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Pandemic waves and the time after Covid-19 – Consequences for the transport sector

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ARTICLE INFO

Keywords:
- Covid-19 pandemic
- Transport sector
- Policy intervention and stimulus funding
- Air and rail intercity transport
- Urban transport
- Environmental effects
- Post pandemic development

ABSTRACT

This paper discusses the dual role of the transport sector in the Covid-19 pandemic: spreading the virus around the world and being most negatively impacted by the pandemic. This paper describes and analyzes the following: (a) actions taken by the governments and international community in order to control the spreading and to alleviate negative economic impacts including massive fiscal and monetary stimulus funding; (b) detailed discussions on the impacts of the pandemic on air transport, rail and bus transport, and urban transit, and major countries’ responses to reduce the negative effects; (c) discussions on the positive effects of the pandemic on the environment and climate change by suggesting policy measures in order to make it sustainable over the long term. Finally, the paper addresses social acceptance issue of the behavioral changes necessary in the post-pandemic world, in particular reflecting historical experience of the Spanish flu case. We end the paper with some observations and discussion of the normative issues for a sustainable development of the transport sector.

1. Introduction

The Covid-19 pandemic imposes the greatest economic and social shocks since the Great Depression of the 1930s. As of end March 2021, Covid-19 has infected about 130 million people worldwide with more than 2.8 million deaths (Worldometer, March 31, 2020). Each country had a different approach to deal with Covid-19. The US and Brazil, for example, focused on economic stability and minimized Covid-19 restrictions at the beginning of the pandemic. As a result, US has the largest number of cases with more than 31 million infected people and about 570 thousand deaths and Brazil shows the highest speed for infections and deaths (13.4 million infections, 349 thousand deaths; Worldometer, March 31, 2020). The pandemic will bring significant changes to the ways we live, work, do business and trade. Since transport networks and services (e.g.: air, sea, rail and highway, and urban transit) are critical enablers of business activities, their prompt recovery and efficient functioning are extremely important to support the economy to recover from this catastrophic downturn. The global economy has declined in 2020 by 3.4% (OECD, March 2021) and 8.8% of working hours were lost compared with 2019 (ILO Monitor, Jan. 25, 2021).

Transport systems influence the spatial distribution of population and are involved in all economic activities which require an overcoming of space. Therefore, the analysis of Covid-19 impacts on the transport sector requires a careful investigation on the economic and social drivers of transportation activities. This paper will give an overview on these interdependencies to result in a global outlook of the possible developments in the forthcoming intermediate phase and the time after overcoming the crisis. Apart from giving selected country and sector examples the paper will not go into details of transport sector developments in different countries. A forthcoming special issue to be published in this journal will include contributions on such details which have been compiled by a Task Force of the World Conference on Transport Research Society (WCTRS).
The paper is organized as follows: Section 2.1 shows the current situation and the worldwide political actions directed towards mitigation of the negative impacts of the pandemic. Section 2.2 presents modes of transportation that are most heavily affected by the pandemic. Section 3 discusses possible recovery trajectories of the transport sector and changes expected in the interim phase and the post pandemic period. Section 4 summarizes the findings and gives the conclusions.

2. Current situation and world-wide political actions

2.1. Infections and economic impacts

2.1.1. World-wide infections

**First wave:** The first wave of the Covid-19 pandemic peaked between early spring and early summer of 2020 (see Fig. 1). While some countries introduced strict lockdown measures to increase physical distancing (e.g.: China, South Korea) or introduced differentiated lockdown measures (e.g., Germany, Scandinavian countries) others had no clear strategy (e.g.: the US, the UK, Brazil). In addition, culture plays a critical role to influence the scope of the pandemic. For example, societies in which close physical human contact is an intrinsic element of lifestyle (e.g.: Brazil, France, Italy, Spain) were much more affected compared to other societies in which people naturally maintain social distance (e.g.: Japan, South Korea, Scandinavian countries).

A significant reduction of Covid-19 cases in late summer and early fall of 2020 strengthened confidence among many countries that the pandemic was under control and could be defeated. In particular, Japan showed low number of cases since the beginning of the pandemic with less than 750 daily new cases in April and less than 50 in June. In Germany, daily infection rate was 6200 in April and declined to 785 in August. The government then relaxed strict lockdown and Covid-19 restrictions believing that the early lockdown had effectively contained the virus transmission. Similarly, countries with high importance of touristic industries like Spain, Italy, Austria or Switzerland started relaxing lockdown restrictions to support tourism.

**Second wave:** However, the quickly rebounding infection rates in October–December 2020 induced a second Covid-19 wave in many countries in late fall and winter 2020/2021 with even more serious health impacts compared with the first wave in spring and forced a re-establishment of lockdown measures. Countries like the US or Brazil showed high peaks and also the world infection rates went up showed much higher values compared with the first wave. The development in early 2021 is characterized by lock-down measures in many countries and the beginning of vaccination campaigns, in particular in the US and the UK.

**Third wave:** The start of vaccination campaigns in early 2021 was widely interpreted as “light at the end of the corona-tunnel”. In several countries the lock-down measures were relaxed, in others they were no longer fully respected by the population. At the same time variants of the virus spread out, like the British, South-African and Brazilian virus variants, which show a much higher infection rate and a higher health risk. Both factors, the spread of more aggressive virus variants and the reduced compliance with precautionary measures pushed a third wave with rapidly increasing infection rates in some countries like India (highest peak in the 3rd wave), France or Germany, while countries like the US and the UK applied successful vaccination strategies including some kind of vaccine protectionism for maximizing vaccination of their population.

2.1.2. Economic impacts

The OECD economic outlook (March 2021) demonstrates a drastic economic downturn caused by the lockdown policies in 2020. China is the only country that shows a positive economic development in 2020 (see Fig. 2). A positive economic development is projected for the years 2021 and 2022. The growth in 2021 predicted for some countries is even higher than the economic losses in 2020 (e.g.: India, China, US).

2.1.3. Economic stimulus activities

Most countries have been expanding both fiscal and monetary stimulus in order to deal with social and economic disruptions of unprecedented scale caused by the Covid-19 pandemic. The IMF (International Monetary Fund) instituted liquidity support to many countries to help them deal with the economic impact caused by the lockdowns and travel restriction measures. Since April 2020, IMF’s special Covid-19 committee has extended the line of credit to the 29th poorest developing nations for them to deal with the current economic crisis (IMF, 2020b). The US government alone spent US$3 trillion as fiscal stimulus while the Federal Reserve Board injected another US$3 trillion of monetary stimulus to purchase bonds and other securities in order to reduce business and municipal government bankruptcies which ended up helping the stock markets at least indirectly (Damb, 2020). Fig. 3 gives an overview of the magnitude of Covid-19 induced fiscal measures. The fiscal instruments are additional public spending and forgone revenues, equity, loans and guarantees. The shares of these instruments vary by countries. Advanced economies have spent about 13% of GDP from their public budgets, emerging economies about 4% and developing countries about 2% on average. This direct fiscal support is increased by equity, loans and guarantees for which the difference between advanced and low-income economies is even more pronounced. The IMF (2020b) estimates that the total global fiscal Covid-19 assistance sum up to US$7 trillion until fall 2020.

The fiscal support activities are continued in 2021. The US will spend additionally 1.9 bill. US$ and the European Commission decided on a €750 billion “Pandemic Emergency Purchase Programme (PEPP)”, which includes purchases of public and private corporate sector assets. Further compensation measures and fiscal stimulus packages are decided by each EU member country. Expert groups are giving recommendations on how to use stimulus packages not only on how to compensate income losses or prevent layoffs (e.g., through short-time work) but also on how to invest in future technologies (digital economy) and green future (climate footprint).

2.1.4. Risk of early abolition of lockdown measures

The Covid-19 first wave infection rate demonstrates a notable correlation between the timeliness of the lockdown measures and their success. Countries that implemented early Covid-19 restrictions showed lower infection rate and were able to relax the measures earlier. The second wave appeared more challenging for the governments because of re-establishing lock-down measures and at the same time increasing compensation and stimulus actions. The third wave is providing the biggest problems because of:

- Country differences: Some countries show much lower infection rates and have started with relaxation of lock-down measures.
- Corona fatigue: People are becoming more and more frustrated and reject behavioral restrictions.
- Different treatment of social groups and regions: Setting different priorities for the vaccination of social groups, different lock-down measures for neighboring regions and different country measures

1. E.g.: Using available vaccine for administering the first vaccination and waiting longer for the second.
for preventing the import of virus variants have created a patchwork of anti-Covid-19 measures which is hard to understand by the population and impossible to control.

The above problems are leading to an increasing pressure of people and of the industry to relax lockdown measures. However, early relaxation of Covid-19 restrictions may have been the main reason for the pandemic revival after the first wave observed in the US, Australia and New Zealand. In Japan, the Go To Travel (started July 22nd, 2020) and the Go To Eat campaigns (started October 1st, 2020) may have contributed to the virus spread and generated two new peaks in November and December 2020 (Fig. 4). The second and third waves are more serious than the first one in many countries because the willingness of people to accept social restrictions and to follow regulations is reducing.

Vaccination campaigns have been started in early 2021. However, it will take until fall/winter 2021 to achieve full herd immunity in industrialized countries, while the intermediate period is characterized by:

- Vaccines will not be sufficiently available until summer/fall 2021 in advanced economies.
- Not all population groups can be vaccinated in the next months (e.g.: children, young people).
- There are population groups rejecting vaccination.
- Some emerging economies and most developing countries are lagging behind and new variants of the virus are emerging, e.g., in India.

The COVAX initiative of the WHO for fair international distribution of vaccines has started in March 2021 with comparably low volumes of...
Some advanced countries are until now not supporting this initiative and don’t export home-produced vaccines at all. It follows from the above that the global pandemic problem will probably not be mastered in the near future although the advanced economies are on the way to herd immunity until fall 2021. Precautionary measures and regulation of social contacts may still be necessary in the medium term. This will have significant impacts on international social contacts for business, education or tourism and will influence the future development of transport demand.

2.2. Role of the transport sector

2.2.1. Transport as a carrier of virus spread

The transport sector plays a dual role during the pandemic. First, transport, especially air transport, made it easier to spread the virus at the global level. The transport sector further contributed to the virus transmission by facilitating people’s gatherings. However, only a few reported cases were infected during the travel (within the transport vehicle) including air or rail (e.g., Shen et al., 2020). Therefore, the transport sector cannot be regarded as a main cause of the pandemic spread but rather a facilitating intermediary between locations with high infection rates. Recent studies in Italy (Carteni et al., 2021) and Japan (Zhang et al., 2020) show that the Covid-19 spread is strongly associated with the transport accessibility. In Italy, transport accessibility has about 40% regression weight compared to other factors which contribute to the virus spread. When the statistics analysis is conducted to model virus spread in Japan since March 2020, the R-squared values of a nonlinear regression increases to be larger than 0.8 after accounting for transport accessibility variable. Even though social contacts can be significantly diminished by

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\(^5\) COVAX stands for Covid-19 Vaccines Global Access. It has been established in April 2020 by the WHO and the European Commission to guarantee a fair distribution of vaccines world-wide. The WHO is furthermore cooperating with other international organizations which are following similar aims.
mobility reduction, many essential human activities require physical movement and as a result a more targeted approach needs to be implemented. Zhang (2020b) developed a differentiated PASS approach by focusing on different roles of various stakeholders as follows:

1. Prepare – protect – provide: Preparing emergency plans, transport capacity of health services, inventory holding for increasing resilience, public participation, and capacity building; Protecting transport service staff and users as well as vulnerable population groups; Providing guidance and information, financial support, and anti-virus services, etc.

2. Avoid – adjust: Avoiding inconsistent and less scientific policy decisions, crowded platforms and vehicles, and unnecessary and non-urgent trips; Adjusting policymaking processes, service operations and demand management, activity-travel schedules, logistic supply chains and so on for minimizing transport.

3. Shift – share: Modal shifts (especially for encouraging sustainable transport), shared mobility, shared operational resources (e.g., using public transport and taxi vehicles to transport both passengers and goods), and information sharing, etc.

4. Substitute – stop: Substitution of transport activity by virtual communication, substitution of face-to-face procedures by online procedures to minimize transport, stop of services with close face-to-face contacts, lockdown, and stay at home, etc.

2.2.2. Transport as a most heavily impacted sector

Although transport sector facilitates the virus spread, the sector itself has been impacted the most by the slowdown of economic activities and the restrictions on social contacts. Thus, this section gives an overview of how Covid-19 pandemic affected some segments of freight and passenger transport.

2.2.2.1. Freight transport. Statistics for maritime freight transport demonstrate a global decline for most commodity categories for the first two quarters of 2020 (UNCTAD, 2020; ITF, 2020). While the biggest reduction is reported for the Roll-on/Roll-off (RoRo) transport with –22.8%, container transport was hit less severely with minus 5.8% (Fig. 5, left). A larger loss can be seen in June, but it decreases substantially in the 3rd quarter. This is supported by the national figures which shows a high country variance (Fig. 5, right).

The land-borne long-distance freight transport appears to be more closely related to GDP. For example, Germany experienced a decline of ton-kms of 5.4% (road), 10.8% (rail), 11.2% (inland waterways) and 3% (combined transport) for the months January–August 2020.

Contrasting the market for bulk and unitized goods transport the e-Commerce market has increased substantially which has driven the transport for the courier, express, parcel (CEP) services in the business-to-consumer (B2C) segment. While this market showed growth rates much higher than the average logistics market (about 17% between 2014 and 2019) it is expected to grow even faster in the phase of the pandemic crisis (about 23% between 2019 and 2022, see Statista, 2020 and Accenture Consulting, 2018). Companies like UPS, DHL or FedEx are the winners of the pandemic and Amazon has decided to establish an own company for parcel service.

2.2.2.2. Changed preferences in passenger transport. A number of studies were conducted to understand current changes in people’s attitude towards passenger transport during the pandemic. In Germany, the research finds that during pandemic people feel safer using a bike or their own car compared to the pre-Covid-19 times (DLR, 2020; see Fig. 6). In Canada, a questionnaire survey conducted in Vancouver, Calgary, Toronto, Ottawa, Montréal, and Halifax in May 2020 found that most of commuters intended to increase use of car and bike, but reduce other travel modes (especially, subway, bus and taxi), after the end of stay-at-home orders, and such changes were mainly driven by perceived risks of health safety, peace of mind and travel experience (Labonté-LeMoyne et al., 2020). In addition, a survey in Scotland shows an increase in people’s confidence in public transit from 24% to 35.5% between the months of May and July; however, the remaining 64.5% of the respondents still felt less confident to use public transit (Scottish Government, 2020). Furthermore, a study in the UK finds that car drivers’ confidence in public transport dropped dramatically such as the percentage of drivers who would reduce the car usage decreased from 57% in 2019 to 43% in2020.⁷

Changes in confidence may be caused by not only internal factors (e.g., knowledge learning) but also external factors (e.g., enforcement of protective measures during use of public transport). Another sampling survey in China revealed that more than 80% of respondents consider public transport and taxi or taxi-hailing to be associated with high infectious risk (Tan and Ma, 2021). Moreover, a nationwide survey conducted in Japan in October 2020 demonstrates that more than 60% of the respondents (2643 respondents) think that the infection risk is higher when riding congested public transport vehicles (Ding and Zhang, 2021). Similarly, a survey in a city of Poland revealed that among people who reduced use of public transport, 40% of them pointed out fear of being infected (Przybylowski et al., 2021). Barbieri et al. (2021) reported that their survey respondents, in six continents: Australia, Brazil, China, Ghana, India, Iran, Italy, Norway, South Africa and the United States, believed that airplane and bus are the two most dangerous travel modes, followed by subway/tram and trains. In a worldwide expert survey conducted in May 2020, Zhang et al. (2021) also show a large shift from public transport to walking (42.3%) and bicycle (35.6%) as well as car (64.8%). It is important to point out that such negative perception about public transit safety among general public is also supported by scientific evidence. For instance, Shen et al. (2020) examined existing evidence and reported several cases suggesting strong association between Covid-19 transmission and air/train travels.

Overall, there are two main reasons for the low confidence in public transit during the pandemic. First, people perceive public transit as a riskier space due to the lack of social distancing measures. Secondly, people do not want to comply with precautionary Covid-19 measures such as mandatory mask wearing.

2.2.2.3. Air transport. This section describes the effect of Covid-19 pandemic on air transport, which is the most heavily damaged sector by the pandemic. ICAO (2020) presented a regionally differentiated monthly time series on the Covid-19 impact on world-wide air transport (Fig. 7). The figures show a decline of about 50% of offered seats, and 2.9 billion passengers and an approximate financial loss of 390 billion USD for the year 2020. ICAO also predicts a reduction of 34–43% of offered seats, 485–601 million passengers and a financial loss of 72–88 billion USD from January to March 2021. The graph shows that domestic and short/medium distance air traffic is less affected by the pandemic and currently on the path to recovery, while intercontinental flights are most severely hit, and it will take much longer for them to normalize their operations. For instance, Lufthansa has lost 95% of transatlantic flight volumes and will have to immobilize at least 25% of its fleet in the medium term, in particular the wide-bodied aircraft, Airbus 380, Boeing 747 or Airbus 340. As of October 2020, the reported financial losses are about 5.6 billion EUR for this airline. Other giant international airlines are also on the edge of collapse, with many already filed bankruptcy (Czerny et al., 2020).

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⁶ This option has in the past been discussed in the context of external costs of transport and is revived in the paper of Oum and Wang (2020).

⁷ https://www.rac.co.uk/drive/features/car-dependency-and-the-pandemic/(Accessed on November 14, 2020).
2.2.2.4. Earth bound passenger long-distance rail transport. While the long-distance rail transport does not play an important role in the North America, it is a critical mode of transportation in Asia (e.g. China, Japan) and Europe. The biggest rail companies of Europe, Deutsche Bahn (Germany) and SNCF (France) reported drastic passenger and financial losses for the long-distance transport in the first half of the year 2020. Deutsche Bahn reported passenger and financial losses of 3.7 billion EUR in the first half and estimated 5.7 billion EUR in total for the year 2020. SNCF announces 21% in passenger’ losses and a 4 billion EUR in monetary losses. Moreover, in France the train occupancy temporarily went down to 10% of the seat capacity because of the rigid lockdown measures following the second Covid-19 wave. In Japan, serious decline in railway ridership (30% or above) was reported including large private railway: 100% decline in April to 37% decline in November; public railway: 100% decline in April to 50% decline in November; large private railway: 94% decline in April to 37% decline in November. As a result, major intercity railway companies experienced a more than 30% decline in either ridership or revenue (Ding and Zhang, 2021). Also, the UIC (2020) forecasted approximately US$ 47 billion losses in global

Fig. 5. Number of weekly container ship calls 2020 (blue) versus 2019 (red) for the first 3 quarters of 2020 (left); Changes in container ship deployment, first 3 quarters of 2020 versus 2019 (right)
Source: UNCTAD (2020). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Fig. 6. Changed preferences of people for passenger transportation modes
Source: Dam (2020).

Fig. 7. Development of air transport in 2019 and 2020
Source: ICAO, 2020.

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8 total losses, not differentiated by loss sources.
9 https://www.mlit.go.jp/common/001369199.pdf.
railway passenger revenues under a fast recovery scenario, while the global losses under a slow recovery scenario will increase to about US $60 billion in 2020. As for freight transport, UIC (2020) further estimated global losses of about US$26 billion under a slow recovery scenario and about US$19 billion under a fast recovery scenario.

2.2.2.5. Urban public transport. Four examples are selected to show the dramatic impacts of Covid-19 on urban public transport:

1. In New York, an epicenter of pandemic in the US, public transit ridership plummeted by 92% (72% for subways) in March 2020. The overall losses of the Metropolitan Transportation Authority (MTA) were estimated to be US$7–8.5 billion in early summer but were corrected upwards in September to US$12 billion. If the state is not able to compensate for these losses, the authority announced a reduction in passenger services within the city by 40% and by 50% for commuter rail lines. The reduction in MTA services may lead to a slowdown in economic recovery because commuters heavily rely on public transit to travel to work. Since New York generates approximately 8% of total GDP in the US, the issue needs to be investigated on a federal level.

2. The Delhi Metro services was partly been suspended by the end of March with the total financial losses estimated at RS1,609 crore (1 crore equals 10 million). While the Delhi Metro has resumed its services by mid-September, stations in containment zones remained closed. Officials gave warnings that trains may not stop at stations if social distancing norms are not complied by the passengers.

3. In Switzerland the MOBIS-Covid-19 panel study (IVT, 2020) has started at the beginning of 2020, as a follow-up study to a panel research of 2019. The results underline that public transport has been hit most severely, as rail and tram traffic has declined by more than 80% in the 2nd quarter and is more than 40% behind in early 2021 compared with last year numbers (see Fig. 8). Biking, on the other hand was booming, a very steep rise was observed in the 2nd quarter followed by a moderate growth and a slight decline in winter 2020/21 due to weather conditions. The development in early 2021 supports the assumption that public transport will not recover soon while there will be little medium and long-term impact on the development of car travel (see Fig. 9).

4. Japan experienced three peaks of Covid-19 pandemic in April, August and November/December 2020 and it has mostly relied on soft restrictions such as announcing a state of emergency and requesting physical distancing measures without any punishments for non-compliance. Tokyo (34,144 infection cases and 470 deaths) observed the largest decline in ridership during the April–May period when a state of emergency was announced for the whole country. The subway traffic was about 30% of the 2019 level (Fig. 8) and the decline occurred within just a few months period. Moreover, once Japan lifted the state of emergency, the traffic recovered to about 60%–70% in October compared to October 2019 levels. However, new peaks of Covid-19 cases in January and March/April 2021 could lead to further reductions of public transit (see Molly et al., 2021).

2.2.3. Environmental impacts

Despite its serious negative economic and social impacts, the Covid-19 pandemic has generated a positive environmental effect around the world, at least in the short term. The emissions of CO₂ were reduced worldwide by 6.3% in 2020 compared with 2019. The transport sector is responsible for about 25% of emissions and has reduced CO₂ emissions in particular in the first quarter of 2020 when the strict lockdown measures led to a reduction of traffic activity in all modes. Le Quére et al. (2020) found that average daily global CO₂ emissions has dropped by 17% due to Covid-19. Liu et al. (2020) estimated a 43.9% reduction of CO₂ emissions from ground transportation, aviation and shipping in the first half year of 2020 and a 17.8%, and 46.7% reduction in the first 7 months of 2020, respectively. Su and Wang (2020) showed that the Covid-19 helps improve air quality in China as well as lowered the nitrogen dioxide level significantly in China. Similarly, the city of Kolkata in India experienced a significant reduction in CO₂ levels (Mitra et al., 2020). Most of the US cities experienced significant decreases in traffic congestion and idling time of private/commercial vehicles, which led to a reduction in CO₂ level in the cities (Geotab Data and Analytics Team, 2020). In Canada, as of August 9, 2020 it shows a 30% reduction in the use of public transit (e.g. bus, subway and train stations) due to the Covid-19 pandemic (Google, 2020). Basically, the Covid-19 pandemic has reduced mobility of people both by private car driving and public transport riderships. All of these are short term effects. What policy makers need to question now is whether and by what means the reduced dependence on private vehicle may be sustained after the lockdown ends.

However, the European figures show a return of car traffic activity to the levels before the pandemic, such that the positive environmental impacts have reduced. Liu et al. (2020) also found that the pandemic’s effects on CO₂ reduction diminished due to relaxing lockdown restrictions and re-opening of economic activities, especially in China and several European countries. It is possible that the second and third waves and the introduction of additional restrictive lock-down measures will change this development again and turn to further CO₂ reductions in the transport sector. But it is doubtful that the pandemic itself will induce a stable downward trend of CO₂ emissions. In addition, as people turn negative to use public transit and prefer using private car post pandemic period, the traffic congestion could be even more serious after the end of lockdown and when the economy activities are fully recovering.

2.3. Roles and forms of the government assistance to the transport sector

2.3.1. General fiscal measures in response to Covid-19

Many countries have introduced huge fiscal stimulus packages for preventing industries from bankruptcy and avoiding massive problems with unemployment. The fiscal measures included payments for short-term work, compensations for losses in lock-down periods, direct

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10 [https://fortune.com/2020/09/03/new-york-city-transit-mta-subway-bailout-us-economy-impact-covid-coronavirus-nyc/](https://fortune.com/2020/09/03/new-york-city-transit-mta-subway-bailout-us-economy-impact-covid-coronavirus-nyc/)

11 [https://www.bloombergquint.com/politics/delhi-metro-services-to-resume-in-3-stages-stations-in-containment-zones-to-remain-closed](https://www.bloombergquint.com/politics/delhi-metro-services-to-resume-in-3-stages-stations-in-containment-zones-to-remain-closed)

12 As of November 12, 2020: 115,523 cumulative infection rate and 1884 deaths.
subsidies, or tax release (e.g., reduction of VAT in Germany). The transport sector was involved in fiscal support measures either indirectly (e.g., tax reductions or deferrals) or directly (e.g., financial aids). The Covid-19 crisis demonstrates vividly that governments are the powers of last resort to make sure that the private sector markets function when facing the scale of natural/economic disasters that no insurance firms can deal with. Since the magnitude of financial problems facing most of the transportation agencies and firms during this Covid-19 pandemic is beyond their ability to deal with, the transport system and services may not survive as usual if there is no special government financial assistance. For example, the US central government has set aside a significant amount of funds from the CARES Act funds of US$2.2 trillion to help cities and municipal governments deal with this pandemic including their public transit system (US Department of The Treasury, 2020). In addition, the US Central Bank (Federal Reserve Board) has been purchasing municipal bonds as well as corporate bonds in order to increase liquidity and thereby, prevents bankruptcies of municipal governments and financially weak corporations. In the following sections we provide some details on the governments' assistance to transport sectors that were severely hit by the pandemic.

2.3.2. Aviation

Most airlines face catastrophic financial difficulties which may lead them into bankruptcy without some form of government assistance. Indeed, many governments around the world are formulating aid packages for airlines to provide financial assistance. For example, the US government earmarked US$25 billion for passenger airlines out of the US$2.2 trillion CARES Act fund. The US Treasury Department allocated this fund to 11 airlines as follows (see Fig. 10; Forbes, 2020).

For each airline, 70% of the above funds were employment subsidy for not laying off airline employees until September 30, 2020. The remaining 30% is a low interest unsecured loan (3% yearly interest rate) for which airlines issue warrants with which the US Treasury Department can convert into non-voting shares at the current depressed share prices so that the taxpayers may be able to profit from the increased share prices when airlines recover normal operations (Poole, 2020).

As shown in Table 1, European countries also provided aid packages for European airlines, with the biggest support given to Lufthansa as a 9 billion Euro state aid package by the German government.

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Fig. 9. Changes in weekday ridership of subway in Tokyo
Source: https://www.jttri.or.jp/201026_symposium-09.pdf (Accessed on November 14, 2020).

As the world second largest aviation market, Chinese government also quickly responded with financial relief measures, such as waiving airport charge and other fees. Such a scale of financial aid is, however, far from enough to sustain Chinese airlines’ liquidity, despite its fast recovery in domestic market due to a successfully controlled pandemic. Since the major Chinese airlines have majority shares held by the government (i.e., state-owned), they are not worried about the bankruptcy. Chinese government is planning to inject RMB100 billion (about US$1.8 billion) to major Chinese airlines if necessary (Czerny et al., 2020).

Given the fiscal responsibilities to taxpayers, many governments are reluctant to give outright subsidies to airlines. In the absence of government financial aid, many airlines have gone bankrupt (for example, Czerny et al. (2020) list 21 such airlines), and many more airlines are close to bankruptcy if the Covid-19 pandemic continues. Then, an important question to ask is what are the reasonable means by which a government should provide financial help to transport firms including airlines.

The decision makers in governments have enormous power to exercise, even to the extent that they may be able to decide which firms to
survive, and which firms to go bankrupt or be liquidated (see WCTR/S, 2020). It is important to note that after the initial crisis is over, the politicians/bureaucrats are likely to develop temptation to exercise their power over the private sector firms in which the government owns significant portions of their shares and/or bonds. Exercise of such government power may lead to inefficiency and/or corruptive practices. To avoid such problems, it is better for the government to purchase bonds or warrants convertible to ‘non-voting shares instead of voting shares. Non-voting shares make it difficult for the government to take over the firm and/or change the Board of Directors including CEO. Even under such an arrangement, the government may be able to recover some positive financial returns for the taxpayers’ money by selling the shares at higher price later, when the firm restores profitability. The airline bailout package employed in the wake of the 9/11 terrorist attacks helped the US government make US$130 million profit for the taxpayers after airlines recovered their profitability (Poole, 2020). This practice of financial assistance packages using non-voting shares appears to be a good practice to follow if we believe that inefficiency and possible corruption may be created via the government influence on private sector firms.

2.3.3. Other transport sectors

Other transport sectors which were seriously hit by the pandemic are passenger rail and regional/urban public transit. Most companies operating in these sectors are either public or receive guaranteed revenues through public service contracts. On August 7, 2020, the European Commission approved a 6 billion Euro German scheme to cover for losses (70–90% decline of ridership) of regional and local public transport services incurred between 1 March and August 31, 2020. In addition, on September 3, 2020, the French government prepared a special fund of 11 billion Euro to promote more environmentally friendly transportation, including 5.0 billion Euro for railways (about 2.0 billion Euro to the state rail company SNCF), 2.0 billion Euro for clean cars, and 1.0 billion Euro for measures encouraging cycling. Compared with such huge financial support in Europe, the central government in Japan has provided very limited direct support to its transport sector. For example, in June 2020, only 13.8 billion Yen (about US$0.13 billion) was allocated to the regional railways and buses, and flights to outlying islands, etc. As indirect supporting measures, the government of Japan gave about 1100 billion Yen (about US$10.5 billion) for a Go To Travel campaign (domestic travel), where half of the travel costs (including transport costs) will be covered.

While data on additional Covid-19 fiscal aids is published for some companies (see section 2.2.2 (d) and (e)), there are no comprehensive statistics on country aids for the transport sector available. In most countries, such fiscal aids are included in the comprehensive pandemic fiscal programs as exhibited in Fig. 3.

3. Outlook of the economic and transport development after Covid-19

3.1. Economic scenarios

Since the beginning of the Covid-19 pandemic, pharmaceutical companies started developing vaccines to control the infection rate around the world. About 40 pharmaceutical companies had started in 2020 with testing different vaccines and about 6 of them have been approved for application in most countries. The world-wide distribution of vaccines is highly unbalanced. The US and the UK are not exporting vaccines and use home produced and imported vaccine only for their population. Other countries like Israel have bought all vaccines which they could get from the producers regardless of the price. The EU has exported 47% of vaccines produced on their territory (mostly to COVAX, see below). This is one reason for the EU lagging behind the US, the UK or Israel besides the slower approval processes and the less professional management of distribution. The COVAX initiative of the WHO had planned to distribute about 2 billion doses in 2021, but the start in the first quarter of 2021 has been very slow: The 50 poorest countries have received only 0.1% of the doses until February20, 21. Vaccination cannot be given to billions of people within a few months because of limited capacities for production, logistics and application of the vaccines. In the first phase, the most vulnerable groups may be vaccinated followed by health care and social care workers, physicians, then the next group could be public service workers including police and firefighters. The rest of population may follow up, but at a voluntary basis in most countries. Children and young people are presently on not vaccinated and it has to be considered that there are population groups rejecting vaccination. A herd immunity thus takes time to form. Many virologists and epidemiologists expect that returning to the “normal” way of life will not be possible globally before the end of 2021 or even later.

If this prediction is correct, then 2021 will still be a year of restrictions and the Corona risks will not disappear once and for all. Temporary successes of anti-Covid-19 measures may not foster prudent behavior rather than stimulate parts of the population to return too early to their individually preferred lifestyles. The suppressed “joie de vivre” may accumulate and lead to over-optimism after first successes of

14 https://www.iisd.org/sustainable-recovery/news/french-stimulus-packa-ge-about-e30-billion-for-green-recovery-measures/.
15 https://www.mlit.go.jp/common/001348825.pdf (in Japanese; Accessed on November 14, 2020).
16 https://www.mlit.go.jp/hakusyo/mlit/r01/hakusho/r02/pdf/np000000. pdf (in Japanese; Accessed on November 14, 2020).
17 The IFRC (International Federation of Red Cross and Red Crescent Societies) warns of “deadly gap in global efforts to distribute vaccines”. https://media.ifrc .org/ifrc/press-release/covid-19-ifrc-warns-of-deadly-gap-in-global-efforts-to-d istribute-vaccines/.
vaccination are perceived. This is the basic assumption of a first scenario which we call “roaring 2020s” taking the historical parallel of the comparable period of 100 years ago, the decade after overcoming the Spanish flu pandemic. A contrasting second scenario is based on the assumption that people and firms have understood the experiences made during the pandemic as a signal for adjusting their behavior and production/distribution structures towards a more sustainable growth path. This contrasting scenario will be called “thoughtful 2020s”. This normative scenario will require substantial changes in the transport sector, which we will discuss in the following sections.

3.1.1. Scenario 1: “Roaring 2020s”

In March 1918, an infection with a deadly virus was found in the US. US soldiers spread the virus to Europe at the end of the World War I, where the pandemic, called the Spanish flu, broke out and spread fast.18 The first wave of the flu, the spring of 1918, was moderate with a death rate not higher than a normal flu epidemic. The second, third and fourth waves, starting in late 1918 and ending in 1920, were much more deadly than the first. The pandemic finally infected about 500 million people which was about one third of the world’s population at that time. There are different estimations on the mortality rate which vary between 17 and 50 million deaths caused by the flu (Spreeuwenberg et al., 2018). Europe was negatively affected by both the World War I and the Spanish flu pandemic. As a defeated country, Germany, suffered from war damages, reparation payments and a hyperinflation of 1923. Nevertheless, the reconstruction of the European economies and the optimism of people initiated a period of rapid economic upturn. The US did not experience a major economic disruption through World War I such that the economic boom started earlier (see Fig. 11). During the 1920s, the demand for innovative consumer products like automobiles, radio, movies or television skyrocketed and boosted the stock exchange market. The “golden” or “roaring” twenties ended with the stock market crash on Thursday, October 24, 1929, and the following day is known as the “Black Friday” which was the start of the great depression in the early 1930s.

Deficit spending and low interest rates of the central banks have helped countries overcome the 2008 financial crisis. The fiscal support for fighting the economic impacts of the Covid-19 crisis and the associated increase of public debt is even higher and will last longer. This reduces the risk of economic slowdown (comparable to the post 1930 phase) but increases the vulnerability of economies. Some economists have expressed warnings with respect to destabilizing (in particular: inflationary) impacts if the public deficit spending is not followed by a consolidation policy.20 Looking at the development of share prices at the stock exchange market and the development of real estate markets gives further warning signals, which look similar to the “roaring twenties”. In the US the highest economic growth rate in 40 years is expected and the inflation rate is rapidly increasing (2.6% in March 2021).21 Although history rarely repeats, and major mistakes of economic and fiscal policy made before and after 1930 are avoided there are indications for over-optimistic expectations of agents which may lead to increasing fluctuations instead of a phase of stable growth.

18 The pandemic was called „Spanish flu“ because Spain at that time was a neutral country (not involved in the first World War) with a free press which could report freely on the pandemic’s effects.
19 https://www2.deloitte.com/us/en/insights/economy/spotlight/economics-insights-analysis-05-2019.html.
20 see e.g.: Deloitte (2019): What are the long-term dangers of the US budget deficit? “The continuing accumulation of government debt remains a problem—even if nobody wants to discuss it. And the longer we wait to attack the problem, the more difficult it will be to solve.” https://www2.deloitte.com/us/en/insights/economy/spotlight/economics-insights-analysis-05-2019.html.
21 https://www2.deloitte.com/us/en/insights/economy/spotlight/economics-insights-analysis-05-2019.html.

3.1.2. Scenario 2: Thoughtful 2020s

Social and economic experience teaches the lesson that major changes of human behavior, political attitudes and economic structures usually start in a phase of crisis.22 If this experience repeats, then the pandemic may change the attitudes of agents and lead to an increase willingness to support policies towards long-term sustainability including protecting the environment and natural resources. International agreements like the Paris Agreement on climate change and social movements of the young generation demonstrate a growing awareness of societies to change current behaviors and economic processes. In this context the experiences with the pandemic can lead to a turning point for behavioral attitudes and industrial patterns. This includes the following aspects:

- Harmonizing with nature
- Acceptance of the Paris Agreement and definition of national road maps for achieving a carbon free economy by 2050 (e.g., the EU Green Deal);
- Restructuring globalization: removing carbon leakages, abolition of production steps in countries with low environmental and social standards;
- Logistics: minimizing transport instead of minimizing inventory holdings;
- Re-organizing tourism activities: reducing short-term stays at different places requiring excess air transport.

- Harmonizing with life
- Re-organizing work: more telecommuting;
- Increasing virtual communication;
- Increased social empathy and long-term thinking;
- Increased relevance of non-monetary components of quality of life for evaluating transport systems development.

This scenario would require major investments for fostering innovations towards sustainable future. This can start with the allocation of funds of the stimulus packages for a green technology. This is for instance foreseen in the US and EU stimulus packages which include dedicated financial support for technological innovations towards zero carbon footprint and fostering the digital economy. This scenario may lead to slower short and medium-term GDP growth, but in the long run new markets could emerge as well as new playing fields for international competition. Furthermore, the compatibility with long-term sustainability challenges would increase stability and resilience of the economy and social life. The European Commission has published a “Green Deal”, including a development path towards a carbon-free economy until the year 2050 and an associated “Strategy for sustainable and smart mobility”23 which takes up the above ideas and underlines that a development towards the ambitious “Thoughtful 2020 ier” is not totally unrealistic.

3.1.3. Quantitative economic outlooks

The economics forecasts of the OECD (see Fig. 2) and the IMF were characterized by high uncertainty in late 2020 and early 2021. The economic outlook of the IMF as of April 2021 is comparatively optimistic and expects a growth of the world economy in 2021 as of 6%. The advanced economies are expected to grow at 5.1%, led by the US with 6.4% which are pushed by the high public stimulus packages. Underemployment in the US is expected to go down from 5.1% to 5.8% (2021) and 4.1% (2022) which is approaching full employment. For the developing countries the IMF forecasts a growth of 6.7% for 2021, led by India with 12.5%. Besides the positive prospects for the economic

22 The most prominent economist propagating this experience was J. A. Schumpeter who established the theory of “creative destructions”.
23 European Commission, 2019: COM (2019) 640 final; 2020: SWD (2020)331 final.
development world-wide the IMF expects an increase of inequality, i.e., counterproductive impacts on social equity.

The US Federal Reserve Bank, European Central Bank and the IMF have announced that they will continue their monetary policy with low interest rates for the next years. This provides an optimistic picture for the economic recovery process in the short run while the warnings with respect to medium and long-term repercussions find increasing attention.

3.2. Transport scenario

3.2.1. Intermediate phase

It is probable that the phase between the start of vaccination and the achievement of world-wide herd immunity can take longer although vaccines will be available for everybody in some countries. It is also probable that the virus will not disappear completely and will need attention in the longer future, in particular if variants are emerging. From the present observations one can draw the conclusion that the impact on transportation will be different for different travel purposes and travel modes even if the economic development is returning to the previous growth path:

- Leisure and touristic travel are expected to return to business-as-usual figures.
- Shopping and education traffic will be influenced by learning effects during the crisis: Online shopping will remain on a significantly higher level and distance learning courses will play a bigger role compared with the situation before the crisis.
- Business and research travel activities will go down, the electronic devices for video meetings and conferences are widely used and estimated such that physical presence is only required if personal contacts are expected to achieve higher value added or needed in case of strict confidentiality.
- In freight transport the courier, express and parcel segment may effect that companies pay more emphasis to aspects of resilience and reliability when constructing their global supply chains.
- The globalization of production, trade and logistics may return to the patterns before the crisis. The experiences made during the crisis may effect that companies pay more emphasis to aspects of resilience and reliability when constructing their global supply chains.

3.2.2. Re-establishing confidence in air and public transport

As was shown by examples in section 2.2.2, people probably have changed their preferences away from the air and public transport because of the higher infection risk and the Covid-19 mandatory requirements. Thus, it will not be easy to re-establish people’s confidence in these transport modes.

After a huge drop in demand in air transport at the early stages of the Covid-19 pandemic, air transport is experiencing traffic recovery in particular for domestic aviation. IATA end-of-year report (2020) shows a slow recovery in the air transport demand and forecasts a continuous increase in air transport in the second half of the 2021 after the vaccines become more available to the public. Despite some positive signals – in particular in countries like China which are on the way to a rapid upturn of the economy – the aviation sector in most countries will face threats in the next years.\(^{24}\)

Different countries have different approaches on how to treat their passengers upon arrival at airports. In the US, each state decides on how to deal with arriving passengers from other states and/or other countries. Furthermore, international traveling became far more constrained and restricted due to the bilateral control on which routes to open and the differential quarantine requirements for passengers arriving from different countries. In the EU, the “Schengen Agreement” guarantees free movement of people within the union. However, the member states have individually introduced quarantine regulations for travelers returning from other countries.

Until herd immunity is achieved through vaccination, the air carriers need to focus on measures that decrease the risk of infection. For instance, anti-genetic testing gives the Covid-19 results after just 15 min with an accuracy of about 90%.\(^{25}\) One can expect that the demand of people for touristic activities which has been suppressed during the crisis will be boosted as soon as restrictions are relaxed. This will lead to an upturn of touristic flight activities which may return soon to the pre-Covid-19 figures. But this relates only to one demand segment of air travel demand while the expectations for other segments are less optimistic.

During the pandemic, many companies have learned that they can reduce expensive (monetary and time costs) business travels, while the whole society has learned to keep social distance and limit social gatherings. People have gotten used to conduct online meetings and classes. These changes will impact needs for air travel in the long run. In addition to the above changes, there are far more complex factors constraining air travel. Long before the Covid-19 became an issue, the globalization trend has been put into question, including the rational needs for maximizing face-to-face business contacts and touristic long-distance travels.

Moreover, environmentalist groups would appreciate a reduction of

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\(^{24}\) https://news.bloomberglaw.com/bankruptcy-law/threat-of-another-lost-summer-stirs-airline-cash-flow-fears.

\(^{25}\) Some providers announce even higher accuracy, e.g., the test developed by Bosch and R-Biopharm. https://www.tagesschau.de/inland/corona-schnelltest-109.html
air travel demand in the long run. Therefore, these groups are against subsidizing regional airports (which in the pre-Covid-19 years had already difficulties to survive) and low-cost carriers. In some countries, these groups have gained political power and can actively influence transport policies. Thus, movement against air transport economic recovery will probably persist after the pandemic until new environmentally safe technologies with low carbon footprint are developed (e.g.: using synthetic fuels).

For intercity rail and bus transport as well as for regional and urban public transit experts have recommended to reduce the seat occupancy during the pandemic to about 25% of seat capacity. This recommendation is followed in several countries by mandatory regulations, for instance in Ireland. A strict control of behavioral regulations (wearing masks, hygiene rules) inside the vehicles will help to re-establish trust in public transport. Nevertheless, as many users have tried alternatives during the pandemic, in particular biking or shared car use, it will be difficult to regain the lost travel patronage. Therefore, pricing and regulatory measures towards car travel will be necessary even after overcoming the pandemic to improve the modal split of public transport.

It has to be noted in this context that there are different observations in regions and cities world-wide which will be presented and compared in more detail in a Special Issue of this journal. Our findings correspond to the results presented in the majority of reports, but they cannot be generalized.

3.2.3. Re-structuring of the transport sector and need for international coordination

Since transport is an enabler of manifold economic activities, it is important that transport firms and organizations get ready to initiate services in the intermediate phase of relaxation of lockdowns and economic recovery. After the Covid-19 pandemic is over, people will be less willing to travel abroad due to the extra risk and changed attitudes (home offices, co-working places, video conferences), and thus, it will take time to build up the travel patronage, in particular for air, rail and bus services.

Yuji Fukazawa (president of East Japan Railway Company) mentioned in a press conference that the total volume of the passengers could not be recovered to the pre-Covid-19 level, and the company has take time to build up the travel patronage, in particular for air, rail and bus services.

Yuji Fukazawa (president of East Japan Railway Company) mentioned in a press conference that the total volume of the passengers could not be recovered to the pre-Covid-19 level, and the company has started to give bonus points to the passenger back to their smart passenger card. Other Japanese railway companies might follow. This means that public transport operators are preparing for a post-pandemic down-sized business operation with less sales - but also with less cost of infrastructure, rolling stock and personnel. A big challenge is how to reduce peak-hour demand and equalize patronage over a day, considering that operators may have to shorten daily operation periods. For this, it is necessary to better understand passengers’ decisions on their daily activities and the resulting travel choices, which contribute to the quality of life. Such activity-travel decisions and the influences on the quality of life should be reflected in the design of post-pandemic transit operation, in association with the contribution of transit operation to CO2 emissions (Acharyaviriya et al., 2020).

As the pandemic will not vanish abruptly and precautionary measure will be needed in a longer intermediate phase, airlines and other modes of transport will have to provide “low risk” services for tourism, leisure and businesses. For example, airline or HSR (high-speed rail) could provide rapid testing services to passengers and employees in the interim phase. Also, airlines could supply their employees and passengers with face masks and sanitizers for passenger safety. Gloria Guevara (president of World Travel & Tourism Council, WTTC) asserts that standardized safety procedures are critical for a fast recovery of international travels (CAPA, 2020). Since each country has different Covid-19 safety measures at this point in time, there is a critical need for international coordination when designing travel procedures and safety measures such as arriving passengers’ quarantine requirements. At the moment, there is no effective global leadership for this much needed work. This type of international coordination and standard setting are the work which may be done effectively under the ICAO (International Civil Aviation Organization) leadership.

Despite countries’ subsidies directed towards transport sector, it is not realistic that sectors like aviation will recover soon and return to the growth paths predicted before the Covid-19 pandemic. Experts forecast that the world’s market size for business travel in 2020 is to fall by US $810.7 billion (Statista, 2020). Interestingly, in terms of equity market capitalization, Zoom video conferencing firm’s market value (US$104 billion in mid-August 2020) is much larger than the combined market capitalization of all US passenger airlines (A4A, 2020). This is one out of many telling evidence examples that our society including most business activities will increasingly rely on digital tools for overcoming spatial resistance.

4. Summary and conclusions

The first wave of the Covid-19 in spring and early summer 2020 has been followed by a second wave starting in October 2020 and a third wave in spring 2021, which has forced many countries to re-establish lock-down measures. Despite the increased availability of vaccines in 2021, it will take some time to produce large quantities, distribute them and vaccinate a sufficient share of population to achieve herd immunity, in particular in the emerging and developing economies. It has further to be considered that not all groups of the country populations are willing to be vaccinated and that new variants can occur which make new vaccination campaigns necessary.

This paper discussed the dual role of the transport sector during the Covid-19 pandemic, both as a distributer of the virus around the world and as a major victim to bear the negative impacts of the pandemic. Specially, maritime transport suffers from the shrinking GDP and global trades, air transport from Covid-19 restrictions, business and tourism from travel demand reduction and public transport from the risk aversion of passengers. As people’s preferences of transport modes have changed towards individual transport modes like a car or a bike, and face-to-face contacts are being replaced by virtual communications in urban, regional, national and international scales, one can expect that air, rail and regional/urban public transportation sectors will have problems to recover in the medium-term.

The long-term impacts will depend on the behavior of people and firms after the pandemic. If the development follows the “roaring 2020s“ scenario, then over-optimism may dominate, which will lead to booming stock and real asset markets followed by increasing risks for economic fluctuations or even turbulences. If the pandemic leads to more thoughtful behavior of people and a broad acceptance of strict sustainability policies, then the growth rates following the pandemic may develop more modestly while a higher stability and resilience can be expected. In this case transport sectors causing high carbon footprint will have to shrink unless technological changes provide zero carbon options. It will take some time for re-establishing confidence in public transport which is a pillar of the “sustainable mobility” strategy but has lost much patronage during the Covid crisis. The use of stimulus funding packages for improving the attractiveness of public transportation modes could restore confidence in more sustainable transport modes and contribute to higher resilience of the transportation systems.

Author statement

Ethical guidelines are accepted and followed.
No interest has to be declared.
The paper has not been submitted to or published by another journal.

26 https://www.japantimes.co.jp/news/2021/02/10/business/corporate-business/jr-record-net-losses/(Accessed on April 17, 2021).
Acknowledgement

Tae Hoon Oum, Anastasia Nosach and Kun Wang gratefully acknowledge the insight research grant support of the Social Science and Humanities Research Council (SSHRC) of Canada.

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