The Role of Business and Government Cooperation in Preventing and Mitigating Global Biogenic Challenges

Elena B. Zavyalova, Larisa S. Pichkova, and Tatyana G. Krotova
MGIMO University, Moscow, Russia
{e.zavyalova, e.zavyalova}@inno.mgimo.ru, tatyana.krotova.mgimo@gmail.com

Abstract. This article is devoted to the very present and relevant topic of combating infectious diseases, maintaining the economy during a pandemic and using public-private partnership mechanisms for this.

The article concludes that during the epidemic, interaction is taking place in the area of health care and in the area of state support for the working of enterprises, mainly small and medium-sized businesses.

Support for vaccine development at the national level and international organizations is also being considered. A comparison is made between these two funding sources.

Keywords: COVID-19 · Pandemic · Collaboration between government · Public-private partnership and business · PPP · PPP practices public-private partnership

JEL Code: F23 · H42 · H44 · I18 · I11

1 Introduction

The COVID-19 pandemic, which has claimed more than a million lives has had severe consequences for the global economy. It has caused an unprecedented shock not only to the world community, but also to the global economy, causing huge financial losses. These consequences will be felt for many years to come.

The Organization for Economic Cooperation and Development has reported an unprecedented decline in production since the pandemic. The economic decline is projected to be 4.5% in 2020. Moreover, forecasts for 2021 remain very uncertain due to the unpredictability of the development of the epidemiological situation in the world. Global trade forecasts range from 13% to 32%.

Around the world, the tourism industry has been hit hard by countries imposing isolation measures. Small businesses, especially those operating in the service and restaurant industry, have suffered the most. In addition, production was completely stopped at many large enterprises.

Even though the forecasts for economic recovery of China, the USA, and the EU are quite optimistic, for a number of countries like Mexico, South Africa, India,
Argentina, Great Britain, everything is much worse. The expected drop in GDP in these countries will likely be 10%. The only country in which growth is expected is China: +1.8% (while not long ago a 6% growth was seen as stagnation in China). The US economy fell by −3.8%, the Eurozone by −7.9% and it is forecasted that France's GDP will fall by 10.6% (European Economic Forecast 2020). For comparison, after the financial and economic crisis in 2009, the decline was just 2.9%. In Russia, the projected drop in GDP will be 4.5%. For comparison, the fall in GDP due to the 2014 crisis was 2.3%. According to various estimates, due to the 2008 crisis, the drop in world GDP was from 0.75% to 2.3% and a decline in world trade by 10%.

According to World Bank forecasts, the level of extreme poverty will rise for the first time in 20 years. From 88 to 115 million people will fall below this line, and by 2021 their number may grow to 150 million. These are people living on less than $1.90 per day. This year, their number can reach 9.4% of the world’s population. If the pandemic had not happened, this figure was projected to be 7.4%. Moreover, urban dwellers (usually from rural areas) will fall into extreme poverty.

In addition, the general welfare of the population which is determined on the basis of the income growth of the poorest 40% of the country's population, is predicted to decline. That is, the crisis will most strongly affect the poorest segments of the population, which, in turn, will lead to mistrust of the authorities and destabilization of the situation, mainly in the developing countries. Thus, the outbreak of COVID-19 has caused a global economic crisis with an unprecedented decline in the economy of almost all countries of the world since the beginning of the millennium.

2 Results

One must be prepared for such shocks in the near future too. The frequency of infectious disease outbreaks is growing steadily. During the period from 1980 to 2013, their number has more than tripled. Outbreaks of 215 infectious diseases were recorded in 219 countries of the world (Smith et al. 2014). An even greater increase in their number is predicted due to global warming, which contributes not only to the occurrence, but also to the rapid spread of infections. Moreover, population density is steadily increasing in the cities of the world's least developed countries, with low levels of sanitation. This also contributes to the rapid spread of diseases.

2.1 Collaboration Between Government and Business in the Fight Against Corona Virus Infection

What difficulties did the countries face in connection with the epidemic? First of all, this is a lack of medical equipment (ventilators), qualified personnel, places in hospitals, an acute shortage of protective equipment: masks, gloves, antiseptics and, of course, a lack of tests to determine the virus and antibodies to it and vaccines that prevent and suppress corona virus. Due to the introduction of large-scale quarantine measures, as noted above, business has suffered greatly.
Under these conditions, it has become extremely important to collaborate between the state and business to quickly resolve the above problems. Cooperation between the state and business is necessary in two directions:

1) Treatment and prevention of the disease (creation and production of vaccines and test systems, medical equipment, masks, antiseptics, protective suits, etc. and places in hospitals, production);
2) Economy and support of the population (tax holidays and subsidies, creation and preservation of jobs, etc.).

The growth rates of corona virus infection and the economic decline in Europe and the United States have shown weaknesses in the application of quarantine measures and general preparedness for the epidemic in these parts of the world. On the contrary, Asian countries, China (where the virus was first registered) and neighboring countries: Taiwan, South Korea, Singapore, have demonstrated effective practices in combating the pandemic, including the practice of public-private partnerships. The rigid vertical of power, the mentality of the Asian population, the experience of combating SARS, swine and bird flu, the high level of development of medicine - all this played a decisive role in stopping the spread of the COVID-19 virus in these countries.

Let us consider in more detail the practice of using PPP in the fight against the virus (see Table 1).

Table 1. Application of PPP practices in different countries of the world

| Country         | China (PRC) | S.Korea | Taiwan | Singapore | Australia | USA | Iran | Switzerland | France | Russian Federation |
|-----------------|-------------|---------|--------|-----------|-----------|-----|------|-------------|--------|-------------------|
| Medicine support measures |             |         |        |           |           |     |      |             |        |                   |
| Public procurement of protective equipment from private companies | ✅ | ✅ | | | | | | | | |
| Subsidies for repurposing production lines | | | | | | | ✅ | | |
| Transfer of test systems to private firms | ✅ | ✅ | ✅ | | | | | | |
| Free Bulk Testing for COVID 19 | ✅ | ✅ | ✅ | | | | | | |
| Reducing administrative barriers when registering new drugs and test systems | | | ✅ | | | | | | |
| Economic support measures |             |         |        |           |           |     |      |             |        |                   |
| Reduction / deferral of tax payments | | | | | | | ✅ | ✅ | ✅ |
| Concessional loans | ✅ | | | ✅ | | | | |
| Subsidies | | | ✅ | | | | ✅ | | |
| Salary co-financing | | | ✅ | | | | | | |
| Direct cash payments to citizens | | | ✅ | | | | | | |
| Small Business Job Retention Policy | | | ✅ | | | | | | |
| Deferral of utility bills, rent | | | | | | | ✅ | | |

Source: Compiled by the authors
**China (PRC):** Interaction between the state and private business is carried out in both of the above areas.

The shortage of necessary medical equipment and protective equipment was eliminated through the provision of subsidies for fixed assets required to establish production lines, tax incentives, simplified registration procedures, reduced administrative costs and a number of other measures.

The introduction of mass quarantines contributed to the rapid development of digital services. Medical company HaoDaiFu conducted 1.68 million consultations in the first 17 days. JD’s grocery delivery volumes increased 226%. Online learning apps have been downloaded 45 million times.

The Hangzhou authorities implemented a QR code system to control the spread of the corona virus.

Thanks to the adherence to quarantine measures prescribed by the government, many companies resumed work two weeks after the quarantine was introduced, subject to distance, wearing masks, using antiseptics, temperature control and disinfection of premises, etc.

Rapid re-profiling of Chinese enterprises in the shortest possible time helped to overcome the shortage of protective equipment. For example, a company that manufactures military uniforms has launched the production of protective clothing for doctors, producing 50 thousand sets per day, providing a third of the required daily requirement. Automotive and electrical equipment manufacturers began producing medical masks, increasing daily production from 20 million to 110 million. In a record 15 days, a new factory for mask fabrics appeared in China.

To support the work of small businesses that provide 80% employment in the PRC in the context of the adoption of quarantine measures: lower administrative fees, lower rent, tax benefits, government subsidies, financial and credit support (Sihombing, Lukas et al. 2018). These measures reduced the burden on firms by $15 billion. To support companies, the Chinese Central Bank has created $45 billion in re-lending funds at a preferential rate.

In addition, a decision was made to reduce the operating costs of enterprises: electricity costs, the suspension of utility bills, assistance in the return to work of employees from other provinces, the abolition of vehicle fares on toll roads, assistance in stabilizing the traditional supply chains that prevailed before the epidemic, active information support (Sihombing, Lukas et al. 2018).

**South Korea:** The South Korean authorities were able to quickly stop the spread of the disease in their territory, largely thanks to the negative experience gained with the spread of MERS syndrome in 2015. Policy and institutional changes were developed to combat future infectious diseases and were successfully tested in the spring of 2020.

Public-private partnerships play an important role in the new policy. The new disease control scheme, including PPP tools, has enabled early response and control of the situation by involving private companies in the fight against the virus (June Park, Eunbin Chung 2020).
The scheme of combating the disease in the Republic of Korea fits into the 3T (Tracing, Testing, Treatment) model, for the implementation of which tools are required for rapid mass testing of the population for the presence of the virus. Test kits for detecting COVID-19 began to be developed by South Korean firms immediately after the outbreak of COVID-19 in China in late 2019. The test kits were quickly distributed to private clinics across the country, reducing the burden on Korea’s state-run Centers for Disease Control and Prevention, thus greatly expanding the system without increasing the administrative burden. The necessary infrastructure for testing was quickly established in partnership with the private sector (June Park, Eunbin Chung 2020). More than 500 clinics and 60 mobile points could test for coronavirus. These clinics allowed citizens to pass through them without even getting out of their cars, and completely free of charge. A system of punishment for refusing to take the test has been introduced.

Legal changes made it possible to use personal data to activate the intelligent management system developed by the Ministry of Land, Infrastructure and Transport (MOLIT) (June Park, Eunbin Chung 2020). This system allows to quickly identify contacts of infected people and identify chains of infection by the geolocation of smartphones and video face recognition. The authorities manage to identify all the movements of the sick over the past two weeks. Mobile applications have been developed and distributed to alert people of potential infection sites. A system of QR codes has been introduced.

A ban has been introduced on the export of masks and other protective equipments.

The effectiveness of the measures taken can be judged by the political effect. The ruling party of Korea confidently won the parliamentary elections in April 2020 (Rossiyskaya Gazeta 2020).

Taiwan: The authorities managed to avoid the spread of the epidemic due to the high level of development of information technology. In the shortest possible time, a system was developed based on people’s travel history and clinical symptoms that allows to draw a conclusion about the possibility of contracting coronavirus. People at risk were quarantined. The government has kept people informed about the evolving COVID-19 situation and the need to wear masks and wash their hands. A ban was introduced on the export of masks and other protective equipment. The military was involved in the production of masks.

Singapore: The Singapore authorities managed to contain the epidemic, as in South Korea, thanks to the developed protocols for the application of quarantine measures and a centralized warning system. The mechanisms of PPP application allowed to develop a test system for determining the coronavirus and conduct mass testing of citizens which was first of its kind in the world.

The test was the result of a collaboration between scientists at the National Center for Infectious Diseases (NCID) and Duke-NUS Medical School. National Public Health Laboratory and private clinics began testing as early as January 2020 and more than 21 thousand tests were carried out in the shortest possible time.

To support citizens and businesses, the government has given quarantined people a payout of $73 a day, where it is prohibited to count quarantine days as leave by employers. Violation of quarantine was severely punished, even up to the deprivation of resident status.
Iran: Iran was among the ten countries with the highest number of cases. In Iran, 20% of hospitals are owned by the private sector, many of which have shared their premises and equipment with government clinics to increase the capacity of the health sector. In the telecommunications sector, a broad partnership has been established between the Iranian government and private companies. Major Iranian telecommunications companies such as MCI and Irancell have allocated 100 gigabytes of free home internet to users to support people at remote work. Communication bandwidth has been greatly improved in response to the growing use of Internet services. In the production of goods related to the treatment and prevention of COVID-19, the government issued a permit to repurpose production lines and turn them into specialized lines for the production of alcohol, antiseptics and masks without complicated bureaucratic procedures and in a short time. In recent years, Iran has been struggling with many problems in the provision of technological equipment domestically. To overcome this problem during COVID-19, the Iranian government has partnered with scientific enterprises. Many companies operate under the auspices of science and technology parks in various provinces to help fight COVID-19, and more than 400 businesses have joined the production of products related to the fight and prevention of coronavirus.¹

Australia: The form of state support for the economy through the preservation of jobs and the reduction of companies’ financial expenses on employee salaries by subsidizing the wages of citizens is remarkable. The Australian government has introduced a fixed per-worker wage subsidy for all workers in businesses experiencing more than a threshold drop in expected earnings. The program was implemented through the Australian Internal Revenue Service.

Compared to similar measures in the US, for example, the Australian tax system was implemented more slowly, but its implementation was simpler and more transparent, with fewer barriers to entry for eligible businesses. The Australian subsidy was much more targeted, but more generous to those who were eligible; The American subsidy, as we will see later, went to many businesses that didn't even need it, and some small businesses that needed help never got it (George Washington University 2020).

A number of policy measures have been developed to overcome the crisis. Consider the two budgetary milestones updated by the Australian government as part of its 2020 corona virus economic response consolidated bill. In the first phase, the business was stimulated directly. The second phase focused on individuals and their employment. In particular, as part of the second section of measures, unemployment benefits were increased, and government assistance was provided to enterprises that had a negative impact due to sanitary restrictions to pay workers.

The Australian government has allocated $260 billion in subsidies, roughly half of the expected total Commonwealth revenue for 2019–2020.

With such a scheme to help the economy, large corporations and capital owners are the winners, while the losers are the self-employed, contract workers, schools, social

¹ Public-Private-People Partnerships (4P) for Improving the Response to COVID-19 in Iran https://www.cambridge.org/core/journals/disaster-medicine-and-public-health-preparedness/article/publicprivatepeople-partnerships-4p-for-improving-the-response-to-covid19-in-iran / A07460CB528A665DB49616720E732EFF.
benefits, science, public transport, in a word, society as a whole (Australia's COVID-19 public budgeting response 2020).

**USA:** The US government has assumed the cost of treating patients with corona virus infection on itself. However, funding is taken from the budget money allocated to help medical institutions, endangering their existence.

To help businesses, the US government introduced a wage subsidy tied to total wages, only for small businesses, regardless of the impact of the crisis on their income. The program was implemented through soft loans issued through the private banking system. Passing through the banking system, the US program had the advantage of providing liquidity quickly as compared to the Australian experience with wage subsidies. However, even such broad measures, being deliberately underfunded within the framework of American budgets, could not provide prompt critical financial assistance to all small enterprises. Some businesses did not receive subsidies even months after the start of quarantine (Australia's COVID-19 public budgeting response 2020).

**France:** In the French economy, small and medium-sized businesses occupy the most important place, such enterprises account for 99.9% of the total number and about a third of the turnover (1300 billion euros) of all French enterprises (Klinova 2020). 3.8 million SMEs employ 6.3 million people, which generate 43% of value added.

The European Commission found temporary targeted support of small and medium-sized businesses, other enterprises, the banking sector and other financial structures as justified due to exceptional circumstances which were beyond the control of the EU member states.

This decision gave France the opportunity to take timely action. These include the following (Klinova 2020):

- Postponement of social payments and/or tax payments;
- Deferral of rent and utility payments;
- Assistance of up to EUR 1,500 to the most affected micro-enterprises and entrepreneurs, self-employed, people of free professions from the Solidarity Fund which is financed by the central and regional authorities;
- Allocation by the state of 300 billion euros for soft loans for enterprises during the crisis;
- Intermediary assistance to enterprises in negotiations with banks on credit restructuring by the state and the Bank of France;
- Support for employment at enterprises by simplifying and facilitating the procedure for introducing a partial unemployment regime;
- Introduction of a business intermediary mechanism to resolve conflicts with customers or suppliers;
- Recognition by the state and local authorities of the epidemic as a force majeure circumstance and exemption from fines for late execution of all public procurement contracts;
- Adoption of a plan of assistance to exporting enterprises.
The investment bank Banque Publique d'Investissement provided guarantees for current commercial loans and line of credit to businesses with up to 5,000 employees before the pandemic, and in times of crisis to all types of businesses. Direct support allows banks to quickly provide liquidity to any enterprise that needs it (Adresse aux Français 2020).

**Italy:** The reason for such serious consequences of the epidemic: 6,616 deaths (as of October 19, 2020) in Italy was the reduction in public spending on medicine and the neglect of the development of innovations in the field of medicine. The reform of the health-care system had resulted in the closure of many small hospitals and the reduction of medical personnel. As a result, in the epidemic there were not enough places in hospitals, equipment, doctors and junior and middle nursing staff.

The state allocates 0.2% of the 119 billion invested in public health for research (European average of 1%). Many research departments were closed, which led to the suspension of the process of researching new drugs and treatments, as well as the reduction of staff and the transfer of researchers and think tanks in institutes on temporary contracts.

**Switzerland:** It is noteworthy that in this country the level of private medicine is so high that, on the contrary, the state asks business to cooperate and transfer developments in the field of combating corona virus infection in exchange for economic incentives. This scheme makes it possible to bring advanced health-care technologies to a wider circle of citizens.

The health of the economy after a pandemic is ensured by economic measures with a social orientation.

In the region, to mitigating the effects of the economic crisis, assistance was provided to companies and citizens who were more vulnerable. Unemployment payments and other social benefits were brought under state control. Effective quarantine, monitoring and effective treatment measures helped to avoid overloading the health-care system.

Switzerland also implemented an ambitious program to detect transmission pathways and contain outbreaks of the epidemic, implementing a national strategy for collecting and managing digital health data.

The army, its hospitals and ambulances were mobilized to help private and public clinics.

**Russia:** The long-term practice of interaction between the state and business in Russia since the beginning of the pandemic has helped to rapidly increase the production of medical masks, antiseptics and other protective equipment. Enterprises producing masks have received large government orders. Even small and micro-enterprises were involved in the work. Many manufactures have re-profiled their production lines for the production of protective equipment, for example, the domestic brand “Bosco” gave 6 out of 8 production lines for the purpose, which made it possible to produce up to 20 thousand masks per day.
The production of testing systems for determining the presence of corona virus, developed in state research institutes, was established at 7 private pharmaceutical companies. Testing can be done free of charge at public clinics and on a paid basis at many private health centers. In addition, the state also purchased of testing systems developed by private enterprises (Rostender.info 2020). Mobile technical assistance teams were organized by private pharmaceutical companies to help set up the equipment and ecosystem in the test labs.

In October, the Government asked metallurgical companies to convert some of their lines from production of technical oxygen to production of medical oxygen.

Large-scale work is also underway to support the population and business. The business is provided with subsidies, the possibility of preferential lending provided that the staff is retained, tax incentives and deductions from the tax base for the purchase of protective equipment are provided. Social payments to parents of children under 14 years old were made for 2 months in a row. Groups qualifying for social benefits were provided with food.

To help the construction business and the population, a program of state co-financing of mortgage programs was launched. During the second wave of the epidemic, the authorities are trying in every possible way not to close small businesses (cafes, salons, restaurants) by introducing a QR code system developed by the Ministry of Telecom and Mass Communications to track the contacts of people with corona virus.

2.2 Development and Introduction of Vaccines

The final victory over the COVID-19 virus is impossible without a vaccine. Usually, developing vaccines without an epidemic is extremely costly due to the need for extensive clinical trials, the latest equipment, etc. The cost of developing a new vaccine is US $1–2 billion, with a high degree of uncertainty for its the demand. In addition, their need disappears after large-scale vaccination and the formation of massive immunity. Thus, the development of a new vaccine cannot be done without large public and/or private investments. But private investments are possible only if there is a certain probability of obtaining a return on investment.

However, all this changed with the outbreak of the COVID-19 epidemic. In this situation, the demand for a vaccine against COVID19 is extremely high and the issue of creating a new vaccine for governments and private medical companies is not only a question of protecting the nation from a terrible epidemic, but also of maintaining public confidence in the government, political influence on a global scale and, of course, a giant financial return on investment. The vaccine is required in billions of doses in all continents. Meeting the demand for the vaccine from India and Indonesia promises huge profits for the country as this has ensured the development, production and supply of the vaccine in such great numbers.

At the moment, about 165 vaccines are being developed in the world by 110 pharmaceutical companies around the world. The main developments are presented in Table 2. Two Russian and two Chinese vaccines have passed registration stage. Vaccines developed in the USA and Germany will soon be registered.
Table 2. Major developers of COVID-19 vaccines

| Vaccine name          | Country | Being developed by | Form of support                                                                 | Participation in trials                                                                 |
|-----------------------|---------|--------------------|---------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| MRNA                  | USA     | Moderna            | Funded by the National Institute of Allergy and Infectious Diseases (NIAID)      | Tests involve 30,000 healthy US citizens                                                |
| Sinovac vaccine       | China   | Sinovac            | The Chinese government has granted an emergency authorization for the limited use of Sinovac vaccine | Trials involving 9,000 volunteers in Brazil and Indonesia                                |
| Wuhan Institute Vaccine | China   | Wuhan Institute of Biological Products | The Wuhan Institute is part of the state-owned Chinese company Sinopharm | Tests in the UAE, Peru, Morocco                                                      |
| Beijing Biological Product Institute Vaccine | China   | Beijing Institute | Beijing Institute is part of the Chinese state group Sinopharm and cooperates with the China Center for Disease Control and Prevention | 5,000 people participate in the tests in the UAE                                      |
| Vaccine CanSino Biologics | China   | CanSino Biologics  | Research is carried out jointly with the Chinese Academy of Military Medical Sciences | Tests in Saudi Arabia and Pakistan                                                   |
| Satellite V           | Russia  | Research Institute Gamaleya | Funded by the state                                                              | More than 2,000 people take part in the tests in Russia, Latin America and the Middle East |
| ChAdOx1               | UK      | Oxford University  | AstraZeneca has agreed to manufacture 300 million doses with the support of the Coalition for Epidemic Preparedness Innovation (CEPI) | Clinical trials in Africa, Brazil, USA and South Africa and over 10,000 volunteers in the UK |
| BNT162                | Germany | Pfizer BioNTech    | The company entered into a € 100 million debt financing agreement with the European Investment Bank to expand European vaccine production | In Germany and the USA. It announced the start of a Phase 2/3 trial involving 30,000 volunteers in the United States, Argentina, Brazil and Germany on July 27 |
| Covaxin               | India   | National Institute of Virology | Funded by the state                                                                       | (continued)                                      |
| Vaccine name       | Country     | Being developed by | Form of support                                                                 | Participation in trials                                                                 |
|-------------------|-------------|--------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| CureVac vaccine   | Germany     | CureVac            | € 300 million from the German government, € 80 million from the European Commission and € 8.3 million from CEPI | The vaccine will be tested on 168 healthy people                                         |
| Vaccine Novavax   | USA         | Novavax            | Bill & Melinda Gates Foundation pledged to invest US $52 million Coalition for Epidemic Preparedness Innovation (CEPI) funding of $388 million | Tests in South Africa                                                                   |
| Anhui Zhifei vaccine | China       | Anhui Zhifei longcom biopharmaceutical, Institute of Microbiology, Chinese Academy of Sciences | Funded by the state                                                               | Tests in collaboration with the Chongqing Medical University branch and Beijing Chao Yang Hospital |
| IMBCAMS vaccine   | China       | Institute of Medical Biology, Chinese Academy of Medical Sciences (IMBCAMS) | Funded by the state                                                               |                                                                                         |
| AnGes vaccine     | Japan       | AnGes              | Developed in partnership with Osaka University and Takara Bio                   |                                                                                         |
| Vaccine Genexin   | S.Korea     | Consortium Genexin | International Vaccine Institute, Korea Advanced Science Institute, and Technological University and Pohang University of Science and Technology | Tests are conducted on 190 healthy people                                               |
| QazCovid          | Kazakhstan  | Research Institute of Biological Safety |                                                                                   |                                                                                         |
| Johnson & Johnson vaccine | USA     | Johnson & Johnson  | Independently, based on previous developments                                  | The trials involve 60,000 people in Latin America                                         |
| Imperial College vaccine | UK       | Imperial College London | £ 41 million from the UK government, £5 million in charitable donations Collaboration with Morningside Ventures to manufacture and distribute the vaccine | Tests are conducted on 300 healthy volunteers, each of whom will receive two doses of the vaccine |

(continued)
It is known that the UK government has allocated 20 million pounds to developing a vaccine. Bill & Melinda Gates Foundation has donated $100 million for vaccine development and 15 million for safety assessments. Wellcome Trust has given $13 million. The Jack Ma Private Foundation of China, has announced a $2 million commitment to development of the drugs for COVID-19.

Supranational organizations involved in the development and distribution of the vaccine include Coalition for Epidemic Preparedness Innovation (CEPI), Gavi, Bill & Melinda Gates Foundation, Wellcome Trust, COVAX (an international mechanism created specifically to fight COVID-19).

These organizations have a specific focus. CEPI provides support for vaccine development. Gavi focuses on manufacture and supply of vaccines. The Bill & Melinda Gates Foundations and the Wellcome Trust collect and provide funds for CEPI, Gavi.

The COVAX International Mechanism is established and jointly led by Gavi, CEPI and WHO. It is aimed at the early development of a vaccine against COVID-19 and guarantees access to it for every country participating in this mechanism. At the moment, more than 170 countries have joined COVAX, including China, the trials of 4 vaccines of which are in the final i.e. third stage of research. Almost €16 billion

### Table 2. (continued)

| Vaccine name          | Country    | Being developed by         | Form of support                                                                 | Participation in trials                                                                 |
|-----------------------|------------|---------------------------|--------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| EpiVacCorona          | Russia     | Institute “Vector”        | State funded                                                                    |                                                                                        |
| Vaccine Sanofi Pasteur and Translate Bio | France&USA | Sanofi and Translate Bio | Sanofi to provide most of its global COVAX vaccine supply through an international collaboration led by Gavi, CEPI and WHO |                                                                                        |
| S-Trimer              | Australia  | Clover                    | US $3.5 million from CEPI                                                       | The tests are being carried out on 50 healthy adults in Australia                      |
| Medicago              | Canada     | Medicago                  | The company is funded in part by cigarette manufacturer Philip Morris           |                                                                                        |
| GRAd-COV2             | Italy      | Biotechnology company ReiThera | In collaboration with the National Institute of Infectious Diseases. Lazzaro Spallanzani |                                                                                        |
| Vaccine Merck         | USA        | Merck                     | Merck acquired the Austrian firm Themis Bioscience and is working on a vaccine that was originally developed at the Pasteur Institute |                                                                                        |

Source: Compiled by the authors
contributed, including €400 million from the European Commission and more than £570 million from the UK.

COVAX will use these funds to purchase 2 billion doses of corona virus vaccines from several pharmaceutical companies. Russia refused to join the organization, as domestic companies have created, registered and already started using two vaccines. The USA also does not participate, because have severed relations with WHO and do not want to sponsor the organization's project.

From Table 1, we can see that the development and production of new vaccines is mainly sponsored by the governments of the countries concerned, or by supranational organizations.

To meet the huge demand, while the development of vaccines is being carried out in national institutes, production is being transferred to private pharmaceutical companies with sufficient scientific and production capacity. In addition, the participation of the country's government and supranational associations in the development of vaccines makes it possible to move quickly and test the vaccine not only in the population of the country, but also abroad, which is necessary to reveal its effectiveness in various climatic conditions and groups of people of different races.

Large-scale vaccination of the country's population is mainly carried out at the expense of the government. There are a number of reasons for this besides protecting its own population from the deadly virus. Such reasons include populist measures on the eve of elections, as in the United States, but also traditional social practices inherent in socialist countries, and purely economic reasoning. The fact is that government spending on the construction of new hospitals, the provision of the necessary equipment, medicines, an increase in the number of medical personnel, measures to support citizens and businesses are much higher than the costs of developing vaccines and universal vaccination.

Thus, providing vaccines to the US population of 328 million people will cost a total of $3.28 billion at the rate of $10 per dose (the price announced on ‘Russia 24’ equal to the export cost of two doses of Russian vaccine) and for the purchase of a Chinese vaccine- $32.8 billion. The American company Pfizer is announcing the cost of its vaccine at $19 per dose, and AstraZeneca is announcing $3–4, therefore providing the US population with these vaccines will cost $62.32 billion and $984–1312 million. These costs are several times lower than the funds already allocated for the fight against corona virus by the government of this country (6 trillion US dollars) (Kommersant 2020).

Vaccination of 146 million people, the total population of Russia with a domestic vaccine will cost approximately 109.5 billion rubles of the 1.4 trillion pledged in April to fight the corona virus.

As can be seen from Table 1, COVAX prefers to finance the development of European research institutes, as well as pharmaceutical companies manufacturing vaccines, rather than developments in China or Russia that have proven their effectiveness. Thus, the main sponsors of this international mechanism finance their own developments, ensure the development of technologies, jobs, and economic recovery. Of course, such a mechanism is not beneficial for Russia, which has its own vaccine developments, two of which are in the final stages of research.
These vaccines were created on the basis of the Ebola virus vaccine, which has been extensively tested and proven to be safe and effective in Guinea. Given that COVAX will distribute vaccines without disclosing the R&D results on the basis of which it was developed, Russia is not interested in financing European development. Moreover, the likelihood of new epidemics is high, and modern vaccines are built on one fundamental basis. The country’s security and economic growth in the future depends on the development of their own vaccines. For most countries that do not have such technologies, international mechanisms such as COVAX are a good opportunity to obtain a vaccine at the lowest cost to protect their populations.

The involvement of government or international organizations in vaccine development speeds up the formal vaccine registration procedures, which can take up to six years. To accelerate the production of vaccines, both governments and international organizations enter into contracts with private pharmaceutical companies.

Russia is currently developing 47 vaccines against the new corona virus infection. These research are funded from the budget. More than 3 billion rubles were allocated for it. Vaccines are being developed mainly by state research institutes and centers (The Chumakov Center, Moscow State University). Two vaccines already registered have also been developed by state scientific centers. Sputnik V was developed by the center ‘Gamalei’. The cost of one dose of the vaccine will be 750–1000 rubles.

The cost of the EpiVacCorona vaccine, developed by the State Research Center for Virology and Biotechnology Vector, is not yet known. It is reported that the vaccine will be produced in carton packs of 10 ampules each. The cost of measles vaccine (5 ampules per package) produced by the center is 1,773.75 rubles (Vector.nsc.ru 2020). This center also developed the country’s first COVID-19 test.

For mass production, which satisfies not only domestic demand, but also requests from abroad, a PPP mechanism is used. For example, for the production of a test batch of Sputnik V vaccine, company Generium was chosen, which possesses the maximum number of GMP certificates, a modern production complex and an R&D center. It has already replicated the technology and scaled it up. The company has released a test batch of the vaccine (undergoing quality control).

In addition, the company is developing tests to determine cellular immunity after vaccine administration. The demand for these tests is also high from the state.

3 Conclusion

The main lesson for the global practice of joint work of the state and business in a pandemic can be considered that to delegate the implementation of some state functions in the field of epidemic security to a private partner is effective. In this case the state and business, both realize the fruits of partnership, because on one side of the scales there is political and financial benefit (each partner has its own reward), and on the other side of the scale is common responsibility and sharing of risks.

Public-private interaction in the fight against epidemics has been carried out in two areas: medicine and the fight against economic consequences.

The first area includes expanding the production and distribution of masks, antiseptics and other protective equipment, expansion of bed capacity by including
private hospitals in the healthcare system, subsidizing the purchase and re-profiling of production lines for the manufacture of medical equipment and personal protective equipment against the virus, as well as transferring technology to private companies for the production of test kits, drugs and vaccines.

The second area includes support for the private sector during a pandemic. This can be done by subsidizing and providing soft loans to enterprises, co-financing of salaries and direct payments to working and privileged groups of citizens, providing legal and consultation support, introducing deferrals for utility and rental payments, tax holidays.

To end the pandemic, health systems must vaccinate 50 to 75% of the world's population. This requires increasing manufacturing capacity and distributing vaccines, making a new vaccine available, deciding who gets access first, and planning massive vaccination campaigns. Here a public-private partnership is needed.

International organizations and foundations created by European states are effective in accumulating funds necessary for the development, testing and distribution of a vaccine to countries in need of it. But they do not support the most promising developments, rather companies and institutes located in Europe, thereby preserving all scientific developments to themselves. Therefore, countries such as Russia and China, which have extensive experience and potential in the development of vaccines against viral diseases, need to finance their own developments since the forecast of an increase in the number and intensity of viral infections in the near future is extremely unfavorable.

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