess the degree of interaction exhibited by state and market prices across cities, again by conducting co-integration and causality tests. We find widespread evidence of co-integration and causality between both types of prices across cities: important economic linkages seem to exist between the local economies encompassed in our study. These findings suggest that, despite obstacles posed by resistant local governments, mafia activity and poor infrastructure, Russia's efforts to implement economic reforms have generated tangible results: the transition to a market economy appears to be well underway.

Our analysis is complementary to related empirical work by Gardner and Brooks (1993), De Masi and Koen (1996), and Goodwin, Grennes and McCurdy (1996), who also sought to quantify the impact of the economic reforms of the Big Bang by studying the behavior of prices in Russia. The first two of these papers focused primarily on differences in the level of food prices across cities within Russia. Using data spanning the first seven months following the Big Bang, Gardner and Brooks found substantial regional differences in prices for a broad range of goods, a finding they in part attributed to regional resistance to economic reform. Using a data set extended through 1994, De Masi and Koen found that regional price differences in Russia have diminished over time, but nevertheless remain large by international standards. They also found that prices of food staples in Russia have approached international standards following the Big Bang, but nevertheless remain low, a finding they attributed in part to lingering price subsidization at the local government level. (However, they noted that the remaining gap "... is consistent with the well-known positive correlation [across countries] between per capita income and price levels." [p.115]) Relative to these two studies, our focus on interactions between prices within Russia yields an alternative perspective on the economic reforms of the Big Bang that casts their effectiveness in a more favorable light: the subsidence of differences in the behavior of state and market prices within and across cities is suggestive of the diminishing importance of local-government resistance to economic reform; and the transmission of market disturbances to state prices within cities, and to market prices across cities, is suggestive of a higher degree of market integration than is indicated by comparisons of price levels.

The study by Goodwin et al. is closely related to the third part of our study; like us, they analyze co-integration and causal relationships between food prices across cities in Russia to assess the strength of economic linkages between local markets.[2] The main difference between their study and this aspect of ours is in the data. They study price behavior in retail outlets and "gray markets"; their retail prices are a combination of the state and market prices that we treat as being distinct here, and their gray-market prices are taken from more transitory sources (e.g., trade booths and street traders). Also, their data run from June of 1993 through December of 1994, and come from five cities that are highly dispersed geographically; our data run from February of 1992 through February of 1995, and come from 25 cities that are relatively tightly dispersed geographically (all are located either in the Central or Volga regions). Goodwin et al. find extensive, although not universal, evidence of co-integration and causality across cities between their retail prices, but less widespread evidence for their gray-market prices. Relative to their results for retail prices, we find more widespread evidence of co-integration and causality between both state and market prices across the cities in our sample. This difference is presumably accounted for by the longer span of our data (giving the tests we conduct higher power), and the closer proximity of the cities in our sample.

Our analysis is also related, albeit more distantly, to many recent papers that have studied the cross-city behavior of consumer-goods prices. For example, Engel and Rogers (1996) examined differences in consumer-goods prices across cities in the U.S. and Canada to provide context for interpreting departures from the law of one price; they found that observed departures cannot be explained fully by distance alone: borders matter. Also, Debelle and Lamont (1997) investigated the relationship between inflation and relative price variability in consumer goods and services at the city level in the U.S.; they found that the positive relationship between these variables observed by Fisher (1981) and others at the aggregate level holds up at the city level. These papers illustrate that aggregate issues can often usefully be addressed by examining disaggregated data; we think this is true in studying transition as well.

2. Background on Pre-Big-Bang Russia

[2]The practice of conducting causality tests to evaluate linkages between markets dates at least back to Gupta and Mueller (1982); co-integration tests are also widely used for this purpose.

In order to provide context for appreciating the impact of the Big Bang reforms in Russia, we begin our analysis by providing some background information on the economic system of the former Soviet Union. Ideally, we would provide direct evidence on the impact of the reforms by performing our statistical analysis using pre- and post-Big-Bang price data. Unfortunately, we have been unable to compile a high-quality data set of pre-Big-Bang prices, hence we employ institutional evidence and theoretical analyses to characterize the role and behavior of prices in the former Soviet Union. Also in this section, we document several obstacles to reform that have existed in Russia following the Big Bang.

The overwhelming share of goods and services were produced and distributed within the state sector of the Soviet economy. Typically, nominal prices in this sector were fixed for long periods of time, and were set according to administrative criteria such as the location of the user and the intended use for the product. Concerning food prices, Bornstein (1987) shows that state prices for bread, pasta products, vegetable oil, basic fish products and sugar that prevailed in 1987 were virtually unchanged since 1954, and state prices for meat and dairy products had not been changed since 1962. Not only were state food prices fixed, they were also typically maintained at below-market levels. This practice encouraged people to waste time in socially inefficient activities such as queuing, reselling, lobbying and bribing (see Kornai (1980)); it also encouraged consumers to hoard durable goods, so that shortages and goods runs often occurred even when supplies appeared to be ample (see Weitzman (1991)). Finally, the practice encouraged state firms to under-supply goods in order to obtain shortage rents (see Shleifer and Vishny (1992)).

In order to mitigate the pervasive shortages which plagued the state sector, the Soviet government often tolerated private business activity in consumer markets. In the case of food, the Soviet government attempted to establish the state sector as a monopoly producer and distributor during the collectivization campaigns in the late '20s and early '30s. However, an illegal private sector flourished during this time, as the state was unable to meet the demand for food goods. Beginning in 1932 the Soviet government recognized the legality of private farmers' markets in which producers and distributors operated outside the state system; the markets quickly became among the most advanced and active markets in the Soviet Union (Gregory and Stuart ((1990)). While entry in these markets was limited by the state, private sellers were free to charge market-clearing-prices. Thus while consumers typically had to queue or make side-payments in the form of bribes or favors, or depend upon re-sellers, to obtain goods in the state sector, private-sector prices reflected a particular good's scarcity.

Through the reforms of the Big Bang, the Russian federal government rapidly lifted price controls on most goods and services: in January 1992, 90 percent of state retail prices and 80 percent of state-administered wholesale prices were legally released from government control by federal

decree.[3] However, prices of basic goods and services such as bread, milk, vegetable oil, baby foods, public transportation, etc. continued to be controlled initially. Furthermore, even though prices in the state distribution sector were raised three to fivefold, these prices were effectively administered through the imposition of markup ceilings (see Koen and Phillips (1993). The extent of price liberalization was broadened in March 1992 when the federal government issued a decree which allowed local governments to abolish price ceilings on a broad set of basic goods and services.

Since 1992, many local governments have resisted the federally mandated price-liberalization reforms. Pockets of vigorous local resistance are well documented for retail food goods during 1992-1993 (see Koen and Phillips (1993)), and nontrivial resistance has persisted beyond this initial period: in January 1995, roughly 30 percent of all goods were subject to locally initiated direct and indirect price controls (European Bank for Reconstruction and Development (1995)). Beyond controlling prices, some local governments have sought to distort trade patterns in private markets. In mid-1992, 23 oblasts that were net exporters of agricultural goods were reported to have set up trade barriers banning exports to other oblasts (see Koen and Phillips); there is also evidence that some cities issued ration tickets and coupons which limited sales of basic goods to residents. These controls, if effective, segment the market by limiting the ability of distributors and arbitragers to move goods where demand is highest. Koen and Phillips, Gardner and Brooks (1994), De Masi and Koen (1996) and Brooks et al. (1996) document unusually high measures of cross-city price dispersion within Russia; their findings seem, at least in part, attributable to local-government resistance to reform.

Along with price liberalization, the federally mandated reforms also called for the privatization of small-scale state-run retail stores: by the end of 1992, approximately one-third of these stores had been sold through auctions or tender offers (SCRFMSP Annual Report, 1992, p. 29). While privatization ostensibly transferred ownership and control of these stores to the private sector, the transfer of control has been limited in many cases by local governments (see Shleifer and Boycko (1994) and Harding (1995)). Local governments have preserved their ability to set or influence prices in privatized stores by maintaining control over the stores' access to basic utilities, and by maintaining control and ownership of commercial real estate. Harding reports that, as late as 1995, virtually all commercial real estate occupied by state and privatized firms was owned by local governments. As Shleifer and Boycko note, "... privatization of real estate has been delayed in most instances by local governments, who view

[3]Other price-liberalization efforts preceded the Big Bang. However, these reforms were only partial: bureaucrats retained broad discretion in setting and influencing prices under these earlier reforms (see Murphy, Shleifer and Vishny (1992)).

control over real estate as the most convenient mechanism for controlling both business and corruption income." [p. 79] Hence while privatization has occurred, it remains unclear whether prices in privatized retail outlets are being determined by political or market forces.

There are several explanations for local-government resistance to price liberalization. As Shleifer and Vishny (1992) note, spreads between posted state prices and market prices provide sources of potential bribe revenue for corrupt local officials and the managers whom they regulate; resistance to price reform would thus help preserve these sources. However, the introduction of competitive local elections in March 1990 forced many local politicians to become more accountable to their constituents (see Hahn (1994)). Resistance to reform in these regions could reflect attempts to win constituent loyalty (as Berkowitz (1996) suggests), or efforts to transfer income to the regions' poorest citizens (as Polterovich (1993) suggests). Finally, Murrell, Korsun and Turner (1992) note that policy makers, facing "...a disastrous and largely unintelligible economic environment..." [p.19], may have resisted reform simply to maintain policies which they understood.

Local mafias have also posed obstacles to reform. Many private producers and distributors have confronted racketeering activity designed either to block entry into existing markets or to generate extortion rent. The following passages from the Russian press exemplify the problem:

> 'It really is scary, but despite the fact that the markets are empty, it's still impossible to sell your produce' in Moscow, St. Petersburg and other large Russian cities, said Tatyana Vasilyeva, president of the local Krasnodar branch of AKKOR, which represents 16,680 private farmers. Highway robbers, traffic police who demand payola in exchange for free passage and payoffs to local gangsters make a mockery of a free market, she said...
>
> Melnik, the Krasnodar farmer, said his cooperative sent a truck of tomatoes to Moscow, but farmers were stopped at the outskirts of the city, where racketeers together with corrupt traffic police insisted that the contents of the truck be handed over at rock-bottom prices.
>
> If you do get through, they tell you what price you can sell for, and no lower,' Melnik said. The complaints of beatings, threats and price-fixing have been repeated by farmers from Siberia to central Russia. [Effron, 1994]

Thus, mafia groups, often in concert with corrupt local government officials, have blocked trade flows and entry in an effort to extract extortion rents.

The transport sector has presented another barrier to market integration in Russia (see Holt (1993) and Joskow, Schmalensee and Tsukanova (1994)). Railroads are the most important form of freight transport: net of shipments of petroleum products via pipelines, railroads carry roughly 90 percent of the ton-kilometers of freight transport in Russia (comparable figures for the U.S. and Western Europe are 40 and 10 percent). While railroads have traditionally moved large loads of goods such as coal and steel over long distances, approximately 18 percent of Russian freight is moved over short distances of up to 100 kilometers. As Joskow et al. note, it is difficult to transport goods between regions using the rail system, as it

> ... is poorly adapted to quick delivery of a broad range of 'light' manufactured products and consumer goods. Shipments must typically be scheduled months in advance, and pickup and delivery dates are nonetheless uncertain. The breakup of the [former Soviet Union] has apparently caused major problems for the railroad system, which along with its system of specialized suppliers, was planned and operated as an integrated whole. [p. 323]

Trucks, the second-most important form of freight transport, have traditionally been used for short trips averaging about 20 kilometers. During the reforms, many trucks previously owned by the state were privatized. Nevertheless, the common carrier remains small by world standards, and the road system is poorly maintained and unable to absorb large increases in trucking service without substantial upgrading. The state of railroads and trucking leads Joskow, et al. to conclude that the speed at which "... regional markets merge into national markets seems likely to depend importantly on the speed with which the transportation system can be modernized." [p. 324]

In sum, several factors have impeded the advance of price liberalization and market integration in Russia: resistant local governments, mafia activity, and poor infrastructure are accountable for persistent differences between state and market prices both within and across cities. However, the evidence presented in the next section suggests that, despite these impediments, market forces do seem to be playing an important role in determining the behavior of food prices: state and market prices are exhibiting increasing correspondence over time; state prices are generally responsive to changes in market prices; and price disturbances are being transmitted across cities. The next section quantifies these observations.

3. The Behavior of Food Prices in Post-Big-Bang Russia

3.1 The data.

The statistical agency of Russia has collected retail food prices on a weekly basis since January 1992 in 132 cities. The cities are located throughout each of the eleven economic regions of the Russian Federation; most of the capitals in Russia's 89 administrative regions (oblasts, krais, autonomous republics and federal cities) are represented in the sample, as are most of the cities with populations exceeding 500,000. The most comprehensive survey is of a basket of 19 basic food goods. This survey is typically conducted one day each week. Through the end of February 1995, enumerators in each city recorded posted prices in the state stores (they made no distinction between privatized and non-privatized stores), and

asked a group of sellers in the private farmers' markets for price quotes.[4] Prices of goods sold by transitory sources such as re-sellers and street traders are not reported in this survey (for information regarding data of this type, see Goodwin et al. (1996)). For the first sixteen months of the survey, enumerators also reported estimated sales volumes in the state and private farmers' markets.

We examine price data for five goods obtained from cities located in the Central and Volga economic regions. As coverage of food markets in relatively small cities is irregular, we excluded cities with populations less than 100,000 from our sample. The five goods included in our sample are beef, milk, onions, potatoes, and vegetable oil; we focus on the prices of these goods because they are the most consistently reported among the 19 goods surveyed by the enumerators: indeed, prices of the other goods are reported so sporadically that they are not amenable to time-series analysis. The Central and Volga regions are the first and third most-developed industrial regions in Russia; they are also among Russia's most densely populated and urbanized regions. We focus exclusively on these two regions because when this project was initiated, they were the only regions for which data were available. The Central region consists of the federal city of Moscow, and twelve oblasts with transport distances from Moscow ranging from 157 to 419 kilometers. All oblast capitals are included in the sample, as are two major cities, Rybinsk and Novomoskovsk, located in the Yaroslavl and Tula oblasts. The Volga region consists of six oblasts and two autonomous republics, one of which was not surveyed. All oblast and republican capitals, as well as the cities of Kamyshin, Syzran, Togliatti and Balakovo, are included in our sample. Transport distances between Moscow and the sampled cities in the Volga region range from 707 to 1068 kilometers (although the transport distance for the city of Astrakhan was not available).

Russia experienced rapid inflation during our sample period of February 1992 through February 1995 (by our calculations, approximately 2324 percent annually). Since we wish to analyze co-movements in state and market prices within and across cities, and since we are not interested in inflation as a source of co-movements, we converted our nominal price data into real terms by constructing a price deflator. This was done by computing a weighted average of the market prices of the five goods included in our sample in all 132 cities included in the Russian survey.[5] In computing the weighted average of the price of a particular good across cities, weights were assigned using sales volumes reported in February 1992.[6]

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[4] At the end of February 1995, the methodology changed and enumerators reported an average price for state stores and farmers' markets.

[5] We did not use state prices in constructing our index because they are more likely to reflect non-market activity.

[6] These weights are not much different than those reported in February of 1993. Unfortunately, volume data were not reported after April 1993.

To map the weighted averages computed for the five goods into a price-deflator index, we used Russian CPI weights reported in De Masi and Koen ((1995), Table A4): the weights for beef, milk, onions, potatoes, and vegetable oil are 2.2, 1.2, 0.5, 1, and 0.5 percent. Since we used data from all 132 cities in constructing the deflator, we encountered many missing observations in doing so: of course, missing price observations received zero weight in compiling the deflator.

In studying individual time series on prices for a particular good in a particular city (e.g., the market price for beef in Moscow), missing observations required greater care: the time-series methods employed in our study require uninterrupted observations on the individual series. By focusing on price data for a small number of goods in a small number of cities relative to those included in the Russian survey, we sought to minimize the number of instances in which we were forced to interpolate missing observations, or discard a series altogether. Nevertheless, we were forced to do some interpolation, and were also forced to discard a total of 15 pairs of series which had gaps too large to interpolate over. There are also many series for which we had missing observations at the beginning of the sample, hence we do not have all 151 observations for each of our series.

3.2 Overview of market/state price ratios.

As a preface to the discussion of our analysis, we caution that, without exception, there are exceptions to all of the generalizations of our results that we offer. In our discussion, we attempt to document the exceptions as carefully as the generalizations.

We begin our analysis by examining the behavior of within-city market/state price ratios. Figure 1 provides an initial overview of this behavior by characterizing the distribution of price ratios across cities for each date covered in our sample; the distributions for each food type are somewhat distinct, and hence are plotted separately. Four time series are plotted for each good: the median ratio, upper and lower bounds of the 80 percent coverage band for the ratios, and the ratios observed for Moscow.[7] Moscow's ratios are highlighted because their behavior is somewhat unusual, particularly in the first half of the sample period.

Early in the sample period, and for each good, the distributions lie above unity and are skewed upwards. The distributions for beef remain this way throughout the sample period, while the coverage bands of the other goods eventually contain unity. Ratios above unity may be the result of state price subsidization, or as Goodwin et al. (1996) note, may also reflect differences in product or service quality across state and market stores.

[7]At any given date, the coverage bands may be approximate rather than exact, because we do not have all 151 price observations for each good in each city.

The medians and dispersions of the distributions for beef are relatively constant throughout the sample period, a pattern which makes beef distinct from the other goods (dispersions for beef actually widen slightly after the first 40 observations). For the other goods, the dispersion of distributions is relatively low late in the sample, most noticeably for milk and vegetable oil (for which the average dispersion of distributions over the last 50 observations is less than half than the average over the first 100 observations). Also, the median ratios are relatively high early in the sample for the goods other than beef, again particularly for milk and vegetable oil. These patterns hold, but less clearly so, for potatoes and onions; the relative lack of clarity for these goods is due to the presence of large seasonal spikes which dominate their diagrams. There are three spikes (most noticeable for potatoes) which occur around observations 20, 70 and 120: these observations correspond to mid-June through mid-July. Evidently, the spikes indicate instances in which state prices failed to respond to upward market pressure, or did so only with a considerable lag. The 1994 seasonal is much less pronounced than those of 1992 and 1993 for potatoes, and is barely discernable for onions.

The primary feature of the ratios for Moscow which make them distinct relative to those observed for the other cities is their large levels. The ratios for beef are relatively high throughout the sample period (although they systematically approach the upper 80-percent bound); are extremely high for milk early in the sample period, and somewhat high late in the sample period; are also extremely high for onions and potatoes during the 1993 seasonal period; and are fairly typical for vegetable oil throughout the sample period. In the latter half of the sample period, the ratios for Moscow behave much more like those observed in the remaining cities; evidently, the local government in Moscow has responded to federal price-liberalization measures only gradually, relative to the other cities in our sample.

Continuing our analysis of the behavior of within-city market/state price ratios, we turn to an examination of the innovations to these ratios that have been realized following the Big Bang reforms. This examination indicates that an initial period of instability in the wake of these reforms has given way to a sustained period of relatively predictable movements in the price ratios: state and market prices have come to exhibit far greater correspondence over time. This is illustrated in Figures 2 and 3. Letting r_t denote the market/state price ratio of a good at time t, Figure 2 plots the time series of residuals $\{\varepsilon_t\}$ from the regression

(1) $$r_t = \gamma + \delta t + \Sigma_{i1}\rho_i r_{t-i} + \varepsilon_t;$$

these residuals represent one-step-ahead forecast errors in predicting r_t using a constant, trend, and past observations $\{r_{t-1}, r_{t-2}, ...\}$.[8] Figure 2 presents residuals obtained for the ratios of prices for beef, milk, vegetable oil and onions in Moscow. (Results for onions closely resemble those obtained for potatoes). The volatility of the residuals for each good is dramatically lower in roughly the second half of the sample relative to the first half. Once again, the 1993 seasonal period dominates the diagram for onions, but the decline in volatility following this episode is obvious nevertheless.

The volatility patterns observed for Moscow are representative of those observed for the other cities, a point we illustrate in Figure 3. Let η_t denote the variance of the residuals in (1) computed using the first t observations in the sample, expressed as a percentage of the variance of the residuals in (1) computed using the entire sample period (which terminates in period T):

(2) $$\eta_t = 100*\text{var}(\varepsilon_{p+1}, \varepsilon_{p+2}, ..., \varepsilon_t)/\text{var}(\varepsilon_{p+1}, \varepsilon_{p+2}, ..., \varepsilon_T).$$

For each good, Figure 3 depicts the behavior of η_t for t = 50, 51,..., 151. In order to clearly illustrate the mapping from the behavior of $\{\varepsilon_t\}$ into the behavior of $\{\eta_t\}$, the diagrams on the right side of Figure 3 illustrate the values of $\{\eta_t\}$ obtained using the residuals depicted in Figure 2 for Moscow; the diagrams on the left side of Figure 3 depict average values of $\{\eta_t\}$ computed using each of the cities in the sample. The top diagrams depict the behavior of $\{\eta_t\}$ for beef, milk, and vegetable oil. They illustrate clearly the decline in volatility described above: the η's lie above 100 percent throughout the sample period covered in these diagrams, and begin a roughly monotonic decline no later than the last third of the sample. The bottom diagrams depict the behavior of $\{\eta_t\}$ for potatoes and onions; they too illustrate the decline in volatility described above, but the presence of the 1993 seasonal spikes makes them less straightforward to interpret. Prior to the 1993 seasonal, the η's lie below 100 percent; this belies the fact that the residuals prior to this period are actually substantially more volatile than those observed following this period (a pattern of behavior clearly illustrated in Figure 2 for Moscow, and which holds generally for the other cities in the sample). The η's increase sharply during the 1993 seasonal period; thereafter, they decline monotonically for Moscow, and roughly monotonically for the 25-city averages (note that the 1994 seasonal temporarily reverses η's decline for potatoes in the 25-city average).

The overviews offered in Figures 1 - 3 suggest the emergence of relatively stable relationships between state and market prices. Within-city differences in these prices have declined, albeit undramatically; market/state price ratios have become increasingly uniform across cities; and the

[8]Here and throughout the paper, the lag length p is determined using the Schwarz (1978) criterion.

volatility of disturbances to these ratios has declined dramatically throughout the cities in the sample. The relatively high degree of correspondence that state and market prices have come to exhibit across cities suggests the subsidence of resistance by local governments to federal price-liberalization initiatives.

3.3 The dynamic interaction of prices within cities.

We now turn to an assessment of the dynamic interaction of state and market prices within cities, with an eye towards determining whether state prices can be viewed as being responsive to changes in market conditions, as represented by innovations to market prices. The primary statistical tool we use to address this question is Granger's (1969) test of causality; the notion of causality is well known, and hence summarized here only briefly. In short, a variable (e.g., the market price of beef) is said to Granger cause another (e.g., the state price) if lagged observations of the market price can be used to improve upon forecasts of the state price obtained using only lagged observations of the state price. Causality tests thus amount to tests of exclusion restrictions in vector autoregressions (VARs). In the above example, the null hypothesis is that the market price does not cause the state price; it is tested by regressing the state price on lagged values of itself and lagged values of the market price, and testing the statistical significance of the market-price coefficients. If the market-price coefficients are significant, the null hypothesis is rejected and the market price is said to cause the state price. We test for significance using the Wald statistic, which is asymptotically distributed as χ^2 given the stationarity of the variables under investigation.

If the variables under investigation are integrated rather than stationary, potential problems arise with the testing strategy outlined above.[9] In this case, unless there exists a linear combination of the variables that is stationary -- i.e., unless the variables are co-integrated -- the Wald statistic will have a nonstandard asymptotic distribution when used to test for Granger causality. Given integration, and lacking co-integration, an appropriate strategy in testing for causality involves applying the Wald test to *first differences* of the data; the usual asymptotic χ^2 distribution for the Wald statistic is relevant in this case. Alternatively, if the individual series are stationary, or jointly co-integrated, an appropriate strategy in testing for causality involves applying the Wald test to *levels* of the data. The usual asymptotic χ^2 distribution for the Wald statistic is relevant in working with levels of the data in either of these cases; moreover, it is inappropriate to work with differenced data in either of these cases, as the asymptotic

[9]Briefly, a time series is said to be integrated if the impact of innovations to the series do not subside over time. If this is the case, the variance of the series will increase linearly with time, hence the series will be nonstationary.

distribution of the Wald statistic is rendered nonstandard due to the problem of overdifferencing (see Watson (1994) for a detailed discussion of these points).

Mindful of these considerations, we pursued the following strategy in our analysis. First, we tested the null hypothesis of integration for logged values of the individual series. (We worked with logged data throughout the remainder of our analysis.) Unfortunately, integration tests have low power against relevant stationary or trend-stationary alternatives, and hence are limited in the quality of information they can convey.[10] We obtained rejections of the integration hypothesis at the 10 percent significance level for 66 series (30 percent of the total), a rejection pattern consistent with the possibility that each of the series in our sample is in fact stationary, either in levels or around a deterministic trend.[11] Nevertheless, wishing to be conservative regarding the issue of integration, we interpret these results at face value: they fail to provide much evidence against the integration hypothesis.

Next, we conducted the Johansen (1988) and Stock-Watson (1988) co-integration tests for each market-state price pair in our sample. The null hypothesis in these tests is that the series are integrated, but not co-integrated; given a rejection of the null, the series are said to be co-integrated. Here, we adopted the inference of co-integration for any market-state price pair for which we obtained a rejection of the null at the 10 percent significance level using either test. Table 1 details our results in the following manner. The table comprises five pages, one for each good; each page has 25 rows of numbers, one for each city. Cities for which we failed to obtain a rejection of the no-co-integration hypothesis are denoted by asterisks. For the 110 price pairs in our sample, we obtained only 26 nonrejections, hence 76 percent of the pairs were deemed to be co-integrated. Milk prices accounted for 14 of the nonrejections, making the behavior of these prices distinct relative to the others. (Recall from Figure 1 that market/state price ratios for milk are also quite high relative to the other goods, particularly early in the sample period.) Aside from milk, these results suggest that disturbances to market/state price ratios are generally characterizable as transitory.

Given the integration of the individual series, the extensive evidence in favor of co-integration we obtained is indicative of the presence of at least a unidirectional causal relationship between market and state prices, a point made by Granger (1988). However, we do not wish to push this

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[10]We tested for integration using the augmented Dickey-Fuller test; see DeJong, Nankervis, Savin and Whiteman (1992) for a discussion of the power problems suffered by this and related tests for integration.

[11]To conserve space, we do not report these tests in detail; a detailed report of the complete set of results obtained in this study is available upon request.

argument too hard: lacking integration, co-integration obtains trivially, even if the series are independent. The primary motive in conducting these co-integration tests was to obtain guidance concerning whether to conduct our causality tests using levels or first differences of the data: causality tests were performed on levels of the series for which we obtained rejections of the no-co-integration hypothesis; the remaining series were analyzed using first differences.

Table 1 details the results of our causality tests by reporting pairs of p values obtained for each city in testing the null that the market price does not cause the state price, and that the state price does not cause the market price. For each good, Table 1 also includes two sets of summaries. First, there is a summary column with the heading "Conclusion": if the market price of a good in a particular city was found to cause the state price at the 20 percent significance level, we concluded that "market causes state"; if the opposite causal pattern was found, we concluded that "state causes market"; if causality was found to run in both directions, we concluded the existence of "feedback"; and if we failed to find causality in either direction, we concluded "no causality". Second, there is a summary paragraph which tallies the number of instances of each of these four possibilities obtained across cities for each good at both the 20 and 10 percent significance levels. (In this summary, an instance of feedback would generate three tallies: one for "m causes s", one for "s causes m", and one for "feedback".)[12] So Table 1 presents details of our results, and summaries of these results across cities for each good. To augment this information, Table 2 summarizes our co-integration and causality results across goods for each city; this is done in an effort to identify cities in which local governments or other factors may be responsible for the existence of weak linkages between market and state price activity. Finally, Figure 4 presents a visual summary of our causality results by presenting scatter diagrams of p-value pairs obtained for each good: p values for the hypothesis "m does not cause s" are plotted on the horizontal axes, and p values for the hypothesis "s does not cause m" are plotted on the vertical axes. Hence clusters of points in the south and west portions of these plots denote evidence of causality; clusters in the southwest portion denote evidence of feedback.

Several features of the causality results are noteworthy. Mindful of the caveat concerning behavioral linkages between co-integration and causality results mentioned above, we nevertheless find it interesting that the results of the causality and co-integration tests exhibit close correspondence: we obtained extensive evidence of at least unidirectional causality between market and state prices, particularly for instances in

[12]We focus on 20 as well as 10 percent significance levels in our summaries in order to obtain greater protection against spurious nonrejections of the no-causality null hypothesis, which for us amounts to a type-1 error. Of course, since Table 1 gives a complete report of the p values we obtained, the reader can generate summaries using significance levels of his or her own choosing.

which the no-co-integration hypothesis was rejected. Indeed, we failed to find at least unidirectional causality in only 16 instances; in 11 of these instances, we also failed to find evidence of co-integration. (Once again, milk is the leading culprit, accounting for 7 of the 16 instances; beef accounts for an additional 5 instances.) Concerning the direction of causality, we found widespread evidence that "m causes s": 84 instances, or 76 percent of the total (note that the rate is only 50 percent for milk, and 63 percent for beef). In 40 of these instances, we also found that "s causes m", and hence feedback was concluded to exist. We obtained 50 total instances in which "s causes m" (45 percent), but only 10 instances in which "s causes m" exclusively (beef and milk account for 9 of these instances). Hence state prices are widely responsive to changes in market prices; further, state and market prices frequently interact, and it is rarely the case that "s causes m" exclusively. Figure 4 illustrates each of these patterns quite clearly: note in particular the clusters located in the western portions of the diagrams for onions, potatoes, and vegetable oil.

Private markets are a relatively unimportant source of milk in the cities included in our sample; this perhaps accounts for the exceptional behavior of milk described above. We have rather spotty data on private and state market shares for the commodities and cities in our sample (recall that these data cover roughly the first half of our sample period). According to these data, the private market share of milk was only 10 percent during this period, while the private market shares of beef, potatoes, onions and vegetable oil were 62, 53, 40 and 37 percent.

Turning to the summary across goods provided in Table 2, we identify eight cities in which relatively weak linkages exist between market and state prices: Moscow and Smolensk in the Central Region, and Kamyshin, Kazan, Penza, Samara, Togliatti, and Ulyanovsk in the Volga Region. In each of these cities, there are at least two goods for which we fail to find causality between state and market prices; in six of these eight cities, we also fail to find co-integration between state and market prices for at least two goods. These eight cities account for 13 of the 16 instances in which we fail to find at least unidirectional causality between market and state prices; they also account for 17 of the 26 instances in which we fail to find evidence that "m causes s". Hence if local resistance to federal price-liberalization initiatives accounts for our failure to detect statistically significant linkages between state and market prices, this resistance seems relatively isolated.

Interestingly, these eight cities are generally located in administrative regions in which shares of budgetary expenditures allocated to food subsidies were high relative to the other local governments represented in our sample.[13] Average shares were 4 and 2 percent in 1992 and 1993. In 1992, seven of the eight cities were above average (Penza providing the exception). Notably, Smolensk oblast, whose capital city is Smolensk, had

[13]Data on regional-government budgets in 1992 and 1993 are taken from World Bank (1995, Annex 1, Table A.7); data for 1994 and 1995 are not yet available.

the highest share in the Central region (3.54 percent); Samara oblast, which contains the cities of Samara and Togliatti, had the highest share in the Volga region (11.29 percent). In 1993, five of the eight cities were above average (Moscow, Smolensk, and Penza providing the exceptions). Notably, Ulyanovsk oblast, whose capital city is Ulyanovsk, had a share of 12 percent.

Ulyanovsk is notorious for maintaining price controls: it typically has the cheapest prices of basic food goods in Russia (Centre for Economic Analysis (1995), pp.36-37). In December of 1994, the average cost per person per month of the basket of nineteen basic food goods was 107,100 rubles in Russia; in Ulyanovsk, the cost was 50,400 rubles (the cost in the next-cheapest region was 69,500 rubles). In interviews with Ulyanovsk's permanent representative to the Russian President, Solnick (1996) learned that administrators in Ulyanovsk maintain low food prices by coercing manufacturers within the oblast to sell portions of their output at artificially low prices. These manufactured goods are then bartered to buy basic foods, or sold to pay for the food subsidies. In order to block non-residential consumption, ration coupons are issued to residents for purchase of subsidized food goods.

We conclude this section with some additional details regarding our causality tests. First, due to the heteroskedasticity exhibited by the data (recall Figures 2 and 3), we employed White's (1980) heteroskedasticity-consistent estimator of the covariance matrix of the VAR parameters in conducting our tests. (Use of this estimator turned out to have a mild impact on our results.) Second, series for which we failed to reject the no-co-integration hypothesis were evaluated in levels as well as differences: we obtained similar results using levels, hence problems potentially associated with overdifferencing seem to be of little concern here. Third, we reconducted our tests using VAR lag lengths selected using the Akaike (1973) information criteria, and obtained similar results. Finally, following Goodwin et al. (1996), we tested for causality using the approach recommended by Dolado and Lutkepohl (1995) for co-integrated systems, and again obtained similar results.[14] Hence our results seem rather robust: statistically important linkages seem to exist between market and state prices within cities, and market prices are in general causally prior to state prices.

3.4 The dynamic interaction of prices across cities.

[14]Given the selection of p lags for the VAR, the approach involves estimating the VAR using p+1 lags, and testing the significance of the first p lags using the Wald test.

To assess the degree of interaction exhibited by state and market prices across cities, we repeated the co-integration and causality tests described above for each good using every possible combination of cities in our sample. Evidence of causality in this analysis would indicate that price disturbances are being transmitted across these cities, suggesting the existence of important economic linkages between them. There are 25*(25-1)/2 = 300 possible city pairs to consider for each good, although recall that we do not have data for all goods in all cities. We tested for co-integration and causality between market prices for each city pair, as well as between state prices. The results we obtained for state prices closely resemble those obtained for market prices, hence we report only those results obtained for market prices to conserve space. Our results are reported in Table 3 and Figure 5.

Figure 5 presents scatter plots of pairs of p values obtained in testing for causality between market prices for each city pair. There are three plots for each good: plots of comparisons of cities only in the Central Region, of cities only in the Volga Region, and of all cities. As in Figure 4, clusters of points in the south and west portions of these plots denote evidence of causality; clusters in the southwest portion denote evidence of feedback. Table 3 reports the number of city comparisons which yielded inferences of co-integration, as well as at least unidirectional causality. Like the figure, the table reports results obtained within and across regions.

Several aspects of these results are notable. First, instances of co-integration and causality do not correspond as highly in this analysis as they did in the within-city comparisons. For example, we rejected the no-co-integration hypothesis in 92 percent of the comparisons made for market beef prices, but found at least unidirectional causality at the 20 percent level in only 50 percent of these comparisons. This skewed pattern of results is reversed for milk prices: we obtained only a 51 percent rejection rate of the no-co-integration hypothesis for these prices, but found at least unidirectional causality in 73 percent of these comparisons. Second, we found widespread evidence of linkages between market prices across cities (and again, we found similar evidence for state prices). Indeed, the 50 percent causality result noted above for beef is by far the lowest we obtained for the five goods: the percentages for milk, onions, potatoes, and vegetable oil are 73, 80, 85 and 89. (The rejection rate of the no-co-integration hypothesis reported above for milk is also the lowest we obtained for the five goods.) We find these numbers particularly striking, since we have made no effort to restrict our cross-city comparisons to cities with direct trade linkages. Third, the results of the regional cross-city comparisons are roughly comparable to the results obtained across all cities: market disturbances seem to be transmitted both within and across regions. Finally, the percentages reported in Table 3 are only slightly altered, and do not always increase, if the eight cities identified in the within-city analysis as

exhibiting relatively limited market-state price interactions are excluded in these cross-city comparisons. Hence the absence of correspondence between market and state prices within cities does not seem to coincide with the absence of market and state price linkages across cities.

4. Conclusion

The sweeping economic reforms initiated by the federal government of Russia in 1992 were designed to bring market forces more fully to bear in determining economic activity there. We have sought to quantify the role that market forces are playing in determining the behavior of food prices in the wake of these reforms, and have found considerable evidence which suggests that this role is substantial. We have reached this conclusion for three reasons. First, we have found that food prices in state-run stores have come to closely resemble prices in private retail outlets: differences in the levels of state and market prices within cities have gradually diminished following the Big Bang; market/state price ratios have become increasingly uniform across cities; and the volatility of disturbances to market/state price ratios has decreased dramatically. These results suggest that resistance to economic reforms encountered at the local level has diminished in importance over time: state price subsidization seems to have subsided, and movements in state and market prices have come to exhibit far greater correspondence. Second, we have found widespread evidence that disturbances to market/state price ratios within cities are generally characterizable as transitory, and that market prices are causally prior to state prices, suggesting that state prices are responsive to changes in market conditions, as represented by innovations to market prices. Third, we have found widespread evidence of causal relationships between state and market prices across cities, suggesting the presence of important economic linkages between the local economies encompassed in our study. Hence despite obstacles posed by resistant local governments, mafia activity and poor infrastructure, Russia's efforts to implement economic reforms have generated tangible results.

We conclude by mentioning some caveats associated with this study. First, the scope of our data, and hence our findings, is limited to only five food types in two regions of Russia. Second, market signals may not be perfectly conveyed by the behavior of the market prices we examine: the market stores from which the data were gathered are subject to local regulations, taxes, extortionary pressures, etc. However, we found widespread evidence supporting the causal priority of market prices over state prices within cities, and linkages between market prices across local boundaries *despite*, not due to, this caveat. Finally, we do not have comprehensive evidence concerning the time-series behavior of state and market prices in pre-Big-Bang Russia, hence it is not possible to cleanly tell a before-and-after story. However, the evidence we do have of the "before" part of the story clearly indicates that state prices were subsidized, and unresponsive to market forces. Equally clearly, this is no longer the case.

5. References

Akaike, H. (1973), "Information Theory and an Extension of the Maximum Likelihood Principle", in B.N. Petrov and F. Csaki, eds., *2nd International Symposium on Information Theory*, 267-281, Adademiai Kiado: Budapest.

Berkowitz, D.M. (1996), "On the Persistence of Rationing Following Liberalization: A Theory for Economies in Transition", *European Economic Review* 40: 1259-1279.

Bornstein, M. (1987), "Soviet Price Policies", *Soviet Economy* 3: 96-134.

Brooks, K., E. Krylatykh, Z. Lerman, A. Petrikov and V. Uzun (1996), *Agricultural Reform in Russia: A view from the Farm Level*. World Bank Discussion Papers, World Bank, Washington D.C.

Centre for Economic Analysis (1995), *Russia - 1995: Economic Situation*, Issue 4.

Debelle, G., and O. Lamont (1997), "Relative Price Variability and Inflation: Evidence from U.S. Cities", *Journal of Political Economy* 105 (1): 132-152.

DeJong, D.N., J.C. Nankervis, N.E. Savin and C.H. Whiteman, (1992) "The Power Problems of Unit Root Tests in Time Series with Autoregressive Errors", *Journal of Econometrics* 53: 323-343.

De Masi, P. and V. Koen (1995), "Relative Price Convergence in Russia", *IMF Working Paper,* May.

___ (1996), "Relative Price Convergence in Russia", *IMF Staff Papers* 43: 97-122.

Dolado, J.J. and H. Lutkepohl (1995), "Making Wald Tests Work for Cointegrated Systems", unpublished manuscript, Humboldt University, Berlin.

Effron, S. (1994), "Russia's Breadbasket Hit by Mafia, Marketing", *Moscow Times*, 23 June, p.12.

Engel, C., and J.H. Rogers (1996), "How Wide the Border", *American Economic Review* 86: 1112-1125.
European Bank for Reconstruction and Development, (1995), *Transition Report 1995*, London.

Fisher, S. (1981), "Relative Shocks, Relative Price Variability and Inflation", *Brookings Papers on Economic Activity* 2: 381-431.

Gardner, B. and K. Brooks (1994), "Food prices and market integration in Russia: 1992-93", *American Journal of Agricultural Economics* 76: 641-66.

Goodwin, B.K., T.J. Grennes and C. McCurdy (1996), "Spatial Price Dynamics and Integration in Russian Food Markets", unpublished manuscript, North Carolina State University, Raleigh.

Granger, C.W.J. (1969), "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods", *Econometrica* 37: 424-438.

___ (1988), "Some Recent Developments in the Concept of Causality", *Journal of Econometrics* 39: 199-211.

Gregory, P.R. and R.C. Stuart (1990), *Soviet Economic Structure and Performance*, Fourth Ed. Harper Collins: New York.

Gupta, S. and R. Mueller (1982), "Analysing the Pricing Efficiency in Spatial Markets: Concept and Application", *European Review of Agricultural Economics* 9: 24-40.

Hahn, J.W. (1994), "Reforming Post-Soviet Russia: The Attitudes of Local Politicians", J.W. Hahn and T. Friedgut, eds., *Local Power and Post-Soviet Politics*, 208-238. M.E. Sharpe: Armonk.

Harding, A.L. (1995), "Commercial Real Estate Market Development in Russia", CFS Discussion Paper #109, World Bank, Washington D.C.

Holt, J. (1993). *Transport Strategies for the Russian Federation*. The World Bank: Washington, D.C.

Johansen, S.J. (1988), "Statistical Analysis of Cointegration Vectors", *Journal of Economic Dynamics and Control* 12: 231-254.

Joskow, P.L., T. Schmalensee, and N. Tsukanova (1994), "Competition Policy in Russia During and After Privatization", *Brookings Papers on Economic Activity: Microeconomics*, 301-381.

Koen, V. and S. Phillips (1993), "Price Liberalization in Russia: Behavior of Prices, Household Incomes, and Consumption During the First Year", *International Monetary Fund Occasional Paper* #104, June, Washington D.C.

Kornai, J. (1980), *Economics of Shortage*. North Holland: Amsterdam.

Murphy, K., Shleifer, A. and R. Vishny (1992), "The Transition to a Market Economy: Pitfalls of a Partial Reform", *Quarterly Journal of Economics* CVII: 889-906.

Murrell, P., K.T. Dunn and G. Korsun (1992),"The Culture of Policy Making in the Transition from Socialism: Price Policy in Mongolia", *IRIS Country Report*, Working Paper No. 32. Forthcoming in *Economic Development and Cultural Change*, 1996.

Polterovich, V.M. (1993), "Rationing, Queues, and Black Markets", *Econometrica* 61 (1): 1-28.

Schwarz, G. (1978), "Estimating the Dimension of a Model", *The Annals of Statistics* 6: 461-464.

Shleifer, A. and M. Boycko (1994), "Next Steps in Privatization: Six Major Challenges", in I.W. Lieberman and J. Nellis, eds., *Russia: Creating Private Enterprises and Efficient Markets*, 75-86, The World Bank: Washington D.C.

Shleifer, A. and R. Vishny (1992), "Pervasive Shortages Under Socialism", *Rand Journal of Economics* 23: 237-46.

SSolnick, S. (1996), "The Political Economy of Russian Federalism: A Framework for Analysis," *Problems of Post-Communism* 43: 13-25.

State Committee of the Russian Federation for the Management of State Property, 1992 Report, Moscow.

Stock, J. and M.K. Watson (1988), "Testing for Common Trends", *Journal of the American Statistical Association* 83: 1097-1107.

Watson, M.K (1994), "Vector Autoregressions and Cointegration", R.F. Engle and D.L. McFadden, eds., *Handbook of Econometrics, Vol. IV*, 2844-2915. Elsevier Science B.V.: Amsterdam.

Weitzman, M.L. (1991), "Price Distortion and Shortage Deformation, or What Happened to the Soap?", *American Economic Review* 81: 401-414.

White, H. (1980), "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity", *Econometrica* 48: 817-838.

World Bank (1995), *Fiscal Management in the Russian Federation*, Report No. 14862-RU, Country Operations Division II, Country Department III, Europe and Central Asia Region.

Figure 1

Market/State Price Ratios, Beef
Key: Lines = Median, 80% Coverage Band; Dashes = Moscow

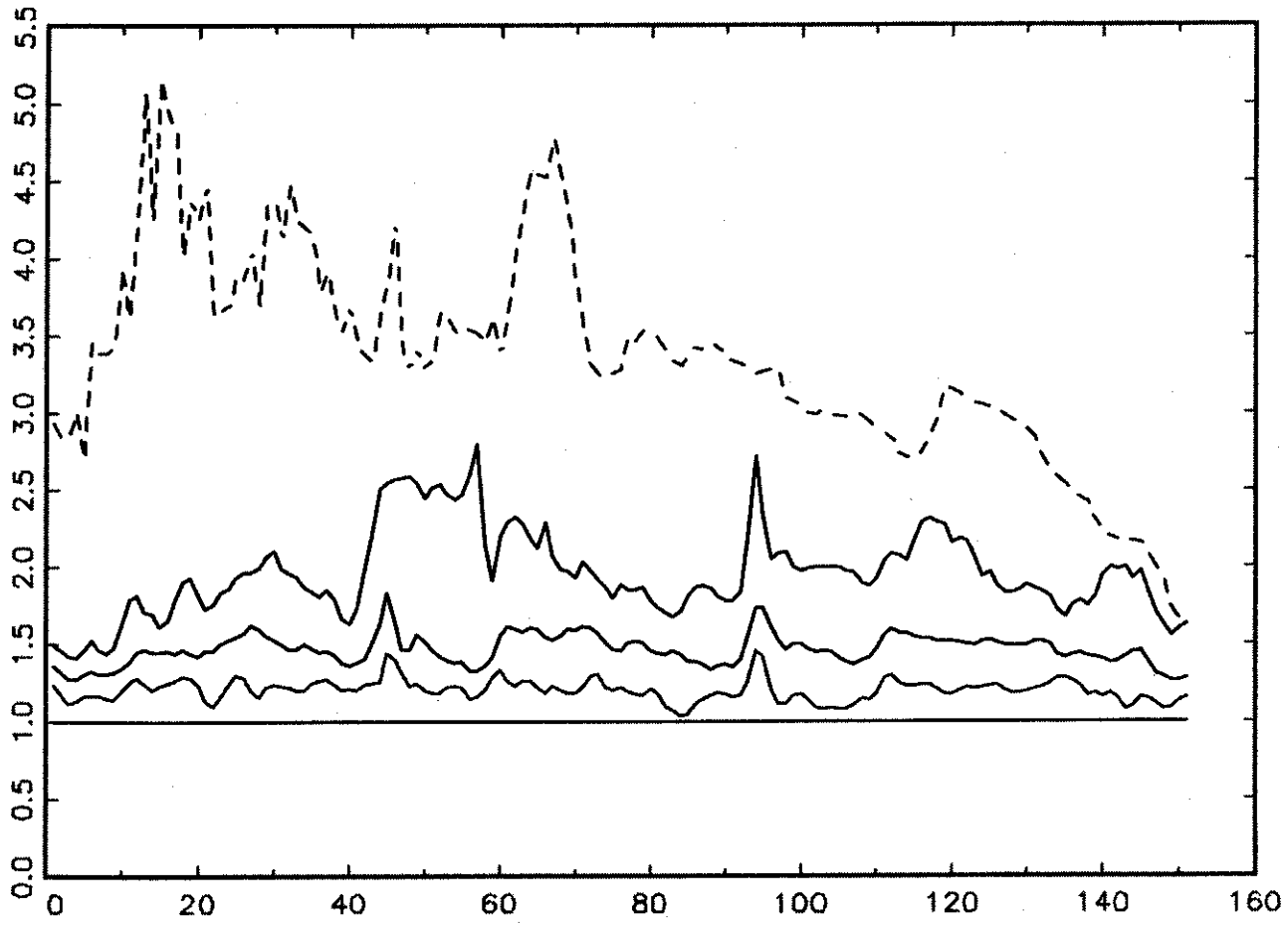


Figure 1, continued

Market/State Price Ratios, Milk
Key: Lines = Median, 80% Coverage Band; Dashes = Moscow

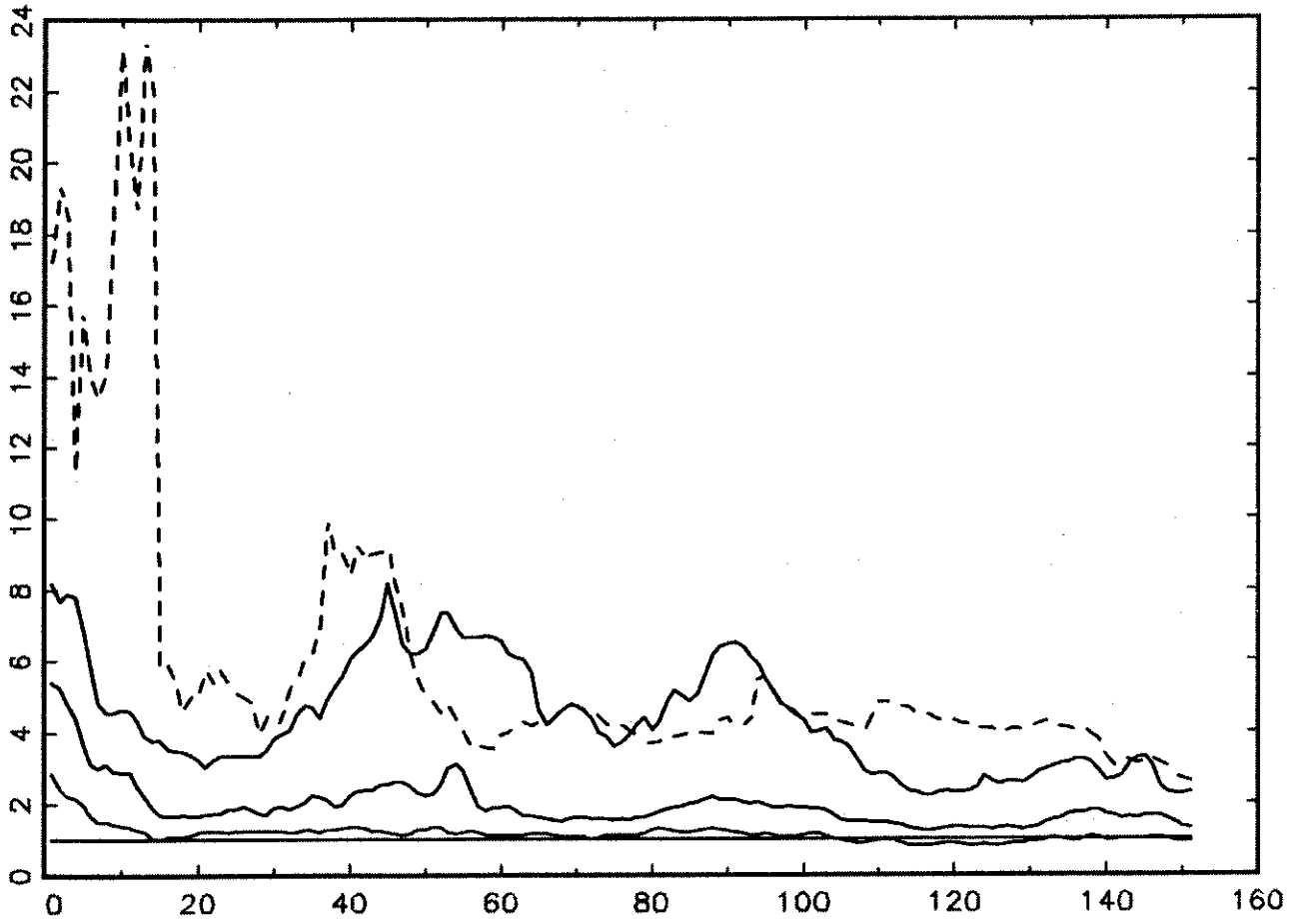


Figure 1, continued

Market/State Price Ratios, Onions
Key: Lines = Median, 80% Coverage Band; Dashes = Moscow

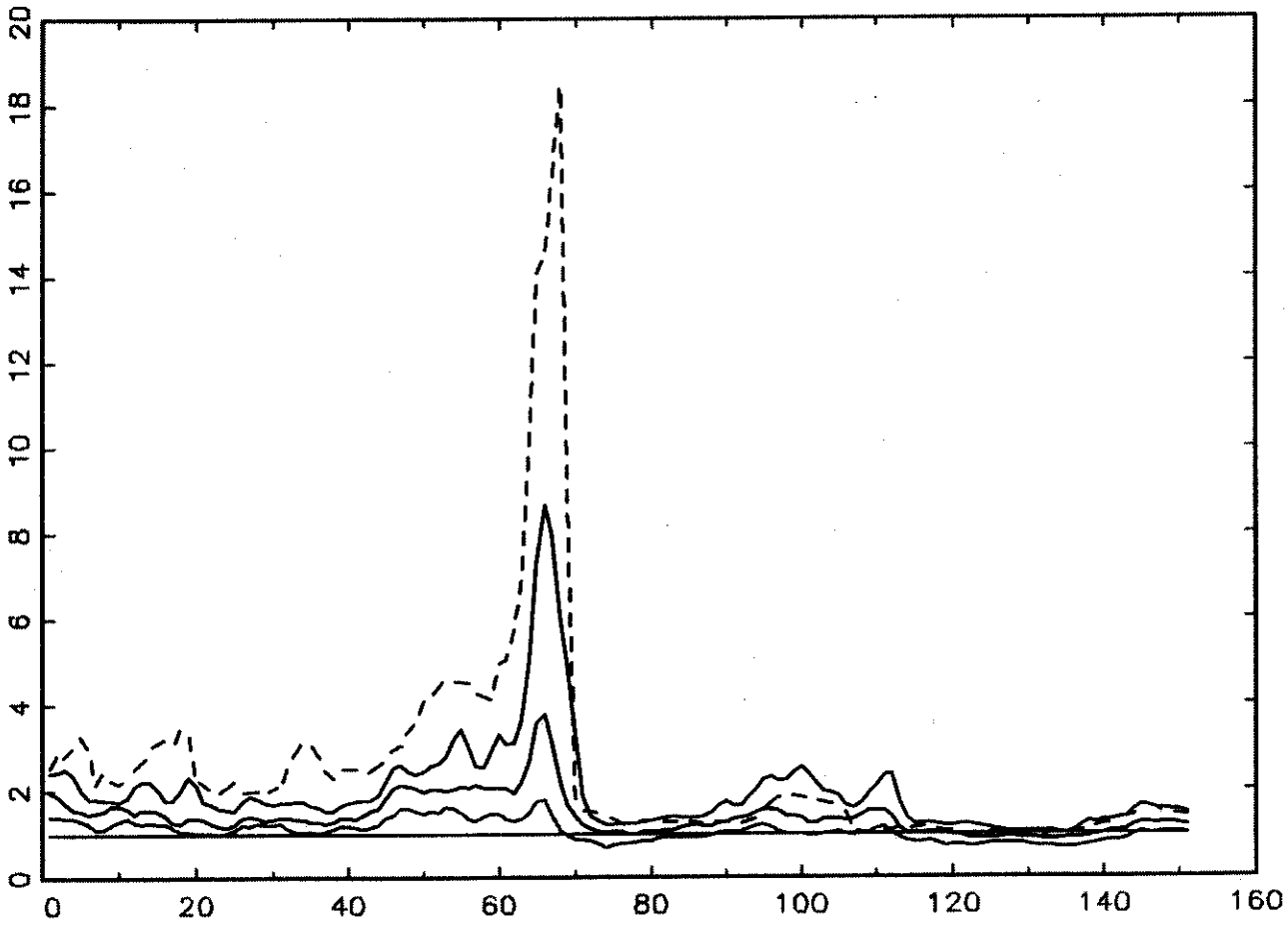


Figure 1, continued

Market/State Price Ratios, Potatoes
Key: Lines = Median, 80% Coverage Band; Dashes = Moscow

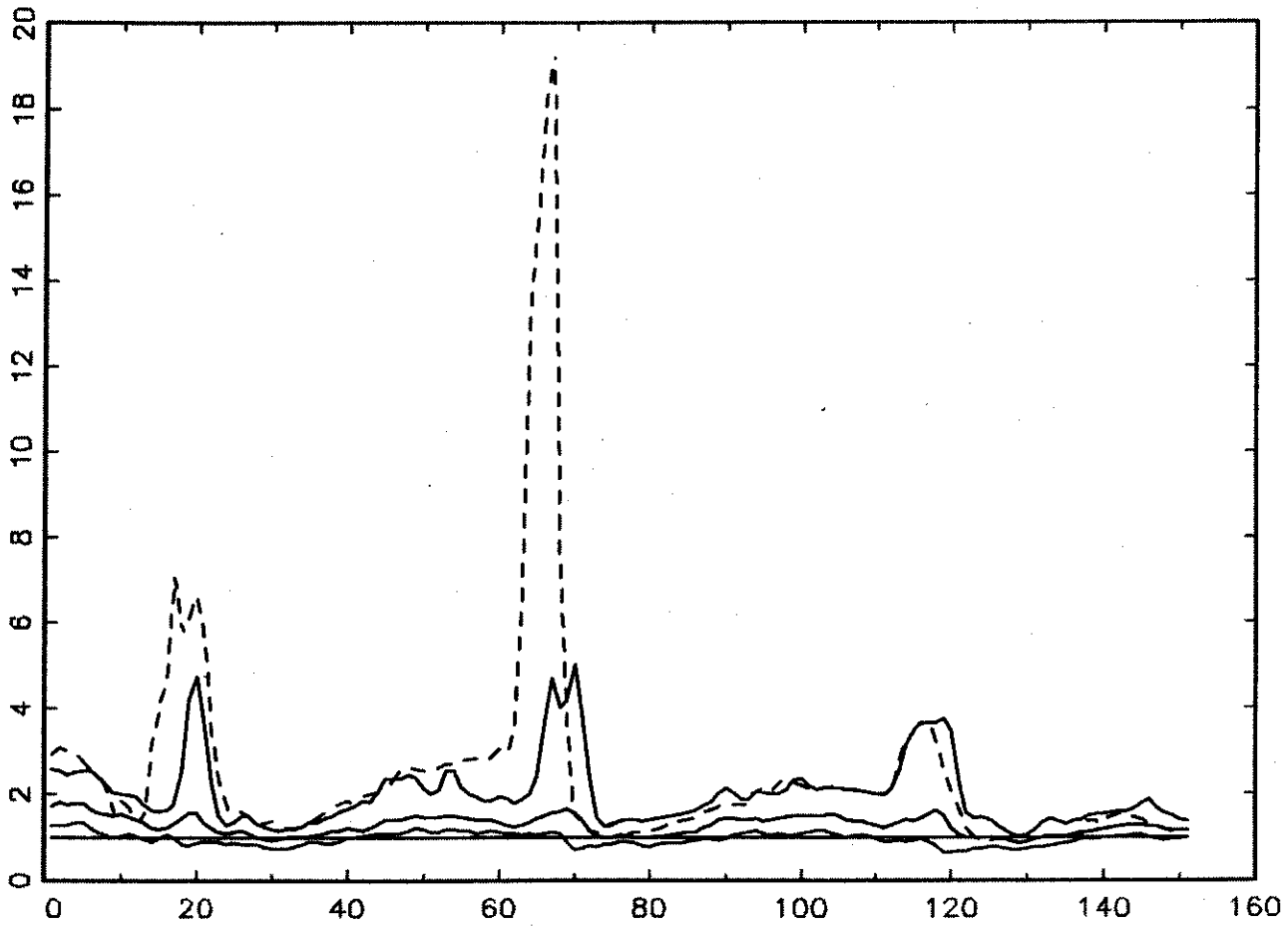


Figure 1, continued

Market/State Price Ratios, Vegetable Oil
Key: Lines = Median, 80% Coverage Band; Dashes = Moscow

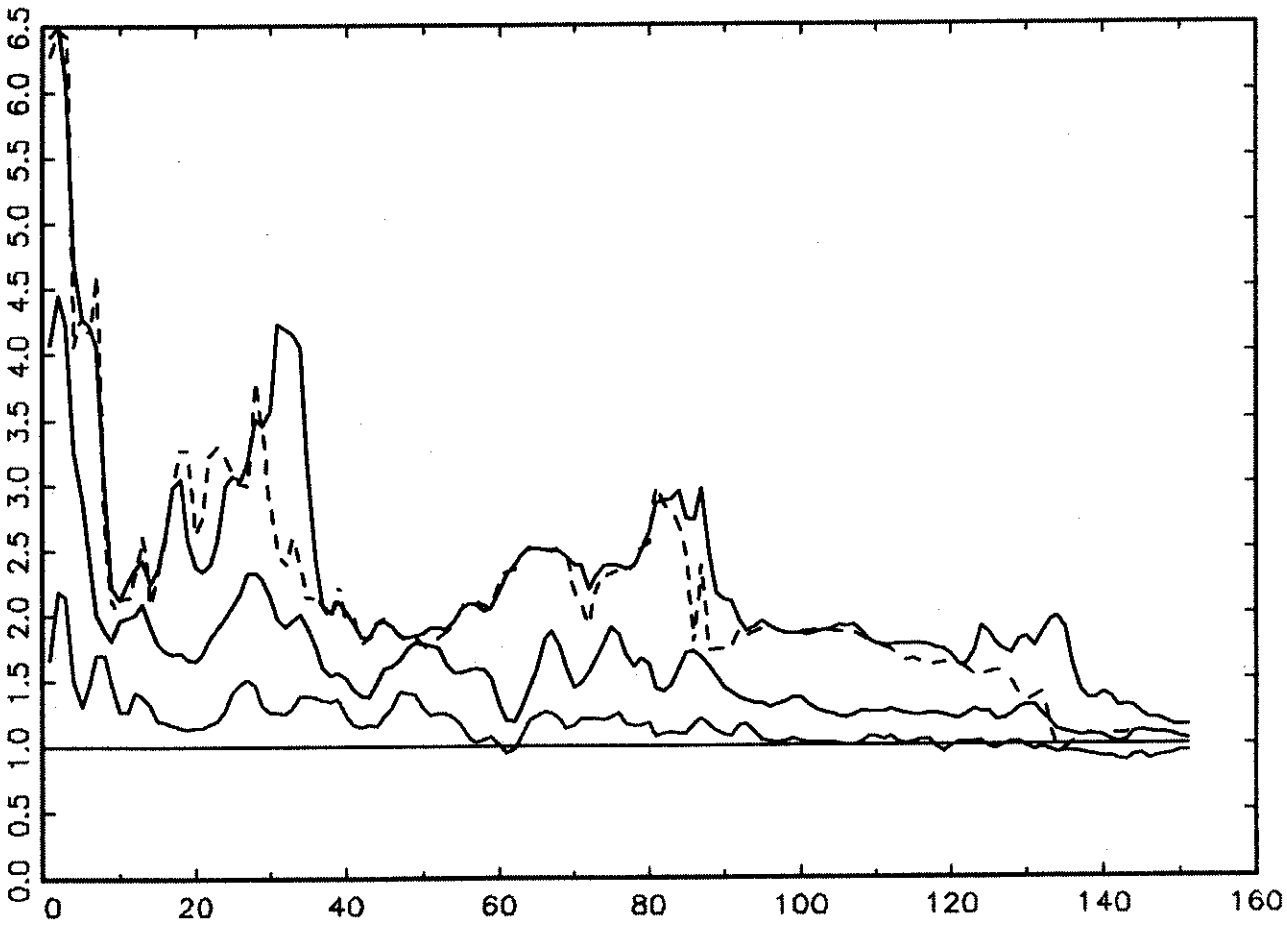
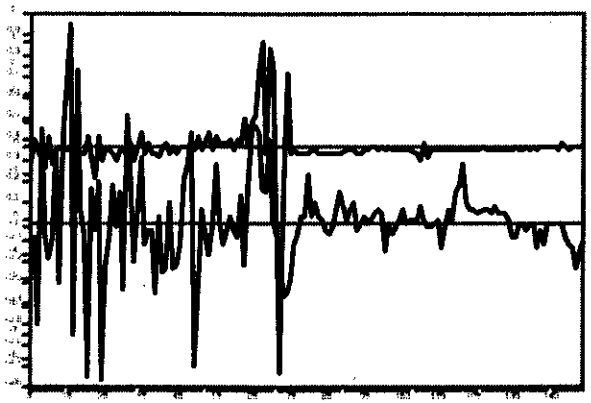


Figure 2

Market/State Price Ratio Innovations: Moscow

Model: $r_t = \gamma + \delta t + \Sigma_{i1}\rho_i r_{t-i} + \varepsilon_t$

Key (clockwise, from upper left): Innovations Obtained for Beef, Milk, Veg. Oil, Onions



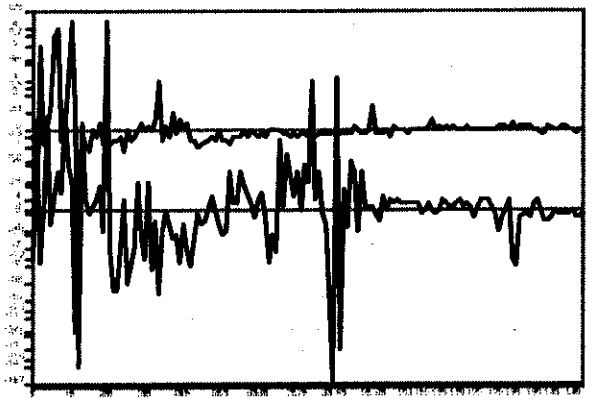
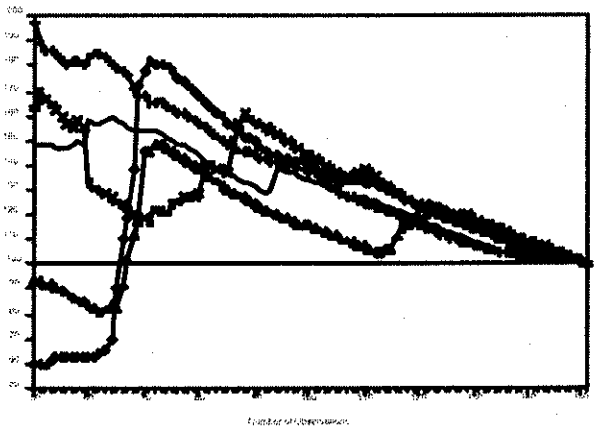


Figure 3

Evolution of Market/State Price Ratio Volatility

Vertical Axes: error variance obtained using first N obsrevations
as a percentage of that obtained using full sample
Left Figures: 25-City Averages Right Figures: Moscow
Key: line = beef, plus = milk, diamond = onions, triangle = potatoes, x = veg. oil



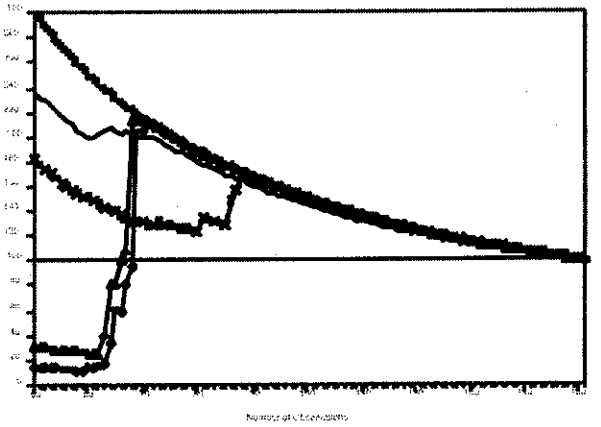


Figure 4

Plots of P Values for Granger Causality Tests Within Cities

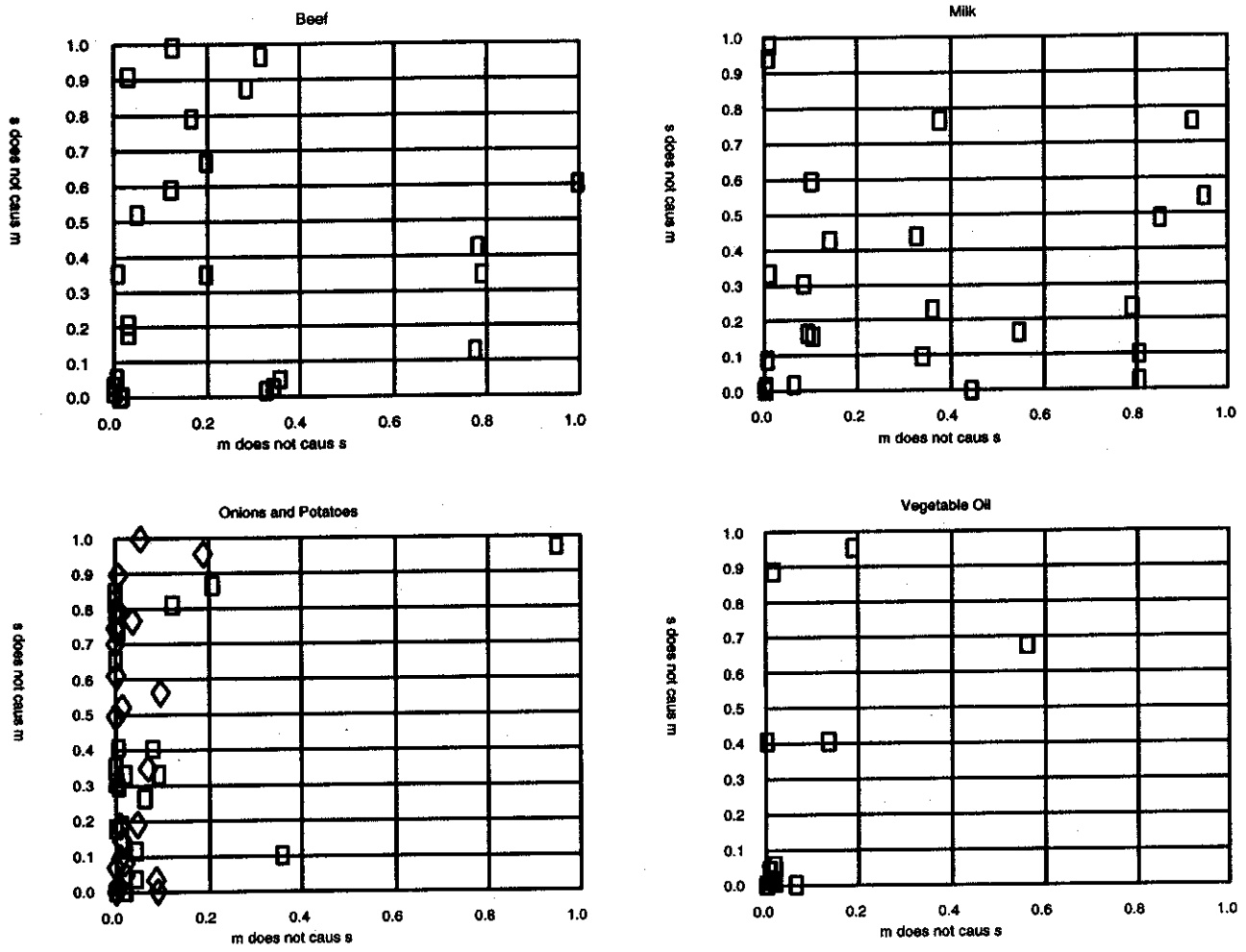
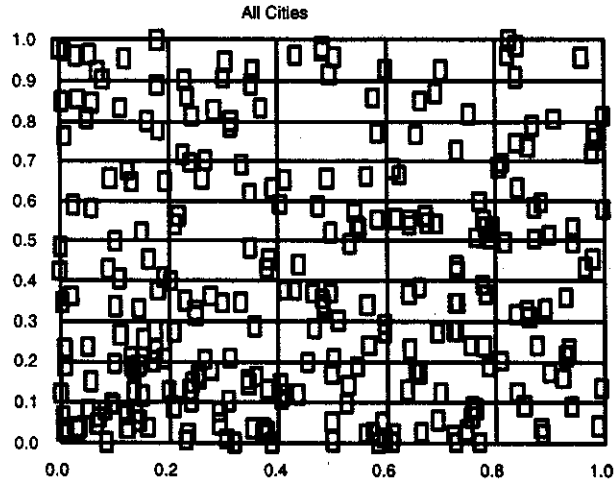
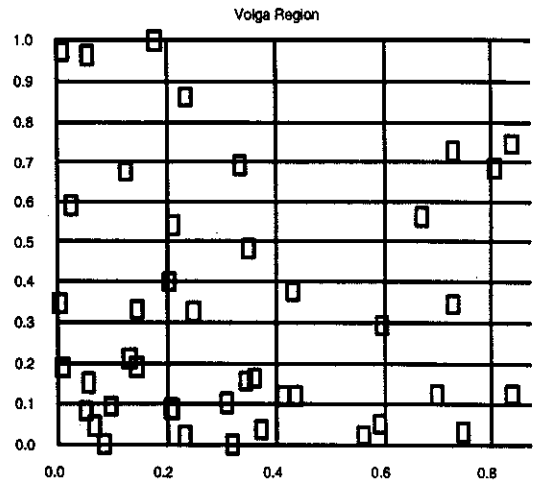


Figure 5

Plots of P Values for Granger Causality Tests Across Cities: Beef





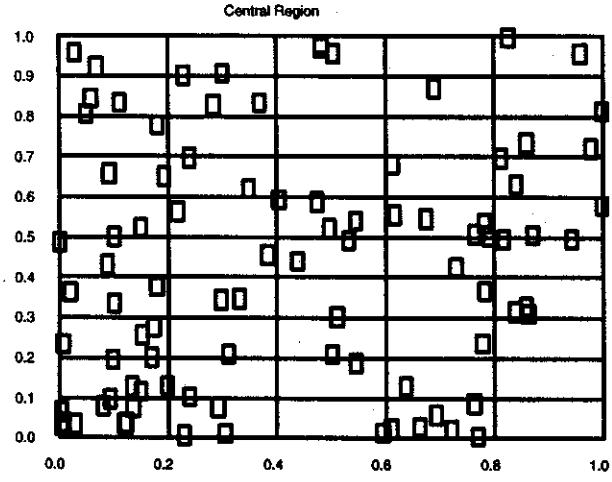


Figure 5, continued

Plots of P Values for Granger Causality Tests Across Cities: Milk

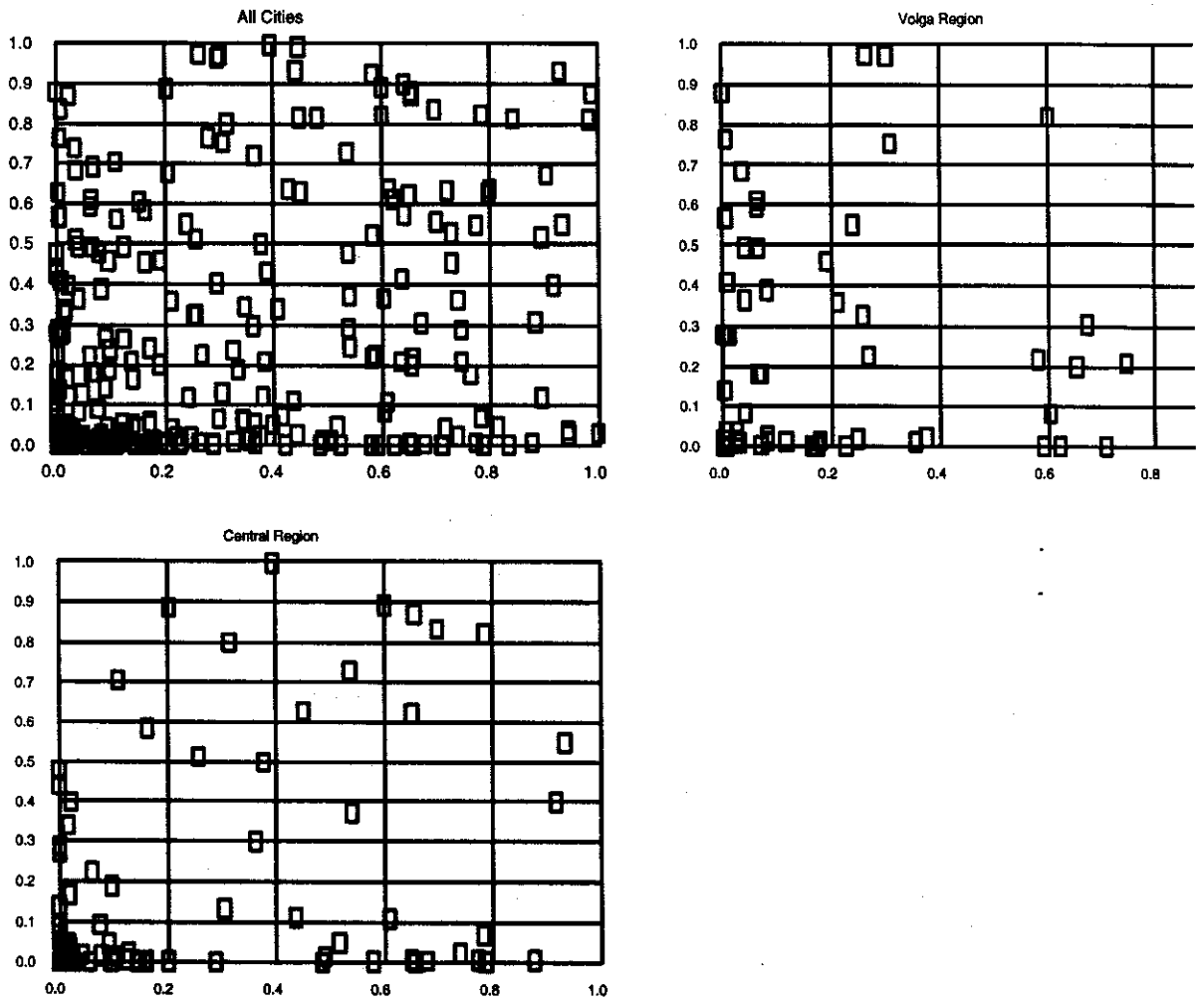
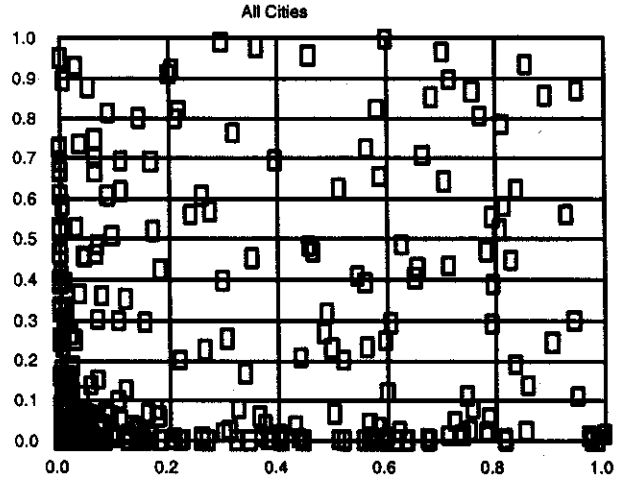
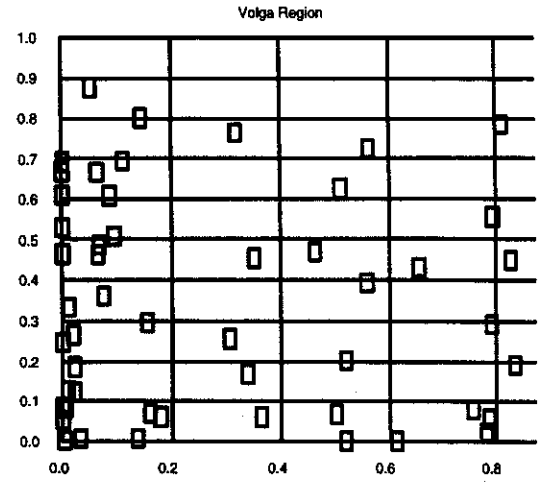


Figure 5, continued

Plots of P Values for Granger Causality Tests Across Cities: Onions





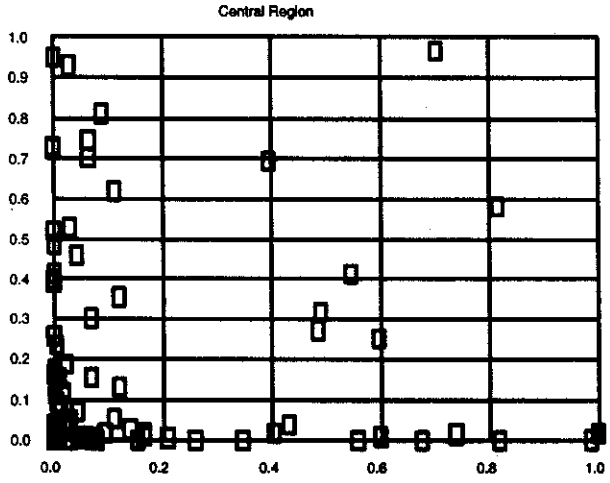


Figure 5, continued

Plots of P Values for Granger Causality Tests Across Cities: Potatoes

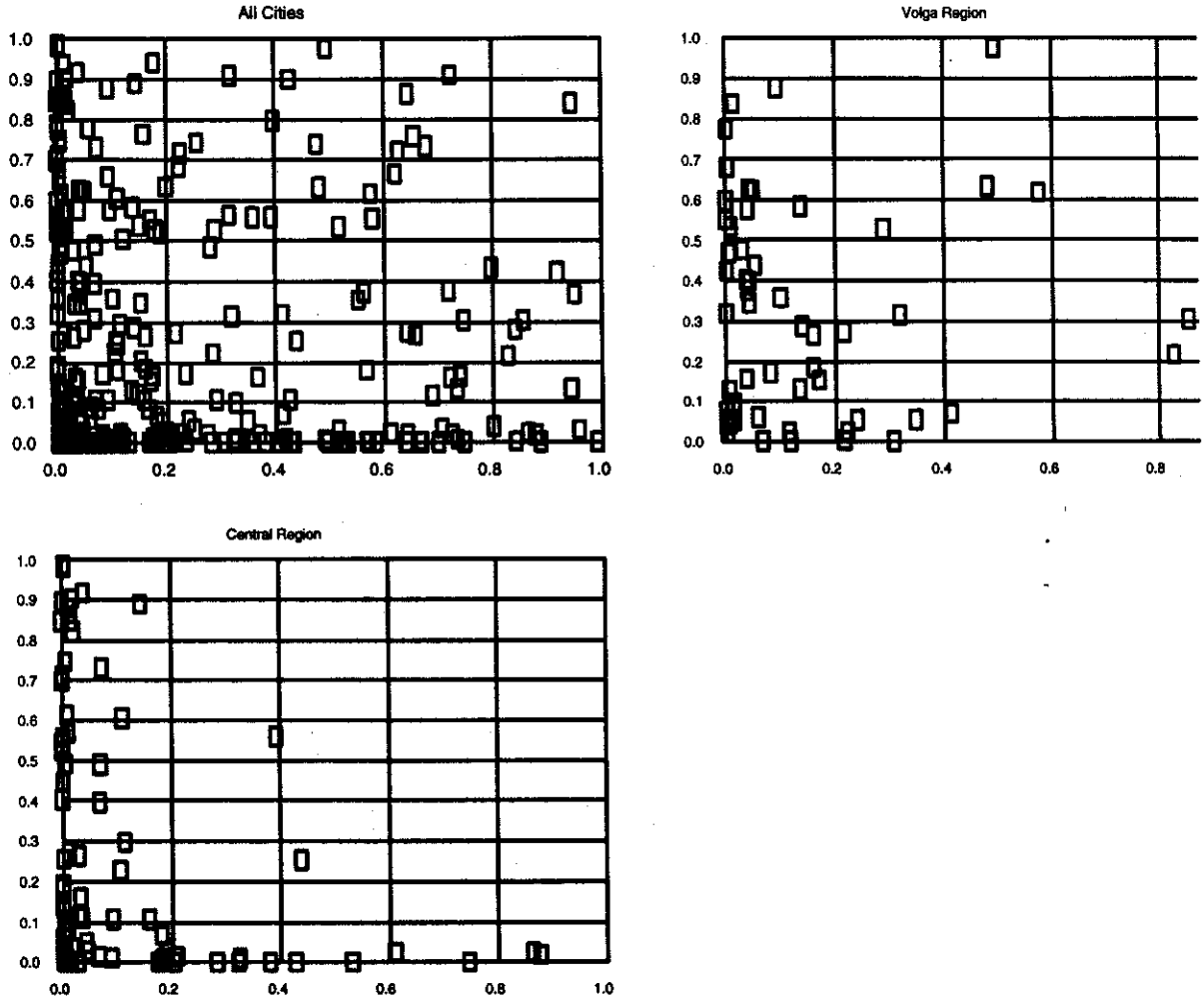
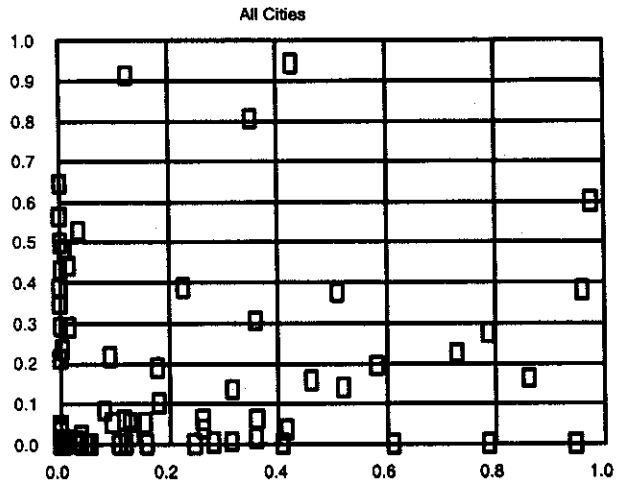
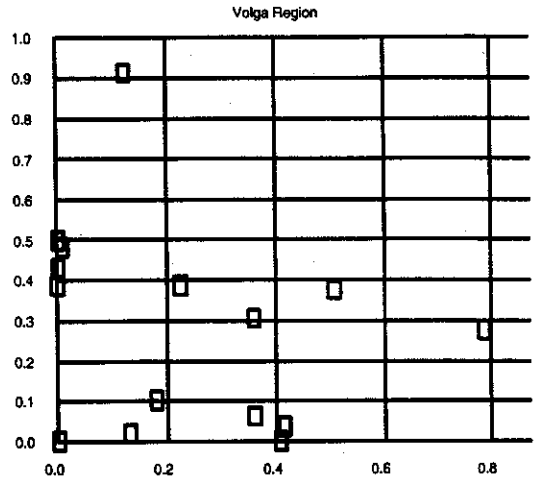


Figure 5, continued

Plots of P Values for Granger Causality Tests Across Cities: Vegetable Oil





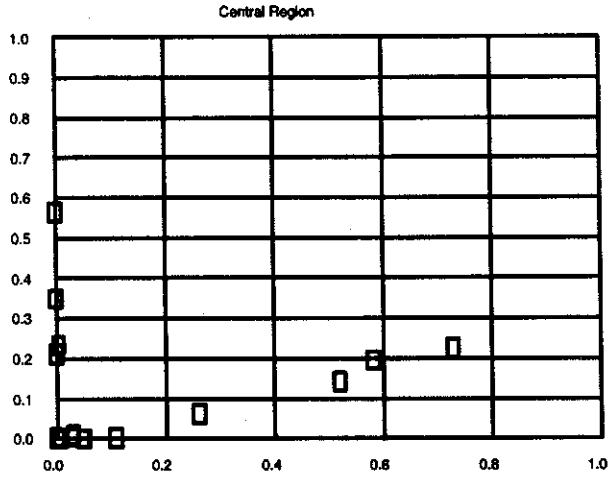


Table 1

Results of Granger Causality Tests Within Cities
Commodity: Beef

Region	City	Dependent Observations		p value for H_0: m _> s	p value for H_0: s _> m	Conclusion
	*Moscow	143		0.197	0.348	m => s
	Bryansk	86	0.121	0.591		m => s
	Vladimir	146		0.049	0.520	m => s
	Ivanovo	128		0.197	0.665	m => s
	Tver	146		0.325	0.019	s => m
	Kaluga	146		0.356	0.050	s => m
	Kostroma	87		0.031	0.208	m => s
Central	Oryol	146	0.010	0.353		m => s
	Ryazan	146	0.165	0.791		m => s
	Smolensk	71		0.781	0.422	no causality
	*Tula	146		0.002	0.013	feedback
	Novomoskovsk	44		0.998	0.602	no causality
	Yaroslavl	146		0.017	0.003	feedback
	Rybinsk	146	0.006	0.056		feedback
	Astrakhan	126		0.000	0.035	feedback
	Volgograd	146		0.124	0.990	m => s
	Kamyshin	NA		NA	NA	NA
	*Samara	125		0.314	0.965	no causality
	Syzran	146		0.030	0.180	feedback
Volga	*Togliatti	107		0.790	0.344	no causality
	Penza	146		0.341	0.028	s => m
	Saratov	134	0.013		0.000	feedback
	Balakovo	140		0.776	0.129	s => m
	Ulyanovsk	146		0.282	0.875	no causality
	Kazan	146		0.030	0.908	m => s

Summary: At the 20% (10%) significance level, m => s in 15 (10) of 24 cases; s => m in 10 (8) of 24 cases; feedback is present in 6 (5) of 24 cases; and no causality is present in 5 (11) of 24 cases.

Notes: Cities with asterisks denote cases in which the null hypothesis of no co-integration could not be rejected. Results for these cities were obtained using differenced data. Otherwise, results were obtained using detrended data. The notation x => y denotes the inference that the variable x Granger causes y; feedback denotes a case in which x causes y, and y also causes x.

Table 1, continued

Results of Granger Causality Tests Within Cities
Commodity: Milk

Region	City	Dependent Observations		p value for H_0: m _> s	p value for H_0: s _> m	Conclusion
	*Moscow	146	0.949	0.545		no causality
	Bryansk	146		0.011	0.335	m => s
	Vladimir	32	0.001	0.003		feedback
	Ivanovo	146	0.008	0.942		m => s
	Tver	146	0.011	0.980		m => s
	Kaluga	143	0.062	0.018		feedback
	Kostroma	146	0.005	0.088		feedback
Central	Oryol	146	0.101	0.593		m => s
	*Ryazan	87	0.327	0.439		no causality
	*Smolensk	146	0.444	0.000		s => m
	Tula	131	0.002	0.014		feedback
	Novomoskovsk	134	0.092	0.163		feedback
	Yaroslavl	NA	NA		NA	NA
	*Rybinsk	146	0.104	0.155		feedback
	*Astrakhan	142	0.340	0.096		s => m
	*Volgograd	146	0.377	0.765		no causality
	*Kamyshin	146	0.361	0.228		no causality
	*Samara	146	0.084	0.303		m => s
	*Syzran	146	0.807	0.026		s => m
Volga	*Togliatti	146	0.790	0.234		no causality
	*Penza	146	0.806	0.099		s => m
	*Saratov	128	0.547	0.162		s => m
	*Balakovo	92	0.141	0.426		m => s
	*Ulyanovsk	59	0.923	0.759		no causality
	Kazan	146	0.851	0.486		no causality

Summary: At the 20% (10%) significance level, m => s in 12 (9) of 24 cases; s => m in 11 (8) of 24 cases; feedback is present in 6 (4) of 24 cases; and no causality is present in 7 (11) of 24 cases.

Notes: Cities with asterisks denote cases in which the null hypothesis of no co-integration could not be rejected. Results for these cities were obtained using differenced data. Otherwise, results were obtained using detrended data. The notation x => y denotes the inference that the variable x Granger causes y; feedback denotes a case in which x causes y, and y also causes x.

Table 1, continued

Results of Granger Causality Tests Within Cities
Commodity: Onions

Region	City	Dependent Observations		p value for H_0: m _> s	p value for H_0: s _> m	Conclusion
	*Moscow	143		0.357	0.102	s => m
	Bryansk	13	0.000	0.000		feedback
	Vladimir	146		0.000	0.181	feedback
	Ivanovo	146	0.000	0.846		m => s
	Tver	72		0.017	0.000	feedback
	Kaluga	34		0.003	0.310	m => s
	Kostroma	146		0.042	0.037	feedback
Central	Oryol	146		0.007	0.407	m => s
	Ryazan	140	0.011	0.191		feedback
	*Smolensk	87		0.950	0.971	no causality
	Tula	77		0.000	0.826	m => s
	*Novomoskovsk	28			0.092	0.331 m => s
	Yaroslavl	146		0.011	0.140	feedback
	Rybinsk	75	0.000	0.787		m => s
	Astrakhan	58		0.005	0.737	m => s
	Volgograd	140		0.020	0.332	m => s
	*Kamyshin	41			0.207	0.866 no causality
	Samara	146	0.061	0.266		m => s
	Syzran	59		0.079	0.404	m => s
Volga	Togliatti	146	0.007	0.296		m => s
	Penza	74		0.021	0.001	feedback
	Saratov	126	0.000	0.356		m => s
	*Balakovo	49			0.121	0.810 m => s
	Ulyanovsk	146		0.000	0.654	m => s
	Kazan	128		0.044	0.115	feedback

Summary: At the 20% (10%) significance level, m => s in 22 (21) of 25 cases; s => m in 9 (4) of 25 cases; feedback is present in 8 (4) of 25 cases; and no causality is present in 2 (4) of 25 cases.

Notes: Cities with asterisks denote cases in which the null hypothesis of no co-integration could not be rejected. Results for these cities were obtained using differenced data. Otherwise, results were obtained using detrended data. The notation x => y denotes the inference that the variable x Granger causes y; feedback denotes a case in which x causes y, and y also causes x.

Table 1, continued

Results of Granger Causality Tests Within Cities
Commodity: Potatoes

Region	City	Dependent Observations		p value for H_0: m _> s	p value for H_0: s _> m	Conclusion
	Moscow	143		0.089	0.002	feedback
	Bryansk	146	0.085	0.035	feedback	
	Vladimir	146		0.095	0.562	m => s
	Ivanovo	146	0.009	0.096	feedback	
	Tver	143		0.037	0.767	m => s
	Kaluga	NA		NA	NA	NA
	Kostroma	146		0.018	0.081	feedback
Central	Oryol	146		0.007	0.897	m => s
	Ryazan	146	0.008	0.185	feedback	
	Smolensk	146		0.045	0.192	feedback
	Tula	146		0.000	0.746	m => s
	Novomoskovsk	146		0.053	0.999	m => s
	Yaroslavl	146		0.005	0.017	feedback
	Rybinsk	143	0.006	0.799	m => s	
	Astrakhan	145		0.002	0.610	m => s
	Volgagrad	122		0.000	0.000	feedback
	Kamyshin	74		0.020	0.047	feedback
	Samara	59	0.014	0.146	feedback	
	Syzran	49		0.000	0.070	feedback
Volga	Togliatti	146	0.014	0.522	m => s	
	Penza	146		0.014	0.145	feedback
	Saratov	146	0.000	0.701	m => s	
	Balakovo	69		0.001	0.496	m => s
	Ulyanovsk	105		0.067	0.349	m => s
	Kazan	123		0.187	0.956	m => s

Summary: At the 20% (10%) significance level, m => s in 24 (23) of 24 cases; s => m in 12 (8) of 24 cases; feedback is present in 12 (8) of 24 cases; and no causality is present in 0 (1) of 24 cases.

Notes: Cities with asterisks denote cases in which the null hypothesis of no co-integration could not be rejected. Results for these cities were obtained using differenced data. Otherwise, results were obtained using detrended data. The notation x => y denotes the inference that the variable x Granger causes y; feedback denotes a case in which x causes y, and y also causes x.

Table 1, continued

Results of Granger Causality Tests Within Cities
Commodity: Vegetable Oil

Region	City	Dependent Observations		p value for H_0: m _> s	p value for H_0: s _> m	Conclusion
	Moscow	125	0.018	0.055	feedback	
	Bryansk	86	0.002	0.405	m => s	
	Vladimir	NA	NA	NA	NA	
	Ivanovo	NA	NA	NA	NA	
	Tver	NA	NA	NA	NA	
	Kaluga	NA	NA	NA	NA	
	Kostroma	NA	NA	NA	NA	
Central	*Oryol	87		0.135	0.406	m => s
	Ryazan	131	0.000	0.001	feedback	
	Smolensk	45	0.007	0.044	feedback	
	Tula	84	0.064	0.001	feedback	
	Novomoskovsk	48	0.000	0.000	feedback	
	Yaroslavl	NA	NA	NA	NA	
	Rybinsk	NA	NA	NA	NA	
	*Astrakhan	145		0.016	0.888	m => s
	Volgograd	143	0.010	0.017	feedback	
	Kamyshin	NA		NA	NA	NA
	Samara	136	0.562	0.675	no causality	
	Syzran	71	0.019	0.009	feedback	
Volga	Togliatti	NA	NA	NA	NA	
	Penza	50	0.003	0.000	feedback	
	Saratov	NA	NA	NA	NA	
	Balakovo	NA	NA	NA	NA	
	Ulyanovsk	NA	NA	NA	NA	
	*Kazan	143	0.362	0.204	no causality	

Summary: At the 20% (10%) significance level, m => s in 11 (10) of 13 cases; s => m in 8 (8) of 13 cases; feedback is present in 8 (8) of 13 cases; and no causality is present in 2 (3) of 13 cases.

Notes: Cities with asterisks denote cases in which the null hypothesis of no co-integration could not be rejected. Results for these cities were obtained using differenced data. Otherwise, results were obtained using detrended data. The notation x => y denotes the inference that the variable x Granger causes y; feedback denotes a case in which x causes y, and y also causes x.