DOI: 10.29141/2218-5003-2022-13-6-2 **EDN:** IMYONM

JEL Classification: D4, L4

Empirical geographic market definition for antitrust: The case of the Russian cement market

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Abstract. Geographic market definition is an important element of antitrust enforcement in the framework of countering monopolistic activities and M&A (mergers and acquisitions) control. Incorrectly defined geographic market can lead to false conclusions about the state of competition. The main way to identify the geographic market is the SSNIP test, which, however, is not always applicable. The study presents the analytical approach to defining a geographic market based on actual data. The methodological basis of the study is industrial organization theory applied to antitrust. The proposed approach makes it possible to obtain empirically based conclusions about geographic market using statistical tests, such as the Elzinga-Hogarty test together with price action analysis (price correlation and relative price stability). The approach is tested using the case study of the cement industry with Russian producers' participation in 2014–2020. Based on Rosstat data on monthly price dynamics and cement supplies between the federal districts, we prove that the cement market geographic boundaries were wider than one federal district for all the districts except the Far Eastern Federal District. The paper discusses the possibilities and limitations of the approach, such as the necessity comply with the requirements for the statistical properties of the studied time series, as well as full access to data. The study is vital for expanding the tools of relevant market definition applied in antitrust research.

Keywords: antitrust; geographic market definition; the Elzinga-Hogarty test; cement market; relevant market; price indicators.

Article info: received July 29, 2022; received in revised form September 19, 2022; accepted September 30, 2022

For citation: Meleshkina A.I., Filippova I.N., Shastitko A.E. (2022). Empirical geographic market definition for antitrust: The case of the Russian cement market. *Upravlenets / The Manager*, vol. 13, no. 6, pp. 15–29. DOI: 10.29141/2218-5003-2022-13-6-2. EDN: IMYONM.

Эмпирические оценки географических границ рынка цемента в целях применения антимонопольного законодательства

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Аннотация. Определение географических границ релевантного рынка – важный элемент антимонопольного правоприменения в рамках противодействия монополистической деятельности и контроля сделок экономической концентрации. Неточности в этой сфере могут привести к ошибочным выводам относительно состояния конкуренции на рынке. Основным способом определения указанных границ считается тест гипотетического монополиста, который, однако, далеко не всегда применим. Исследование направлено на разработку и апробацию методики определения географических границ рынка на основе фактических данных, которая позволяет получать эмпирически обоснованные выводы с применением статистических тестов. Методологической базой работы является теория отраслевых рынков применительно к антимонопольному регулированию. Метод исследования включает проведение теста Эльзинга – Хогарти совместно с анализом ценовых индикаторов: оценка корреляции цен и стабильности относительных цен. Данный инструментарий апробирован на примере производства цемента с участием российских производителей. Информационной базой послужили сведения Росстата о ежемесячной динамике цен и поставках цемента между федеральными округами за период 2014–2020 гг. Результаты теста Эльзинга – Хогарти, тестов на корреляцию цен и на стабильность относительных цен свидетельствуют о том, что Дальневосточный федеральный округ является отдельным географическим рынком, тогда как другие регионы объединяются с соседними и имеют общие географические границы. Раскрыты возможности и ограничения применения предложенной методики, в частности необходимость соблюдения требований к статистическим свойствам исследуемых временных рядов, а также наличие доступа к данным. Результаты исследования расширяют инструментарий анализа релевантных рынков для целей антимонопольного регулирования.

Ключевые слова: антимонопольная политика; географические границы рынка; тест Эльзинга – Хогарти; рынок цемента; релевантный рынок; ценовые индикаторы.

Информация о статье: поступила 29 июля 2022 г.; доработана 19 сентября 2022 г.; одобрена 30 сентября 2022 г.

Ссылка для цитирования: Meleshkina A.I., Filippova I.N., Shastitko A.E. (2022). Empirical geographic market definition for antitrust: The case of the Russian cement market // Управленец. Т. 13, № 6. С. 15–29. DOI: 10.29141/2218-5003-2022-13-6-2. EDN: IMYONM.

INTRODUCTION

Defining product and geographic market boundaries is inherent in the analysis of competition in product markets in order to apply antitrust laws (control of economic concentration, countering abuse of dominant position, anticompetitive agreements and concerted actions) [Fletcher, Lyons, 2016]. Product market definition is the basis for establishing its volume, participants and their market shares, the level of market concentration, as well as testing the hypothesis of a company's market dominance.

Accordingly, if these boundaries are defined incorrectly, this can result in the under- or overestimation of the seller's market share, erroneous conclusion about the presence/absence of dominance, inaccurate assessment of the state of competition in the relevant market [Shastitko, Meleshkina, Markova, 2021; Meleshkina, 2021], as well as incorrect identification of the company's behaviour on the market with the corresponding type I and type II errors in the decision and order of the antitrust authority.

Examining the methodology for product market definition is beyond the scope of the current study. This topic is widely debated in foreign [MacLeod, 1981; Walker, 1983; Fishwick, 1993; Morse, 2003] and Russian research studies [Shastitko, Meleshkina, Dozmarov, 2019; Pavlova, Shastitko, 2019; Shastitko, Meleshkina, Markova, 2022].

The issue of geographic market definition for antitrust is less developed. In our opinion, within this field there are unused opportunities for finding a compromise between the accuracy and economy of estimates, which are typical of the geographic market problem, and therefore have been undeservedly ignored (with a few exceptions, e.g. [Shastitko, 2019]) by researchers.

The purpose of the article is to develop and test a methodology for geographic market definition based on actual data for implementing antitrust laws.

The paper presents the results of defining the cement geographic market in Russia. The uniqueness of the work lies in not only testing the effectiveness of the unfairly forgotten Elzinga-Hogarty test on actual statistical data, but also in using a special computer software as a means to compensate for the test's weaknesses in the 'accuracy-economic' coordinate system. The study is a logical continuation of the publication by Shastitko [2019] and demonstrates the practical applicability of its theoretical conclusions using the case study of the cement market.

The novelty of the obtained results builds on the Elzinga-Hogarty test being operationalized using actual data and programming tools (computer software). This highlights the relevance and legitimacy of using this technique in antitrust enforcement today. Additionally, the paper proves the falsity of the assumptions underlying the regulatory authority's decisions without due regard for the structure of product flows between federal districts.

Having analysed an array of relevant scientific works, we found that there was a lack of empirical studies conducted by Russian scientists based on up-to-date industry data that would characterize a product-specific geographic market using a set of tools to verify the outcomes obtained. At that, the given technique is universal and can be reproduced for other product markets.

Our approach meets the managerial goals and objectives both in state regulation and at the level of firm and allows:

- improving the validity/conclusiveness of decisions made in the field of antitrust enforcement without increasing their complexity;
- strengthening the methodological part of antitrust compliance programs developed by companies.

In the Russian law enforcement practice, the Elzinga-Hogarty test is not the major method for geographic market delineation. For this reason, the first section of the article discusses the problems of geographic market definition using the SSNIP[1] test. The next section reveals the results of geographic market definition using the Elzinga-Hogarty test with an emphasis on the cement industry's characteristics that are important for determining the relevant market. In the third section, we analyze price indicators that allow verifying the estimates obtained through the Elzinga-Hogarty test. In the final section, conclusions and recommendations for further research in the area under study are presented.

GEOGRAPHIC MARKET DEFINITION METHODS

The necessity to define the geographic product market is stipulated by the Order No. 220 of the Federal Antimonopoly Service (FAS) of Russia dated April 28, 2010 "On approval of the Procedure for conducting an analysis of the state of competition in the product market" (hereinafter referred to as the Order No. 220), which regulates the analysis procedure in accordance with the provisions of the Federal Law of July 26, 2006 No. 135-FZ "On protection of competition".

[1] Small but significant and non-transitory increase in price.

Geographic market definition aims to establish the territory, where its participants exert competitive pressure on each other. According to the Order No. 220, these boundaries correspond to the territory, where the buyer acquires or has the economic, technical or other opportunity to acquire goods which they are unable to acquire outside this territory.

In accordance with para 4.5 of the Order No. 220, the geographic product market can be defined through:

1) the SSNIP test (para 4.6 of the Order No. 220);

2) identification of (a) actual sales areas (buyer locations), and (b) economic entities (sellers) making sales in the given product market;

3) the combination of methods (1) and (2) or any other method that unambiguously localizes sales areas where sellers compete with each other in selling goods to predetermined buyers.

The SSNIP test. According to the Order No. 220, the SSNIP test is applied to clarify buyers' opinion on delineation of the geographic product market. To this end, buyers are asked a question "From what sellers (located outside the predetermined product market) and in what quantity do you prefer to purchase a product if there is a 5–10% long-time (for at least 12 months) increase in its price (within the predetermined product market) while the price outside this territory stays the same?".

Thus, to expand the geographic market beyond the predetermined boundaries, two conditions should be met. Firstly, a 5–10% increase in prices in the market should provoke consumers to purchase goods in other territories. Secondly, the consequent decline in sales should make this price increase unprofitable. The SSNIP test is based on the prerequisite that companies operate rationally (according to the principle of profit maximization). Hence, if the increase in price leads to a decrease in profits, it is unlucrative.

Assume that a market participant with market power has the production capacity to supply goods to territories pre-defined as different geographic markets (territories X and Y). The SSNIP test allows assessing whether it is possible for a manufacturer to raise the product price in territory X while keeping profits unchanged due to consumers switching to territory Y. If so, then territories X and Y form two different geographic markets. If not, these territories are identified as the same geographic market.

The test algorithm is graphically shown in Fig. 1. Starting with the smallest possible market, the market boundaries are gradually expanded with additional geographic regions until a hypothetical monopolist benefits from a small but significant and long-term price increase within the considered market boundaries (that is, by 5–10%).

Although the SSNIP is used to compensate for the complexity of economic-theoretical modelling, this test has a number of significant drawbacks. One of them is the difficulty in obtaining survey data. The survey itself can be costly. For instance, consumers are assumed to be aware of producers operating in neighbouring territories, which they are likely to switch to in the event of a price increase. However, in practice, they may not have such information or hide it for fear of sanctions imposed by the supplier. Moreover, there are no obvious reasons for participating in the survey and giving truthful answers. While the FAS is entitled to request the necessary information from market participants, including in the form of a survey as part of the SSNIP test, independent researchers may not be able to receive answers in a similar survey.

In addition, in terms of the test's operationalization, its disadvantages are:

1) inapplicability for those markets, where goods are sold through direct contracts that do not allow estimating the price level and the size of consumption on the basis of open market data;

2) labour intensity (resource and time) of using the survey method with a significant number of market participants.

The above limitations can justify the use of alternative methods for defining the relevant market. The Elzinga-Hogarty test can be used as a method to reliably delineate the geographic market based on open data from customs statistics.

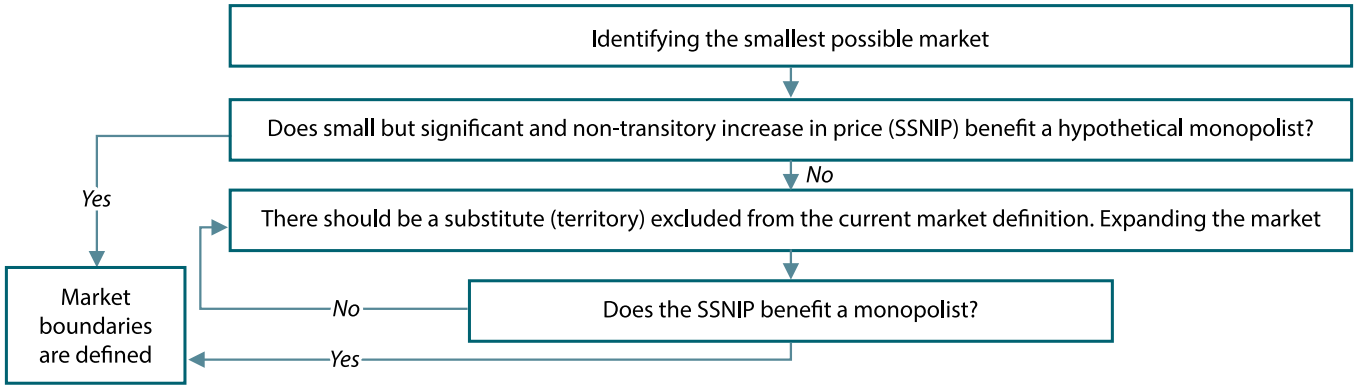

Fig. 1. The SSNIP test algorithm[1]

Рис. 1. Алгоритм проведения теста гипотетического монополиста

[1] Compiled by the authors based on the provisions of the Order No. 220.

The Elzinga-Hogarty (E-H) test. The Order No. 220 regulates the possibility of using the method for establishing actual sales areas to define the geographic market, which, in conjunction with item 4.2c allows focusing on the structure of product flows, namely, delineating the territory, where product flows both into and out of the region should not exceed 10%.

Such stipulations of the Order No. 220 make it possible to apply the E-H test to define a geographic market using the data on product flows [Elzinga, Hogarty, 1973; Elzinga, Hogarty, 1978; Elzinga, 1981]. This test is based on the analysis of international/interregional supply volumes to test the hypothesis that several regions/countries belong to the same geographic market. In addition, it can be used to deal with more complex cases of defining geographic boundaries where we assume that they do not coincide with the fixed radius market definition [Bowblis, North, 2011].

The test includes two indicators, these are LIFO and LOFI. LIFO (Little In From Outside) reflects the ratio of local supply and demand for a product. It should be close to 1, since the amount of goods consumed from outside the expected geographic market should be minimal. LOFI (Little Out From Inside) shows the percentage of production not consumed locally, i.e., exported. It should be close to 1, since for correct geographic market definition the share of production not consumed locally should be minimal. This means that the relevant geographic market covers all territories that either export or import significant volumes of the product under study. LIFO and LOFI are calculated by formulas (1) and (2), respectively:

$$LIFO = 1 - (import/consumption); \quad (1)$$

$$LOFI = 1 - (export/production). \quad (2)$$

The general idea of this combined test lies in expanding the possible market boundaries until both indicators are close to 1, which characterizes the situation where imports and exports for the territory defined as the geographic market are close to zero. The threshold values for ceasing market expansion are 0.9, i.e., no more than 10% of products can be exported from or imported into the territory of the relevant market.

For applying the LOFI criterion, it is expedient to start with analysing product flows: to select a reference point (the region or the country of the manufacturer, which is a more common practice in antitrust analysis), then find the region with the maximum volume of deliveries (exports) and calculate the LOFI indicator. If it is greater than 0.9, then there is no need to expand the geographic market; if less than 0.9, the test is not passed and the region with the next largest exports should be added to the relevant market. A similar procedure is carried out for LIFO. The value of 0.9 corresponds to the Order No. 220 criterion of a 10% threshold for product flows between different geographic markets.

Despite being in demand in US antimonopoly practice [Scheffman, Spiller, 1987; Elizalde, 2012; Gaynor et al., 2013] and the EU [Elizalde, 2012; Pietrzak, Roman, Mucha, 2016], the test has a number of limitations [Massey, 2000; Elzinga, Swisher, 2011]:

- its results are contingent on the selected reference point, i.e., the E-H test-based geographic market definition varies according to the pre-defined relevant market;
- interpretation of imports and exports is not always applicable to service markets, which imposes restrictions on the use of the test in certain industries.

The advantage of the Elzinga-Hogarty test in defining geographic markets is that, to be calculated, the test uses data on product flows between the regions and the volumes of production and consumption within them. It is possible to solve the problem of the pre-defined reference point by testing all territories under study as the initial point. Such calculations can be too laborious to perform manually; however, this procedure can be performed using algorithms (in this case, in the Stata software).

Obviously, the Elzinga-Hogarty test has its limitations: only potential competition is assessed, that is, the possibility of increasing supplies between territories with rising prices. That is why, in order to clarify the results of the test, it should be supplemented with analysis of the actual price dynamics in the territories in question using price indicators.

Analysis of price indicators: criteria for price correlation and relative price stability. The idea behind correlation criterion is that if goods belong to the same market, i.e., they exert competitive pressure on each other, then the dynamics of their prices cannot differ significantly. Then, with change in the price of one good, the price of the other good shifts accordingly. To measure the extent to which these price changes are synchronized, correlation is used. It acts as an indicator of the systematic change in the value of one random variable with a shift in one or several variables, which describes a correlation between them.

The criterion of price correlation (goods in different territories) is a common approach to assessing competitive pressure when defining the geographic market [Stigler, Sherwin, 1985; Hatzitaskos, Card, Howell, 2012]. Correlation shows the relationship between variables. It considers whether the changes are unidirectional and addresses the stability of the ratio of deviations from the mean for each variable. That is, if the change in variables over time is not unidirectional or/and the ratio of deviations from the mean for each variable is unstable, then the correlation coefficient is low, while in the case of synchronous changes, the correlation is high. To confirm the hypothesis that the territories where the product was sold belonged to the same geographic market, the correlation of product prices in these territories should be high. Moreover, the synchronism of the change should not be due to the factors that similarly affect the price dynamics in the two territories (for example, changes in prices for common raw materials).

However, prices in different territories may be subject to different external shocks (for example, a natural disaster in one of the regions), or companies may respond to changes in market conditions in the same market with a time lag, while correlation analysis is aimed at checking whether price changes occur simultaneously. This can lower the correlation coefficient so that it does not reflect the actual relationship between prices. Thus, in addition to the price correlation method, other tests should be used to check the result, for example, a test for relative price stability.

According to the criterion of relative price stability, goods in the same market face similar supply and demand, and this interaction results in the market price. Then, the price ratio of such goods should be relatively stable in time. To measure the stability of relative prices, it is necessary to check the time series corresponding to the log of the price ratio to stationarity (a process that does not change its properties over time refers to a stationary process) [Forni, 2004]. To determine whether a time series is stationary, the Dickey-Fuller test is applied.

However, the stationarity of the time series corresponding to the price ratio can be caused by the fact that the time series of each price is stationary. This fact neither rejects the hypothesis that the goods belong to the same market, nor confirms it. This constitutes grounds for further testing of the market boundaries with other methods, but not for concluding that the market boundaries are exactly as where they are.

Testing prices for cointegration is an alternative statistical approach to determining relative price stability. Cointegrated time series are those categorized as non-stationary, while their linear combination is stationary, that is, the series are subject to mutual changes.

Among the advantages of price tests is the availability of data on price dynamics (usually such information is in the public domain, since collected by Rosstat[1]). The insufficient length of the studied time series can be a potential problem as a large amount of statistical data is needed for the tests to work correctly. Another problem is presence of clear seasonal fluctuations or trends that distort the causality of the time series' mutual fluctuation. In some cases, such challenges make statistical tests impossible.

THE ELZINGA-HOGARTY TEST IN DEFINING THE CEMENT MARKET GEOGRAPHIC BOUNDARIES

The overview of the methods for defining the geographic market shows that it is possible to conduct research on the basis of actual statistical data in cases where undertaking a survey seems problematic. Using the Elzinga-Hogarty test along with price indicators analysis for defining the geographic market is also justified from the standpoint of antitrust laws.

The approach proposed in the given study is relevant to the requirements of the Order 220 as it includes:

1) analysing the volume of interregional supplies to test the hypothesis about several regions defined as the same geographic market;

2) pre-defining the geographic product market by choosing the reference point for the Elzinga-Hogarty test;

3) confirming the results of the tests/criteria through their consistency.

In addition, para 4.2 of the Order No. 220 stipulates the requirements for information underlying the geographic product market definition. The data set used in the study satisfies these requirements, in particular:

1) using the data about the region where the economic entity, being the object of antitrust control, operates;

2) considering the pricing in the cement market and the differences in price levels in the territory of the Russian Federation;

3) examining the structure of product flows (in the territory, where the extent of product flows both into and out of the region should not exceed 10%), which is directly implemented in the E-H test.

Transportation costs are beyond the scope of the present study, which, given the large territory of the country, needs to be justified. According to para 4.4 of the Order No. 220, "if, following the purchase of goods supplied from any territories (from sellers located in any territories), the buyer incurs significant costs typically exceeding 10% of the weighted average price of the goods available to the buyer(s) within the pre-defined geographical boundaries of the relevant market, then such territories (sellers) should belong to distinct product markets." However, according to Art. 4 of the Federal Law "On protection of competition", "a product market is the area of circulation of a product (including foreign-made one) that cannot be substituted for another product, or of interchangeable products, within which (including its geographical boundaries) *the buyer can purchase the product based on economic, technical or other possibility or expediency*, and there is no such possibility or expediency outside this area."

Thus, in the context of consumers *actually switching* to goods sold in other regions, the 10% criterion in respect of price-related costs (including transportation) cannot be the basis for attributing individual sales areas to other product markets. The findings of our study are based on product flows analysis, i.e., data on actual consumption, which is sufficient to recognize their reliability without assessing the share of transport costs in the total price of a product.

Terms of product circulation in the relevant market definition. There is a large number of cement manufacturers in the Russian Federation scattered all over its territory (the specificities of cement production in Russia are discussed in [Kiselev, 2008; Parshina, 2013; Shutko, Merzlyakova, 2016; Makarov, Ponomarev, 2021]). However, there are several top producers in the Russian cement market. Table 1 presents statistics on relative economic output of all Russian cement companies, which shows that five

[1] The Federal State Statistics Service of the Russian Federation.

Table 1 – Shares of Russian cement producers in total supplies in the RF, 2014–2020, %
Таблица 1 – Доли российских производителей цемента в 2014–2020 гг. в общих отгрузках на территорию РФ, %

Producers	2014	2015	2016	2017	2018	2019	2020 (November)
Eurocement Group	27.5	31.7	29.7	28.6	26.5	28.4	28.3
Gazmetallproekt	8.5	9.9	9.2	9	9.7	10.1	9.4
Lafarge & Holcim	8.8	7.7	7.7	8.4	9.7	9.1	8.9
HeidelbergCement	5.5	6.8	8.2	7.9	8.2	7.8	8.2
Sibcem	9.5	9.4	8.7	8.4	8.7	8.3	8.2
SLK Cement	3	4.2	4.7	4.7	4.9	5.2	6.6
Smikom	2.7	3.5	3.7	3.6	3.8	4.4	4.6
Sebryakovcement	4.3	4.7	5.1	5.3	5.2	4.5	4.6
Vostokcement	3	3.3	3.6	3.9	4.2	4.4	4.4
Others	20.4	14	15.9	16.4	16.4	15.2	13.9

Source: compiled based on data from the information-analytical portal Beton.ru. https://beton.ru/. (in Russ.)

main producers provided more than 60% of cement production in the Russian Federation during 2014–2020.

Among the top cement producers of the Russian Federation are:

1. Eurocement Group. According to the company's official website[1], the holding has 16 cement plants across Russia and aggregate-mining quarries. The Group's annual production capacity is 50 million tonnes of cement, which is comparable to concrete consumption in Russia in 2021 (60 million tonnes[2]).

2. Gazmetallproekt has two enterprises in Krasnodar krai (the Southern Federal District): OAO Novoroscement that owns three cement plants, and OAO Verhebakansky Cement Plant. The total annual production capacity amounts to 8.1 million tonnes of cement[3], which is significantly lower than that of Eurocement Group.

3. Sibcem (Siberian Cement) holding has 14 enterprises, including a quarry, which means the company has its own supply of raw materials. Cement plants are located in the Siberian Federal District and the Far Eastern Federal District: Kemerovo oblast, the Republic of Buryatia, Krasnoyarsk krai, Novosibirsk and Irkutsk oblasts. The total production capacity is comparable to the capacity of Gazmetallproekt and amounts to 9 million tonnes of cement per year.

4. Lafarge & Holcim. In Russia, the company owns four factories in Moscow, Kaluga and Saratov oblasts (the Central Federal District[4]). One of the factories is mothballed. In addition, the company is a raw materials producer having three quarries (one is mothballed) in Karelia.

5. HeidelbergCement. The company has three cement plants in Leningrad oblast (the Northwestern Federal District), the Republic of Bashkortostan (the Volga Federal District), and Tula oblast (the Central Federal District)[5].

The remaining production volumes are covered by a significant number of small cement producers.

There is an imbalance in cement supplies in favour of megalopolises, particularly Moscow and Saint Petersburg[6]. Regional consumers experience a shortage of cement and are forced to look for suppliers from other sales areas. Market imbalances are also due to buyers (manufacturers of precast concrete and ready-mixed concrete) reserving cement under extended contracts with cement plants.

According to para 4.1 of the Order No. 220, a product market may cover the territory of the Russian Federation or go beyond its boundaries (federal market), cover the territory of several constituent entities of the Russian Federation (interregional market), be within the boundaries of a constituent entity of the Russian Federation (regional market), be within the boundaries of a municipality (local market). The above specificities of the cement industry in Russia underlie the need to answer the following questions: are cement producers operating in the RF territory really participants of the same geographic market? are there any grounds for referring market participants to smaller markets, i.e., within the RF constituent entities or the RF federal districts?

Why do these questions matter in the light of antitrust enforcement? If the cement geographic market coincides with the borders of the Russian Federation, then, strictly speaking, the activities of cement companies would not come to the attention of the FAS of Russia, since the structure of the market would not meet the quantitative crite-

[1] Eurocement Group official website. https://www.eurocement.ru/cntnt/rus/company.html. (in Russ.)

[2] Overview of the cement industry of the Eurasian Economic Union. April 2022. Eurocement. https://www.eurocement.ru/engine/documents/document17814.pdf. (in Russ.)

[3] Gazmetallproekt. https://www.gmpro.ru/o-kompanii. (in Russ.)

[4] Holcim. https://holcimrus.ru/about/. (in Russ.)

[5] HeidelbergCement. https://www.heidelbergcement.ru/ru. (in Russ.)

[6] Gorodnova A., Katargyn D. (2021). "Cement is leaving for Moscow": Tatarstan is running out of "bread for construction". https://www.business-gazeta.ru/article/527681. (in Russ.)

ria for collective dominance ($CR_3 < 50\%$ and $CR_5 < 70\%$[1]) (see Table 1).

Allowing for the location of producers and consumers, as well as cement storing/transporting conditions, we can assume that the geographic boundaries of the cement market may coincide with the boundaries of the federal districts. In the next part of the study, we test this hypothesis using the E-H test and price indicators.

Product flow analysis. The Elzinga-Hogarty test. To conduct the E-H test for the cement market in order to define its geographical boundaries, we used annual data for 2014–2020 on the volumes of production and consumption in eight federal districts (the Central Federal District (CFD), the Northwestern Federal District (NFD), the Volga Federal District (VFD), the Southern Federal District (SFD), the Ural Federal District (UFD), the Siberian Federal District (SibFD), the North Caucasian Federal District (NCFD), and the Far Eastern Federal District (FEFD)), as well as on imports/exports of cement between the federal districts. The data for the test were retrieved from monthly reports of CM PRO Analytics "Pro market. Analysis of the cement market in Russia" (hereinafter referred to as CM PRO) aggregated to annual data.

We apply this test to assess the chain accession of territories [Shastitko, 2019]. To resolve the problem of choosing the reference point, we have automated those calculations where each of the federal districts is taken as the reference point. To that end, the code we developed in the Stata software was used.

The general idea of the algorithm is as follows.

For each region, it is necessary to:

1) define the region having the largest total imports with the territory in question;

2) calculate the share of imports in product flows between the territories for consumption (LIFO) and the share of exports for production (LOFI);

3) if both shares are less than 10%, the region under review cannot be combined with any of the others to have common boundaries; if both shares are more than 10%, the reference territory and the one in question are combined;

4) identify the territory with the next largest trade flows with the reference region;

5) after that, the following are calculated: the share of imports between the federal district considered for accession and the united federal districts for consumption (LIFO); the share of exports between the federal district considered for accession and the united federal districts for production (LOFI);

6) if both shares are less than 10%, the region under review is not included in the common borders that are defined within the two territories united in the first step. If both shares are more than 10%, then the district's territories are combined and the geographical borders cover three territories;

7) the procedure is carried out to add subsequent territories.

This cycle is repeated for each territory designated the reference point.

The test is performed for each year individually, which helps trace the dynamics of interregional product flows. The test results in the form of LOFI and LIFO are given in Table 2.

According to the results obtained, the LOFI and LIFO measures (or at least one of them) are significantly less than 1 (cells filled with colour) for all the federal districts, excluding the Far Eastern Federal District. LOFI and LIFO for this district are close to 1, which allows delineating this territory as a distinct geographic market. Thus, the E-H test indicates that the geographic market is wider than the boundaries of each federal district, except for the FEFD.

To determine the relevant market, it is necessary to expand its geographic boundaries by combining the federal districts so that the LOFI and LIFO measures near 1. At that, it is possible to start with any of the seven federal districts. Based on the reference point, there are several combinations for consolidating the geographic boundaries. The first one to join is the district having the largest amount

[1] According to Part 3 Art. 5 of the Federal Law of July 26, 2006 No. 135-FZ «On protection of competition».

Table 2 – LOFI and LIFO test results for product flows between the federal districts, 2014–2020
Таблица 2 – Результаты оценок показателей LOFI и LIFO по товаропотокам между федеральными округами, 2014–2020

FDs	2014		2015		2016		2017		2018		2019		2020*	
	LOFI	LIFO	LOFI	LIFO	LOFI	LIFO	LOFI	LIFO	LOFI	LIFO	LOFI	LIFO	LOFI	LIFO
CFD	0.925	0.792	0.900	0.821	0.894	0.806	0.894	0.784	0.896	0.804	0.889	0.793	0.897	0.823
VFD	0.793	0.911	0.807	0.892	0.771	0.881	0.720	0.900	0.744	0.905	0.711	0.902	0.719	0.895
SFD	0.594	0.831	0.614	0.800	0.639	0.801	0.639	0.802	0.623	0.822	0.650	0.808	0.720	0.865
UFD	0.822	0.772	0.786	0.742	0.775	0.785	0.780	0.766	0.779	0.738	0.745	0.736	0.732	0.792
SibFD	0.855	0.930	0.861	0.924	0.878	0.951	0.870	0.939	0.866	0.934	0.837	0.918	0.890	0.943
NFD	0.969	0.896	0.994	0.886	0.993	0.824	0.995	0.741	0.985	0.746	0.986	0.694	0.992	0.674
NCFD	0.760	0.487	0.832	0.524	0.832	0.509	0.846	0.503	0.878	0.482	0.877	0.549	0.929	0.550
FEFD	0.940	0.997	0.953	0.997	0.960	0.996	0.956	0.992	0.986	0.985	0.988	0.962	0.998	0.977

Note. (*) As of November, 2020.
Source: compiled using data from CM PRO (https://cmpro.ru/rus/catalog/analitika/cement/).

of imports with the reference region. Then, the regions with maximum product flows with one of the districts within the market boundaries are added in sequence. The district is added to the reference point if import/export flows between the federal districts account for more than 10% of consumption/production in the districts, respectively. Thus, the greater the volume of consumption and production in the federal district, the smaller the proportion of product flows and the less reason to expand the geographic boundaries. This can be interpreted in a way that prices in this district are less affected by prices in the other federal districts, but it can still exert significant pressure on the other FDs if included in the geographic boundaries with a different reference point. The results of the federal districts' consolidation are shown in Table 3.

The calculation results are stable in time, with the exception of 2020, which is due to the shocks caused by the economic turmoil and markets' adaptation to the COVID-19 pandemic. Definition of the Far Eastern Federal District as a distinct market is stable in time, as is the unification of the CFD and the UFD into the single geographic market, which was expanded with the VFD in 2015 and the NFD (through the SibFD), the VFD (through the NFD), and the CFD (through the VFD) in 2017. Except for 2020, the NCFD is stably defined within the same geographical boundaries with the SFD and the CFD. At the same time, the SFD is also stably combined with the CFD, which leads to the stable results extending to the NCFD and the VFD.

Thus, the cement geographic market is defined as follows:

- in 2014 – the SFD, the NCFD, the CFD, the VFD, the UFD, and the SibFD;
- in 2015 – the SFD, the NCFD, and the CFD, at that the VFD and the UFD form a distinct geographic market;
- in 2016 – the SFD, the NCFD, and the CFD, at that the SibFD and the UFD form a distinct geographic market;
- in 2017 – the SFD, the NCFD, the CFD, the VFD, the NFD, the SibFD, and the UFD;
- in 2018 – the SFD, the NCFD, the CFD, and the VFD, at that the SibFD and the UFD form a distinct geographic market;
- in 2019 – the SFD, the NCFD, the CFD, the VFD, and the NFD, at that the SibFD and the UFD form a distinct geographic market;
- in 2020 – the SFD and the NCFD, at that the CFD, the VFD, the UFD, the NFD form a distinct geographic market.

The results obtained are summarized in Fig. 2, where each colour corresponds to a geographic market.

Table 3 – Consolidation of the federal districts with the expansion of the cement market geographic boundaries, 2014–2020
Таблица 3 – Объединение федеральных округов при расширении географических границ рынка цемента, 2014–2020

Reference point	2014	2015	2016	2017	2018	2019	2020
CFD	VFD	SFD	–	VFD	VFD	VFD	VFD
VFD	UFD	–	–	–	–	–	CFD, UFD
SFD	CFD	CFD	CFD	CFD	CFD	CFD	–
UFD	SibFD	VFD	SibFD	SibFD	SibFD	SibFD	VFD
SibFD	UFD	–	UFD	UFD	UFD	UFD	–
NFD	–	–	–	SibFD, VFD	–	VFD, CFD	CFD, VFD
NCFD	CFD, SFD	CFD, SFD	CFD, SFD	CFD, SFD	CFD, SFD	CFD, SFD	SFD
FEFD	–	–	–	–	–	–	–

Fig. 2. Results of cement geographic market definition, 2014–2020
Рис. 2. Обобщение результатов оценки географических границ рынка цемента, 2014–2020

The presence of overflows indicates that competitive pressure is possible, but not guaranteed. That is why, in order to confirm the obtained results, relative prices need to be analysed.

Price indicators. Competition and the possibility of switching between suppliers ensure that there is no room for arbitrage: it is impossible to make a cheaper purchase in one territory and sell it at a higher price in another one if both territories belong to the same geographic market. In addition, due to competitive pressure of producers and the spillover of demand within geographic boundaries, prices are expected to equalize over time. We should also observe the same adaptation of prices to demand shocks, if any.

To assess the similarity of price dynamics, we use the following tests:

– price correlation criterion;

– relative price stability criterion.

Since each of the methods applied has its advantages and disadvantages, we use all methods available. Similar results allow one to make more confident conclusions about the actual market definition compared to the results of a separate test (ceteris paribus).

To evaluate the price dynamics, monthly purchase price data in the public domain (91 observations) for the period from January 2014 to July 2021[1] were used. Analysis of the price dynamics (Fig. 3) shows that the purchase (buyer) price of cement in the Far Eastern Federal District noticeably exceeds the price level in the other seven federal districts (more than twice in some time periods). On average, the price of cement in the FEFD is 88% higher. This confirms the conclusion obtained at the previous stage of research that the FEFD is defined as a separate geographic market. To claim the same about the other regions, further tests are needed.

To assess competitive pressure when delineating the geographic market, it is typical to use the criterion of correlation between product prices in different territories [Hatzitaskos, Card, Howell, 2012]. To confirm the hypothesis that the territories where the product is sold are defined as the same geographic market, the correlation of product prices in these territories should be high. But since price analysis implies time series analysis, we should account for the specificities of this type of data.

High correlation in time series can be due to not only the joint price changes, but also to a third factor, e.g., a temporary upward trend in prices, which is associated with overall inflation in the economy rather than mutual price pressure between the federal districts. Therefore, in order to assess the correlation coefficient correctly, it is necessary to ensure the stationarity of the time series under study. To examine stationarity, the Dickey-Fuller test was carried out. The null hypothesis is that the series is not stationary. Table 4 presents *p*-values for testing the null hypothesis.

[1] Official website of the Federal State Statistics Service. Indicator "Average purchase prices of basic construction materials, parts and structures by contractors, cement".

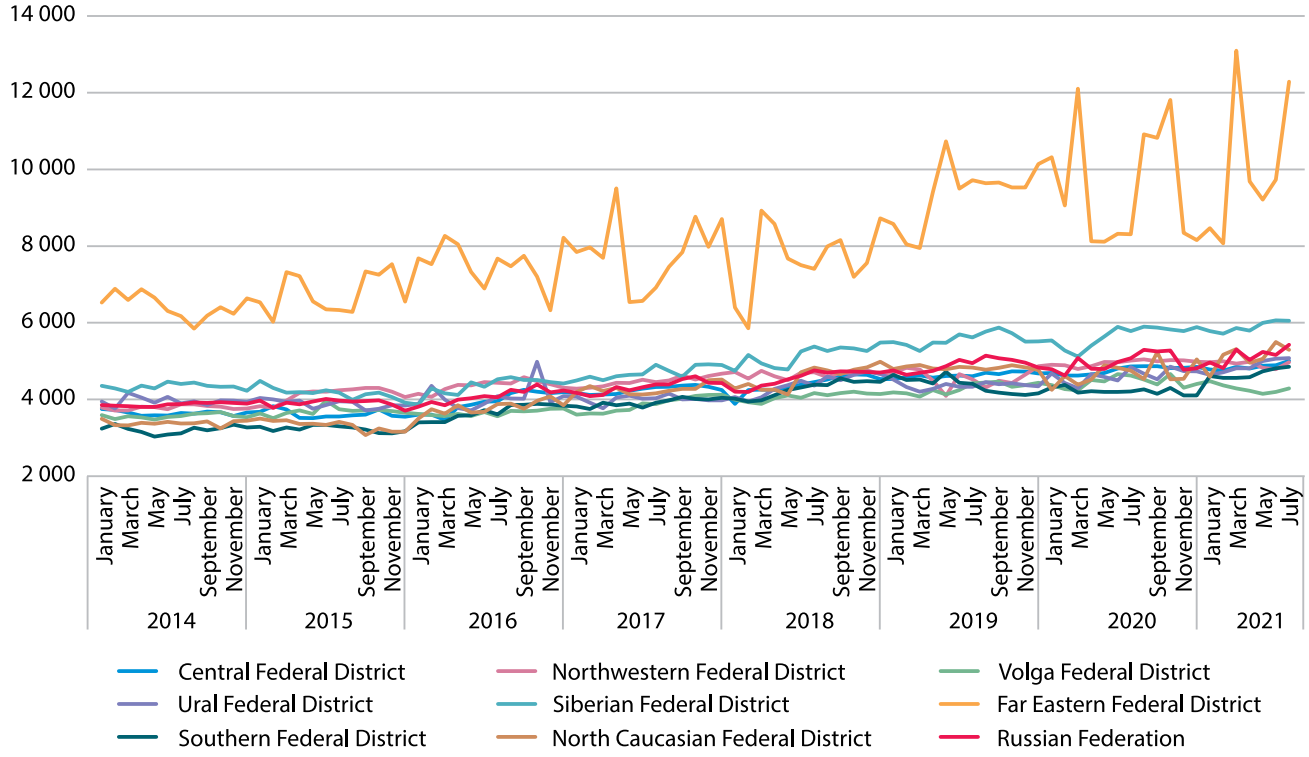

Fig. 3. Average purchase price of cement, 2014–2021, rubles per tonne[1]

Рис. 3. Средняя цена приобретения цемента, 2014–2021 гг., руб./т

[1] Showcase of statistical data. Indicator "Average purchase prices of basic construction materials, parts and structures by contractors, cement". https://showdata.gks.ru/.

Table 4 – Testing cement purchase prices for stationarity
Таблица 4 – Результаты тестирования цен приобретения цемента на стационарность

FD	CFD	NFD	VFD	SFD	UFD	SibFD	NCFD	FEFD
p-value	0.8960	0.4014	0.5076	0.8517	0.0954	0.8618	0.5967	0.0022

The test result show that only prices in the FEFD and the UFD are stationary; for the other federal districts, the null hypothesis is not rejected. To proceed to stationary series, we switched to constant prices taking into account the general increase in the price. To assess the overall inflationary pressure, the consumer price index (CPI) was chosen rather than the producer price index, since at the level of the federal district the increase in cement prices reflected in the producer price index may be associated with a low level of competition in the district. Thus, the uniqueness of competition in the federal district is already covered in the producer price index, and the index-based adjustment would exclude the investigated cause of price variation. Hence, it is necessary to look at the growth of the general price level, which is not associated with competition in the territory. To that end, the CPI in the federal district was used. Table 5 presents *p*-values for the Dickey-Fuller test for stationarity of the times series adjusted for the general increase in the price level.

According to the results, the time series are stationary at the significance levels of 5 % or 10 % in all the federal districts, which allows more correct estimation of the correlation coefficient.

An estimate of the pairwise correlation coefficients of constant CPI-adjusted prices is given in Table 6.

The results of the correlation analysis confirmed the hypothesis that the Far Eastern Federal District forms a separate geographic market. In addition, based on a significant correlation level above 0.5, the following districts can be combined in pairs to delineate a single geographic market: the Northwestern Federal District with the Volga, Ural and Siberian Federal Districts, and the Southern Federal District with the North Caucasus, Central and Siberian Federal Districts. The prices in the Central Federal District correlate with the prices in all the federal districts.

To make reasonable conclusions based on the correlation coefficients, the synchronism of change should not be due to factors having a similar effect on the price dynamics in two territories (for example, changes in prices for common raw materials), which is ignored within the framework of the presented approach. This is why it is important to use other tests to check the result, such as the relative price stability test.

To measure the stability of relative prices, the logarithm of the ratio of prices of one territory to another is checked for stationarity using the Dickey-Fuller test [Forni, 2004]. The stationarity of such a series can be interpreted in such a way that, on average, the price ratio does not change, and fluctuations in the values of the price ratio around the average do not increase or decrease over time. Testing the logarithm of the price ratio correlates with the test for cointegration, so we run both for better clarification.

However, the stationarity of the time series corresponding to the price ratio can be caused by the fact that the time series of each price is stationary. In other words,

Table 5 – Testing the CPI-adjusted cement purchase price for stationarity
Таблица 5 – Тестирование цен приобретения цемента, скорректированных на ИПЦ, на стационарность

FDs	CFD	NFD	VFD	SFD	UFD	SibFD	NCFD	FEFD
p-value	0.0118	0.0134	0.0556	0.0818	0.0053	0.0847	0.0135	0.0

Table 6 – Correlation coefficient for the CPI-adjusted purchase price, January 2014 – July 2021
Таблица 6 – Коэффициент корреляции цен приобретения цемента, скорректированных на ИПЦ, январь 2014 г. – июль 2021 г.

FDs	CFD	NFD	VFD	UFD	SibFD	FEFD	SFD	NCFD
CFD	1.0000	–	–	–	–	–	–	–
NFD	0.4115*	1.0000	–	–	–	–	–	–
VFD	0.6698*	0.6963*	1.0000	–	–	–	–	–
UFD	0.6409*	0.6123*	0.7571*	1.0000	–	–	–	–
SibFD	0.8391*	0.2767*	0.6662*	0.6069*	1.0000	–	–	–
FEFD	0.2089*	–0.1701	0.0692	0.0509	0.2757*	1.0000	–	–
SFD	0.6664*	0.0987	0.2677*	0.3389*	0.6011*	0.1427	1.0000	–
NCFD	0.6032*	–0.1105	0.1337	0.1604	0.6796*	0.2177*	0.7463*	1

(*) The significance level of correlation is 5%.

the fact that the time series of each price is stationary and the ratio of the corresponding prices is stationary neither rejects the hypothesis that the goods belong to the same market nor confirms it, since, in this case, the price ratio can only be a consequence of the stationarity of the price series in each territory. Therefore, for this test, as well as for testing cointegration, non-stationary time series at current prices for the period from January 2014 to July 2021 are used. The Far Eastern Federal District was excluded from the test, since the series of nominal current prices in it is stationary.

The results of testing the logarithm of the pairwise price ratio for stationarity are given in Table 7, which presents *p*-values to test the null hypothesis that the logarithm of the price ratio is a non-stationary series.

The test results demonstrate that at the significance level of 5% we can talk about the stability of relative prices between the federal districts.

According to the data obtained, the ratio between cement prices is stable at the significance level of 1% in the following regions:

1) CFD and NFD, SFD, UFD, SibFD, NCFD;
2) NFD and VFD, UFD;
3) VFD and NFD, UFD;
4) UFD and CFD, NFD, VFD, SFD, SibFD;
5) SibFD and CFD, SFD, UFD, NCFD;
6) NCFD and CFD, SFD, SibFD.

The price ratio in the federal districts is stable due to the fact that the goods circulating there belong to the same market and exert competitive pressure on each other, but not the fact that the very prices in each of the federal districts are stable. This gives grounds to assert that the FDs belong to the same geographic market.

Refine the obtained results by testing time series for cointegration. To do this, it is necessary to carry out the standard Engle-Granger procedure [Engle, Granger, 2015], which consists in analysing the correspondence of the series to the following criterion: the series are not stationary, but their first differences are stationary. Next, using the least squares method, a linear combination of two prices is determined, and the retained regression residuals are tested for stationarity. If they are stationary, then there is a linear combination of two variables that is stationary, i.e., the variables are cointegrated. It is noteworthy that, in order to test the residuals for stationarity, it is reasonable to use the corrected statistics of critical values [MacKinnon, 2010], which is equal to –3.405 for the significance level of 5%. The results of the test for cointegration (*z*-statistics of the test for stationarity of residuals) are shown in Table 8.

Table 7 – Results of the Dickey-Fuller test for stationarity of the logarithm of the consumption price ratio (p-value)
Таблица 7 – Результаты теста Дики – Фуллера на стационарность логарифма отношения цен потребления (p-value)

FDs	CFD	NFD	VFD	SFD	UFD	SibFD	NCFD	FEFD
CFD	–	–	–	–	–	–	–	–
NFD	0.0251	–	–	–	–	–	–	–
VFD	0.0553	0.0062	–	–	–	–	–	–
SFD	0.0026	0.1004	0.3264	–	–	–	–	–
UFD	0.0003	0.0001	0.0001	0.0106	–	–	–	–
SibFD	0.0013	0.1201	0.0887	0.0056	0.0034	–	–	–
NCFD	0.0006	0.0772	0.0557	0.0000	0.0127	0.0004	–	–
FEFD	–	–	–	–	–	–	–	–

Note. The cells with *p*-value below 0.05 are highlighted.

Table 8 – The results of the Engle-Granger cointegration test for consumption price (z-statistics), January 2014 – July 2021
Таблица 8 – Результаты теста Энгла – Гренжера на коинтеграцию для цены потребления (z-статистика), январь 2014 г. – июль 2021 г.

FDs	CFD	NFD	VFD	SFD	UFD	SibFD	NCFD	FEFD
CFD	–	–	–	–	–	–	–	–
NFD	–3.944	–	–	–	–	–	–	–
VFD	–3.847	–3.459	–	–	–	–	–	–
SFD	–3.871	–3.66	–2.734	–	–	–	–	–
UFD	–6.085	–4.283	–4.055	–5.354	–	–	–	–
SibFD	–4.211	–3.36	–4.35	–3.447	–5.471	–	–	–
NCFD	–6.024	–3.95	–4.218	–8.225	–5.133	–5.023	–	–
FEFD	–	–	–	–	–	–	–	–

Note. In the cells highlighted, the calculated statistics exceed the critical ones, i.e., the null hypothesis about non-stationarity is rejected.

Testing the series for cointegration showed that all series are pairwise cointegrated, except for prices in the Siberian Federal District and the Northwestern Federal District, as well as the Volga Federal District and the Southern Federal District.

Analysis of price criteria supported the results of the Elzinga-Hogarty test showing that the geographic boundaries of the Russian cement market are wider than one federal district, for all the districts except the FEFD. When performing pairwise estimates of joint price changes, there were both more stable and less stable pairs of the federal districts. Having combined these findings and the results of the E-H test, we can define the Far Eastern Federal District as a separate market, and unify the North Caucasus, Southern and Central Federal Districts. Through the CFD, the Northwestern, Volga, Ural, and Siberian Federal Districts can also be defined as a single geographic market (Fig. 4).

The advantage of the proposed method for defining a geographic market is that the assessment is based on actual data, and accurate quantitative methods are used that have a criterion for accepting or rejecting the formulated hypotheses. However, the approach has its drawbacks as well. Firstly, for some of the time series used, the indicators of stationarity and non-stationarity were correct at different levels of significance, including the level of 10%, which indicates the variable accuracy of the results obtained for various federal districts. Secondly, when defining territories as a single geographic market, we are guided by the premise of a chain reaction between prices in different regions. Price indicators show that the mutual influence of prices is present only between paired regions.

Thus, the proposed methods allow determining whether the geographic market is wider than one federal district. However, to clarify these boundaries, additional factors may be required to confirm the premise of the chain reaction between prices.

CONCLUSION

The article developed a methodology for empirical analysis of the geographic market using the case study of the Russian cement market in 2014–2020, which implied performing the Elzinga-Hogarty test combined with the analysis of price indicators. The test, which considers the effect of the reference point and, therefore, carried out for each federal district, showed that the Russian neighbouring regions are defined as the geographic market, with the exception of the Far Eastern Federal District. The results of such delineation depend on the chain interpretation of the test results. The tests for price correlation and relative price stability also proved that the FEFD is a distinct geographic market, while the other neighbouring districts are combined into the single geographic market. The results of the analysis of price indicators do not contradict the Elzinga-Hogarty test. The practical implementation of the proposed methodology demonstrated that the cement market geographic boundaries were wider than one federal district for all the districts, excluding the Far Eastern Federal District

The advantage of the proposed methodology lies in using actual statistical data, obtaining research results based on statistical tests, as well as enshrining the tests in the logic of the Order No. 220, which provides formal grounds to apply it when defining a geographic market. At the same time, this approach also has a number of limitations: it is necessary to comply with the requirements for the statistical properties of the time series under study and have access to data. If monthly price statistics are in the public domain, then information on product flows is less available. Data on the cement market are collected by industry-specific analytical agencies at the federal level, which is due to the spread of manufacturers across federal districts rather than regions. But for other markets with a large number of producers, analysis of regional data, possibly restricted, might be required. Therefore, if

Fig. 4. Cement geographic market based on the Elzinga-Hogarty test and price indicators

Рис. 4. Географические границы рынка цемента на основе теста Эльзинга – Хогарти и ценовых индикаторов

we talk about the widespread use of the Elzinga-Hogarty test, it is important to expand the availability of data not only on production and consumption in a region (access to such information is provided by Rosstat), but also on flows between territories.

If the issue of data access is resolved, then the proposed approach may become one of the standard practices for analysing the geographic market. Its obvious advantage is arriving at an independent conclusion regarding the need to combine a particular area with neighbouring ones into the single geographic market. The use of statistical data and statistical tests will increase the independence and validity of conclusions about the relevant market and produce more correct results. ■

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