Market of the Novosibirsk Oblast in the System of Regional Markets

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This paper studies integration of the Novosibirsk Oblast market for final goods with markets of all other Russian regions. It considers an aggregated market represented by a basket of basic foods (staples basket). The law of one price serves as the criterion of market integration. It is the base for constructing time series models of the regional costs of the staples basket over 2001–2015 relative to its cost in the Novosibirsk Oblast. Regional markets are divided into four groups: perfectly integrated with the Novosibirsk Oblast market, conditionally integrated with it, not integrated but tending towards integration, and neither integrated nor tending towards integration. Nonlinear time series models with asymptotically decaying trends describe the movement towards integration (price convergence).

Keywords: market integration, law of one price; price convergence; nonlinear trend; Russian regions.

JEL classification: C32, L81, P22, R15

1. Introduction

Regional integration is a very wide concept which includes many various aspects of economic interaction between regions (see, e.g., Granberg, 1999). Integration of *regional product markets* is a much narrower concept; it concerns only one aspect of regional integration, namely, openness of regional markets with one another and their interconnection. This study aims at obtaining a pattern of integration of the Novosibirsk Oblast market for consumer goods (represented by a food basket) with markets of each of rest regions of Russia.

Regional markets for a tradable good[1] are integrated if there are no impediments to trade between them. In other words, costs of a transaction between market participants from the same region and participants from different regions are equal. Then, for instance, a rise in price of the good in some region will give rise to goods arbitrage, i.e. buying the good where it is cheaper and selling it in the given region. Such a mechanism provides establishment and maintenance of spatial equilibrium that manifests itself in the law of one price: equalizing the price of the good across all regions (the strict law of one price). However, there is a 'natural,' irremovable impediment between sufficiently remote regions. It is the distance itself between regions; because of it, costs of intra- and inter-regional transactions will differ by transportation costs. In this case, the weak law of one price describes spatial equilibrium: the price of the good in two regions should differ by no more than transportation costs (per unit of the good). A transitional case between integration and its absence is possible, namely, the movement towards integration. It implies permanent convergence of prices between regions. Thus, integration of market of some region with another one can be judged from the difference in the price between them – more exactly, from its dynamics.

It is worth noting that integration of markets of two regions does not necessarily imply direct trade between them. In perfectly integrated market of a country (where the strict law of one price holds), spatial disconnectedness of regions loses significance; the market operates like a comprehensive whole, being in fact an exact counterpart of a 'point' perfectly competitive market. In such a market, all demand and supply agents are equivalent. Therefore, it can be deemed that parties to any transaction are determined randomly. Owing to this, situations of no trade between

[1] The tradable goods are those that can take part in inter-regional trade (an example of nontaradable goods is dwellings).

some regions in a perfectly integrated market are entirely probable. Thus, the presence or absence of trade flaws between some regions tells nothing about their integration. It is the *potential* possibility of unimpeded trade between these regions that is important. If there is no trade between two regions, prices in one region influence on prices in another region through a chain (more exactly, a network) of 'intermediate' regions.[2]

A number of papers investigate spatial integration of the Russian product market in initial stage of the transition to market economy (prior to 2000): Gardner and Brooks (1994), Berkowitz et al. (1998), Goodwin et al. (1999), etc. They cover different goods, location samples, and time spans. The results obtained suggest poor spatial integration of the Russian market in early years of the market transformations and its improvement since approximately 1994–1995. Much less papers consider the period following the 1998 financial crisis in Russia. Akhmedjonov and Lau (2012) obtain a spatial pattern of integration of the Russian markets for diesel, gasoline, electricity, and coal in 2003–2010. They analyze the differences between regional and national prices, that is, integration of regional markets with the market of the country as a whole. Applying such an approach, 35 to 57 % (depending on specific good) of regional markets are found to be integrated with the national market. Lau and Akhmedjonov (2012) consider differences between regional and average Russian prices for outer clothing across 44 regions in 2002–2009. They find 72 % of regional markets to be integrated. Perevysin and Skrobotov (2017) analyze the law of one price for 69 goods in 2003–2015. They also study the differences between regional and average national prices. Their results suggest that the law of one price does not hold for 32 % of goods; as concerns regions, the pattern is rather mixed. There are also papers analyzing integration of regional markets for intermediate goods, particularly, wheat – e.g., Yusupova (2004).

This paper for the first time studies integration of the Novosibirsk Oblast market with markets of other country's regions. The reason of interest in this region is not so much the fact that it is author's place of residence as the role of Novosibirsk as a large-scale center of trade in consumer goods ('terminal') for many Siberian regions.

[2] The definition of market integration that is adopted here is merely one of possible definitions. It operationalizes, in a way, a theoretical conception, according to which regional markets are connected (integrated to some extent), if demand and supply shocks arising in one region are transmitted – to a degree – to another region, influencing on price dynamics in it (Fackler, Goodwin, 2001, p. 978). Similarly, the shocks can be transmitted through a chain (network) of regions rather than directly.

2. Methodology of the analysis

The tool for the analysis is time series econometrics. Let p_{rt} be price for a tradable good in region r at time point t and p_{0t} be its price in the Novosibirsk Oblast. The strict law of one price is formalized as $p_{rt}/p_{0t} = 1$ for all $t = 0,\ldots,T$. Describe $P_{rt} = \log(p_{rt}/p_{0t})$ as the price differential (or price disparity, since $P_{rt} \approx p_{rt}/p_{0t} - 1$). Then the law of one price takes the form $P_{rt} = 0$. It holds statistically, accurate to random shocks ν_t. The prices depend on their previous values, i.e. are autocorrelated. Then the econometric model of the law of one price is the autoregression model AR(1): $P_{rt} = \nu_t, \nu_t = (\lambda + 1)\nu_{t-1} + \varepsilon_t$, where $\lambda + 1 = \rho$ is the autoregression coefficient and ε_t is the Gaussian white noise (to economize notation, the region indices for disturbances and model parameters are suppressed). Substituting the second equation into the first one and denoting $\Delta P_{rt} \equiv P_{rt} - P_{r,t-1}$, we get (hereafter, $t = 1,\ldots,T$):

$$\Delta P_{rt} = \lambda P_{r,t-1} + \varepsilon_t. \tag{1}$$

The law of one price holds if time series P_{rt} is stationary (contains no unit root). In this case, markets of region r and the Novosibirsk Oblast are deemed perfectly integrated with each other.

The weak law of one price allows for time-invariant price disparity:[3] $p_{rt}/p_{0t} = 1 + c_r$ or $P_{rt} = C_r$, where $C_r = \log(1 + c_r)$. This leads to the AR(1) model with constant $\gamma = -\lambda C_r$:

$$\Delta P_{rt} = \gamma + \lambda P_{r,t-1} + \varepsilon_t. \tag{2}$$

The weak law of one price holds if time series P_{rt} is stationary about a nonzero constant. In this case, markets of region r and the Novosibirsk Oblast are deemed conditionally integrated with each other. Disparity C_r quantifies arbitrage transaction costs. However, in the framework of time series analysis, it is impossible to reveal their nature. They can, indeed, reflect transportation costs only, but it can also include effects caused by ‘artificial’ or eliminable (in principle) impediments to integration, e.g., local protectionism, price regulations, organized crime, etc. That is why the term ‘conditional integration’ is applied here: markets could be acknowledged as integrated on condition that C_r is determined by transportation costs *only*.

The process of the movement towards integration (price convergence) is described by an asymptotically decaying trend: $p_{rt}/p_{0t} = 1 + c_r(t)$, $c_r(t) \to 0$ with $t \to \infty$, $\mathrm{sgn}(c_r(0))\cdot dc_r(t)/dt < 0$, or

[3] Other versions are possible, e.g., $C_{(-)r} \leq P_{rt} \leq C_{(+)r}$, which leads to a threshold autoregression model. For instance, Akhmedjonov and Lau (2012) and Lau and Akhmedjonov (2012) apply this way.

$P_{rt} = C_r(t)$, where $C_r(t) = \log(1 + c_r(t))$. Taking account of autocorrelation, we get an AR(1) model with a trend:

$$\Delta P_{rt} = C(t) - (\lambda + 1)C(t - 1) + \lambda P_{r,t-1} + \varepsilon_t. \tag{3}$$

Two types of the trend are applied: exponential trend $C(t) = \gamma e^{\delta t}$, $\delta < 0$, and fractional trend $C(t) = \gamma/(1 + \delta t)$, $\delta > 0$.. The respective versions of Model (3) look like:

$$\Delta P_{rt} = \gamma e^{\delta t} - (\lambda + 1)\, \gamma e^{\delta(t-1)} + \lambda P_{r,t-1} + \varepsilon_t; \tag{3a}$$

$$\Delta P_{rt} = \gamma/(1 + \delta t) - (\lambda + 1)\gamma/(1 + \delta(t - 1)) + \lambda P_{r,t-1} + \varepsilon_t. \tag{3b}$$

Price convergence takes place if time series P_{rt} is stationary about the trend (one of them or both), γ и δ are statistically significant, and parameter δ has the 'correct' sign. Then markets of region r and the Novosibirsk Oblast are deemed tending towards integration with each other. The rate of convergence towards integration (to the strict law of one price) can be characterized by half-life time θ, i.e., time needed for the price difference $p_{rt}/p_{0t} - 1$ to halve. For the exponential trend, it equals:

$$\theta = \frac{1}{\delta}\log(\frac{\log(0{,}5(e^{\gamma} + 1))}{\gamma});$$

for the fractional trend, it equals:

$$\theta = \frac{1}{\delta}(\frac{\gamma}{\log(0{,}5(e^{\gamma} + 1))} - 1).$$

If no one of the above three models describes the behavior of the prices differential or δ has an 'incorrect' sign, the markets of the relevant region and the Novosibirsk Oblast are deemed neither integrated nor tending towards integration with each other (hereafter, simply non-integrated for brevity). The 'incorrect sign' of δ implies price divergence, hence the respective region pair (r and the Novosibirsk Oblast) is deemed non-integrated (and diverging). In this case, θ does not exist.

The most important in estimation of Models (1)–(3) is testing time series for stationarity, i.e. the hypothesis tested is whether time series P_{rt} has a unit root, $\lambda = 0$ (against $\lambda < 0$). Its rejection implies that time series P_{rt} is stationary, fluctuating around its long-run path. Intuitively this means that when a random shock makes the price differential to deviate from the long-run path, market forces return it (after a time) back. Otherwise, if the time series of the price differential is non-stationary, no return occurs. The long-run path is the price parity, $P^* = 0$, in Model (1), and a time-invariant constant, $P^* = C_r$, in Model (2). In the case of Models (3), the long-run path is trend $P^*_t = C_r(t)$.

To test for a unit root, the augmented Dickey-Fuller (ADF) test and Plillips-Perron test are applied that take account of possible autocorrelation of a form other than AR(1). This makes it possible to use Models (1)–(3) even if the assumption that the prices are influenced by their values solely in the previous period does not hold. Appendix A reports specific details of unit root testing that is adopted in this study. The unit root hypothesis is deemed rejected if both tests reject it at the 10 % level. The same critical level is accepted for significance of parameters γ and δ. The specific-to-general approach is applied to select a relevant model. That is, the first significant model in the sequence (1) $\rightarrow$ (2) $\rightarrow$ (3) is accepted as the relevant model. If models with both trends turn out to be completive, the model providing the best fit – namely, the minimal sum of squared residuals – is accepted.

3. Data

In this study, by a region is meant a federal subject of Russia (among them, the federal cities of Moscow and Saint Petersburg). However, the composite federal subjects (that include or included autonomous *okrugs*) are considered as single regions, jointly with autonomous *okrugs*.[4] The spatial sample for the analysis covers 79 regions, all Russia's regions except for the Chechen Republic, Republic of Crimea and City of Sevastopol, where full data on prices over the whole time span covered are lacking.

A market for an aggregated good, the minimum food basket (staples basket), is considered. This basket includes 33 foods, quantities of the goods in the basket being uniform across regions and time-invariant (Rosstat, 2005, p. 161). The time series of the cost of the staples basket have a monthly frequency and cover 2001–2015 (180 observations for each region). The price data are drawn from the Integrated Interagency Informational and Statistical System of Russia (EMISS), https://www.fedstat.ru/indicator/31481.do.

Figure 1 plots the evolution of the cost of the staples basket in the Novosibirsk Oblast relative to the national average (which is the weighted average over regions with weights being regions' proportions of the national population).

[4] The Arkhangelsk, Tyumen, and Irkutsk *oblasts*, and the Perm, Krasnoyarsk, Transbaikal and Kamchatka *krais*.

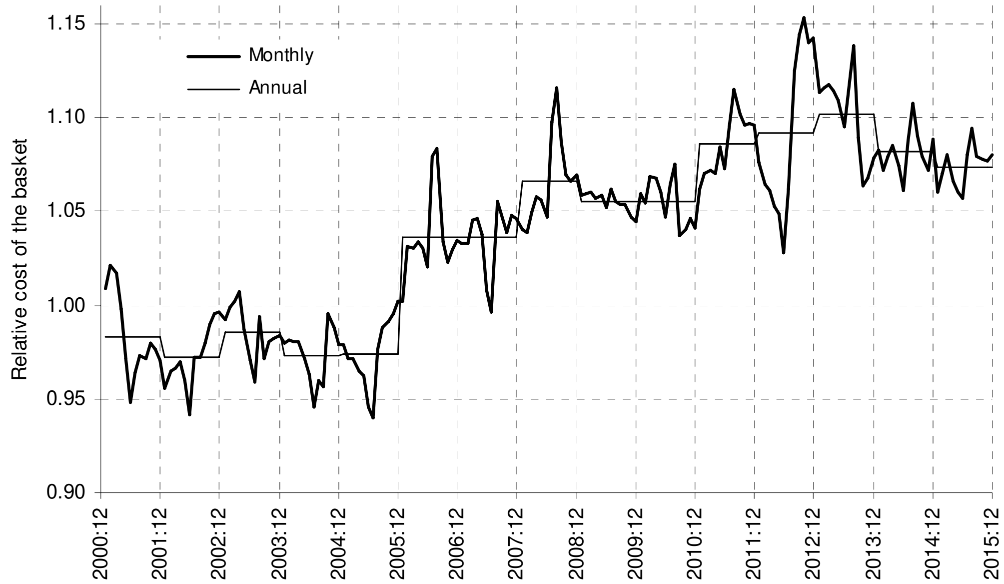

Figure 1. Cost of the staples food basket in the Novosibirsk Oblast relative to the Russian average

In 2001–2005, the relative cost of the basket in the Novosibirsk Oblast generally fluctuated in the range from 95 % to 100 % of the Russian average. Its annual averages were stably below the national average by 1.5–2.5 percentage points. However, starting from the beginning of 2006, the cost of the basket rose dramatically; since then, it permanently surpassed the national average. The annual average cost of the basket was above the national average by 3.6 percentage points in 2006 and 2007. The rise continued thereupon (albeit with a small decrease in 2009–2010), reaching 110 % by 2013 (and even 115 % in some months of 2012 and 2013). In subsequent two years, a minor decrease occurred, to 108–107 % on average over year (it can be noted that this tendency continued also in 2016–2017 with a small reduction of annual averages). Thus, two periods can be distinguished: the first five years, when the cost of the staples basket was below the national average (albeit not too much) with annual relative cost being near-constant, and the subsequent years, when the cost of the basket more and more outran the national average. (Possibly, the third period started since 2014, stabilization of the relative cost of the basket at the level of 106–108 %).

The statistical observation of consumer prices in the Novosibirsk Oblast covers three cities: Novosibirsk, Berdsk, and Kuibyshev (Rosstat, 2005, p. 98). The regional average price is computed as a weighted average over these cities with weights being the city population proportions of the total population of the three cities. The weight of the city of Novosibirsk is more than 91 %. Thus, statistical estimates of prices in the Novosibirsk Oblast are almost entirely determined by prices in the city of Novosibirsk. Hence, the latter are responsible also for all features of price behavior in the Novosibirsk Oblast, namely, the change of the 2001–2005 tendency, when the cost of the stales basket rose in the Novosibirsk Oblast with the same rate as in the country as a whole, to the tendency of rise with rates progressively passing ahead of the national average rates.[5]

4. Results and discussion

Before presentation and discussion of results, let us consider specific examples of perfect integration with the Novosibirsk Oblast, conditional integration, and the movement towards integration ('positive' dynamics of the price differential, Figure 2) as well as examples of non-integration ('negative' dynamics of the price differential, Figure 3). For each case, the figures depict the actual evolution of the price differential $P_{rt} = \log(p_{rt}/p_{0t})$ and its theoretical long-run path (no long-run path exists for the case shown in Figure 3a).

Figures 2 and 3 illustrate econometric considerations in Section 2. Equation (1) describes the price disparity between the Novosibirsk and Vologda *oblasts*, Figure 2a. The price differential fluctuates around the price parity line $P^* = 0$; that is, prices in these regions continually tend to equalize with each other. Markets of the Novosibirsk Oblast and Altai Krai are conditionally integrated (Figure 2b), satisfying Model (2). Here, the price differential fluctuates around a nonzero constant. This means that prices in these regions tend to maintain a constant price disparity, 12.6 % (on average) in real terms.[6] Markets of the Novosibirsk and Tyumen *oblasts* are moving towards integration with each other (Figure 2c). Model (3b) with trend $C(t) = 0.341/(1 + 0.014t)$ describes the evolution of the price differential. It diminishes over time (halving every 4.9 years), approaching the parity line. Certainly, price convergence does not imply that this line will be necessarily reached. Most probably, such a process will result (beyond the time span under

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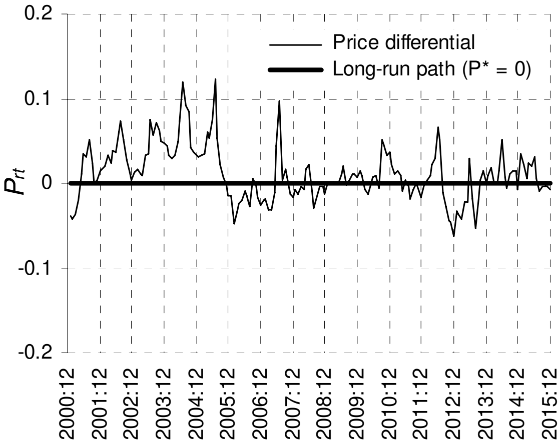
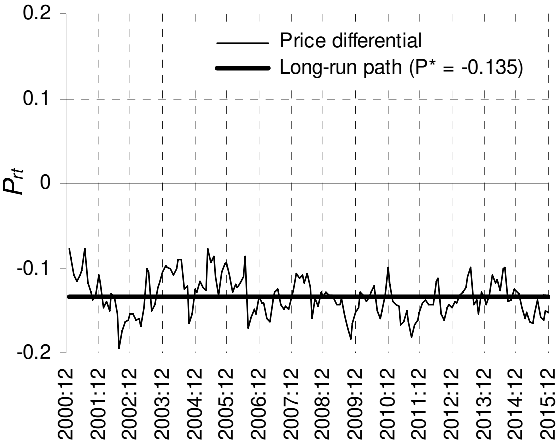
[5] A participant at the International Scientific Forum "Education and Entrepreneurship in Siberia: Directions of Interaction and Development of Regions" (Novosibirsk, October 12–13, 2017) made a proposal that this had been an effect of coming retail networks to Novosibirsk that ousted small shops; at the same time, a number of marketplaces were liquidate in the city. Such a hypothesis seems quite likely; however, to check it, operation of retail in Novosibirsk calls for investigation

[6] Taking account of closeness of the Atai Krai and Novosibirsk Oblast, such a magnitude seems to owe not only to transportation costs, but also to some (unobservable) impediments to inter-regional trade. Therefore the characterization of integration as 'conditional' is quite reasonable in this case.

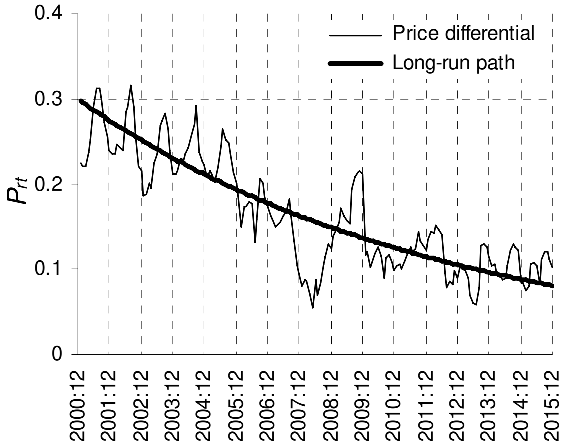
consideration) in stabilization of the price differential at some nonzero level, i.e., in conditional integration.



a) Perfect integration
(with the Vologda Oblast)



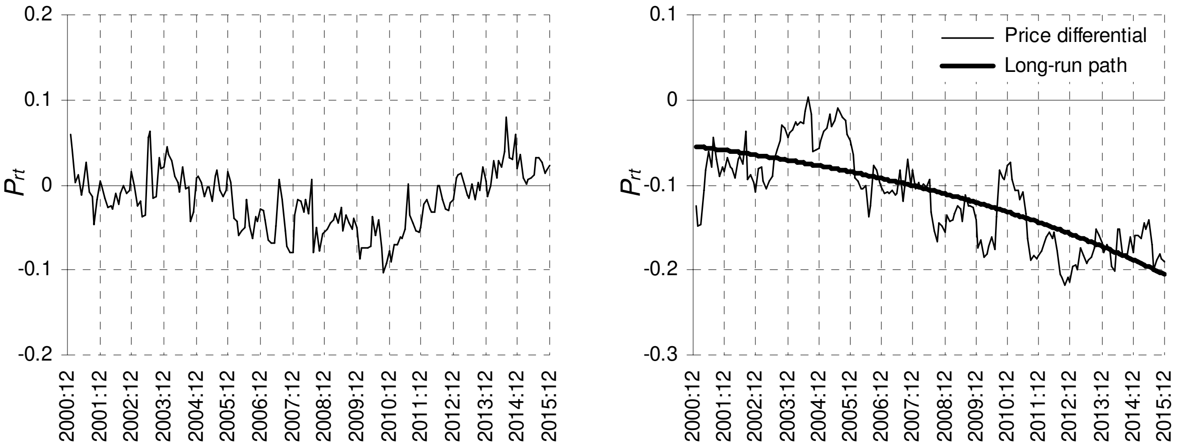
b) Conditional integration
(with the Altai Krai)



c) Movement towards integration
(with the Tyumen Oblast)

Figure 2. Examples of different types of ‘positive’ dynamics of the price differential

No one model describes the behavior of price differential in Figure 3a; no regularity is seen in it. At last, Figure 3b illustrates a case of price divergence. The gap between the cost of the staples basket in the Novosibirsk and Kirov *oblasts* is progressively rising, which is described by Model (3a) with trend $C(t) = -0.055e^{0.0074t}$. It suggests that the price differential doubles every eight odd years.



a) Absence of integration
(with the Republic of Altai)

б) Divergence
(with the Kirov Oblast)

Figure 3. Examples of different types of ‘negative’ dynamics of the price differential

Let us turn to the results obtained. In general terms, they can be characterized as follows. The market of the Novosibirsk Oblast is perfectly integrated with marketы of 16 regions (20.5 % of the total), conditionally integrated with 14 regional markets (17.9 %), and moves towards integration with 5 regional markets (6.4 %), in total – 35 regional markets (44.9 %). Thus, it is neither integrated nor moving towards integration with markets of 43 regions, which makes up 55.1 % of all regions under consideration. Among them, there are 14 cases (17.9 %) of price divergence. Table 1 lists respective regions (‘Obl.’ = Oblast, ‘Rep.’ = Republic).

Table 1. General pattern of integration of the Novosibirsk Oblast

Perfectly integrated regions
Rep. of Karelia, Vologda Obl., Leningrad Obl., Novgorod Obl., Pskov Obl., Kaliningrad Obl., Tver Obl., Rep. of Ingushetia, Krasnodar Krai, Sverdlovsk Obl., Rep. Of Buryatia, Rep. Of Tuva, Rep. Of Khakasia, Krasnoyarsk Krai, Irkutsk Obl., Transbaikal Krai
Conditionally integrated regions
Rep. of Komi, Arkhangelsk Obl., Ivanovo Obl., Oryol Obl., Rep. of Tatarstan, Perm Krai, Altai Krai, Rep. of Sakha (Yakutia), Jewish Autonomous Obl., Primorski Krai, Khabarovsk Krai, Amur Obl., Magadan Obl., Sakhalin Obl.
Regions moving towards integration
Murmansk Obl., Moscow City, Tyumen Obl., Chukchi Autonomous Okrug, Kamchatka Krai
Non-integrated regions (without diverging)
Saint-Petersburg City, Bryansk Obl., Kaluga Obl., Kostroma Obl., Moscow Obl., Smolensk Obl., Yaroslavl Obl., Rep. of Mordovia, Chuvash Rep., Nizni Novgorod Obl., Rep. of Kalmykia, Astrakhan Obl., Volgograd Obl., Samara Obl., Saratov Obl., Ulyanovsk Obl., Rep. of Adygeya, Rep. of Dagestan, Kabardian-Balkar Rep., Rep. of Northern Ossetia, Rep. of Bashkortostan, Udmurt Rep., Kurgan Obl., Orenburg Obl., Chelyabinsk Obl., Rep. of Altai, Kemerovo Obl., Omsk Obl., Tomsk Obl.
Diverging regions
Vladimir Obl., Ryazan Obl.., Tula Obl., Rep. of Mariy El, Kirov Obl., Belgorod Obl., Voronezh Obl., Kursk Obl., Lipetsk Obl., Tambov Obl.., Penza Obl., Karachaev-Chirkassian Rep., Stavropol Krai, Rostov Obl.

Figure 4 plots price differentials averaged over the region groups. As can be expected, the average price differential in the group of perfectly integrated regions predominantly fluctuates around zero. In the group of conditionally integrated regions, it fluctuates about 0.106 (11.2 % in real terms). There are regions in this group where the cost of the staples basket is lower than in the Novosibirsk Oblast (a number of regions from the European part of Russia and the Altai Krai) as well as 'expensive' regions (Far Eastern regions and northern regions of the European part). It is the predominance of the latter that determines the positive value of the average price differential.

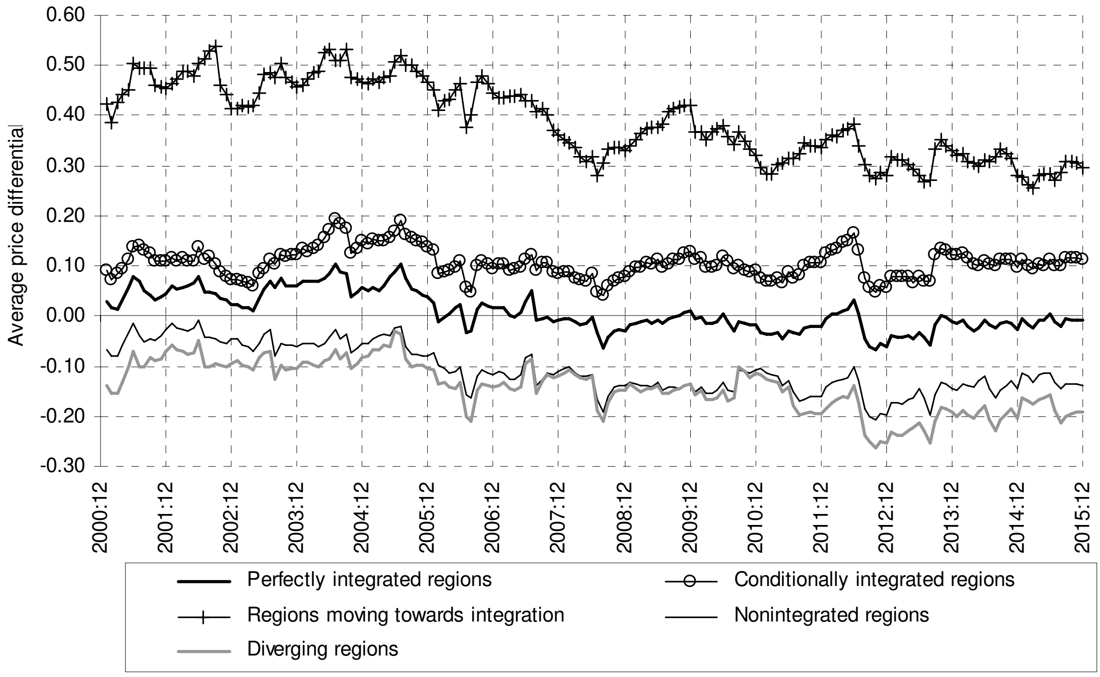


Figure 4. Average price differentials in groups of regions

The average price differential diminished over 15 years from circa 0.5 to 0.3 (or from 65 % to 35 % in real terms) in the group of regions moving towards integration with the Novosibirsk Oblast. In the group of diverging regions, where the price differential was equal to about –0.1 in the beginning of the period in question (i.e., the staples basket was cheaper than in the Novosibirsk Oblast by 10 %), price divergence resulted in its doubling by the end of the period. Interestingly, the group of non-integrated (but not diverging) regions demonstrates a similar trend: average price differential in this group tends to rise in absolute value over time. Thus, albeit price divergence is not observed in each region from this group, it manifests itself in the group as a whole.

Table 2 reports the results of the econometric analysis. It contains estimates of significant models only (that is, the models with all parameters being statistically significant and unit roots being rejected by both tests); recall that the specific-to-general approach is applied to select models. Appendix B reports the full set of estimates of all four models.

Table 2. Estimation and unit root test results

Region	Model	λ		Unit root test p-values (PP/ADF)	γ		δ		Half-life time, θ (years)
1. Rep. of Karelia	(1)	-0.037	(0.020)	0.062 /0.062					
2. Rep. of Komi	(2)	-0.187	(0.042)	0.000 /0.000	0.018^{***}	(0.004)			
3. Arkhangelsk Obl.	(2)	-0.175	(0.041)	0.001 /0.001	0.013^{***}	(0.003)			
4. Vologda Obl.	(1)	-0.195	(0.044)	0.005 /0.084					
5. Murmansk Obl.	(3a)	-0.156	(0.039)	0.008 /0.008	0.280^{***}	(0.024)	-0.0059^{***}	(0.0011)	8.8
6. St. Petersburg City	none								
7. Leningrad Obl.	(1)	-0.042	(0.022)	0.057 /0.057					
8. Novgorod Obl.	(1)	-0.093	(0.031)	0.003 /0.003					
9. Pskov Obl	(1)	-0.094	(0.031)	0.010 /0.009					
10. Kaliningrad Obl.	(1)	-0.094	(0.032)	0.023 /0.038					
11. Bryansk Obl.	none								
12. Vladimir Obl.	(3a)	-0.264	(0.049)	0.000 /0.000	-0.039^{***}	(0.010)	0.0058^{***}	(0.0019)	none
13. Ivanovo Obl.	(2)	-0.141	(0.038)	0.042 /0.081	-0.015^{***}	(0.005)			
14. Kaluga Obl.	none								
15. Kostroma Obl.	none								
16. Moscow City	(3b)	-0.127	(0.018)	0.000 /0.039	1.333^{***}	(0.287)	0.1233^{***}	(0.0327)	0.4
17. Moscow Obl.	none								
18. Oryol Obl.	(2)	-0.127	(0.037)	0.037 /0.057	-0.019^{***}	(0.006)			
19. Ryazan Obl.	(3a)	-0.222	(0.046)	0.002 /0.004	-0.047^{***}	(0.009)	0.0086^{***}	(0.0014)	none
20. Smolensk Obl.	none								
21. Tver Obl.	(1)	-0.059	(0.025)	0.058 /0.068					
22. Tula Obl.	(3a)	-0.187	(0.044)	0.014 /0.058	-0.024^{***}	(0.009)	0.0108^{***}	(0.0025)	none
23. Yaroslavl Obl.	none								
24. Rep. of Mariy El	(3a)	-0.100	(0.034)	0.100 /0.100	-0.108^{***}	(0.024)	0.0042^{**}	(0.0017)	none
25. Rep. of Mordovia	none								
26. Chuvash Rep.	none								
27. Kirov Obl.	(3a)	-0.145	(0.038)	0.011 /0.011	-0.055^{***}	(0.012)	0.0074^{***}	(0.0016)	none
28. Nizhni Novgorod Obl.	none								
29. Belgorod Obl.	(3a)	-0.189	(0.044)	0.006 /0.014	-0.107^{***}	(0.014)	0.0056^{***}	(0.0010)	none
30. Voronezh Obl.	(3a)	-0.185	(0.042)	0.007 /0.016	-0.070^{***}	(0.016)	0.0058^{***}	(0.0017)	none
31. Kursk Obl.	(3a)	-0.175	(0.043)	0.033 /0.070	-0.088^{***}	(0.015)	0.0079^{***}	(0.0012)	none
32. Lipetsk Obl.	(3a)	-0.259	(0.051)	0.001 /0.004	-0.126^{***}	(0.012)	0.0045^{***}	(0.0007)	none
33. Tambov Obl.	(3a)	-0.184	(0.045)	0.018 /0.036	-0.166^{***}	(0.015)	0.0026^{***}	(0.0008)	none
34. Rep. of Kalmykia	none								
35. Rep. of Tatarstan	(2)	-0.081	(0.030)	0.070 /0.070	-0.016^{***}	(0.006)			
36. Astrakhan Obl.	none								
37. Volgograd Obl.	none								
38. Penza Obl.	(3a)	-0.186	(0.043)	0.006 /0.014	-0.095^{***}	(0.011)	0.0059^{***}	(0.0009)	none
39. Samara Obl.	none								
40. Saratov Obl.	none								
41. Ulyanovsk Obl.	none								

Region	Model	λ		Unit root test p-values (PP/ADF)	γ		δ		Half-life time, θ (years)
42. Rep. of Adygeya	none								
43. Rep. of Dagestan	none								
44. Rep. of Ingushetia	(1)	-0.046	(0.022)	0.036 /0.036					
45. Kabardian-Balkar Rep.	none								
46. Karachaev-Cirkassian Rep.	(3a)	-0.268	(0.052)	0.000 /0.002	-0.098***	(0.014)	0.0028**	(0.0012)	none
47. Rep. of Northern Ossetia	none								
48. Krasnodar Krai	(1)	-0.078	(0.027)	0.024 /0.043					
49. Stavropol Krai	(3b)	-0.286	(0.052)	0.007 /0.007	-0.062***	(0.008)	-0.0035***	(0.0004)	none
50. Rostov Obl.	(3a)	-0.377	(0.058)	0.000 /0.072	-0.092***	(0.010)	0.0032***	(0.0009)	none
51. Rep. of Bashkortostan	none								
52. Udmurt Rep.	none								
53. Kurgan Obl.	none								
54. Orenburg Obl.	none								
55. Perm Krai	(2)	-0.075	(0.029)	0.088 /0.088	-0.005**	(0.002)			
56. Sverdlovsk Obl.	(1)	-0.111	(0.034)	0.077 /0.048					
57. Chelyabinsk Obl.	none								
58. Rep. of Altai	none								
59. Altai Krai	(2)	-0.307	(0.053)	0.000 /0.014	-0.041***	(0.007)			
60. Kemerovo Obl.	none								
61. Novosibirsk Obl.	Benchmark								
62. Omsk Obl.	none								
63. Tomsk Obl.	none								
64. Tyumen Obl.	(3b)	-0.151	(0.038)	0.042 /0.042	0.341***	(0.046)	0.0144***	(0.0043)	4.9
65. Rep. of Buryatia	(1)	-0.051	(0.023)	0.028 /0.028					
66. Rep. of Tuva	(1)	-0.075	(0.026)	0.010 /0.018					
67. Rep. of Khakasia	(1)	-0.061	(0.024)	0.013 /0.013					
68. Krasnoyarsk Krai	(1)	-0.024	(0.014)	0.075 /0.075					
69. Irkutsk Obl.	(1)	-0.043	(0.018)	0.018 /0.018					
70. Transbaikal Krai	(1)	-0.055	(0.023)	0.017 /0.017					
71. Rep. of Sakha (Yakutia)	(2)	-0.092	(0.032)	0.051 /0.051	0.036***	(0.012)			
72. Jewish Autonomous Obl.	(2)	-0.075	(0.028)	0.085 /0.085	0.012**	(0.005)			
73. Chukotka A.O.	(3a)	-0.124	(0.036)	0.036 /0.036	1.176***	(0.070)	-0.0020***	(0.0006)	18.3
74. Primorsky Krai	(2)	-0.107	(0.034)	0.027 /0.027	0.025***	(0.008)			
75. Khabarovsk Krai	(2)	-0.080	(0.030)	0.087 /0.087	0.019***	(0.007)			
76. Amur Obl.	(2)	-0.075	(0.028)	0.076 /0.076	0.008**	(0.003)			
77. Kamchatka Krai	(3a)	-0.122	(0.032)	0.011 /0.011	0.645***	(0.044)	-0.0030***	(0.0007)	15.2
78. Magadan Obl.	(2)	-0.084	(0.030)	0.061 /0.061	0.041***	(0.015)			
79. Sakhalin Obl.	(2)	-0.077	(0.030)	0.095 /0.095	0.029**	(0.012)			

Notes: 1. PP and ADF stand for the Phillips-Perron test and augmented Dickey-Fuller test, respectively; 2. Standard errors are in parentheses; 3. Significance at 1% (***), 5% (**), and 10% (*); 4. 'Obl.' = Oblast, 'Rep.' = Republic, and 'A.O.' = Autonomous Okrug.

As it is seen, the degree of integration of the Novosibirsk Oblast market with markets of other regions is rather smallish. This *oblast* ranks 58–60th with the Penza and Vologda oblasts in the number of regions with which it is integrated (perfectly or conditionally) or moves towards integration (Gluschenko, 2017). A negative feature is a considerable number of cases of price divergence (the lack of θ, half-life time of price disparity, corresponds to them in Table 2). The

Novosibirsk Oblast is in the group of top ten regions with the greatest number of cases of divergence with other regions.

Nevertheless, the geographical pattern shown in Figure 5 conforms in its significant part to a pattern that would be expected from the theoretical viewpoint. In a well-established market, such a pattern would look like, relatively speaking, as a system of concentric 'circles' with the center in the region under consideration (benchmark region). The first 'circle' consists of nearby regions, where costs of transportation between them and the benchmark region are small. Therefore, perfect integration between markets of these regions and the benchmark region takes place here. The next 'circle' is comprised of more distant regions. Model (2) with a constant reflecting transportation costs describes integration among them and the benchmark region. The third 'circle' is made up of even more distant regions that are moving towards integration with the benchmark region. The last 'circle' consists of the most distant regions which can be not integrated with the benchmark region.

Indeed, a number of perfectly integrated regions lie eastward of the Novosibirsk Oblast; further, conditionally integrated regions are located. The most distant regions – Chukotka and Kamchatka – are not integrated with the Novosibirsk Oblast, however, convergence with it takes place there. Westward of the Novosibirsk Oblast, the movement towards integration with it is observed in the Tyumen Oblast. But it is most probably due to Khanty-Mansi and Yamalo-Nenets autonomous *okrugs* (comprising the northern part of this *oblast*) which determine a high price level in the Tyumen Oblast as a whole. It can be hypothesized that if the southern part of this *oblast* were separated (price data for it are available only for a few recent years), it would turn out perfectly integrated with the Novosibirsk Oblast. Further to the northwest, a group of conditionally integrated regions lie.

However, the theoretical pattern dramatically breaks in the number of regions in the central part of European Russia and especially in its southern part. The majority of these regions are not integrated with the Novosibirsk Oblast, and a significant proportion of them owing to divergence at that. One more substantial violation of the theoretical pattern is in that the Novosibirsk Oblast is surrounded with a belt of neighboring regions that are not integrated with it, namely, the Omsk, Tomsk, and Kemerovo *oblasts*, and the Republic of Altai.

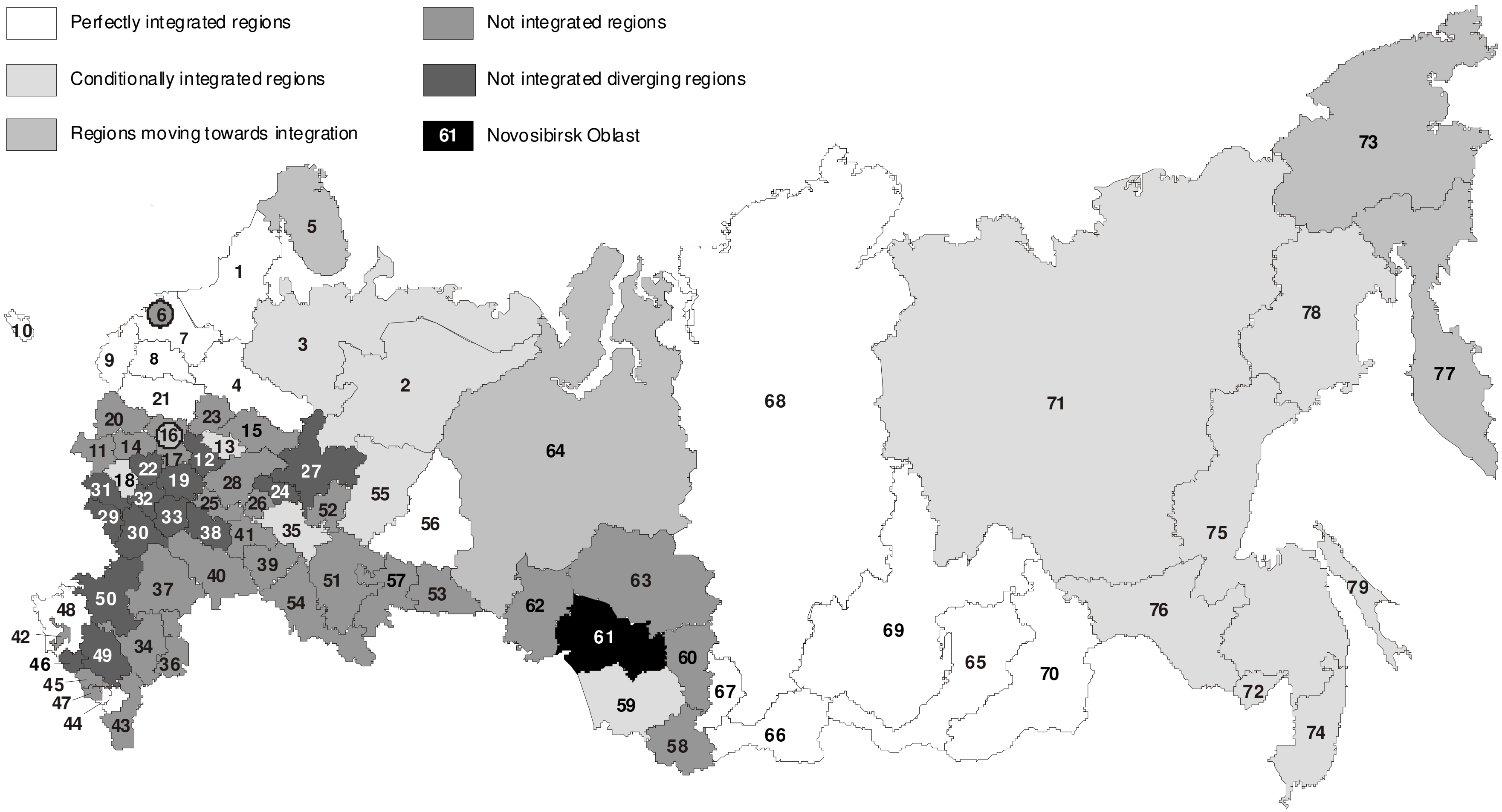


Figure 5. Geographical pattern of integration of the Novosibirsk Oblast market with markets of other Russian regions.
Notes: See Table 2 for numerical designations of regions. Not numbered region is the Chechen Republic.

Different dynamics of prices in these regions and the Novosibirsk Oblast can provide an explanation of this fact. The behavior of the cost of the staples basket in the Novosibirsk Oblast relative to the national average has been considered in Section 3 and shown in Figure 1. Recall that the cost was somewhat below the national average in 2001–2005; it started rising in 2006; and somewhat decreased in 2014–2015. The behavior of prices in the listed regions was quite different. The evolution of the price differential in three out of these regions is depicted in Figure 6.

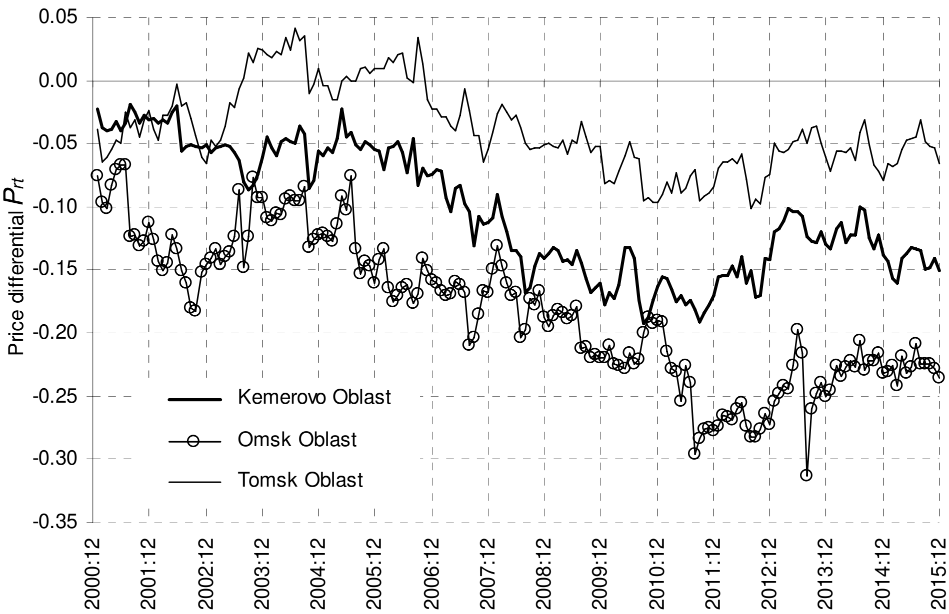


Figure 6. Price differentials in regions that are neighbors of the Novosibirsk Oblast and are not integrated with it

As compared to the national average, the cost of the staples basket in the Kemerovo and Omsk oblasts permanently remained below it. Although the annual average cost in these regions fluctuated over years, it had no trend relative the national average in the Kemerovo Oblast, and has a weak downward trend in the Omsk Oblast. As the cost of the basket increased in the Novosibirsk Oblast relative to the Russian average since 2006, the price gap between the Novosibirsk Oblast and the Kemerovo and Omsk oblasts was widening. Thus, as Figure 6 suggests, price divergence in fact occurred, albeit without unequivocal deterministic trends (which implies that trends are stochastic). The rise in the cost of the staples basket relative to the national average took place in the Tomsk Oblast and Republic of Altai; however, its evolution was radically different from that in the Novosibirsk Oblast. This also determined the lack of integration between these regions and the Novosibirsk Oblast. It may be concluded herefrom that markets of the Novosibirsk Oblast and considered regions are connected very weakly, if at all (which manifests itself in weak or even absent mutual influence of prices). The same may be related to nonintegrated regions of the European part of the country (divergence of these owes to increasing lagging of the cost of the staples basket from its cost in the Novosibirsk Oblast). At the same time, the price dynamics in the most part of Siberian and Far Eastern regions as well as in a number of northern and western regions from the European part of Russia have a nature similar to that observed in the Novosibirsk Oblast.

5. Conclusion

In this paper, regional markets for an aggregated good, namely, the staples basket, has been considered; the cost of this basket has played a role of price representative in these markets. The analysis has been focused on integration of the Novosibirsk Oblast market with markets of other regions of Russia. The law of one price in its strict and weak forms has served as the criterion of integration; long-run convergence to this law (price convergence) has served as the criterion of the movement towards integration. The data used cover the period of 2001–2015.

The analysis performed suggests that the degree of integration of the Novosibirsk Oblast market is rather smallish. It is neither integrated nor moving towards integration with markets of 55.1 % of other regions, price divergence occurring in a third of them. The spatial pattern of integration has features both conforming to theoretical considerations and significantly deviating from them. One unexpected deviation is in that regions neighboring with the Novosibirsk Oblast turn out not to be integrated with it.

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Appendix A. Technical details of unit root testing

To test for the unit root hypothesis (i.e. the hypothesis of non-stationarity of time series) $\lambda = 0$ (against $\lambda < 0$), τ-statistic of λ, $\tau = \lambda/\sigma_\lambda$, is used (in fact, it is the t-statistic; however, it is denoted τ rather than t because it has nonstandard distributions). The augmented Dickey-Fuller (ADF) test and Plillips-Perron test make it possible to take into account possibility of not only autocorrelation with a previous value of the dependent variable that is assumed by Models (1)–(3), but autocorrelation with earlier values and even autocorrelation of forms other than autoregression. To do this, an auxiliary regression is estimated. It consists of original regression with additional regressors $\Delta P_{r,t-1},\ldots, \Delta P_{r,t-p}$. For instance, such a regression for Model (2) has the form:

$$\Delta P_{rt} = \gamma + \lambda P_{r,t-1} + \xi_1 \Delta P_{r,t-1} + \ldots + \xi_p \Delta P_{r,t-p} + \varepsilon_t.$$

To select optimal lag length p^*, the auxiliary regression is estimated with p varying from 0 to $p_{\max} = [12(T/100)^{1/4}]$, where $[x]$ stands for integer part of x, whereas the number of included observations remains constant and equals $T - 1 - p_{\max}$ according to Ng and Perron (2005). Optimal lag length $p = p^*$ is such that minimizes an information criterion. However, Ng and Perron (2001) find that 'ordinary' information criteria (such as Bayesian, Akaike, etc. criteria) tend to select a lag length p^* that is very small, making the test to suffer from size distortions. Therefore a modified Bayesian information criterion put forward by Ng and Perron (2001) is applied in this study. Then the reestimation of the auxiliary regression with optimal lag length p^* and the actual number of observations yields the adjusted value of λ and, in turn, test statistic $\tau = \lambda/\sigma_\lambda$. Note that the auxiliary regression is purely technical. It is used exclusively for obtaining the adjusted value of τ; the estimates of λ and other regression parameters are taken from the original regressions (1)–(3).

In contrast to the ADF test, the Phillips-Perron test adjusts values of σ_λ rather than λ. In doing so, kernel-based spectral density estimators are usually applied. However, this test is known to suffer from size distortions. The use of an autoregressive spectral density estimator significantly moderates this shortcoming (Perron and Ng, 1996). Therefore, the OLS (not-detrended) autoregressive spectral method is applied in this study with the use of the same auxiliary regression as in the ADF test; the lag length p^* is selected as described above.

The above methods are realizable by choosing respective options for the ADF and Phillips-Perron tests in the EViews package. These standard tools have been employed to test linear

Models (1) and (2). For Models (3a) and (3b), nonlinear counterparts of the ADF and Phillips-Perron tests have been developed with similar testing procedures. To obtain distributions of the test statistics for the nonlinear models, τ-statistics have been estimated for sample size T = 180 with the use of a sample of 1,000,000 random walks. The following critical values have been obtained: for the model with exponential trend (3a), significance at the 1 % level with $\tau = –3,865$, at the 5 % level with $\tau = –3,279$, and at the 10 % level with $\tau = –2,974$; for the model with fractional trend (3a), significance at the 1 % level with $\tau = –5,162$, at the 5 % level with $\tau = –3,825$, and at the 10 % level with $\tau = –3,302$. Figure A1 plots the 10-percent tails of the distributions of these τ-statistics, comparing them with the Dickey-Fuller distributions for linear and quadratic trends from MacKinnon (1996).

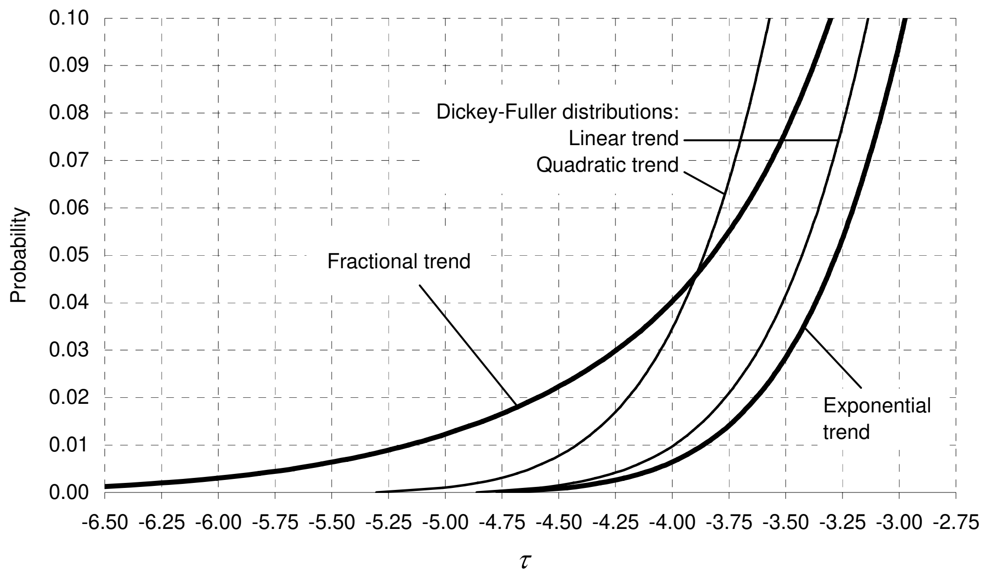

Figure A1. Distributions of τ-statistics for models with nonlinear trends (T = 180)

It should be noted that the adopted methods of testing stationarity are more severe with respect to rejection of the unit root hypothesis than methods in common use. If those (using the Bayesian information criterion with no sample-dependent penalty factor to select p^* in the ADF test and a kernel-based spectral estimator in the Phillips-Perron test) were applied, the pattern of integration of the Novosibirsk Oblast market would turn out to more optimistic. However, according to Perron and Ng (1996) and Ng and Perron (2001), such an 'improvement' of the pattern may be most probably due to size distortions of the unit root test, hence, their significantly lesser reliability.

Appendix B. Full set of estimates

Region	Model	λ		Unit root test p-values (PP/ADF)	γ		δ		SSR
1. Rep. of Karelia	**(1)**	-0.037	(0.020)	0.062 /0.062					
	(2)	-0.144	(0.039)	0.005 /0.005	0.010***	(0.003)			
	(3a)	-0.223	(0.046)	0.000 /0.000	0.133***	(0.021)	-0.0074***	(0.0021)	0.0809
	(3b)	-0.217	(0.046)	0.017 /0.017	0.145***	(0.032)	0.0132*	(0.0069)	0.0811
2. Rep. of Komi	(1)	-0.020	(0.016)	0.182 /0.182					
	(2)	-0.187	(0.042)	0.000 /0.000	0.018***	(0.004)			
	(3a)	-0.196	(0.042)	0.001 /0.001	0.118***	(0.018)	-0.0021	(0.0016)	
	(3b)	-0.195	(0.042)	0.020 /0.020	0.118***	(0.020)	0.0024	(0.0023)	
3. Arkhangelsk Obl.	(1)	-0.025	(0.018)	0.155 /0.155					
	(2)	-0.175	(0.041)	0.001 /0.001	0.013***	(0.003)			
	(3a)	-0.204	(0.044)	0.001 /0.001	0.055***	(0.012)	0.0031*	(0.0018)	0.0596
	(3b)	-0.204	(0.044)	0.020 /0.020	0.056***	(0.010)	-0.0024**	(0.0010)	0.0596
4. Vologda Obl.	**(1)**	-0.195	(0.044)	0.005 /0.084					
	(2)	-0.223	(0.047)	0.017 /0.309	0.003*	(0.002)			
	(3a)	-0.253	(0.049)	0.008 /0.293	0.049*	(0.025)	-0.0184	(0.0124)	
	(3b)	-0.244	(0.048)	NA	0.051	(0.050)	0.0381	(0.0676)	
5. Murmansk Obl.	(1)	-0.008	(0.008)	0.265 /0.265					
	(2)	-0.047	(0.023)	0.282 /0.282	0.007*	(0.004)			
	(3a)	-0.156	(0.039)	0.008 /0.008	0.280***	(0.024)	-0.0059***	(0.0011)	0.0565
	(3b)	-0.146	(0.038)	0.048 /0.048	0.306***	(0.039)	0.0101***	(0.0033)	0.0567
6. St. Petersburg City	(1)	-0.024	(0.017)	0.137 /0.137					
	(2)	-0.073	(0.028)	0.141 /0.183	0.005**	(0.002)			
	(3a)	-0.111	(0.035)	0.477 /0.666	0.163***	(0.047)	-0.0110**	(0.0045)	
	(3b)	-0.139	(0.025)	0.004 /0.125	0.741***	(0.190)	0.1546***	(0.0466)	
7. Leningrad Obl.	**(1)**	-0.042	(0.022)	0.057 /0.057					
	(2)	-0.126	(0.036)	0.009 /0.009	0.007***	(0.002)			
	(3a)	-0.161	(0.039)	0.005 /0.005	0.103***	(0.026)	-0.0082**	(0.0035)	
	(3b)	-0.159	(0.039)	0.038 /0.038	0.118**	(0.047)	0.0164	(0.0137)	
8. Novgorod Obl.	**(1)**	-0.093	(0.031)	0.003 /0.003					
	(2)	-0.164	(0.041)	0.124 /0.382	-0.006***	(0.002)			
	(3a)	-0.219	(0.046)	0.001 /0.001	-0.013	(0.008)	0.0099**	(0.0046)	
	(3b)	-0.206	(0.045)	0.021 /0.021	-0.020**	(0.008)	-0.0040***	(0.0010)	
9. Pskov Obl.	**(1)**	-0.094	(0.031)	0.010 /0.009					
	(2)	-0.179	(0.044)	0.015 /0.045	-0.006***	(0.002)			
	(3a)	-0.201	(0.046)	0.019 /0.076	-0.058***	(0.021)	-0.0056	(0.0045)	
	(3b)	-0.196	(0.046)	0.070 /0.143	-0.057**	(0.028)	0.0070	(0.0102)	
10. Kaliningrad Obl.	**(1)**	-0.094	(0.032)	0.023 /0.038					
	(2)	-0.136	(0.038)	0.066 /0.100	0.004*	(0.002)			
	(3a)	-0.165	(0.041)	0.058 /0.074	0.081**	(0.038)	-0.0098	(0.0073)	
	(3b)	-0.156	(0.041)	0.138 /0.141	0.079	(0.063)	0.0154	(0.0266)	
11. Bryansk Obl.	(1)	-0.006	(0.009)	0.404 /0.404					
	(2)	-0.096	(0.032)	0.105 /0.152	-0.017***	(0.006)			
	(3a)	-0.172	(0.043)	0.275 /0.744	-0.128***	(0.016)	0.0033***	(0.0010)	
	(3b)	-0.161	(0.042)	0.079 /0.122	-0.137***	(0.015)	-0.0023***	(0.0006)	
12. Vladimir Obl.	(1)	-0.046	(0.022)	0.084 /0.114					
	(2)	-0.193	(0.044)	0.049 /0.314	-0.014***	(0.004)			
	(3a)	-0.264	(0.049)	0.000 /0.000	-0.039***	(0.010)	0.0058***	(0.0019)	0.0894
	(3b)	-0.258	(0.049)	0.009 /0.009	-0.046***	(0.008)	-0.0033***	(0.0007)	0.0899

Region	Model	λ		Unit root test *p*-values (PP/ADF)	γ		δ		SSR
13. Ivanovo Obl.	(1)	-0.026	(0.016)	0.192 /0.202					
	(2)	-0.141	(0.038)	0.042 /0.081	-0.015***	(0.005)			
	(3a)	-0.147	(0.039)	0.087 /0.154	-0.094***	(0.025)	0.0017	(0.0023)	
	(3b)	-0.146	(0.039)	0.148 /0.216	-0.097***	(0.024)	-0.0012	(0.0018)	
14. Kaluga Obl.	(1)	-0.012	(0.013)	0.466 /0.471					
	(2)	-0.038	(0.021)	0.574 /0.604	-0.005	(0.003)			
	(3a)	-0.095	(0.033)	0.517 /0.993	-0.041*	(0.021)	0.0095***	(0.0036)	
	(3b)	-0.072	(0.029)	0.717 /0.805	-0.065**	(0.026)	-0.0038***	(0.0010)	
15. Kostroma Obl.	(1)	-0.022	(0.015)	0.161 /0.182					
	(2)	-0.125	(0.035)	0.171 /0.596	-0.012***	(0.004)			
	(3a)	-0.198	(0.041)	0.005 /0.116	-0.056***	(0.012)	0.0055***	(0.0016)	
	(3b)	-0.192	(0.041)	0.045 /0.251	-0.065***	(0.010)	-0.0032***	(0.0006)	
16. Moscow City	(1)	-0.012	(0.010)	0.247 /0.251					
	(2)	-0.035	(0.020)	0.574 /0.593	0.004	(0.003)			
	(3a)	-0.138	(0.036)	0.032 /0.036	0.356***	(0.045)	-0.0115***	(0.0020)	0.0817
	(3b)	-0.127	(0.018)	0.000 /0.039	1.333***	(0.287)	0.1233***	(0.0327)	0.0807
17. Moscow Obl.	(1)	-0.034	(0.020)	0.115 /0.128					
	(2)	-0.037	(0.021)	0.452 /0.482	-0.001	(0.001)			
	(3a)	-0.057	(0.026)	0.419 /0.466	-0.005	(0.014)	0.0166	(0.0187)	
	(3b)	-0.049	(0.023)	0.577 /0.149	-0.013	(0.019)	-0.0047***	(0.0015)	
18. Oryol Obl.	(1)	-0.014	(0.012)	0.320 /0.298					
	(2)	-0.127	(0.037)	0.037 /0.057	-0.019***	(0.006)			
	(3a)	-0.167	(0.041)	0.017 /0.026	-0.110***	(0.020)	0.0033**	(0.0015)	0.1212
	(3b)	-0.163	(0.041)	0.067 /0.083	-0.118***	(0.019)	-0.0023***	(0.0009)	0.1216
19. Ryazan Obl.	(1)	-0.013	(0.014)	0.483 /0.472					
	(2)	-0.069	(0.028)	0.361 /0.414	-0.008**	(0.004)			
	(3a)	-0.222	(0.046)	0.002 /0.004	-0.047***	(0.009)	0.0086***	(0.0014)	0.0862
	(3b)	-0.198	(0.045)	0.036 /0.100	-0.065***	(0.009)	-0.0040***	(0.0003)	0.0877
20. Smolensk Obl.	(1)	-0.117	(0.035)	0.067 /0.415					
	(2)	-0.248	(0.049)	0.009 /0.543	-0.009***	(0.003)			
	(3a)	-0.320	(0.054)	0.000 /0.534	-0.017**	(0.007)	0.0081***	(0.0030)	
	(3b)	-0.306	(0.053)	0.013 /0.932	-0.023***	(0.006)	-0.0038***	(0.0008)	
21. Tver Obl.	**(1)**	-0.059	(0.025)	0.058 /0.068					
	(2)	-0.128	(0.037)	0.288 /0.581	-0.007**	(0.003)			
	(3a)	-0.169	(0.041)	0.177 /0.728	-0.025*	(0.014)	0.0075*	(0.0041)	
	(3b)	-0.158	(0.040)	0.354 /0.914	-0.034**	(0.014)	-0.0035***	(0.0013)	
22. Tula Obl.	(1)	-0.022	(0.018)	0.193 /0.193					
	(2)	-0.071	(0.029)	0.297 /0.357	-0.006**	(0.003)			
	(3a)	-0.187	(0.044)	0.014 /0.058	-0.024***	(0.009)	0.0108***	(0.0025)	
	(3b)	-0.154	(0.040)	0.117 /0.208	-0.040***	(0.009)	-0.0042***	(0.0005)	
23. Yaroslavl Obl.	(1)	-0.021	(0.017)	0.205 /0.205					
	(2)	-0.058	(0.026)	0.525 /0.570	-0.005*	(0.003)			
	(3a)	-0.166	(0.041)	0.274 /0.798	-0.022**	(0.010)	0.0119***	(0.0029)	
	(3b)	-0.128	(0.037)	0.590 /0.854	-0.040***	(0.012)	-0.0043***	(0.0005)	
24. Rep. of Mariy El	(1)	-0.004	(0.008)	0.503 /0.503					
	(2)	-0.054	(0.024)	0.188 /0.188	-0.009**	(0.004)			
	(3a)	-0.100	(0.034)	0.100 /0.100	-0.108***	(0.024)	0.0042**	(0.0017)	
	(3b)	-0.091	(0.032)	0.193 /0.193	-0.122***	(0.023)	-0.0026***	(0.0009)	

Region	Model	λ		Unit root test p-values (PP/ADF)	γ		δ		SSR
25. Rep. of Mordovia	(1)	-0.005	(0.009)	0.500 /0.500					
	(2)	-0.052	(0.025)	0.353 /0.382	-0.009^{**}	(0.004)			
	(3a)	-0.105	(0.033)	0.113 /0.131	-0.097^{***}	(0.024)	0.0054^{***}	(0.0019)	
	(3b)	-0.097	(0.032)	0.211 /0.235	-0.112^{***}	(0.023)	-0.0031^{***}	(0.0008)	
26. Chuvash Rep.	(1)	-0.005	(0.009)	0.586 /0.598					
	(2)	-0.085	(0.030)	0.191 /0.233	-0.016^{***}	(0.006)			
	(3a)	-0.142	(0.039)	0.080 /0.142	-0.127^{***}	(0.020)	0.0036^{***}	(0.0013)	
	(3b)	-0.134	(0.038)	0.162 /0.227	-0.137^{***}	(0.019)	-0.0024^{***}	(0.0007)	
27. Kirov Obl.	(1)	-0.006	(0.010)	0.468 /0.468					
	(2)	-0.048	(0.024)	0.298 /0.298	-0.006^{*}	(0.003)			
	(3a)	-0.145	(0.038)	0.011 /0.011	-0.055^{***}	(0.012)	0.0074^{***}	(0.0016)	0.0512
	(3b)	-0.128	(0.036)	0.072 /0.072	-0.070^{***}	(0.011)	-0.0037^{***}	(0.0005)	0.0519
28. Nizhni Novgorod Obl.	(1)	-0.019	(0.017)	0.730 /0.720					
	(2)	-0.089	(0.032)	0.613 /0.421	-0.009^{**}	(0.004)			
	(3a)	-0.194	(0.044)	0.183 /0.675	-0.046^{***}	(0.012)	0.0078^{***}	(0.0020)	
	(3b)	-0.168	(0.042)	0.295 /0.565	-0.061^{***}	(0.012)	-0.0038^{***}	(0.0006)	
29. Belgorod Obl.	(1)	-0.005	(0.009)	0.471 /0.471					
	(2)	-0.061	(0.026)	0.331 /0.382	-0.012^{**}	(0.005)			
	(3a)	-0.189	(0.044)	0.006 /0.014	-0.107^{***}	(0.014)	0.0056^{***}	(0.0010)	
	(3b)	-0.158	(0.041)	0.076 /0.108	-0.125^{***}	(0.015)	-0.0032^{***}	(0.0005)	
30. Voronezh Obl.	(1)	-0.019	(0.015)	0.302 /0.304					
	(2)	-0.115	(0.035)	0.075 /0.116	-0.015^{***}	(0.005)			
	(3a)	-0.185	(0.042)	0.007 /0.016	-0.070^{***}	(0.016)	0.0058^{***}	(0.0017)	0.1218
	(3b)	-0.185	(0.042)	0.044 /0.063	-0.080^{***}	(0.013)	-0.0034^{***}	(0.0006)	0.1220
31. Kursk Obl.	(1)	-0.004	(0.010)	0.680 /0.682					
	(2)	-0.041	(0.022)	0.651 /0.684	-0.009^{*}	(0.005)			
	(3a)	-0.175	(0.043)	0.033 /0.070	-0.088^{***}	(0.015)	0.0079^{***}	(0.0012)	
	(3b)	-0.144	(0.040)	0.185 /0.265	-0.117^{***}	(0.015)	-0.0038^{***}	(0.0004)	
32. Lipetsk Obl.	(1)	-0.006	(0.010)	0.604 /0.584					
	(2)	-0.101	(0.033)	0.135 /0.221	-0.020^{***}	(0.007)			
	(3a)	-0.259	(0.051)	0.001 /0.004	-0.126^{***}	(0.012)	0.0045^{***}	(0.0007)	0.1121
	(3b)	-0.240	(0.049)	0.027 /0.049	-0.137^{***}	(0.011)	-0.0029^{***}	(0.0004)	0.1134
33. Tambov Obl.	(1)	-0.004	(0.007)	0.455 /0.455					
	(2)	-0.108	(0.034)	0.082 /0.131	-0.023^{***}	(0.007)			
	(3a)	-0.184	(0.045)	0.018 /0.036	-0.166^{***}	(0.015)	0.0026^{***}	(0.0008)	0.0726
	(3b)	-0.182	(0.044)	0.066 /0.096	-0.171^{***}	(0.014)	-0.0020^{***}	(0.0005)	0.0728
34. Rep. of Kalmykia	(1)	-0.023	(0.016)	0.397 /0.314					
	(2)	-0.318	(0.055)	0.001 /0.180	-0.049^{***}	(0.009)			
	(3a)	-0.328	(0.056)	0.003 /0.284	-0.166^{***}	(0.015)	-0.0009	(0.0009)	
	(3b)	-0.328	(0.056)	0.030 /0.334	-0.166^{***}	(0.016)	0.0009	(0.0011)	
35. Rep. of Tatarstan	(1)	-0.006	(0.008)	0.422 /0.422					
	(2)	-0.081	(0.030)	0.070 /0.070	-0.016^{***}	(0.006)			
	(3a)	-0.108	(0.034)	0.067 /0.067	-0.148^{***}	(0.028)	0.0025	(0.0015)	
	(3b)	-0.104	(0.034)	0.134 /0.134	-0.156^{***}	(0.026)	-0.0018^{*}	(0.0010)	
36. Astrakhan Obl.	(1)	-0.035	(0.020)	0.555 /0.625					
	(2)	-0.215	(0.046)	0.026 /0.253	-0.023^{***}	(0.005)			
	(3a)	-0.344	(0.057)	0.002 /0.459	-0.064^{***}	(0.010)	0.0051^{***}	(0.0012)	
	(3b)	-0.325	(0.056)	0.033 /0.527	-0.073^{***}	(0.009)	-0.0030^{***}	(0.0005)	

Region	Model	λ		Unit root test p-values (PP/ADF)	γ		δ		SSR
37. Volgograd Obl.	(1)	-0.020	(0.016)	0.382 /0.393					
	(2)	-0.127	(0.036)	0.076 /0.146	-0.016***	(0.005)			
	(3a)	-0.262	(0.051)	0.050 /0.609	-0.068***	(0.012)	0.0061***	(0.0013)	
	(3b)	-0.235	(0.049)	0.172 /0.698	-0.082***	(0.011)	-0.0033***	(0.0005)	
38. Penza Obl.	(1)	-0.002	(0.008)	0.600 /0.600					
	(2)	-0.049	(0.025)	0.511 /0.563	-0.009**	(0.004)			
	(3a)	-0.186	(0.043)	0.006 /0.014	-0.095***	(0.011)	0.0059***	(0.0009)	
	(3b)	-0.176	(0.043)	0.058 /0.111	-0.110***	(0.010)	-0.0034***	(0.0003)	
39. Samara Obl.	(1)	-0.057	(0.025)	0.145 /0.154					
	(2)	-0.060	(0.026)	0.515 /0.515	-0.002	(0.002)			
	(3a)	-0.080	(0.030)	0.629 /0.691	0.868	3.300)	-0.0601	(0.0628)	
	(3b)	-0.076	(0.029)	0.788 /0.708	-0.015	(0.020)	-0.0046**	(0.0018)	
40. Saratov Obl	(1)	-0.002	(0.009)	0.597 /0.597					
.	(2)	-0.029	(0.017)	0.597 /0.602	-0.007*	(0.003)			
	(3a)	-0.092	(0.033)	0.502 /0.605	-0.083***	(0.026)	0.0077***	(0.0022)	
	(3b)	-0.066	(0.028)	0.658 /0.712	-0.119***	(0.034)	-0.0035***	(0.0009)	
41. Ulyanovsk Obl.	(1)	-0.005	(0.009)	0.473 /0.473					
	(2)	-0.066	(0.027)	0.426 /0.472	-0.012**	(0.005)			
	(3a)	-0.120	(0.036)	0.269 /0.414	-0.112***	(0.023)	0.0043***	(0.0016)	
	(3b)	-0.110	(0.035)	0.378 /0.496	-0.125***	(0.022)	-0.0027***	(0.0008)	
42. Rep. of Adygeya	(1)	-0.032	(0.019)	0.260 /0.245					
	(2)	-0.194	(0.044)	0.099 /0.614	-0.021***	(0.005)			
	(3a)	-0.317	(0.055)	0.006 /0.331	-0.063***	(0.010)	0.0053***	(0.0012)	
	(3b)	-0.307	(0.055)	0.053 /0.506	-0.072***	(0.009)	-0.0032***	(0.0005)	
43. Rep. of Dagestan	(1)	-0.032	(0.018)	0.140 /0.130					
	(2)	-0.211	(0.046)	0.047 /0.246	-0.023***	(0.006)			
	(3a)	-0.214	(0.047)	0.120 /0.464	-0.101***	(0.019)	0.0009	(0.0017)	
	(3b)	-0.214	(0.047)	0.179 /0.489	-0.102***	(0.019)	-0.0007	(0.0015)	
44. Rep. of Ingushetia	**(1)**	-0.046	(0.022)	0.036 /0.036					
	(2)	-0.051	(0.023)	0.196 /0.196	-0.002	(0.002)			
	(3a)	-0.076	(0.031)	0.624 /0.691	-0.008	(0.020)	0.0153	(0.0162)	
	(3b)	-0.063	(0.028)	0.690 /0.733	-0.023	(0.032)	-0.0042	(0.0027)	
45. Kabardian-Balkar Rep.	(1)	-0.020	(0.016)	0.386 /0.373					
	(2)	-0.187	(0.044)	0.156 /0.370	-0.030***	(0.007)			
	(3a)	-0.319	(0.055)	0.003 /0.304	-0.104***	(0.012)	0.0043***	(0.0010)	
	(3b)	-0.300	(0.054)	0.044 /0.410	-0.114***	(0.012)	-0.0027***	(0.0005)	
46. Karachaev-Cirkassian Rep.	(1)	-0.026	(0.017)	0.233 /0.200					
	(2)	-0.222	(0.047)	0.018 /0.141	-0.028***	(0.006)			
	(3a)	-0.268	(0.052)	0.000 /0.002	-0.098***	(0.014)	0.0028**	(0.0012)	0.1496
	(3b)	-0.264	(0.051)	0.018 /0.031	-0.102***	(0.013)	-0.0020**	(0.0008)	0.1500
47. Rep. of Northern Ossetia	(1)	-0.027	(0.018)	0.573 /0.637					
	(2)	-0.290	(0.053)	0.003 /0.241	-0.037***	(0.007)			
	(3a)	-0.394	(0.060)	0.000 /0.221	-0.095***	(0.010)	0.0032***	(0.0009)	
	(3b)	-0.385	(0.060)	0.013 /0.310	-0.100***	(0.009)	-0.0023***	(0.0005)	
48. Krasnodar Krai	**(1)**	-0.078	(0.027)	0.024 /0.043					
	(2)	-0.229	(0.047)	0.002 /0.013	-0.015***	(0.004)			
	(3a)	-0.252	(0.049)	0.002 /0.019	-0.046***	(0.015)	0.0037	(0.0026)	
	(3b)	-0.248	(0.049)	0.030 /0.069	-0.052***	(0.014)	-0.0023	(0.0014)	

Region	Model	λ		Unit root test *p*-values (PP/ADF)	γ		δ		SSR
49. Stavropol Krai	(1)	-0.028	(0.018)	0.246 /0.237					
	(2)	-0.171	(0.042)	0.226 /0.601	-0.017***	(0.005)			
	(3a)	-0.282	(0.051)	0.000 /0.000	-0.055***	(0.010)	0.0059***	(0.0014)	0.1099
	(3b)	-0.286	(0.052)	0.007 /0.007	-0.062***	(0.008)	-0.0035***	(0.0004)	0.1099
50. Rostov Obl.	(1)	-0.031	(0.018)	0.374 /0.626					
	(2)	-0.294	(0.053)	0.001 /0.486	-0.037***	(0.007)			
	(3a)	-0.377	(0.058)	0.000 /0.072	-0.092***	(0.010)	0.0032***	(0.0009)	
	(3b)	-0.379	(0.058)	0.008 /0.157	-0.096***	(0.009)	-0.0024***	(0.0005)	
51. Rep. of Bashkortostan	(1)	-0.004	(0.009)	0.498 /0.498					
	(2)	-0.062	(0.025)	0.212 /0.198	-0.009**	(0.004)			
	(3a)	-0.091	(0.032)	0.246 /0.298	-0.105***	(0.025)	0.0031	(0.0019)	
	(3b)	-0.085	(0.031)	0.329 /0.364	-0.114***	(0.025)	-0.0021*	(0.0012)	
52. Udmurt Rep.	(1)	-0.005	(0.010)	0.498 /0.498					
	(2)	-0.045	(0.021)	0.247 /0.247	-0.007**	(0.003)			
	(3a)	-0.070	(0.028)	0.241 /0.241	-0.095***	(0.036)	0.0045	(0.0028)	
	(3b)	-0.064	(0.027)	0.330 /0.330	-0.110***	(0.035)	-0.0026*	(0.0014)	
53. Kurgan Obl.	(1)	-0.010	(0.011)	0.493 /0.483					
	(2)	-0.132	(0.036)	0.066 /0.158	-0.017***	(0.005)			
	(3a)	-0.170	(0.043)	0.114 /0.284	-0.102***	(0.016)	0.0024*	(0.0013)	
	(3b)	-0.164	(0.042)	0.183 /0.345	-0.107***	(0.015)	-0.0017*	(0.0009)	
54. Orenburg Obl.	(1)	-0.001	(0.007)	0.640 /0.640					
	(2)	-0.032	(0.017)	0.336 /0.336	-0.006**	(0.003)			
	(3a)	-0.058	(0.027)	0.375 /0.375	-0.113***	(0.037)	0.0042*	(0.0024)	
	(3b)	-0.051	(0.024)	0.468 /0.468	-0.132***	(0.040)	-0.0024*	(0.0014)	
55. Perm Krai	(1)	-0.026	(0.018)	0.149 /0.149					
	(2)	-0.075	(0.029)	0.088 /0.088	-0.005**	(0.002)			
	(3a)	-0.126	(0.037)	0.035 /0.035	-0.026*	(0.014)	0.0087**	(0.0038)	
	(3b)	-0.116	(0.035)	0.066 /0.288	-0.036***	(0.013)	-0.0039***	(0.0009)	
56. Sverdlovsk Obl.	**(1)**	-0.111	(0.034)	0.077 /0.048					
	(2)	-0.120	(0.036)	0.476 /0.419	0.001	(0.001)			
	(3a)	-0.219	(0.047)	0.078 /0.501	0.097***	(0.034)	-0.0301**	(0.0130)	
	(3b)	-0.218	(0.043)	NA	0.270*	(0.145)	0.2326*	(0.1273)	
57. Chelyabinsk Obl.	(1)	-0.018	(0.016)	0.230 /0.230					
	(2)	-0.052	(0.023)	0.170 /0.170	-0.003**	(0.002)			
	(3a)	-0.090	(0.031)	0.117 /0.117	-0.026	(0.016)	0.0081*	(0.0044)	
	(3b)	-0.078	(0.028)	0.219 /0.219	-0.037**	(0.017)	-0.0036***	(0.0013)	
58. Rep. of Altai	(1)	-0.165	(0.041)	0.009 /0.137					
	(2)	-0.214	(0.045)	0.013 /0.450	-0.004**	(0.002)			
	(3a)	-0.214	(0.046)	0.059 /0.696	-0.025	(0.018)	-0.0025	(0.0075)	
	(3b)	-0.214	(0.046)	0.120 /0.684	-0.023	(0.019)	0.0021	(0.0104)	
59. Altai Krai	(1)	-0.006	(0.010)	0.732 /0.687					
	(2)	-0.307	(0.053)	0.000 /0.014	-0.041***	(0.007)			
	(3a)	-0.324	(0.054)	0.000 /0.035	-0.126***	(0.007)	0.0007	(0.0005)	
	(3b)	-0.324	(0.054)	0.014 0.084	-0.126***	(0.007)	-0.0006	(0.0005)	
60. Kemerovo Obl.	(1)	-0.001	(0.008)	0.644 0.644					
	(2)	-0.035	(0.018)	0.320 0.320	-0.004**	(0.002)			
	(3a)	-0.071	(0.028)	0.548 0.670	-0.064***	(0.020)	0.0052**	(0.0023)	
	(3b)	-0.062	(0.025)	0.319 0.319	-0.077***	(0.020)	-0.0029***	(0.0010)	
61. Novosibirsk Obl.	Benchmark								

Region	Model	λ		Unit root test p-values (PP/ADF)	γ		δ		SSR
62. Omsk Obl.	(1)	-0.001	(0.007)	0.789 /0.768					
	(2)	-0.060	(0.024)	0.290 /0.410	-0.012**	(0.005)			
	(3a)	-0.179	(0.043)	0.048 /0.158	-0.118***	(0.012)	0.0046***	(0.0008)	
	(3b)	-0.155	(0.040)	0.147 /0.286	-0.131***	(0.012)	-0.0028***	(0.0004)	
63. Tomsk Obl.	(1)	-0.025	(0.018)	0.147 /0.147					
	(2)	-0.063	(0.027)	0.155 /0.155	-0.003*	(0.001)			
	(3a)	-0.095	(0.032)	0.099 /0.099	-0.015	(0.011)	0.0089*	(0.0050)	
	(3b)	-0.087	(0.031)	0.188 /0.188	-0.023**	(0.011)	-0.0038***	(0.0012)	
64. Tyumen Obl.	(1)	-0.009	(0.008)	0.225 /0.225					
	(2)	-0.039	(0.021)	0.338 /0.338	0.006	(0.004)			
	(3a)	-0.154	(0.039)	0.008 /0.008	0.297***	(0.026)	-0.0073***	(0.0012)	0.0567
	(3b)	-0.151	(0.038)	0.042 /0.042	0.341***	(0.046)	0.0144***	(0.0043)	0.0566
65. Rep. of Buryatia	**(1)**	-0.051	(0.023)	0.028 /0.028					
	(2)	-0.053	(0.024)	0.195 /0.195	-0.001	(0.002)			
	(3a)	-0.065	(0.027)	0.258 /0.258	-0.003	(0.013)	0.0169	(0.0263)	
	(3b)	-0.060	(0.025)	0.337 /0.337	-0.010	(0.018)	-0.0046**	(0.0023)	
66. Rep. of Tuva	**(1)**	-0.075	(0.026)	0.010 /0.018					
	(2)	-0.107	(0.033)	0.322 /0.544	0.003	(0.002)			
	(3a)	-0.185	(0.044)	0.246 /0.591	0.130***	(0.039)	-0.0197**	(0.0077)	
	(3b)	-0.170	(0.038)	NA	0.417**	(0.207)	0.1724**	(0.0869)	
67. Rep. of Khakasia	**(1)**	-0.061	(0.024)	0.013 /0.013					
	(2)	-0.061	(0.024)	0.119 /0.119	-0.001	(0.001)			
	(3a)	-0.086	(0.028)	0.082 /0.082	-0.001	(0.004)	0.0246	(0.0235)	
	(3b)	-0.077	(0.027)	0.181 /0.181	-0.007	(0.009)	-0.0050***	(0.0009)	
68. Krasnoyarsk Krai	**(1)**	-0.024	(0.014)	0.075 /0.075					
	(2)	-0.044	(0.021)	0.234 /0.234	0.002	(0.002)			
	(3a)	-0.161	(0.041)	0.042 /0.080	0.209***	(0.032)	-0.0176***	(0.0034)	
	(3b)	-0.172	(0.023)	NA	0.844***	(0.142)	0.1992***	(0.0404)	
69. Irkutsk Obl.	**(1)**	-0.043	(0.018)	0.018 /0.018					
	(2)	-0.062	(0.024)	0.106 /0.106	0.002	(0.002)			
	(3a)	-0.146	(0.039)	0.016 /0.016	0.157***	(0.040)	-0.0179***	(0.0058)	
	(3b)	-0.133	(0.035)	NA	0.265	(0.415)	0.0722	(0.1471)	
70. Transbaikal Krai	**(1)**	-0.055	(0.023)	0.017 /0.017					
	(2)	-0.090	(0.030)	0.038 /0.038	0.004*	(0.002)			
	(3a)	-0.136	(0.039)	0.026 /0.026	0.127***	(0.047)	-0.0140**	(0.0070)	
	(3b)	-0.133	(0.031)	NA	0.594***	(0.186)	0.1714***	(0.0546)	
71. Rep. of Sakha (Yakutia)	(1)	-0.001	(0.005)	0.574 /0.605					
	(2)	-0.092	(0.032)	0.051 /0.051	0.036***	(0.012)			
	(3a)	-0.098	(0.034)	0.119 /0.119	0.404***	(0.039)	-0.0005	(0.0009)	
	(3b)	-0.098	(0.034)	0.175 /0.175	0.406***	(0.040)	0.0006	(0.0010)	
72. Jewish Autonomous Obl.	(1)	-0.008	(0.010)	0.361 /0.361					
	(2)	-0.075	(0.028)	0.085 /0.085	0.012**	(0.005)			
	(3a)	-0.075	(0.028)	0.194 /0.194	0.173***	(0.052)	-0.0009	(0.0027)	
	(3b)	-0.075	(0.028)	0.250 /0.250	0.172***	(0.054)	0.0009	(0.0032)	
73. Chukotka A.O.	(1)	-0.003	(0.004)	0.382 /0.382					
	(2)	-0.060	(0.027)	0.194 /0.194	0.057**	(0.027)			
	(3a)	-0.124	(0.036)	0.036 /0.036	1.176***	(0.070)	-0.0020***	(0.0006)	0.4180
	(3b)	-0.119	(0.036)	0.096 /0.096	1.182***	(0.083)	0.0024***	(0.0009)	0.4193

Region	Model	λ		Unit root test p-values (PP/ADF)	γ		δ		SSR
74. Primorsky Krai	(1)	-0.003	(0.007)	0.454 /0.493					
	(2)	-0.107	(0.034)	0.027 /0.027	0.025***	(0.008)			
	(3a)	-0.118	(0.036)	0.045 /0.045	0.208***	(0.026)	0.0013	(0.0011)	
	(3b)	-0.118	(0.036)	0.099 /0.099	0.210***	(0.025)	-0.0011	(0.0009)	
75. Khabarovsk Krai	(1)	-0.001	(0.007)	0.640 /0.640					
	(2)	-0.080	(0.030)	0.087 /0.087	0.019***	(0.007)			
	(3a)	-0.092	(0.032)	0.123 /0.123	0.202***	(0.033)	0.0017	(0.0014)	
	(3b)	-0.093	(0.032)	0.178 /0.178	0.202***	(0.030)	-0.0015	(0.0010)	
76. Amur Obl.	(1)	-0.012	(0.013)	0.175 /0.182					
	(2)	-0.075	(0.028)	0.076 /0.076	0.008**	(0.003)			
	(3a)	-0.080	(0.029)	0.158 /0.158	0.083**	(0.034)	0.0020	(0.0034)	
	(3b)	-0.080	(0.029)	0.214 /0.214	0.084***	(0.031)	-0.0016	(0.0023)	
77. Kamchatka Krai	(1)	-0.002	(0.004)	0.498 /0.523					
	(2)	-0.052	(0.024)	0.217 /0.217	0.025**	(0.012)			
	(3a)	-0.122	(0.032)	0.011 /0.011	0.645***	(0.044)	-0.0030***	(0.0007)	0.1346
	(3b)	-0.118	(0.031)	0.055 /0.055	0.664***	(0.057)	0.0040***	(0.0013)	0.1348
78. Magadan Obl.	(1)	-0.001	(0.004)	0.532 /0.570					
	(2)	-0.084	(0.030)	0.061 /0.061	0.041***	(0.015)			
	(3a)	-0.083	(0.030)	0.149 /0.149	0.472***	(0.045)	0.0003	(0.0008)	
	(3b)	-0.083	(0.030)	0.205 /0.205	0.471***	(0.044)	-0.0003	(0.0008)	
79. Sakhalin Obl.	(1)	-0.003	(0.004)	0.426 /0.426					
	(2)	-0.077	(0.030)	0.095 /0.095	0.029**	(0.012)			
	(3a)	-0.084	(0.031)	0.159 /0.159	0.415***	(0.047)	-0.0009	(0.0010)	
	(3b)	-0.084	(0.031)	0.219 /0.219	0.414***	(0.050)	0.0009	(0.0012)	

Notes: 1. PP and ADF stand for the Phillips-Perron test and augmented Dickey-Fuller test, respectively.
2. Standard errors are in parenthesis. 3. Significance at 1% (***), 5% (**), and 10% (*).
4. SSR = sum of squared residuals.
5. Selected model specifications (under both 'specific-to-general' and 'general-to-specific' approaches) are marked with bold font.
6. NA means that the nonlinear OLS algorithm has failed in estimating auxiliary regressions while testing for unit root.
7. 'Obl.' = Oblast, 'Rep.' = Republic, and 'A.O.' = Autonomous Okrug.