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THE SPREAD OF THE COVID-19 INFECTION IN RUSSIA'S BALTIC MACRO-REGION: INTERNAL DIFFERENCES

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This article explores the spread of the COVID-19 infection in Russia's Baltic macro-region. The monthly excess mortality rate in the Baltic region is analysed along with regional and municipal COVID-19 response acts to identify regional features affecting the spread of the disease. The spatial characteristics of Russia's Baltic regions, germane to the propagation of COVID-19, were distinguished by examining selected social and economic statistical indicators. Based on the space of places/space of flows dichotomy, Russia's Baltic regions can be divided into three spaces: 1) St. Petersburg, the Leningrad and Kaliningrad regions (dominated by spaces of flows; highly permeable space); 2) the Republic of Karelia and the Murmansk region (the key factors are rotational employment and the introduction of the virus from without); 3) the Novgorod and Pskov regions (lowly permeable spaces of places; the central role of local foci of the disease). The principal risk factor for the space of flows is the rapid spread of COVID-19 along transport arteries, whilst, within the space of places, the coronavirus spreads through spatial diffusion from isolated foci along short radii. In the former case, local authorities counteracted spatial diffusion by restricting movement in the local labour market; in the latter, by limiting travel between the centre and the periphery. The traditional ideas about positive (openness, centrality) and negative (closedness, peripherality) characteristics of space are reversed in the context of the pandemic: periphery gains the benefit of natural protection from the pandemic, whilst centres become acutely vulnerable.

Keywords:
Baltic macro-region; horizontal, hierarchical spatial diffusion of coronavirus; space of flows and space of places; monthly excess mortality; regional COVID-19 response legislation

Introduction and problem setting

The COVID-19 pandemic presented Russian economic geographers with new challenges relating to the study of infection spread across regions and municipalities. For the first time in recent history, the country was confronted with a global

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phenomenon affecting all aspects of life and thus all sectors of the economy. Yet, the reaction of space and society to the pandemic varied from region to region and from town to town.

Russian economic geographers responded to the challenge of the pandemic with copious research publications. Some works explore the course of the pandemic in selected territories; others look at how the virus spread across Russian regions on a national scale. Stepan Zemtsov and Vyacheslav Baburin conclude that, at early stages, i. e. during the first two waves, the pandemic spread across Russia according to the diffusion of innovations principle [1; 2]. Natalya Zubarevich and Sergey Safronov link specialisation in car production and exporting industries (oil extraction, diamond mining, non-ferrous metallurgy) to maximum economic damage suffered by Russian regions [3]. Similar results have been reported for the Kaliningrad region by Larisa Yemelyanova and Anna Lyalina [4]. At the same time, a regional specialisation in medical supply manufacturing gave an impetus to international trade [5].

The data collected nationwide require refinement, which, for some regions has been carried out by local researchers [6—8]. Little effort has been made so far to analyse the spread of the COVID-19 pandemic across Russian macro-regions. Such an analysis is particularly important for the Baltic region, one of Russia's most export-oriented territories. The automotive industry, whose vulnerability to the pandemic crisis has been repeatedly noted in the literature, is key to the economies of St. Petersburg, as well as the Leningrad and Kaliningrad regions.

In exploring the impact of the COVID-19 pandemic, it is imperative that research not only considers the economic and geographical factors of a region, but also takes into account its physical and environmental conditions. Evidence from Vicent Rios and Lisa Gianmoena's work on Italy suggests that temperature and humidity are crucial factors in the spread of the virus, alongside social ties and contacts [9]. Thus, a comprehensive approach would involve examining the influence of the Baltic Sea, which extends to varying degrees across several regions, including St. Petersburg, Leningrad, Kaliningrad, Novgorod, Pskov, Murmansk, and the Republic of Karelia, as highlighted by Klemeshev et al.

Defining the Baltic macro-region as a geographical area having a common economic specialisation and similar physical and geographical conditions makes it possible to pose the question explored in this study: what were the specific characteristics of the spread of the COVID-19 infection in the Baltic region? Finding an answer to this question requires examining the internal

differential of the spatial diffusion of the pandemic and investigating the processes taking place in the Baltic macro-region in the Russian context. This approach seems to be relevant and reasonable against the background of insufficient scholarly attention paid to the Covid-related properties of the spaces of regions facing the inevitable challenges of new viral infections [11]. It is vital to understand how the space of the Russian Baltic region responded to COVID-19 and put forward recommendations based on an analysis of this unintended hands-on training.

Methodology

Our methodology for studying the spatial spread of COVID-19 in the Baltic macro-region is a product of summarising the methodological groundwork laid by Russian and international scholars and adapting it to the limitations imposed by the object of the study. Many authors believe the excess death measure to be the most suitable for analysing the situation in the vast spaces of Russia [12—14]. In some other countries, demographers support its use as a tool to track the course of the pandemic and assess the damage it inflicted [15—18]. Excess mortality was an important medical-demographic indicator of the spread of the pandemic across regions and municipalities.

Other indicators are less accurate as deaths from COVID-19 are not always recorded as such, and the symptoms of the infection often resemble those of other viral illnesses and may be statistically associated with them (e. g. acute respiratory infections). Regional hospitalisation rates do not always correlate with COVID-19 morbidity and mortality.

Amongst quantitative methods, regression analysis was employed most frequently to analyse the factors affecting the national and regional patterns of coronavirus spread. For example, Aleksandr Pilyasov, Natalya Zamyatina and Yegor Kotov proposed a regression model for all Russian regions to explain the dependence of excess deaths rate on the share of people employed in contact-intensive wholesale and retail, manufacturing (large teams working at continuous production facilities), as well as on the proportion of the population over 65 and the number of retail outlets per 1,000 population [19].

The description of the situation in Russia differs significantly from, for example, that in the United States, where excess mortality was associated more with racial composition and political preferences [20]. However, the same strong correlations exist in EU countries and Russian regions: those with the share of senior citizens and the intensity of international trade [21]. Russia differs from some European states, particularly, Italy, in that the traditional

core-periphery virus spread models are not fully applicable there, with local sociocultural and institutional factors having a much greater role [19; 22]. Institutional factors seem to be crucial to the investigation of the pandemic in the Russian domestic context.

Some works looking at institutional factors affecting virus spread do not use regression analysis and focus on governmental response to the pandemic instead. Studying EU policy responses to the pandemic has revealed a tendency to abandon reactive measures for long-term strategic solutions: increasing vaccine availability and developing a European framework to control the spread of infections [23]. The response of the UK authorities as regards risk management and political communication, such as awareness campaigns, has been shown to have a number of deficiencies: inconsistency of the decisions made and excessive politicisation [24]. Spanish researchers have proposed an original quantitative model for assessing the lockdown effectiveness, which made it possible to determine the amount of GDP that would have been saved had the lockdown been imposed earlier [25]. Southeast Asia's Covid response policy has been examined by Singaporean experts by analysing local coronavirus regulations [26]. The authors of the study have concluded that the nature of government response was as important in the context of pandemic control as national geographical and economic parameters.

The focus of this research on the Baltic macro-region comprising seven Russian territories complicates the application of regression analysis, which is well suited for larger universes (dozens or hundreds of objects). It would be ill-considered to draw on municipal statistics, such as total and major-cause mortality, when analysing the spatial spread of the pandemic in the Baltic regions of Russia because data on COVID-19 mortality, especially in the first year of the pandemic, are generally recognised as insufficiently reliable due to inaccurate cause of death records, problems with locating COVID-19 deaths, etc.

Thus, we used monthly excess mortality data to track the spread of the pandemic, relying on a qualitative analysis of policy responses to the pandemic instead of conducting a quantitative regression-based analysis. The properties causing the vulnerability of the space of Russia's Baltic region to the spread of COVID-19 have been identified by analysing selected social and economic statistical indicators. Special attention was paid to the extreme values: regional minima and maxima within the universe of Russia's seven Baltic regions under consideration.

An effective way to describe the COVID-related features of the Baltic region's space is by utilizing Manuel Castells' distinction between spaces of plac-

es and spaces of flows [27]. The space of places is the conventional form of spatial organization, which governs the interactions between people. In contrast, the space of flows, a novel spatial paradigm that emerged with the rise of information technology, allows social practices to be systematically structured, making exchanges and interactions between actors more predictable and measurable.

The coronavirus pandemic undermines the traditional idea about the virtues and deficiencies of the two types of spaces. Today's global economy gives an advantage to the space of flows as they are more receptive to new information and capital. The spaces of places are inertial and less adaptable to current economic conditions. In a situation where the intensity of human interactions has a substantial impact on the spread of COVID-19, the hermetic spaces of places find themselves in a less vulnerable position than the spaces of flows, which are open to innovations, including harmful (viral) ones.

Methods

The algorithm we developed for the analysis of the spatial diffusion of the pandemic in Russia's Baltic regions draws on the international experience of national and regional studies and includes three stages.

Firstly, the characteristic pattern was identified of changes in excess mortality in Russia's Baltic regions of Russia. The calculation was based on the Rosstat data on excess deaths registered between April 2020 and December 2021 compared to the average for the same months of 2015—2019, weighted per capita without regard to the mortality trend. The weighted indicator was applied to eliminate the effect of the initial low base effect present when the traditional measure of percentage excess of the 2020 absolute mortality rates over the 2015—2019 average.

Secondly, regional and, in some cases, municipal statutory instruments laid in response to the pandemic were analysed, which made it possible to describe the institutional differentiation in the COVID-19 response of Russia's Baltic regions. To this end, the number of the statutory instruments was examined alongside the time of their approval and their stringency; content analysis was conducted to identify what type of spatial diffusion of the virus was targeted by the study measures.

Thirdly, the findings were integrated with the spatial characteristics of concrete Baltic regions, which were determined based on statistical extremes (regional minima and maxima).

Results

An analysis of excess mortality data (Fig. 1) made it possible to distinguish four types of regions with similar monthly changes in the indicator:

a) St. Petersburg and the Leningrad region: excess mortality peaks occur earlier than on average across the country; the peaks are more pronounced in St. Petersburg;

b) the Kaliningrad region and the Republic of Karelia: sharp fluctuations in monthly excess mortality; the peaks coincided with the national average;

c) the Novgorod and Pskov regions: monthly changes and peaks were similar to those observed across the country with the number of excess deaths below the national average;

d) the Murmansk region, an Arctic territory, is a special case: camps of rotational workforce, the region's many closed towns and manufacturing facilities where personnel work in isolated conditions often became COVID-19 hotbeds. Excess mortality had peaks unique to the Baltic region.

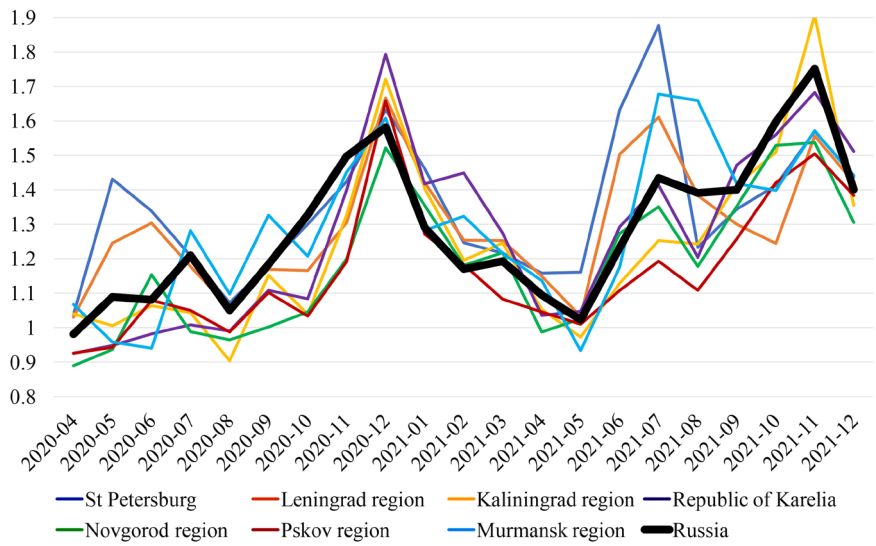

Fig. 1. Ratio of excess deaths in the Baltic region and across Russia

Calculated by B. V. Nikitin, a PhD student at the Faculty of Geography of Lomonosov Moscow State University

To stop the spatial diffusion of COVID-19, some Baltic regions (the spaces of places) imposed restrictions on movement in the local labour market, whilst others (the spaces of flows) tried to limit both horizontal movements in the local labour market and hierarchical ones between the city centre and rural district periphery, a core town and a core town of a lower order.

To find local factors differentiating the course of the pandemic, we examined a set of statutory instruments introducing COVID-19 restrictions (Table 1) and media reports on local outbreaks.

Table 1

A summary of COVID-19 response laws in Russia's Baltic regions (01.01.2020—18.12.2021)

Region	Total number of statutory instruments (SI)	including municipal ones	including cities	SIs mentioning rotational employment	SIs mentioning lockdown and related measures
St. Petersburg	803	None	None	0	9
Leningrad region	797	Over 550	Over 50	0	69
Kaliningrad region	572	Over 200	Over 200	0	82
Republic of Karelia	389	None	None	4	10
Pskov region	710	Over 200	Over 75	10	107
Novgorod region	489	Over 50	Over 30	6	6
Murmansk region	1098	Over 450	Over 350 (including 155 in closed towns)	4	37

Source: calculated by the authors using the ConsultantPlus legal research database.

The largest body of COVID-19 response legislation was introduced in the Murmansk region, whose unique spatial features produced a specific COVID-19 situation. The region's closed towns were mentioned in 155 municipal and regional regulations adopting regional and federal measures to the peculiarities of the local economy, lifestyle of the communities residing in the region, and the Arctic climate, geography and transport arrangements. Municipalities of the Leningrad region were most prolific in terms of Covid response legislation, having issued more statutory instruments than their counterparts in other regions. Most of these instruments governed measures introduced in the municipalities whose relationship with the core-centre of St. Petersburg can be described by the von Thünen's model. The Kaliningrad region was the leader in the number of COVID-19 regulations brought in by city districts, which points to the largely urban system of settlement in the territory. The Republic of Karelia adopted an extremely centralised approach to COVID-19 responses with few regulations

adopted at the municipal level: the regional authorities made decisions applicable to all the municipalities. The Pskov region was exceptionally active in introducing lockdown measures, such as sweeping travel restrictions, to combat the pandemic. It adopted the largest number of regulations pertaining to rotational employment, albeit the latter is practised in the region only at construction sites and to a much lesser degree than in the Murmansk region. The Novgorod region sought a more centralised COVID-19 response with most statutory instruments adopted at the regional level and very few at the level of city and municipal districts.

To determine the timeline of COVID-19 legislation in the Baltic region, we analysed the evolution of the principal regional response act, focusing on the months when amendments were made and new versions produced and tracked legislation activity by month (Tables 2, 3).

The intensity of making amendments and producing a new version of the law follows the pandemic waves as seen in the chart showing monthly changes in excess mortality. In most of the regions, the peak in rule-making coincided with the first wave of the pandemic, which took place between March and June (July) 2020. The second wave triggered a new surge of amendments to the principal statutory instruments (October—December 2020). The third wave did not cause a peak in the amendments and new versions of the law: the legislative efforts were not concentrated in time as it happened earlier. Yet, a cluster of amendments made between October and November 2021 can be seen in the Kaliningrad, Pskov and Novgorod regions and the Republic of Karelia.

Our conclusions about the waves of the pandemic being reflected in rule-making are supported by an analysis of monthly peaks in legislative activity in Russia's Baltic regions. Like in the case of amendments to, and new versions of, the principal statutory instrument, the first cluster is seen between March and July 2020; the second, dispersed, cluster, between October and December 2020; the third one, October and November 2021. The clusters coincide with the pandemic peaks (Table 3).

The stringency of restrictions imposed before COVID-19 vaccines became available was evaluated using a traffic light rating system: red stands for tight restrictions; yellow, moderate; green, lax. Table 4 shows the results of the evaluation.

Table 2

Amendments to the principal regional statutory instrument issued to counter the spread of the COVID-19 infection[1]

Region/Month	2020										2021											
	03	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11	12
St. Petersburg	7	4	3	6	2	3	2	3	4	4	3	1	2	3	1	3	2	1	1	3	1	0
Leningrad region	4	2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kaliningrad region	1	0	0	5	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	6	5	1
Republic of Karelia	12	12	16	10	5	6	3	5	13	11	7	5	6	1	3	6	1	2	2	6	5	2
Novgorod region	4	7	4	2	3	2	3	4	2	5	2	2	4	3	2	1	4	2	2	4	3	0
Pskov region	0	14	10	7	8	4	2	4	3	4	2	4	2	2	1	3	5	1	1	5	4	2
Murmansk region	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: calculated by the authors using the ConsultantPlus legal research database.

[1] The principal statutory instruments, by region: On measures to control the spread of the COVID-19 infection: *Resolution* of the Government of St. Petersburg of 13 March 2020 № 121; On the introduction of a high-alert state in the Leningrad region for administrative bodies and the Leningrad Regional System for Early Warning and Response in Emergencies and on some measures to prevent the spread of the COVID-19 infection in the Leningrad region: Resolution of the Government of the Leningrad region of 13 March 2020 № 117; On the introduction of a high-alert state in the Kaliningrad region for administrative bodies and the Kaliningrad Regional System for Early Warning and Response in Emergencies and on some measures to prevent the spread of the COVID-19 infection in the Kaliningrad region: Resolution of the Government of the Kaliningrad region of 16 March 2020 № 134; On the introduction on 12 March 2020 of a high-alert state in the Republic of Karelia for administrative bodies and the Karelian Republican System for Early Warning and Response in Emergencies and on some measures to prevent the spread of the COVID-19 infection in the Republic of Karelia: Resolution of the Government of the Republic of Karelia of 12 March 2020 № 127-r; On the introduction of a high-alert state: Order of the Governor of the Novgorod region of 06 March 2020 № 97; On measures to ensure security in the Pskov region amid the spread of the COVID-19 infection: Order of the Governor of the Pskov region of 15 March 2020 № 30-UG; On measures to counter the spread of the 2019-ncov infection in the Murmansk region: Resolution of the Governor of the Murmansk region of 16 March 2020 № 47-pg.

Table 3

The timeline of COVID-19 rule-making in Russia's Baltic region (January 2020—December 2021)

Region/Month	2020												2021											
	01	02	03	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11	12
St. Petersburg	3	3	53	92	68	63	53	57	25	41	39	79	17	16	24	20	20	23	23	16	14	19	24	11
Leningrad region	1	0	71	100	91	78	42	21	23	40	34	35	13	21	16	13	13	22	35	31	16	31	17	33
Kaliningrad region	1	1	58	83	38	50	37	25	23	21	25	37	9	9	15	13	19	17	15	13	16	19	18	10
Republic of Karelia	2	3	19	49	39	29	19	12	11	20	23	40	6	8	13	8	8	17	17	9	12	11	8	6
Pskov region	1	3	71	117	58	60	46	32	13	26	24	41	13	22	14	16	9	20	19	15	13	38	24	15
Novgorod region	1	2	34	72	62	59	38	30	11	28	18	22	8	9	14	6	4	16	9	7	7	16	9	7
Murmansk region	0	3	107	177	154	145	58	45	21	55	54	78	13	25	17	18	14	19	22	14	6	17	26	10

Source: calculated by the authors using the ConsultantPlus legal research database.

Table 4

An evaluation of the stringency of COVID-19 response measures introduced by regional authorities in 2020

Region	Stringency (traffic light rating)
St. Petersburg	Red
Leningrad region	Yellow
Kaliningrad region	Green
Republic of Karelia	Red
Novgorod region	Green
Pskov region	Green
Murmansk region	Red

A detailed analysis of the Covid-related legislation adopted by Russian regions and municipalities, as seen in the ConsultantPlus legal research database, shows that a distinction exists between national and regional restrictions on travel. In 2020, many regions copied the travel regulations adopted in Moscow and at the federal level. We looked at the unique measures taken by regional authorities to accommodate the course of the pandemic specific to their 'spaces'. Summarising the COVID-19 regulatory framework adopted by all Russian regions in 2020 during the first waves of the pandemic allowed us to distinguish five types of additional travel restrictions: 1) those on intra-regional passenger travel luggage transfer at airports and/or checkpoints (yes/no); 2) the 'extended' version of national regulations on the self-isolation of new arrivals (yes/no); 3) the move to remote working (yes/no) and its details (the category of employers, the percentage of the employees required to work from home); 4) lockdown imposed for selected municipalities at a regional level (rather than mayors and heads of municipalities) (yes/no); 5) fines for violating travel restrictions (yes/no).

Further, all Russian regions, including those of the Baltic macro-region, were rated on a yes/no scale against the five criteria. No region scored the maximum of five. The Republic of Karelia, St. Petersburg and the Murmansk region scored between two and three (red). The Leningrad region raked in the middle with a more 'anxious' agglomeration part abutting St. Petersburg and the more remote periphery (yellow). The Kaliningrad, Novgorod and Pskov regions scored the lowest (green).

Let us look at the types of restrictions by region in effect as of the end of 2020 (Table 5). Mass vaccination had not yet begun at that time, and the non-pharmaceutical measures against a pandemic were as varied as possible.

Table 5

Measures to counter COVID-19 spatial diffusion as of late December 2020

Region	Horizontal diffusion (home — work), public and private transport	Hierarchical diffusion (classical, along land routes)	Comment
St. Petersburg	At least 30 % of employees of city executive bodies moved to remote work, along with people over 65 and with chronic conditions employed by organisations and private entrepreneurs	None	Penalty for the first violation is an administrative fine of 4,000 roubles; for repeated violations or those on public transport, 5,000 roubles
Leningrad region	Employees over 65 years moved to remote work	Individuals driving across the Leningrad region are not allowed to stop before reaching the destination	—

The end of Table 5

Region	Horizontal diffusion (home — work), public and private transport	Hierarchical diffusion (classical, along land routes)	Comment
Kaliningrad region	At least 50 % of office employees moved to remote work, including pregnant women and people with certain conditions	None	—
Republic of Karelia	Remote work, primarily for people over 60 and with certain conditions (unless self-isolation at the workplace is possible). Remote work and self-isolation are a priority for people over 65 and those working in the largest regional settlements	Individuals arriving on business from other Russian regions must have a negative COVID-19 test result received within two days before the arrival	Priority cities and towns for the shift to remote working: Petrozavodsk, Belomorsk, Kem, Kondopoga, Lahdenpokhya, Medvezhyegorsk, Olonets, Pitkyaranta, Pudozh, Segezha, Sortavala, Kostomuksha, Suoyarvi, Louhi, Muezersky, Pryazha
Novgorod region	At least 30 % of employees of city executive bodies moved to remote work, along with employees with certain conditions and pregnant women	None	—
Pskov region	At least 30 % of employees of city executive bodies moved to remote work	None	Masks are not mandatory at places of communal gathering (markets, fairs, shopping malls) but at those associated with certain activities (retail, services provision, work)
Murmansk region	Employees over 65 moved to remote work; at least 50 % of office and management personnel and employees of the regional executive and municipal bodies moved to remote work	Restrictions on non-resident arrivals by car in Kirovsk and Apatity. Individuals with a permit to access restricted areas are required to stop at checkpoints.	The term ‘restricted access areas’ was introduced to refer to territories where stringent quarantine measures have been introduced.

Source: prepared based on the collection of laws and regulations *Coronavirus (COVID-19). Travel and access restrictions in Russian regions*, as available through the ConultantPlus legal research system.

Scholars investigating the spatial patterns of infection spread compared the process to the diffusion of innovation long before the COVID-19 pandemic [28]. Originally proposed by Torsten Hägerstrand in the 1950s (the work was first published in English in 1967 [29]), the model was developed further by Everett Rogers [30]. They have distinguished three forms of innovation diffusion [31]:

— hierarchical core-periphery diffusion (described in Hägerstrand's classic work) following the nodes of the land transport network and the hierarchical system of core cities of different ranks: from larger to smaller ones;

— horizontal diffusion associated with day-to-day or event-driven communication at places of residence and work or when commuting within the local labour market area;

— relocation diffusion: the transfer of the virus by plane from one pandemic hotbed to another, separated by hundreds or even thousands of kilometres. This type of diffusion was not included in our institutional analysis of regional legal frameworks for COVID-19 as it can be classified as an external factor.

Since St. Petersburg is a federal city with a population density greater than in the other study regions, the local authorities focused on measures to counter horizontal diffusion across the city space and the local labour market area, which includes the contiguous districts of the Leningrad region.

In the Leningrad Region, the key factor behind the spread of the virus was proximity to St. Petersburg (the types of monthly excess mortality change coinciding in the two regions is indicative enough). The influence of St. Petersburg on the diffusion of the pandemic in the Leningrad region can also be seen in the regulation of zoning municipal entities according to the stringency of the restrictions imposed on business entities.[2] The Vsevolozhsky, Vyborg, Gatchinsky, Tikhvinsky and Tosnensky districts were included in the first zone associated with the highest risk. All of them are in close proximity to St. Petersburg, constituting the periphery of its agglomeration.

In the other two zones of the Leningrad region, the restrictions were less tight. In the first zone, single-window service centres provided a limited range of services by appointment only; the clients were required to wear masks when visiting the centres. In the second zone (the Volosovsky, Kirishsky, Kirovsky, Lomonosovsky, Luga, Priozersky, Slantsevsky and Sosnovy Bor districts), the centres offered all the services within their remit; making an appointment and wearing a

[2] *Resolution* of the Government of *the Leningrad region of* 5 November 2020 № 716, *Official Legal Research Website*, URL: http://publication.pravo.gov.ru/Document/View/4700202011060001 (accessed 26.05.2022).

mask were also mandatory. Finally, in the third zone (the Boksitogorsk, Volkhov, Kingisepp, Lodeynopolsk and Podporozhsk districts), all the services were provided, and masks were obligatory.

The coronavirus pandemic highlighted a specific feature of the region: it consists of two distinct parts. The first one belongs to the St. Petersburg agglomeration, with many social and economic ties connecting it to the city, and the region's COVID-19 policy response concentrated on this part. The other one has its own local centres, which turned into hotbeds of infection and transmitted it further to their rural periphery.

The Leningrad region was affected by horizontal and spatial diffusion of COVID-19. In terms of horizontal diffusion, the region was both a source and adopter of the infection. Although many residents of the region commute to St. Petersburg, a number of local towns (for instance, Gatchina and Vsevolozhsk) act as cores attracting the workforce from the periphery. This is evidence of the hierarchical nature of agglomeration links: in addition to the main centre (St. Petersburg), which pulls the flows of information, goods and people, there are second-order cores serving as partial alternatives to the main centre.

The Kaliningrad region took another important measure in addition to moving at least half of the employees to remote working: businesses, both legal entities and private entrepreneurs working in the transport industry, which had sustained substantial losses, received subsidies.[3] The latter fact stresses the significance of inter-municipality passenger traffic for the local economy: the density of hard surface roads in the region was 527 km/km^2 in 2020 against 64 km/km^2 on average in the country, 47 km/km^2 in the Republic of Karelia and 24 km/km^2 in the Murmansk region. Sergey Tarkhov has demonstrated that a territory's accessibility by car has a key role in the spread of COVID-19 once the virus has entered it by plane [32].

The statutory instruments adopted in the Republic of Karelia governed intraregional and interregional rotational employment.[4]The instruments approximated those in effect in the Murmansk region, where access control was introduced for rotational workers.[5]

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[3] *Resolution* of the Government of the Kaliningrad region of 26 November 2021 № 766, *Official Legal Research Website*, URL: http://publication.pravo.gov.ru/Document/View/3900202111300001 (accessed 26.05.2022).

[4] Order of the Head of the Republic of Karelia of 12 March 2020 № 127-r, *Official website of the Republic of Karelia*, URL: https://gov.karelia.ru/coronaviridae/5837/ (accessed 26.05.2022).

[5] *Resolution* of the Government of the Murmansk region of 4 April 2020 № 175-PP, *Rossiyskaya Gazeta*, URL: https://rg.ru/documents/2020/04/05/murmansk-post175-reg-dok.html (accessed 26.05.2022).

The factor of rotational employment was decisive for the spatial spread of the pandemic in the Murmansk region. For instance, an outbreak of coronavirus infection amongst rotational workers occurred in late April 2020 in the village of Belokamenka, where the Offshore Superfacility Construction Yard was being built at the time. The absolute number of cases was several times the regional average.[6] Another targeted restriction peculiar to the Murmansk region was a temporary ban on entry to the region's many closed towns.[7] This measure applied, in particular, to the closed towns of Severomorsk, Zaozyorsk and Ostrovnoy. The Republic of Karelia and the Murmansk region tailored their policy response to prevent both the horizontal and hierarchical diffusion of the infection, i.e. the spread of COVID-19 within the local labour market area and following the core-periphery pattern (from cities to villages, from larger urban cores to smaller urban cores).

In many countries, for example, Sweden, the infection did not always spread exclusively from larger cities to less densely populated areas: often the hotbeds were small isolated facilities, such as retirement homes [33]. The virus then spread from isolated sites to adjacent, unrestricted areas.

The problem of isolated hotbeds of infection was also acute in the Pskov region, where COVID-19 struck retirement homes, in-patient psychiatric care facilities, convents and monasteries.[8] Although such facilities posed a challenge in other regions as well, in Pskov, the scale of outbreaks was more considerable and the number of hotbeds greater.

Comparable to Pskov in both areas (55,401 km^2 and 55,399 km^2 respectively) and population size (592,400 and 620,200 people respectively), the Novgorod region shows a similar pattern of excess mortality and proportion of employment in manufacturing, also experienced outbreaks of the type discussed above.[9]

The Pskov and Novgorod regions adopted regulations with a view to counter the horizontal rather than hierarchical diffusion of COVID-19. Since the two territories do not have large agglomerations, their legislative efforts focused on preventing horizontal diffusion, which may point to the difficulty of moving to remote working and the need to maintain a high intensity of personal contacts during the pandemic.

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[6] Increase in COVID-19 cases stops at rotational worker camp in Belokamenka, 2020, *Interfax,* URL: https://www.interfax.ru/russia/706151 (accessed 26.05.2022).

[7] *Resolution* of the Government of the Murmansk region of 4 апреля 2020 № 175-PP, *Rossiyskaya Gazeta*, URL: https://rg.ru/documents/2020/04/05/murmansk-post175-regdok.html (accessed 26.05.2022).

[8] Right hotspots of COVID-19 in Pskov region, 2021, *Delovoy Peterburg*, URL: https://www.dp.ru/a/2021/01/12/V_Pskovskoj_oblasti_ostal (accessed 26.05.2022).

[9] Valdai monastery closed to public due to coronavirus, 2020, *Interfax-Tourism*, URL: https://tourism.interfax.ru/ru/news/articles/73403/ (accessed 26.05.2022).

Of particular interest are the Chudovsky and Malovishersky districts of the Novgorod region, located near the border with the Leningrad region, where the disease situation was much worse than in the regional centre and the Novgorod district skirting the city. The explosive increase in incidence resulted in a temporary closure of road and rail links to these municipalities.[10] Such a drastic restrictive measure was necessitated by the two districts lying within a 1.5—2 hours' drive from the outskirts of the city.

3. Analysis of regional and municipal COVID-19 regulation and investigation of regional digital media, such as *Delovoy Peterburg* and *53 Novosti*, have revealed an internal differentiation of the space of the Baltic macro-region: it includes both spaces of flows and spaces of places.

In the regions dominated by the spaces of flows, the main factors affecting the spread of COVID-19 were the openness of the economy and labour mobility. These areas are the Kaliningrad region and the St. Petersburg agglomeration comprising the city of St. Petersburg and the Leningrad region (mainly the areas bordering the city). The most significant risks for the space of flows are associated with developed transport infrastructure and greater mobility of labour causing a rapid spread of infection. In the regions classified as such, the main challenge faced by the authorities was the timely move to remote working to reduce the passenger flow.

In the regions dominated by the spaces of places, the central role in the spread of the pandemic was played by isolated hotbeds: small closed towns, in-patient care facilities, retirement homes, etc. (Table 6). Here, the authorities had to deal with local outbreaks, often by imposing lockdowns.

Table 6

Local hotbeds of the pandemic in Russia's Baltic regions

Region	Predominant space type	Types of local COVID-19 hotbeds	Risk factors
St. Petersburg, Leningrad region, Kaliningrad region	Space of flows	—	Rapid virus spread
Republic of Karelia, Murmansk region	Space of places	Camps for rotational workforce	Infection coming from other towns and municipalities

[10] Traffic jam on road to 'closed' Chudovo district, 2020, *53 Novosti,* URL: https://53news.ru/novosti/56847-na-v-ezde-v-zakrytyj-chudovskij-rajon-skopilas-probka.html (accessed 26.05.2022).

The end of Table 6

Region	Predominant space type	Types of local COVID-19 hotbeds	Risk factors
Murmansk region	Space of places	Restricted areas	Rapid infection spread in isolated spaces
Pskov region, Novgorod region	Space of places	Convents and monasteries	Rapid infection spread in isolated spaces
	Space of places	In-patient psychiatric care facilities; retirement homes	Rapid infection spread in isolated spaces; infection coming from other towns and municipalities

The COVID-19 regulations reflected the priorities of regional authorities in combating the spread of the infection. In the spaces of flows, the primary objective was to reduce the intensity of the flows and seek ways to identify the infected within them. In the space of places, the authorities had to focus on isolating local hotbeds.

The results of the qualitative analysis aimed to identify the spaces of flows and the spaces of places coincide with the typology of regions based on monthly excess mortality patterns. The Pskov and Novgorod regions once again fall into the same category; Kaliningrad is grouped with St. Petersburg and the Leningrad regions; the Murmansk Region with the Republic of Karelia.

Quantitative analysis is not sufficient for a comprehensive understanding of the processes causing the differences in the spread of the infection. It must be supplemented by a qualitative analysis of regional COVID-19 legislation and digital news outlets (this study examines reports by *Interfax*, *Delovoy Peterburg* and the Novgorodian website *53 Novosti*). Similar values of the indicators could conceal different forms of space organisation and, as a consequence, differences in the spread of the pandemic.

Discussion: a Covid-based assessment of the spaces of Russia's Baltic regions

Summarising international research into the COVID-19 pandemic makes it possible to outline several priority topics to be explored in the context of Russian regions. These include a regression search for new factors affecting COVID-19 morbidity and mortality; looking for new metrics of the impact of the infection

on regional economies; investigating the effect of COVID-19 on intraregional and interregional migration; using GIS and big data technologies to track the spatial spread of the pandemic; modelling the pre-vaccine spread of the pandemic particularly to assess the effectiveness of non-pharmaceutical measures to combat the pandemic; examining the impact of the pandemic on regional industries, such as tourism; analysing attitudes of local regional communities to vaccination, travel restrictions, etc.

The global challenge of the COVID-19 pandemic is reshaping many familiar social processes and phenomena, such as urbanisation and the internal organisation of cities. This observation was made at the peak of the first waves of the pandemic by well-known economic geographers Richard Florida, Edward Glaeser and others. For economic geography, this means putting the problems of communication and human contacts on the research agenda. These include, in particular, the contact intensity associated with different kinds of economic activity, the configuration of regional and local social networks, the spatial mobility of talent, transport channels as infrastructure social communication rather than traditional freight transport, etc. The points (platforms), channels and structures of human/social/industrial contacts are becoming priority areas of research.

In this vein, an attempt was made to investigate the spaces of Russia's Baltic regions by considering the COVID-19 pandemic and regional authorities' restrictive measures as a test, an experiment revealing specific communication-related properties. Out of the whole pool of statistical indicators, 14 indicators seemed suitable for this purpose: area; total population; population density; density of paved public roads per 1000 km^2; railway density per 10 000 km^2; the share of paved roads in the total length of public roads; the number of private cars per 1,000 population; the proportions of regional rural and urban population (the degree of urbanisation); the share of the population of the regional centre in the total regional population (monocentric or polycentric structure, the intensity of the agglomeration effect); the proportion of retail chains in total trade (an indicator of urbanisation); the proportion of households and businesses with broadband Internet access (in the total number of surveyed households and organisations); the percentage of arrivals and departures from the region in the total number of arrivals and departures (openness to migration); the proportion of post-working age population (the degree of communication activity).

Together, these measures describe the unique features of each space of Russia's Baltic regions from the perspective of communication, which has the key role in the spatial diffusion of COVID-19, and the measures taken by the regional authorities. For example, ubiquitous broadband access simplified the move to remote working. The extremes (minima and maxima for the entire sample of seven

regions) were identified for each region and for each study indicator to thoroughly describe the specific properties of local spaces (for example, St. Petersburg and the Leningrad region are the largest by population; the Republic of Karelia, by area, etc.).

Then, the regional indicators were examined to reveal the unique clustering of their distinct values within the sample into integrated conjugate chains characterising the specific properties of space. These properties manifested themselves in outbreaks, excess mortality, and the special measures taken by regional authorities during the pandemic. This way, a continuum of spatial features — restrictive measures emerges, supporting the conclusion that each case is unique.

A direct formalised integration of the selected indicators into a single index is impossible due to their varying significance. Therefore, an expert attempt was made to obtain a qualitative but systematic picture of regional Covid spaces.

St. Petersburg had the highest per capita morbidity and excess mortality during the first waves of the pandemic due to the super-intensity of all socio-economic processes and interactions (all the density indicators had the maximum values in the sample). The Leningrad region is organised according to the von Thünen's model. The inner rings, the closest to St. Petersburg, fall into the city's morbidity rhythm through commuting-driven horizontal diffusion. The outer rings develop the rhythm of relocation diffusion, similar to that of the Pskov and Novgorod regions. The maximum number of municipalities (205) and the maximum share of the rural population in the sample prompted the regional authorities to systematise the COVID-19 restrictions by setting up three zones according to the degree of stringency.

The Kaliningrad region is an exclave region characterized by a significant population density, a prominent regional centre, and a well-developed network of high-quality roads and railways. Intensive hierarchical and horizontal diffusion of the virus could have occurred here, but moderate intra-regional migration and outward mobility (the exclave is isolated from mainland Russia) created natural barriers to the spread of the pandemic despite the intense internal social and economic activity.

In the Republic of Karelia, the regional centre is home to about half the population, which translates into a high degree of urbanisation. The republic has the largest territory and the lowest population density among the Russian Baltic regions. The spread of COVID-19 within the region was primarily confined to intra-city spaces, having a well-developed telecommunications network. However, the rural areas remain poorly connected to the city centres due to the general lack of high-quality roads and railways.

The Novgorod region with its polycentric settlement and considerable car traffic along numerous but poor-quality roads experienced the classic hierarchical diffusion of the virus from its numerous urban centres to the rural hinterland. There, COVID-19 mostly affected elderly people residing in 'closed' spaces, such as retirement homes (the Novgorod and Pskov regions have the highest proportions of pensioners). The situation was very similar in the Pskov region, whose space has many features in common with Novgorod.

In the Murmansk region, the peculiarities of its space, as well as demographic and socio-economic processes, made COVID-19 a disease of the urban working-age population, including rotational workers. Relocation diffusion played a major role in this region characterised by openness to migration. Lockdowns were often imposed in the closed towns and camps for workers. The introduction of quarantine measures was simplified by the local working-age households being avid Internet users. Whilst horizontal diffusion was hampered by the insufficient road density, whilst classic hierarchical diffusion reinforced by a polycentric settlement structure was conspicuous in the region.

Conclusions

The spread of the pandemic had some specific features in Russia's Baltic region. None of the territories exhibited an excess mortality pattern similar to the national average (April 2020—December 2021). A comparison of the Baltic macro-region with the Far Eastern federal district shows that the territories of the latter had much greater fluctuations in excess mortality.

A month-by-month analysis of the intensity of COVID-19 rule-making across the Baltic regions of Russia has confirmed the existence of three pandemic waves: the first cluster of March—July 2020, the diffuse second peak of October-December 2020 and the third cluster of October—November 2021 largely coincided with the peaks in excess mortality.

Regional policy responses to the spatial spread of COVID-19 were differentiated by the type of diffusion into horizontal diffusion restrictions affecting the local labour market (commuting) and hierarchical diffusion restrictions limiting traffic along a region's motorways.

A special case was camps of rotational workers and isolated hotbeds, such as covenants, monasteries, retirement homes and in-patient psychiatric care facilities, where the number and scale of the pandemic outbreaks were particularly significant and lockdowns were often imposed by the authorities.

The Russian regions comprising the Baltic macro-region differ in the pattern of the pandemic spread. Horizontal diffusion of COVID-19 through local labour markets was observed in St. Petersburg, the Pskov, Novgorod and Kaliningrad

regions, whilst the pandemic entered the Republic of Karelia, the Leningrad and Murmansk regions penetrated through both horizontal and hierarchical diffusion, as indicated by regional regulations.

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