Measurement and Testing for Neutrality of Foreign Price and CPI Transmission in Russia

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Abstract

This paper examines domestic and international food market integration in Russia before and after the financial crisis of 1998. Using monthly prices of bread, pork, and beef in 80 regions of Russia from 1994 to 1999, we measure the short-run response of regional prices to changes in foreign prices and domestic inflation. We find that both changes in foreign prices and domestic inflation have distinct impacts on the prices of these commodities in different Russian markets, indicating poor market integration in the short run. An analysis of the effect of the financial crisis shows that market integration for bread and beef deteriorated after the crisis. However, integration improved for pork in some parts of Russia, and the integration of Siberian pork markets with Chinese pork markets also improved after the crisis.

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05/15/01

1.   Introduction

The goal of this paper is to measure the extent of short-run domestic market integration in Russia by analyzing and comparing the transmission of foreign to domestic meat prices across different regions in Russia. Since prices were set arbitrarily by administrative fiat before the price reforms of 1992, it is of considerable interest to Russian observers whether prices now serve their function of transmitting information from one market to another. Numerous authors have addressed the issue of long-run[1] integration of post-reform Russian food markets. Collectively, they have obtained mixed results (Berkowitz and Dejong , 1999, Berkowitz, 1997, Gardner and Brooks 1994, Goodwin et. al, 1999). In contrast, the issue of short-run distortions in the relationship among regional prices has received less attention. Yet imperfect and varying short-run absorption of exogenous price changes by the different regional markets in Russia can influence market integration in the short run by distorting regional price relationships, which in turn can lead to misallocation of resources, increased risk, and reduced welfare, whether regional markets are integrated in the long-run or not.

An analysis of market integration within Russia during the late 1990's cannot ignore the 1998 financial crisis which caused a 75% nominal and 37% real depreciation in the value of the ruble by January 1999.[2] Food imports fell significantly following the devaluation but food production remained constant. One of several possible explanations that could account for this

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[1] For the purposes of this paper, a "long-run" relationship is a stable relationship in levels of the variables in question. A "short-run" relationship is the relationship in differences. This distinction is consistent with the Johansen-Juselius cointegration technique.

[2] Since the crisis was a response to the Russian government's default on domestically issued debt, most of the devaluation occurred in August. The real exchange rate as calculated by the Stockholm Institute of Transition Economics fell 30% from August to September 1998. The real exchange rate halted its devaluation in January 1999 at 37% of the August level and has been appreciating ever since.

uneven response to the crisis is that the price shocks from the crisis were transmitted to the major urban consuming markets but not the markets in producing regions. We investigate whether the crisis had an impact on the evenness of price transmission to internal markets and the effect this had on short-run market integration.

In this paper we define regional markets to be segmented in the short-run if regional prices have a significantly different short-run response to a change in an exogenous variable, such as domestic inflation or the world market price. Thus, for the purposes of this paper, we say that Russian markets are short-run integrated if changes in foreign prices and/or inflation do not have significantly different impacts on prices in Russia's different regional markets. Our definition of market integration is consistent with empirical studies that measure the degree of integration by testing whether price changes are related among markets (see, Goodwin and Schroeder 1990). By focusing on the relationship between price changes rather than price levels we avoid mixing together the issues of market integration and market equilibrium (see Rong Li).[3]

Rather than testing all possible bilateral price relationships among all regional markets, we use one overall test to compare the response of each market's price to changes in common exogenous factors that should affect all the markets equally. That is, by jointly evaluating the response of many markets to a single exogenous shock (rather than testing each possible bilateral relationship separately) we insure that our empirical test for market integration is parsimonious in the use of data and computational power. Our test is somewhat similar to a market integration test proposed by Ravallion (1986) that compares various markets' price responses to changes in a

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[3] Jau Rong Li provides an exhaustive review of the various definitions of market integration and methods used to test for it. She finds that no traditional method or definition is problem free.

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common exogenous variable. However our test is different from Ravallion's test in several key ways.

The next section of the paper, "Russian market segmentation," discusses the issues of Russian market segmentation and the possible effect the 1998 crisis had on segmentation. The "Literature" section briefly notes some of the literature on this and related subjects. In the "Method" section we present our method. Then we briefly discuss our data in the "Data" section, and finally in the "Results" section we show that neither the beef nor pork markets are integrated in the short-run according to the definition used in our paper. The "Results" section contains a subsection that discusses the effect the 1998 financial crisis had on short-run market integration and shows that short-run market integration on average deteriorated after the financial crisis in the beef markets, but improved in some regions for the pork market. Finally we provide concluding comments.

Russian Market Segmentation

The emergence of strong regional governments, the weakening of the central government, and worsening transportation links in the mid-1990's led to a widespread belief that Russia's internal markets have become segmented. Specifically two reasons have been offered to explain segmentation of the agricultural market in Russia. One is that regional governors, in the name of food security, restrict the flow of food products from one administrative region to another (Berkowitz, 1999, Goodwin, et al, 1999). The second reason is that the poor physical and commercial infrastructure impedes Russian farmers' ability to transport goods from rural to urban areas. In this explanation "commercial infrastructure" includes: commercial laws that

protect property and enforces contracts; a regulatory system that significantly reduces corruption; and a system of market information (Wehrheim et al., 2000).[4]

It is difficult to determine which of these factors would cause markets in Russia to be segmented, but the problem of physical transportation and commercial infrastructure is economy-wide, while poor transmission of prices in isolated regions of the country would be more indicative of a policy-generated problem.[5] If market segmentation is prevalent throughout all of Russia, then it may indicate that a "poor infrastructure" explanation is a likely source of the uneven transmission of price information to Russia's different regions. However even in this case, policy generated distortions from specific regions could also be a contributing factor.

There are also competing explanations for the effect the 1998 financial crisis had on market integration and consequently price transmission. On the one hand, the crisis and attendant food security concerns may have shocked local officials into stockpiling food and increasing local protectionism. This would have led to reduced trade among domestic markets and less integration in internal markets, and would have led to less integration with international markets (See De Masi and Koen, 1996). Furthermore, the risk of financing internal trade and receiving payments may have been higher in post-crisis Russia, leading to higher transaction costs. The subsequent reduction in trade among different domestic markets would lead to wider regional differences in the measured short-run price foreign transmission elasticities.

On the other hand, a depreciated real exchange rate improves a country's terms of trade, providing a stimulus to exports and encouraging Russia's consuming regions to purchase from

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[4] In May 2000, a Russian company and the administration of Orel oblast announced plans to provide a website to allow grain trade to occur over the internet. One of the goals of the site was to "allow the participants in the grain market to move from the regional to the national level." (http://www.rusfund.ru/press/zerno3105.html). The new website is now operational: www.mtszerno.ru.

[5] Berkowitz (cite) suggests that policies that distort market integration originate from a subset of regions in the south of Russia he terms the "Red Belt," because they voted for the Communist candidate Ziuganov in the 1995 elections.

Russian producing regions rather than from foreign sources.[6] This trade between regions would leave the Russian market more integrated. While this response to the crisis would lead to lower transmission elasticities from international markets, it would also lead to a more unified response to international price changes throughout Russia. Thus, even if the overall international price transmissions were lower, the elasticities measured in different regions would move closer together after the crisis.

Given the plausibility of either of these scenarios it is difficult *a priori* to predict what the effect of the financial crisis would have on Russia as a whole. Therefore an empirical investigation which compares regional price transmissions and their variance among different regions in Russia could be a key first step to understanding the effect of the financial crisis on market integration in Russia.

Literature

Li reviews the various methods used to test the various definitions of market integration, finds no method perfect, and introduces a method for testing market integration which relies on both quantity and price data (Li, 1997). Previous papers on market integration in Russia rely on available price data, have focused primarily on long-run market integration, and have found mixed results concerning the progress of price reforms since 1992. Gardner and Brooks (1994), using standard empirical techniques for stationary data, find that unexplained price differences between cities do not decline over time, indicating that Russia's price reform in 1992 and early 1993 was unsuccessful. Berkowitz, et al, (1998), using a longer data series (from 1992 to 1995), used cointegration analysis to determine the flow of causality between state-owned and privatized stores. They found that prices in state-owned stores were Granger-caused by prices in

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[6]Following the devaluation food imports fell significantly. According to Russians Customs statistics, imports of HS codes 1-24(produce and agricultural materials) in the third and fourth quarter of 1998 was 66% and 48% of the

private stores (indicating that government interference in the food markets declined), and that price differences between cities declined significantly in the period studied. Goodwin *et al* (1999) found that Russian food markets were integrated in general but regional pockets of resistance to price reform tend to hinder price response. Berkowitz and Dejong (1999) show that these pockets of resistance may be concentrated in regions that voted for Ziuganov (the leader of the Communist part in Russia) in the 1995 presidential elections and tend to be located in the south of European Russia. A working paper by Osborne (2001) indicates that there are no cointegrating relationships between international meat prices and prices in cities in Russia, besides in Moscow and St. Petersburg. Loy and Weaver (1998) also found evidence of uneven domestic market integration in Russia.

Our paper adds to the literature on Russian market integration in two ways. First, we investigate if short-run price transmission is significantly different among regions, regardless of whether these Russian regions are integrated in the long-run. Despite the lack of long run integration in Russian food price *levels* (Osborne 2001), our method allows us to examine market integration in the short-run by examining correlations between price *changes*. It is possible that price levels are in fact related to each other, but the frequent structural changes of the post-reform Russian economic environment make it impossible to detect these relationships using cointegration techniques (particularly because the time series under investigation is fairly short). If the price relationships are constantly in disequilibrium due to structural shocks, at least the changes in prices should be correlated to each other as the system moves back to equilibrium.[7] Second, by using a longer time series than previous studies we are able to examine the effect of the financial crisis of 1998 on market integration.

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previous year's value.
[7] Again, it is important to distinguish between market integration, as defined in this paper, and market equilibrium,

It is also important to note that the issues this paper addresses are not completely unrelated to the economic issues of Western economies. Many economists have debated whether one sector of the economy reacts more or less to changes in the general price level than another sector ((Fischer, 1981, Parks, 1978, Domberger, 1987, Frankel, 1986, Chambers, 1984, Belongia, 1991, Stamoulis et. al, 1988). In Russia, this topic was explored by Loy and Weaver (1998) when they analyzed the increased price variation associated with high inflation in Russian food markets and found that distortions in real prices in Russian food markets could be explained by anticipated inflation. Our study can be related to such literature by noting that we also examine the empirical evidence for variation in the price response to both the FP and the domestic level of inflation. However, we compare the different regional price responses of a single commodity across different regions of a country to changes in inflation (CPI) rather than comparing the price response of different commodities.[8]

Another contribution of this paper is that we test the impact of both foreign price changes and CPI changes on domestic prices by specifying one set of equations. Previous papers usually ignored one of these variables when examining the transmission of the other, which we feel risks introducing a parameter bias given the possible impact of both inflation and foreign trade on relative prices.

Method

We test for market integration by analyzing the response of various domestic prices to exogenous variables, like foreign prices (FP) and the CPI. The magnitude of the price transmission coefficients from international to domestic prices (across all lags) would measure

as Li pointed out.
[8] Regional differences can arise from structural barriers to trade. If there are structural barriers to price transmission, then relative price distortions in Russian food markets can result even when inflation is anticipated, which would explain Loy and Weaver's results.

international integration. The variability of transmission parameters among regions measures domestic market integration, by the following reasoning: If markets are integrated domestically, then information transmitted to one region should be transmitted to the other regions as well, so the transmission coefficients should be approximately equal. We test to see if the variability among transmission parameters across regions is consistent with the null hypothesis that the transmission parameters are the same.

Price transmission equations are typically specified to include only the domestic and foreign price of the commodity of interest (See Gardner, 1975. For a bibliography of price transmission literature, see Schwartz and Willet (1994)). In contrast our transmission equations contain international prices, the CPI, and trigonometric variables to capture the seasonality which is inherent in agricultural data.[9] Integration studies often explore all possible bilateral relationships among market prices or are limited in the number of multi-lateral relationships they measure. In contrast, we follow a procedure similar to Ravallion (1986) who compared price regional transmission equations from a single source to test for market integration. Since our test is applied to monthly food prices from 80 administrative regions in Russia, this approach requires significantly less computation than exploring all possible bilateral relationships.

Our method, as well as Ravallion's, can be distinguished primarily by its reliance on a jointly estimated *system* of market transmission equations. However, our method differs from Ravallion's in several ways.

First, while Ravallion tested if transmissions coefficients across regions together equaled a particular number, our technique is more flexible in that we only test whether they are equal. We do not impose *a priori* what the transmission parameters should be. We only test for

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[9] Li-Rung faults traditional integration studies which used correlation coefficients of two market prices to measure integration for excluding the influence of factors such as the CPI and seasonality (page 15 chapter 4) on both

consistency of transmission across markets. Then we apply standard hypothesis tests to the cross equation restriction that price transmission coefficients are equal in each market specific equation.

Second, Ravallion's exogenous price was part of the market he was testing. In our case the foreign price (FP) is truly exogenous to Russia. Third, by only focusing on short-run integration, our method is meant to complement, and not substitute for, tests of long-run market integration. By emphasizing the short-run, our method becomes a test of temporary market distortions from possible long-run regional price relationships. Fourth, we represent our dependent variable in log differences. So doing, we are able to also test for short-run distortions in *relative* price levels among regions.

We also included a dummy variable to measure the effect of the financial crisis on the individual price transmissions for each region. We use the dummy variable to indicate whether transmission elasticities improved or deteriorated after the crisis and to determine if the variance in transmission elasticities was higher among regions after the crisis.

As already noted, an obvious alternate means of testing short-run market integration would be to estimate and compare every possible bilateral price relationship among the 80 regional markets. By instead testing for equality of transmission coefficients of foreign price and inflation to the many regions we greatly reduce the number of equations that need to be estimated. Thus our method is parsimonious in the used of data and computational power.

<u>Our estimating equation</u>

To test for market integration, we proceed as follows. First, we specify the following equation to explain $\Delta \ln P_{it} = \ln(P_{it}/P_{it-1})$:

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markets' prices.

$$\Delta \ln P_{it} = \boldsymbol{b}_{i1}(\Delta \ln(\mathbf{CPI}_t)) + \boldsymbol{b}_{i2}(\Delta \ln(\mathbf{FP}_t)) + \boldsymbol{b}_{i3}(\mathbf{DM} \cdot \Delta \ln(\mathbf{PF}_t)) + \sum_j \boldsymbol{q}_{ij}\mathbf{TSEA} + u_i \qquad (2)$$

$$for \ \ i = 1,2,....n$$

where:

CPI represents the Russian Consumer Price Index; **FP** represents the foreign price (distributed lags of the CPI and FP are discussed later); **DM** is a dummy variable which is zero before the crisis and 1 after; **TSEA** are harmonic trigonometric variables used to capture seasonal changes in prices (these are defined as: $\sin = \text{sine}((j/6)\pi t)$ and $\cos = \text{cosine}((j/6)\pi t)$, where t is the observation number, i is the city observation, and j=1,2). Thus both one and two frequency cycles per year are modeled. In order to keep the model simple higher frequency cycles were not included. Finally, u_i is the error in equation i.

We then jointly estimate equation (3) for 80 different city observations in a SUR system of equations. To test if the CPI and foreign price transmissions influence the relationship between city prices within or across regions, the restriction that the coefficient ß_1 (or ß_2) is equal across equations is imposed. A system likelihood ratio (LLR) test can be used to determine if this restriction can be rejected (see Greene, 1993 pp. 497.) If the transmission from the CPI or FP to the regions alters the regional relationship between commodity prices, the cross equation restriction will significantly reduce the fit of the system. If the restriction does not significantly reduce the fit of the system, the transmission is regionally neutral.

The complete transmission from inflation, or the foreign price, to retail price may take time, so we specified our model to have an impact effect and four months of lagged effects. Though testing procedures for optimal lag lengths are available (Greene, 1993 pp 515), they may result in different lag lengths for different equations. Therefore we set a standard lag length for all equations.

One advantage of the above approach is that it is possible to test for similar transmissions of exogenous factors on any combination of regional prices contained in the system of equations. For example, in this paper, we later test if markets in importing regions have significantly different transmissions than exporting regions. Another advantage is that it allows for the testing of neutrality of transmissions for as many exogenous variables as the equation specification allows. For example, we test the neutrality of both CPI and FP transmissions from the same set of equations. We also use a dummy interaction term to test the impact of the 1998 financial crisis on price transmissions.[10]

To address the crisis we estimated the system of equations with and without the dummy variable on the foreign price. We then used a systems LLR test to test for the significance of the dummy variable on the complete system of equations. If significant, then the post-crisis transmission is significantly different than pre crisis transmission. Upon finding that the change in transmission variables was significant, we then measured the standard deviation of the total pass-through (the sum of transmission coefficients over all lags) before and after the crisis to see if the financial crisis improved or worsened market integration.

Data

We used a series of monthly retail prices of beef and pork for markets in 80 Russian cities (the capitals of the 80 oblasts, republics, and autonomous districts). The data period ran from January 1994 to September 1999. We used monthly prices since we wanted to evaluate market response within a year and monthly prices were the highest frequency data available. We converted the foreign price into rubles to avoid having to specify and test yet another variable (the

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[10] It is also possible to include exchange rate changes, a specific region's prices within Russia, or the money supply as explanatory variables. However, this study focuses on CPI and foreign price transmissions.

exchange rate). So we test for a combination of foreign price transmission and the transmission of changes in the real exchange rate.[11]

The domestic prices of beef and pork were provided by the Ministry of Agriculture of the Russian Federation.[12] The international pork price was the retail pork price from ERS/USDA. Since China is the largest exporter of pork to Russia, we also used retail pork prices from the China Ministry of Agriculture. The international beef price was that of US choice yield grade 3. The data from all variables was stationary once transformed to the differenced log form as specified by our model.

The Russian data set was quite large and joint testing required specification of an equation for every city. We felt that testing all Russian cities in the data set jointly for neutrality of transmissions was too broad a test. Therefore we broke the data into subregions-West, North, Caucus, Black Earth and Volga (BEV), West Siberia and East Siberia. We then tested for neutrality of CPI and FP price transmissions by estimating one system of price transmission equations for all city markets within a region. We did this, in turn, for each of the subregions.

In applying the pork tests we also included separate tests for transmission of the Chinese meat price to the western and eastern Siberian regions.

Results

Neutrality of Price Transmission: Within 6 Russian Regions.

We specified the exogenous variables, CPI and FP, in log differences. This specification insured that all our data was stationary and insured our test statistics were not distorted by using

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[11] Under the null hypothesis of purchasing power parity, real exchange rate transmission is undefined, since the real exchange rate would not change. However, algebraic manipulation of the law of one price shows that the real exchange rate transmission on real prices should be one. For the sake of this paper, we assume the real exchange rate transmission is 1.

non-stationary data. For six separate regions[13] within Russia we estimated a system of price

transmissions equations. Each equation in a regional system represented one market inside the

region. Each system was estimated with and without the cross equations restrictions, which

imposed the equality of FP transmissions across all markets in the region. The first test imposed

the equality of the sum of FP transmissions across all lags, thus testing whether prices transmit

all information from one region to another. Then we tested for equality of transmission at

impact, then jointly at impact and the first lag and so on. We evaluated the feasibility of the

restrictions for each region using a systems LLR test.[14] We applied the same set of tests to the

CPI transmission coefficients in each regional market.

Table 1 reports the percent of markets within each region where the foreign price

transmission over all lags were significantly different from zero. As noted earlier, our market

integration rests on the assumption that at least one regional market price transmission is greater

than zero (see footnote 8). Table 1 shows this assumption holds for every commodity and in

every region.

Table 1 also reports the average regional transmission after summing over all lags. That

is for a particular region, each market's total price transmission, or what could be called pass

through (PT), was calculated by summing over all the lags of each market's transmission

coefficients. Then the PT's of each market were averaged over the region. The PT can be

interpreted as the degree of integration with international meat prices.

Finally, table 1 reports the variance of PT among markets in each region. A higher

variance indicates wider regional market variation of price response to a change in foreign prices

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[13] West, North, Caucus, Black Earth and Volga (BE&V), West Siberia and East Siberia

[14] We also used a system LLR to test the joint significance, over all lags, of each market's FP transmission coefficients (testing, in turn, each equation in every regional system). This test determines whether the PT over all lags is signficantly different from zero.

and suggests that a region's markets may not be integrated in the short-run. Both before and after crisis averages and variances of regional PT's are presented in this table.

Tables 2 and 3 present the results of testing for similar FP and CPI transmission among city markets within each region. Each table presents $?^2$ statistics obtained from applying a log likelihood ratio test for equality of transmission coefficients in each region's city markets[15]. Since this statistic compares the fit of the system of equations with the restriction and without it, it embodies system fit statistics.

The $?^2$ test statistics in tables 2 and 3 show that the sum of the coefficients (the PTs) are significantly different from each other in most regions. This means there is price information transmitted to some regions that is not passed on to others. It is also evident from the test statistics presented in these tables that changes in FP and changes in the CPI do not have a neutral impact on relative prices among Russian markets within each region. That is, imposing equality of transmission of either FP or the CPI significantly reduces the fit of the system of equation. Therefore it can be inferred that both FP and CPI transmissions are different among city markets within each region.

Neutral transmissions of FP and CPI can be rejected within most regions just from testing the impact and first lag effects on retail prices. All regions reject neutrality of transmission by the second lag, for tests of both CPI and FP transmission.

Other tests:

Having established that the FP and CPI were significantly different within regions (and thus did have a neutral effect on relative market prices within most regions), we believed that it was likely that FP and CPI transmissions also would be significantly different among markets located across different Russian regions. We applied a formal test to address this question. We

randomly choose one city market from each region, estimated a system of inter-regional equations, and applied the same test for neutrality for the six city markets each representing a separate region of Russia. Since the outcome of this test could be dependent on the city chosen from each region, we applied this test six times over, choosing different combinations cities to test across regions.[16] As expected, when all lags are jointly taken into account we rejected neutrality of both FP and CPI transmissions in each inter-regional sample we tested.

As noted earlier, the advantage of our system test is that equations can be grouped into any sub-system the modeler chooses. We set up a system of equations that represented regions (oblasts, republics, and autonomous districts) that export and import beef and pork to and from other Russian regions. We used a system LLR test to ascertain whether the price transmissions were similar for exporters and importers. We jointly tested for similar exporter/importer transmissions at all lags and also applied a test where the sum of the transmission coefficients over all lags of exporters equaled the sum of the importer transmission coefficients over all lags. To do this, we set up a test that was the least likely to reject equal transmission for importers and exporters. We tested a system with equal importer and exporter transmission against a system where all importer transmissions were equal and where all exporters were equal but importers transmission did not equal exporter transmission. Despite this, we found that the $?^2$ statistic from the log likelihood ratio rejected that the total passthrough was equal for importers and exporters at the 99% confidence level for pork and beef markets.

<u>Crisis Dummy Variable</u>:

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[15] The appendix describes our testing procedure in further detail.

[16] We chose to test repeatedly, because of the possibility of spurious results from just one randomly selected test. After six rounds, however, it became apparent that further testing would not yield significantly different results. Tables reporting the inter-region tests can be sent upon request.

Earlier we argued that the 1998 financial crisis in Russia may have an influence on integration of the Russian food market and provided several competing explanations what this influence might be. Driving regions towards less integration were food security concerns that lead regional administrators to restrict trade. Driving towards more integration was the improved terms of trade resulting from the ruble's devaluation. These arguments in particular should apply to the short-run transmission of prices, which more likely reflect the response to sudden changes in market conditions rather than long-run price relationships.

To test the influence of the crisis on short-run transmission of prices, over the period immediately following the crisis, a price interaction dummy variable was included, at each lag, on the FP variable in every transmission equation. The dummy variable was set equal to zero before the crisis and one afterwards (the crisis being marked by Russia's default on domestically issued debt in August 1998). A significant price interaction dummy variable would mean the price transmission from foreign markets was significantly different in the period immediately following the crisis from what it had been before. We then estimated a system of regional equations and used a systems Log Likelihood Ratio (LLR) test to test for the joint significance of the dummy variable across the system of equations. We applied this test at impact and at each of four monthly lags. While it would have been possible to test the dummy variable equation by equation, lag by lag, we felt such a broad scatter of tests would provide results that, as a group, would be difficult to interpret.[17] The results of the dummy variable tests are provided in table 4. Below is a summary of the post crisis model results.

Pork:

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[17] Coefficients and t-statistics on the FP, CPI , and Dummy interaction variables, of all equations can be provided upon request.

Table 4 makes plain that the crisis dummy was significantly different from zero in all regions at all lags for pork. The only exception was that in the Caucus region the pork transmission elasticity was not significantly different at impact. Comparing transmission elasticities summed across all lags before and after the crisis, the trade-weighted average of the differences in the FP transmission elasticity was positive in the West, North, and West Siberian regions, indicating higher transmission rates after the crisis. In the Caucuses, the BE&V region, and in East Siberia the differences were negative, indicating lower transmission after the crisis. However, at the first lag pork price transmissions were lower in all regions, indicating that the rate of price transmission may have slowed after the crisis. The overall trade weighted variance of the transmission elasticities was lower in all but the East Siberian region.

It is counter-intuitive that the price transmissions rose in the West, North, and West Siberian regions, since the crisis caused imported pork to become more expensive. Arbitrageurs taking advantage of low prices of imported pork would be less likely to import pork when it becomes more expensive, leading to higher isolation from the international pork market and less integration. Perhaps effects not captured in our model can explain the higher transmission elasticities. An alternative explanation is that higher domestic integration has translated into greater response to prices of imported pork, transaction costs notwithstanding. The lower variances of the transmission elasticities are consistent with preliminary evidence that the pork sector in Russia is showing signs of positive growth as a result of the favorable market conditions presented by the low real value of the ruble. As argued above, if domestic pork production is displacing imports as a result of the ruble devaluation, the pork market should become more integrated.

The elasticities between China and West and East Siberia increased after the crisis, although the variance of the measured elasticities was higher in East Siberia. China was the largest exporter of pork to Russia prior to the crisis, and the quality of the pork is not necessarily as high as that provided (usually at subsidized prices) from the West. The real price of Western pork increased after the crisis while Chinese pork prices probably were more subdued because of China's involvement in the Asian financial crisis. So it is not surprising, but reassuring, to find the empirical results confirm that Russian pork traders in Siberia turned to the Chinese pork market following the crisis.

Beef:

Table 4 shows that for beef, the crisis dummy was significantly different from zero in all regions at all lags. The only exception was that in the Caucus region the beef transmission elasticity was not significantly different at impact. Yet it was significantly different at other lags. Comparing elasticities summed across all lags it was clear that the trade-weighted average of the change of the FP transmission elasticities before and after the crisis was negative for all regions but the North region (see table 5). The variance of the measured elasticities increased after the crisis, except in the Caucus (where the elasticities were not significantly different) and in East Siberia. Together these results provides some indication that, in the short-run at least, regional beef markets were less open after the crisis and that both integration between Russia and world markets and market integration within Russia decreased.

Conclusions:

Our tests for neutral transmission of foreign price and CPI changes show that domestic market prices across Russia have significantly different reactions to changes in world prices. We also found that different domestic markets react differently to changes in the overall Russian price

level. We conclude that there are significant barriers between the regional markets that prevent rapid transmission of prices from one region to another and that in the short-run, the Russian domestic meat market is not integrated. However, we do not take a stand on the mixed findings of numerous studies that deal with the separate issue of long-run trends in market integration across Russia. We do claim that even if Russian markets were found to be integrated in the long-run, that numerous short-run distortions exist, perhaps arising from the nascent nature of Russian markets.

Our tests for the change in price transmission from foreign markets to specific city markets in Russia following the 1998 financial crisis show that market segmentation in the beef market, in the short-run, became more severe over the period immediately following the crisis. This is perhaps surprising, considering that the devaluation of the ruble improved the terms of trade for Russian food sellers, providing a stimulus to import substitution and therefore higher domestic production and, presumably, enhancing regional market integration. This may have been the case, for example, in the West, North, and West Siberian regions for the pork market, where the price transmission elasticities were higher and the variance between the measured elasticities was lower. However, post-crisis concerns over food security may have led regional administrators to impose restrictions on trade, leading to more market segmentation. Another possible explanation is that the business environment became more risky after the crisis, increasing the transaction costs of trade.

Our study's goal was to determine if Russian regional markets showed any signs of short-run segregation. A second question is why the markets might be short-run segregated. In the text we put forth two reasons why markets may be segmented in the short-run. One is that regional authorities have imposed policy barriers to prevent the export of food products to food-deficit regions.   The other cause of market segmentation is the poor physical infrastructure and risk

associated with doing business in Russia that raises significant barriers to interregional trade. This second phenomenon should be more economy wide. Since we find that uneven price transmission between markets characterizes the entire geographic area of Russia, we are inclined to believe that physical infrastructure problems dominate the problems caused by regional trade policy[18]. However this does not rule out that policies of specific regional administrative units may have contributed to the lack of market integration. Nor does it rule out that in the long-run, or when prices stabilize, enough trade occurs to insure city markets follow common long-term trends. The findings in this paper should encourage additional studies that focus exclusively on the related issue of why markets in the nascent Russian market may be segregated over short instances of time.

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[18] In this case one would expect total pass through to be inversely related to distance. When we regressed our total FP pass-through measures on distances to three ports of entry we found that distance itself explained 40 % of the pass through for beef and none of the pass through for pork.

Tables:

Table 1. Regional Average and Variance of Total Transmissions

Pork:[1,2, 3, 4]

Regions:	West	North	Caucus	BE&V	Siberia West	Siberia East	SiberiaC West	SiberiaC East
% sig:	50%	25%	100%	50%	57%	43%	80%	35%
Before Crisis Avg.	1.67	2.81	1.45	0.99	1.39	1.41	0.30	1.19
Variance	1.59	5.01	1.41	4.13	0.64	3.22	0.80	1.23
After Crisis Avg.	1.61	2.93	0.21	0.93	1.17	1.35	0.37	1.00
Variance	1.22	1.06	0.25	0.43	0.81	1.14	1.49	2.28
System Log Likelihood	2177	421	671	1389	1848	1487	1832	1461

Beef:

Regions:	West	North	Caucus	BE&V	Siberia West	Siberia East
% sig:	86%	75%	85%	100%	60%	100%
Before Crisis Avg.	1.00	1.25	0.87	0.84	0.17	-0.03
Variance	1.56	0.12	0.23	0.29	0.65	1.85
After Crisis Avg.	0.56	2.12	0.25	-0.43	-0.49	-1.07
Variance	0.86	3.37	0.26	0.48	0.81	1.38
System Log Likelihood	3058	533	777	1265	1837	1381

[1] % sig – indicates the percent of markets in each region where the total pass through (PT) was significantly different from zero.
[2] Average represents the average PT among a region's markets. Variance represents the variance of PT among a region's various markets. A higher variance indicates the markets within a region respond unevenly to a outside price change. The crisis represents the August 1998 Russian financial crisis.
[3] Regions tested were: West, North, Caucus, Black Earth and Volga regions, Western Siberia, and Eastern Siberia. A c next to the Siberian regions in the pork markets indicates that our test of transmission of the Chinese price.
[4] A system of price transmission equations, representing the markets in each regions, was estimated for every region. The system log likelihood reports the fit of each regional system.

Table 2. Test for Neutrality of US Price Transmissions Within Regions

Pork:[1,2,3,4]

Regions:	West	North	Caucus	BE&V	Siberia West	Siberia East	SiberiaC West	SiberiaC East
Sum PT equal	74.10*	0.96*	5.44	52.7*	51.16*	20.17*	31.16*	10.2
Impact	67.00*	6.60	6.02	18.2	19.90	20.20*	15.90	14.6
Im, 1lag	NN[5]	15.9*	26.90*	29.54	78.10*	43.5*	44.4*	31.20
Im, 2lag	NN	NN	NN	61.46*	NN	NN	NN	70.8*
Im, 3lag	NN	NN	NN	NN	NN	NN	NN	NN
Im, 4lag	NN	NN	NN	NN	NN	NN	NN	NN

Beef:

Regions:	West	North	Caucus	BE&V	Siberia West	Siberia East
Sum PT equal	79.0*	21.72*	9.22	14.46	36.0*	26.01*
Impact	66.20*	15.30*	4.06	24.62*	26.31*	31.11*
Im, 1lag	NN	NN	16.09*	NN	NN	NN
Im, 2lag	NN	NN	NN	NN	NN	NN
Im, 3lag	NN	NN	NN	NN	NN	NN
Im, 4lag	NN	NN	NN	NN	NN	NN

[1] The * mark indicates significant at the .05 confidence level. If significant with 95% confidence we can reject the coefficient restriction that imposes neutrality at the lag(s) being tested.

[2] Sum PT equal tests whether the sum of transmission over all lags are equal. It does not impose that transmission at any particular lag is equal.

[3] Restrictions were tested against an unrestricted model. For example, for the test labeled im, 2lag, a model restricted to have a neutral impact, first and second lag transmission was tested against an unrestricted model.

[4] The significance level cutoff point changes through sequential hypothesis testing. Also each regional test had different degrees of freedom, since each region had a distinct number of city markets to test.

[5] NN – No need for further testing since earlier tests, at previous lags, rejected neutrality. See text.

Table 3. Test for Neutrality of CPI Price Transmissions Within Regions

Pork:[1]

Regions:	West	North	Caucus	BE&V	Siberia West	Siberia East
Sum PT equal	74.8*	4.72	4.8	27.42*	52.7*	27.42*
Impact	44.20*	10.4*.	5.90	17.38	15.50	11.8
Im, 1lag	NN	NN	18.20	29.54*	59.80*	69.76*
Im, 2lag	NN	NN	NN	NN	NN	NN
Im, 3lag	NN	NN	NN	NN	NN	NN
Im, 4lag	NN	NN	NN	NN	NN	NN

Beef:

Regions:	West	North	Caucus	BE&V	Siberia West	Siberia East
Sum PT equal	41.48*	7.20	20.42*	18.0	12.8	22.78*
Impact	60.10*	16.08*	8.28	17.47	16.40	24.16*
Im, 1lag	NN	NN	32.40*	32.68*	28.24	NN
Im, 2lag	NN	NN	NN	NN	54.20*	NN
Im, 3lag	NN	NN	NN	NN	NN	NN
Im, 4lag	NN	NN	NN	NN	NN	NN

[1] Same format and interpretation as earlier tables

Table 4. Test for Change in Post Crisis Foreign Price Transmissions

Pork:[1,2]

Regions:	West	North	Caucus	BE&V	Siberia West	Siberia East	SiberiaC West	SiberiaC East
All Cfs	270.1*	90.0*	97.9*	194.0*	285.4*	228.8*	218.3*	158.8*
4 Cfs	231.7*	80.4*	86.5*	161.0*	243.6*	212.1*	187.6*	134.2*
3 Cfs	200.4*	78.3*	71.7*	139.1*	194.2*	185.8*	139.4*	106.3*
2 Cfs	148.6*	65.8*	50.7*	103.4*	109.6*	126.6*	99.0*	78.0*
Impact Cf	78.0*	31.2*	26.5	48.8*	47.4*	78.2*	57.2*	39.4*

Beef

Regions:	West	North	Caucus	BE&V	Siberia West	Siberia East
All Cfs	373.5*	150.5*	80.4*	140.2*	279.0*	233.9
4 Cfs	317.3*	150.3*	65.5*	129.5*	256.8*	201.2*
3 Cfs	286.4*	115.6*	41.4*	88.9*	152.3*	163.1*
2 Cfs	189.1*	51.9*	25.3*	56.2*	79.2*	118.5*
Impact Cf	90.5*	34.9*	15.0	20.1*	47.8*	63.7*

[1] All Cfs: Joint testing for post crisis change in transmission coefficients at all lags. 4 Cfs: joint test on the first 4 lags, 3 Cfs: joint test on the first 3 lags, 2 Cfs: jointly test on the first 2 lags, Impact: tests whether the impact transmission changed after the crisis.

[2] A '*' indicates the dummy variable is significant at the .05 level, signifying a change in the price transmission elasticity after the August 1998 crisis.

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