A proactive approach to fighting SARS-CoV-2 in Germany and Europe

Part 2: Plan of Action

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Introduction

The following document and all recommendations contained therein build on the framework document "A proactive approach to fight SARS-CoV-2 in Germany and Europe" of 18 January 2021, which elaborates the general principles of the NO-COVID strategy. Our strategy proposes a departure from the mitigation strategy pursued so far ("living with the virus"). We develop ideas and approaches for a proactive local elimination strategy with the goal of a sustained low incidence – ideally zero.

Our proposal comes at a time which is characterized by three developments: As a result of the lockdowns of recent months, case numbers are falling in Germany and some other European countries. At the same time, new mutations of the coronavirus are spreading, which, if not suppressed, could trigger a third pandemic wave in Germany and other countries. There are considerable delays in vaccination programs, which means that several months may pass before they will have an effect. The goal must be to regain control over the pandemic now.

From a scientific perspective, the NO-COVID strategy is the best path forward in this situation with regard to both the health of our society and our economy. In addition to vaccination programs, hygiene protocols and other means of infection control, the strategy is based on four interlinked elements: **Green Zones + Early Detection + TTI Acceleration + Local Outbreak Management**. Aiming to support and sustain the current trend of falling infection numbers to reach a low incidence, the strategy will allow for comprehensive and sustainable easing of restrictions in all sectors of society, while averting a resurgence of infection and, consequently, further lockdowns. The current exceptional situation, which is hardly sustainable in any respect, should be brought to an end, and the fundamental rights guaranteed in the Basic Law for the Federal Republic of Germany should be permanently and fully restored – as quickly as possible.

To this effect, this paper presents a set of **toolboxes (TBs)** covering the following topics: the concept of Green Zones (TB 1), and how to implement them in Europe (TB 2), the Test-Trace-Isolate strategy (TB 3), and the domain of the economy and labor market (TB 4)[1]. The purpose of these toolboxes is to facilitate the implementation of the NO-COVID strategy by laying out concrete potential courses of action for decision-makers at the municipal, district, state, and national level within the EU. The toolboxes aim to facilitate proactive, smart and comprehensive action to produce a faster, earlier and more targeted pandemic response. The toolboxes can be flexibly applied and refined. They offer specific solutions for these and other challenges of pandemic management while taking into account Germany's geographical position in the center of Europe. They are intended to advance a holistic strategy, the adoption and implementation of which is – of course – subject to political decisions.

The strategic, conceptual and technological solutions presented in the toolboxes are based on best practice examples that have already been successfully applied in different regions and countries worldwide. Our proposals are based on empirical observations as well as recent scientific evidence from different disciplines. In addition, our team has taken practical, legal and institutional parameters of implementation on the ground into account. The level of detail of our proposals varies: we want to provide ideas, inspiration and options while also leaving room and flexibility for local adjustments and refinements. Finally, we are aware that most

[1] Other toolboxes, for example on education, testing strategies and communication, are being prepared.

measures have to be implemented while taking into account legal and practical limitations as well as value judgments.

For this reason, the use of experimental clauses and a testbed approach in the regulatory implementation of measures seems apposite to the current situation. We are convinced that the toolboxes may help to regain control over the pandemic more quickly, because they are based on a holistic view of its economic, social and individual aspects. This perspective is made possible by the inter- and transdisciplinary composition of our group which involves scientists from different disciplines and cooperates with experts from different fields of practice and countries.

Consistent objectives. In the framework document mentioned above, we described a positive goal for citizens, the economy and political institutions: the goal of zero infections. The NO-COVID approach aims to get through the global pandemic with as little damage to health, the economy, and democracy as possible, both in the near and the long term. NO-COVID means that we as a society do not want to and cannot live with the virus, but want to end its uncontrolled spread completely and sustainably. This principle applies to every community, every federal state, to Germany, Europe and worldwide. The central instrument for achieving this goal is the creation of one or several Green Zone(s), which are meant to expand quickly and progressively across Germany and Europe. Like other countries, we want to completely control all remaining SARS-CoV2 infections through joint efforts of citizens and the state. We want to get *ahead* of the infection curve instead of being overtaken by it.

Smart termination of the lockdown	**Entering the Green Zone phase**	**Protect and expand green zones**
Until an incidence of 10 is reached	Incidence less than or equal to 10	Risk incidence = 0: no infections of unknown origin for 2 weeks
Prospect: New infections and death rates decrease, positive competition between regions. Massive testing. An end to restrictions seems possible.	**Prospect:** An initial easing of restrictions is possible without jeopardizing the goal of zero risk incidence. An end to restrictions is in sight.	**Prospect:** Extensive and permanent easing of restrictions. **Remaining measures:** Restrictions on mobility to/from Red Zones. Monitoring and early detection of outbreaks.

Table 1: Phases of pandemic management for 2021

Areas where there is no unexplained local/community transmission will be declared Green Zones. These zones can then largely return to normality within their boundaries. Local virus imports and possible resulting local outbreaks can and should be controlled by fast local measures, while elsewhere the regained freedoms can be maintained. The medium-term goal is to link different Green Zones together in order to drive a successive expansion of mobility and radius of action. We are not formulating a vision of complete eradication of the virus – the goal in a globalized world must be to enable local control of any outbreak while minimizing damage to society.

Locally coordinated action. Measures must be coherent at the strategic level and should be adapted, implemented and monitored in a decentralized manner. The effectiveness of implementation is monitored locally in the community; the results are published daily. For the protection of Green Zones, a local, sensitive early warning system is crucial, as are the strict, rapid and complete implementation of quarantine measures; targeted testing strategies; and a significant process optimization of the test-trace-isolate strategy. In Red Zones, contact and mobility restrictions – similar to the current phase of the lockdown – apply.

Clear communication. NO-COVID is based on the understanding that the reactive approach of "muddling through" must be replaced by a long-term commitment to an overall plan. The reactive mode needs to give way to proactive and predictable action. The measures to be taken should be communicated regularly, in a way that is memorable, generally comprehensible, and compelling. This is to ensure that there is widespread understanding of the measures "on the ground", i.e. in districts, cities and municipalities. Pursuing NO-COVID as a target means that clear epidemiological parameters (an incidence of no more than 10 infections per 100,000 inhabitants in 7 days and a risk incidence of zero, being defined as "no local transmissions of unknown origin") are the decisive factor. In this way, the perception of self-efficacy is strengthened; uncertainty as well as the psychological and economic pressure on both society as a whole and its individual members are being reduced. The NO-COVID approach requires the understanding, support and participation of the entire population. To this end, we propose a nationwide, yet locally adapted communication and motivation campaign. It should communicate the new objective and enable supportive activities from the bottom up.

Collective learning and flexible coordination. The pandemic is characterized by highly dynamic conditions. To be faster than the virus and to successfully contain its spread, we need to leverage the full innovative, cooperative and solidary potential of our democratic societies. The successful and efficient protection of Green Zones and rapid outbreak management are made possible by pragmatic coordination and networking among authorities, businesses and associations. Democratic societies rely on taking responsibility for oneself and others, mutual care and subsidiary action. If we are to become faster than the virus, social and technological innovations are crucial (e.g. digital forms of care and education for those in quarantine; new air purification systems and rapid testing methods). With an ethos of adaptation and continuous learning, leaders at all levels can become role models for other regions and areas. This enables the flexible coordination of individual pandemic measures across organizational and bureaucratic boundaries.

Caveat. As scientists, we are particularly aware of the possibility of error. For example, it is conceivable that our goal of achieving a low incidence of under 10 could be missed if no social consensus to support that goal is reached. For a high frequency and high-volume transit country like Germany, the mobility requirements might make it more difficult to maintain a low incidence in the long term. As a team, we have grappled with these possibilities of failure. However, several aspects give us hope that our proposal can be successfully implemented: novel technological innovations (vaccination, better testing procedures, digital tracing technologies) and the higher efficiency of the pandemic control measures that we are demanding. To achieve the latter, we have developed concrete proposals for implementation which should be feasible in a prosperous and highly developed country like Germany. The alternative – waiting for the next surge of new infections, which would in turn result in further

lockdowns – is so unappealing from an economic, public health and constitutional viewpoint that we propose the strategy outlined here.

Brief Summary of the Toolboxes

Green Zones: A Green Zone strategy is one in which flexibly definable geographic areas, established utilizing local resources and under the guidance of local political decision-makers, strive to achieve and maintain a state of lowest incidence – ideally zero. In Green Zones, the existing restrictions on the freedoms of individual, social and economic life can be completely withdrawn in predictable steps. The Green Zone approach is based on the practical experience and success of other countries. It constructively addresses a key weakness of our current pandemic management, namely the fragmentation of jurisdictions in the federal system, and transforms it into a strength by motivating the regions themselves to improve their own situation through proactive action.

European solutions: The European continent is not only closely intertwined politically, socially and economically - Europe is also *a single* epidemiological area. Accordingly, it is difficult for individual countries to effectively control the pandemic on their own. Therefore, a joint approach by EU members would be desirable. The Green Zone model we propose offers solutions to two central challenges of pandemic management, namely pan-European cooperation and the simultaneous preservation of freedom of movement in the Schengen area. It can be implemented decentrally by sub-state institutions in the EU countries. If the European governments fail to reach an agreement, Green Zones can still be created and expanded in like-minded regions or countries. Instead of prolonged border closures, we propose smart mobility restrictions based on political, social and economic realities.

Test Trace Isolate (TTI): The term TTI refers to a package of measures and procedures to prevent the spread of the virus through targeted detection and isolation of infected persons and their contacts. Optimization of TTI procedures is a crucial component of the NO-COVID strategy of pandemic response. In order to efficiently contain the spread of the infection, all possible efforts must be made to reduce the time between the infection and isolation of infected persons. Three steps are crucial in determining how fast this happens: rapid and generous testing of potentially infected persons ("test"); rapid and comprehensive contact tracing ("trace"); and immediate and consistent isolation of both infected and suspected cases ("isolate"). Acceleration of these steps, in combination with efficient quarantine measures, is key to efficiently controlling the pandemic.

The economy and the labor market: The NO-COVID strategy employs non-pharmaceutical interventions with the aim of getting the pandemic under control in the fastest and most sustainable way possible. In public discourse, it is often suggested that the interests of health and the economy are in opposition to one another. This perspective, however, has already been proven wrong in other pandemics, such as the Spanish flu of 1918. It is true that in the short term, strong containment measures can cause greater economic damage than the pandemic itself. In the long run, however, these damages are made up for by the shorter duration of the measures and the fact that the pandemic is brought under control faster. The toolbox suggests several policies, such as building optimized and faster strategies for evaluating data, creating a dynamic of innovation to foster creative solutions (e.g. digital contact tracing), mobilizing additional resources (e.g. for laboratory services), and accelerating the TTI procedures. These policies can support effective and sustainable pandemic control within the NO-COVID framework.

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Toolbox #1: Using Green Zones to Achieve a Permanent Relaxation of Restrictions

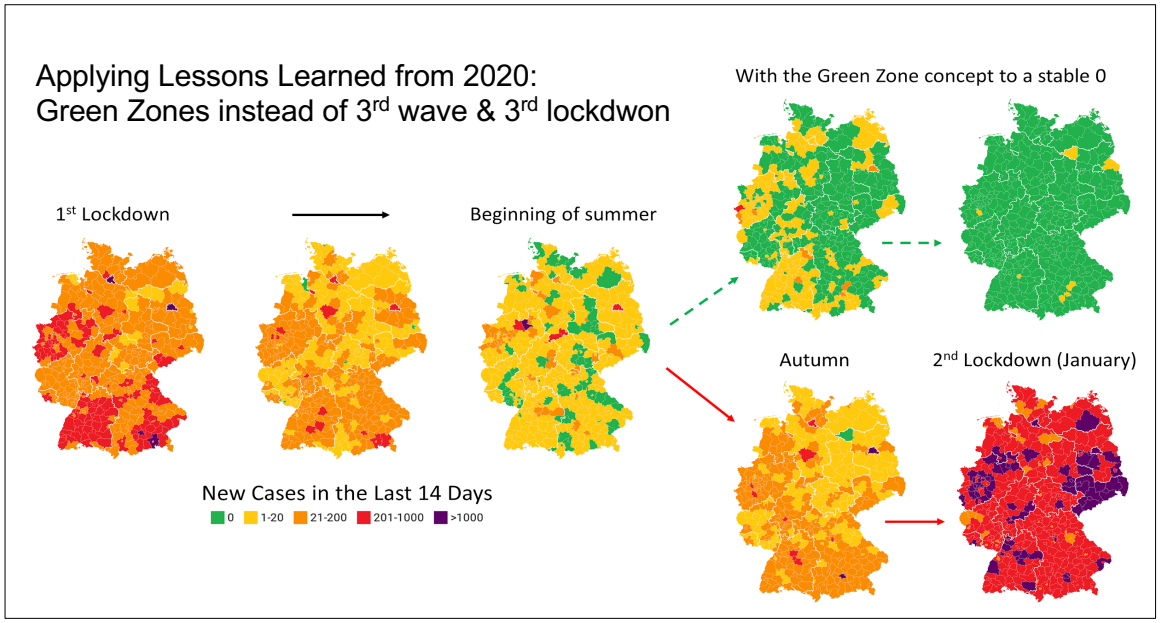


Figure 1: Green Zones and lockdowns in Germany. Own illustration.
Infection figures: RKI. Map data: GeoBasis-DE / BKG 2016. Upper right scenario hypothetical.

In summer 2020, many districts had an incidence of zero or just above zero for several weeks. It could be possible to preserve such a situation with the Green Zone (GZ) approach (Siegenfeld & Bar-Yam, *Nature Com.* 2020). This approach aims at rapid and lasting relaxation of restrictions. Safe areas, i.e. areas that have, among other things, had **no infections from an unknown source for at least 14 days (risk incidence = 0),** are declared Green Zones. In the GZs, comprehensive measures must be taken to prevent new cases of infection from being brought in from outside and spread (Green, Shen, Bar-Yam, Travel Restrictions, *NECSI,* May 2020see also TB "Test-Trace-Isolate" in this paper).

Risk Incidence

Only cases that are relevant for further infections, like infections from an unknown source, are included in the evaluation of this status.

The population should be motivated by a common goal: the safe, rapid and sustainable lifting of restrictions as soon as the risk incidence of 0 is reached. Identified cases that do not pose further risk of new infection chains are disregarded. After 14 days, the resulting GZs can be connected with other GZs so that life can be lived within and between the two zones with only a few restrictions (such as monitoring, masks, etc.).

To motivate the population to participate, it is essential to inform them clearly and regularly about the data regarding new infections.[2] This facilitates cooperation and competition for innovative solutions; individuals and municipalities can actively help to expand the GZs and establish GZ networks.

[2] https://www.mckinsey.com/industries/public-and-social-sector/our-insights/collaboration-in-crisis-reflecting-on-australias-covid-19-response, 15.2.2021.

Definition of Zones

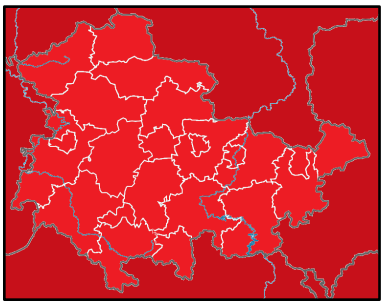
Green Zone (GZ): Risk incidence of zero for at least 14 days. This state is reached when there are no cases that are relevant for further infections. Examples of cases that are not relevant are: 1) infections in incoming travelers that were immediately isolated on arrival, 2) local infections that were isolated in time by contact tracing, or 3) local infections that can be fully attributed to an existing cluster or chain of infection.

Red Zone (RZ): Local transmission outside quarantine or isolation occurred in the last 14 days; only essential travel is allowed from a RZ to a GZ.

Contact Points: Buffer zones within the GZs that do not have acute infection events but are at risk due to an adjacent Red Zone and therefore require special control measures. Persons commuting between GZ and RZ and their employers are also subject to special requirements and controls.

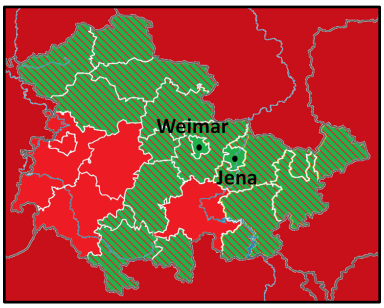
Hypothetical Scenario – Thuringia opts for the NO-COVID Strategy Through Green Zones

Step 1: Rapid Reduction of Local Infection Rates to Zero



The decision to push cases to zero, the goal, the strategy and its results are clearly and continuously communicated to residents of Thuringia. Using a "race to zero", citizens as well as public and private sector actors are to be motivated to take responsibility for achieving the common goal. All effective public health measures are used in unison to reduce the number of cases as quickly as possible. Before reaching zero, only essential mobility (e.g. professional commuting) is allowed.

Step 2: Formation and Lasting Protection of Green Zones



Rural or urban districts become GZs as soon as the risk incidence remains at zero for 14 days and the danger of introduction of new cases can be kept sufficiently low. To ensure this, temporary buffer zones between GZs and RZs can be helpful (shown here hatched).

In this example, a large part of Thuringia (the smallest partitioning here is at the district level) has managed to reduce the incidence to zero. However, transition zones are not yet sufficiently protected from the RZ. Travel between the two GZs shown here (Jena and Weimar) is possible if the route is safe (see section on mobility between zones).

Step 3: Expanding Green Zones with the Help of Consistent Outbreak Management

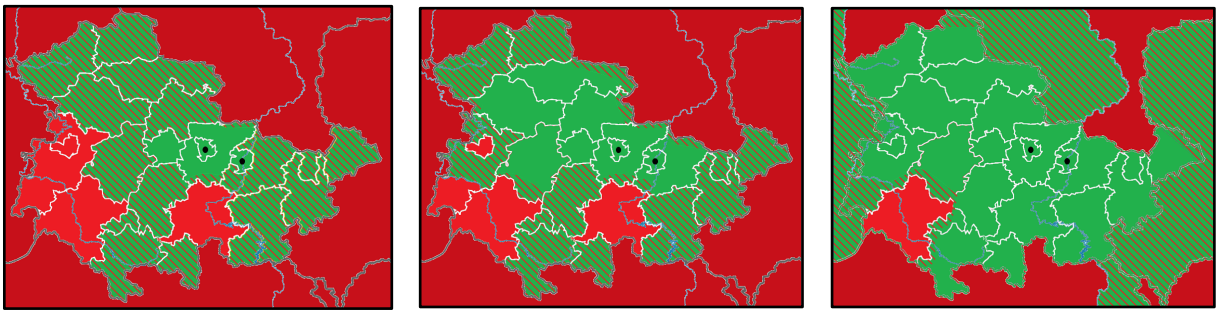


Figure 2: From Red to Green Zones.

Through intelligent designation and control of zone boundaries, GZs can network and expand. In all zones, prevention of the undetected importation of new infections from outside continues to be the goal.

With the help of the Green Zone approach, Thuringia has successfully managed to significantly reduce the number of cases and make them almost completely traceable. If the application of the Green Zone strategy is coordinated with other federal states and regions in Europe, it will become more effective and attractive and will consequently be easier to communicate and implement (Oliu-Barton & Pradelski, Green Zone Traveling*, esade,* 2020; see also TB "NO-COVID Partnership Europe").

Flexible Division Into Zones

The Green Zone approach is in principle applicable to zones of different sizes (residential buildings, residential areas, municipalities, districts, states, countries, continents). The exact division of zones depends on pragmatic considerations such as monitoring capacity, local mobility flows and other factors (Schlosser et al., *PNAS* 2020). Due to certain mobility patterns, it may make sense to consider two or more districts or even an entire metropolitan region as *one* larger zone. In Germany, cities and districts could initially serve as the relevant administrative units, as they often have sovereignty in local pandemic management and contain the relevant public health facilities.

Transitional areas and contact points between RZs and GZs should serve as buffer zones to reduce the residual risk, e.g. through travel restrictions and more comprehensive monitoring (shown hatched in the figure). To apply a differentiated, appropriate response while maintaining a high level of safety and reducing the restrictions for as many people as possible, zones should be partitioned more finely where possible.

Create Green Zones and Keep Them Stable

In order to achieve Green Zone status in defined regions as quickly as possible, comprehensive measures are implemented based on the experience of other countries. In border regions (hatched), risks should be assessed, and solutions found by drawing on the experience of the municipalities and existing partnerships. Concrete proposals for such measures are included in other toolboxes we have developed (see e.g. TB "Test-Trace-Isolate"). Fast, consistent action and resolute measures enormously shorten the duration of necessary restrictions.

Once a region enters the single-digit 7-day incidence range, first steps to reopen could be made gradually, as long as public health measures are maintained and social distancing,

hygiene measures, face masks and ventilation rules continue to be applied consistently (as successfully practiced in Melbourne). Once GZ status is achieved, an early detection system should be initiated, including targeted and regular testing of high exposure groups, self-testing of even those with only minimal symptoms, introduction of PCR pooling and wastewater monitoring, as well as maintaining sufficient testing capacity. In the event of a new case of infection of unknown origin, the spread should be contained as quickly as possible through effective outbreak management. Decisions about whether or not the whole zone's status needs to be changed, and to what extent specific measures such as mass screening and local contact restrictions have to be applied, will be made based on the information available. Again, the experience of other counties or countries (e.g. Australia or New Zealand) can help in the decision-making process.

Reduce and Regulate Mobility Between Zones

To ensure the stability of Green Zones, only essential travel will be permitted from RZs to GZs. In the case of unavoidable commutes, employers should implement comprehensive testing and safety protocols for their employees.

The residual risk in transition areas and at contact points is minimized through comprehensive testing strategies, quarantine, and hygiene measures, as well as through the use of designated transit points (e.g. specially protected petrol stations). Where appropriate, temporary buffer zones (hatched) can be declared within GZs where all the rules of an RZ apply. As summarized in Figure 3, we can generally distinguish between four different cases: mobility between neighboring GZs, between GZs and RZs, between two RZs and between two GZs separated by an RZ (Shen, Bar-Yam, Travel between Zones, *NECSI*, July 3rd 2020).

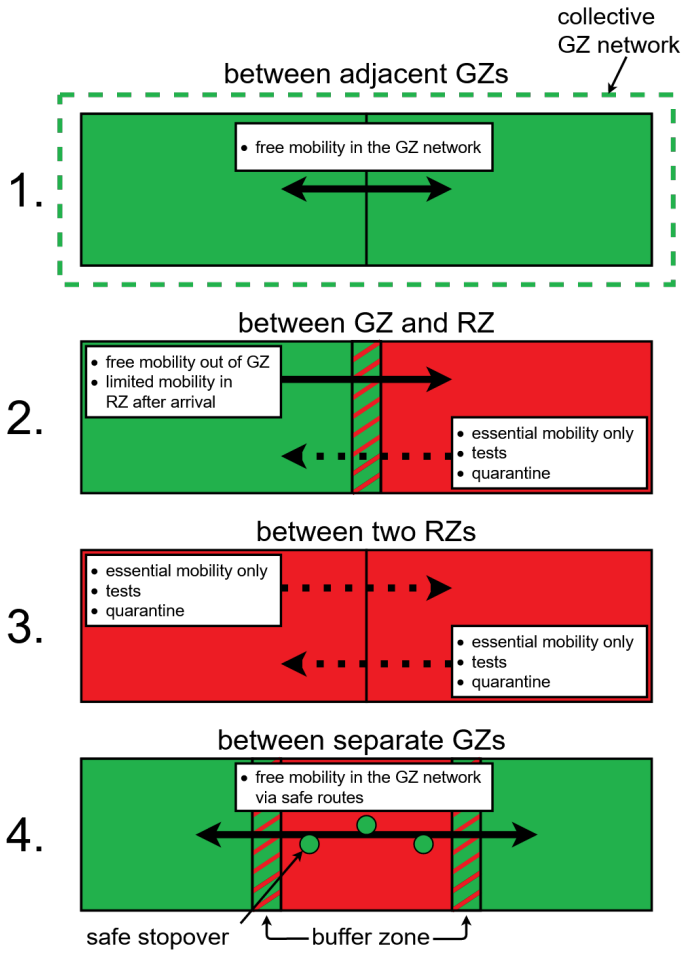


Figure 3: Mobility between zones. Own illustration.

Toolbox #2: NO-COVID Partnership Europe

Europe is not only closely interconnected politically, socially and economically – it is also a *single* epidemiological area. Accordingly, it is difficult for individual countries to control the pandemic effectively; a joint approach by EU members would therefore be desirable. The Green Zone model is *particularly well-suited* to the European context because it offers solutions to two central challenges of pandemic management: pan-European coordination and cooperation and freedom of movement in the Schengen area. These (complementary) solutions are:

(1) The Green Zone model can be implemented in a **decentralized** manner by sub-state institutions in different EU countries;

(2) If European governments cannot agree on a NO-COVID strategy, Green Zones can still be created and expanded according to a **'Like-Minded' principle**;

(3) Instead of border closures, the method of choice for effective pandemic control is to impose **smart restrictions on mobility** (combined with testing systems), which take into account political, social and economic realities.

The core idea of this toolbox is that Europe is a closely interconnected cultural and living environment, which, at the sub-state level, is organized regionally and federally, and whose members have a high interest in cooperation. In this context, inter-state borders should play only a marginal role.

Approach 1: Decentralized Governance

In Europe, the NO-COVID strategy has the best prospects for quick and sustainable success if it is implemented as a uniform strategy coordinated between states and EU institutions ("NO-COVID Partnership Europe"). But it can also succeed if, to begin with, individual counties (or smaller/larger administrative units) in various European countries aim for a risk incidence of zero and their proactive approach encourages others to follow suit. Over time, it is to be expected that the strategies will converge across Europe, as has already happened with the containment strategy.

A European NO-COVID strategy combines both political-institutional and psychological core elements of the Green Zone model. The political-institutional element is that governance is decentralized: it lies in the hands of stakeholders at different levels of action and decision-making in different European states, from the Portuguese district of Coimbra to the German district of Göttingen to the Romanian district of Constanța. Regional administrations, municipalities and even citizens themselves can actively participate in the process – ideally, supported by a joint agreed-upon framework – by setting themselves the goal of a risk incidence of zero and taking steps to achieve it. The crucial psychological element lies in motivating people by encouraging them to assume responsibility and work toward a positive common goal: the goal of restoring freedom and stability, reviving communal and social life, and ensuring freedom of movement throughout Europe.

Approach 2: Unite with Like-Minded Parties

Effective pan-European pandemic management is more likely to be achieved if all member states can agree to change their strategies towards a Green Zone model ("NO-COVID Partnership Europe"). Although this is a goal to strive for, it is not a mandatory requirement. If

national governments can agree on a pan-European strategy, it nonetheless remains essential that it be accompanied by a decentralized 'Like-Minded' approach. And even if national governments cannot reach an agreement, the decentralized 'Like-Minded' approach still allows for implementation of a Green Zone strategy.

The 'Like-Minded' approach relies on supporters who actively reach out to others, seeking to persuade them of the merits of the NO-COVID strategy and then to implement it *together*. If a region/province/municipality decides to become a Green Zone, it aims to collaborate with partners who share the same goal, are willing to make common arrangements, and share best practices. These partners can be other governmental and administrative units that are on the same level, such as municipalities in one's own or different countries – or, indeed, other counties, regions or European governments.

To identify and prioritize potential partners who should be convinced first, and with whom cooperation should be sought first, we suggest a simple heuristic (which is also applicable at different levels of government):

		Like-Minded	
		Yes	**No**
Neighbors	**Yes**	Priority 1	Priority 2
	No	Priority 2	Priority 3

Table 2: Potential Green Zones partners.

As a large portion of mobility takes place locally or among immediate neighbors, they are the ones who must first coordinate with each other to manage the pandemic cooperatively and become a joint Green Zone with unrestricted mobility. Like-minded neighbors have to be prioritized, followed by non-like-minded neighbors and like-minded non-neighbors. Non-like-minded non-neighbors have lower priority, as it can be assumed that there will be other stakeholders for whom they are a higher priority and who, in this case, should be contacting them.

Such a 'Like-Minded' approach is functional. It recognizes that mobility needs to be organized locally and regionally if the pandemic is to be managed effectively while ensuring that essential economic and social mobility is as unimpaired as possible. The approach is also self-reinforcing. It is designed to trigger an essential dynamic of the Green Zone approach: Those who lead by example demonstrate that the strategy is feasible. By reducing infections and deaths, reducing the burden on the health system and restoring freedoms, they create incentives for others to follow the same path. This approach thus paves the way for the pandemic response strategy to gradually converge across the EU even if governments cannot initially agree. In other words, the Green Zone approach focuses on what is feasible and uses small-scale action to work toward large-scale changes.

Approach 3: Keep Borders Open, Restrict Mobility Smartly

Open borders: To close borders within the EU is not only to ignore its status as a single epidemiological area (according to the WHO), but also to ignore the strong political, social and economic interdependence of European countries and citizens. In European border regions, in particular, where one third of the European population lives, closed borders cut apart natural

living units. Impediments to the movement of goods, services and people in Europe rapidly have a negative political, social and economic impact. They are also counterproductive to the goal of treating pandemic response as a joint effort and motivating sustainable, individual behavioral changes, because they encourage to give up responsibility and tempt people to comply with or violate the rules depending on which side of the border they are. For this reason, if borders have to be closed (e.g. to ward off new virus variants), this should only be done selectively and temporarily. Comprehensive and permanent border closures should be avoided and are not necessary for the NO-COVID approach.

Taking into account the problematic nature of border closures in Europe, mobility restriction policies must achieve two things. Firstly, mobility must be restricted in such a way that an epidemiological effect is achieved, i.e. contacts between areas with different incidences are restricted and re-introduction of the virus is prevented. On the other hand, such restrictions must have as few political, social and economic side-effects as possible. This means that of those people who have to remain mobile for essential professional or private reasons, as few as possible are put in the situation of regularly crossing the borders between epidemiological zones.

Smart mobility restrictions: Whether and to what extent mobility restriction measures are epidemiologically effective as well as socially and economically acceptable depends decisively on the definition of an epidemiological zone. Two criteria can be used for this definition: firstly, governmental-administrative units that are authorized to make decisions, and secondly, actual mobility.

In line with the decentralized, local idea of the Green Zone approach (see TB 1 "Green Zones" in this paper), the basic governmental-administrative units are regional and / or municipal administrations. This is where most measures are decided upon and implemented, where the majority of infections occur and where a large proportion of mobility is concentrated. However, as data shows, mobility flows are not always congruent with politically defined geographical areas.[3] Therefore, real mobility patterns should be considered when defining epidemiological zones. In cases where there is a large discrepancy between political geography and mobility patterns, such as in metropolitan regions and conurbations with large commuter belts, mobility patterns should be the decisive factor – after all, they are often determined by factors that cannot be easily changed, as in the case of commuters.

Depending on specific local circumstances, an epidemiological zone that takes into account mobility patterns could thus be made up of a variety of different administrative units – municipalities, counties and / or federal states (or their counterparts in other European states, such as departments or arrondissements in France or provinces in Spain). It is in the interest of these administrative units to coordinate their pandemic response and to act together. Such an approach would have a dual benefit. First, the restrictions on cross-zonal mobility would be milder, because they would affect fewer people. Second, the pandemic could be fought more effectively because the stakeholders have an incentive both to succeed in their management of the pandemic, and to learn from each other. In areas where structures for cooperation are already established, as in European border regions, these can be used. Where they are lacking, they should be established.

[3] http://ec2-35-153-102-199.compute-1.amazonaws.com/elastic/NSF_paper.pdf, 9.2.2021.

Toolbox #3: Test - Trace - Isolate (TTI)

The term Test-Trace-Isolate (TTI) is used to describe measures that are intended to limit the spread of the virus through targeted detection and isolation of virus carriers and their contacts. As crucial instruments of pandemic control, these measures are intended to help turn regions into Green Zones more quickly, allowing them to lift restrictions. In order to effectively contain the spread of infections, it is of utmost importance to shorten the time between the infection and isolation of those infected.

Since the affected persons are not only infected themselves, but also carriers of the virus, individual responsible behavior has the fastest effect. Such behavior – self-isolation at the slightest suspicion of an infection, immediate testing, and warning others who are at risk – ensures that the chain of infection is broken as quickly as possible.

At the same time, all steps within the TTI-process which are carried out by physicians, testing stations, laboratories and the public health service need to be strongly accelerated and improved. Such processes involve three central elements:

(1) rapid and ample testing of people who are suspected to be infected ("testing");

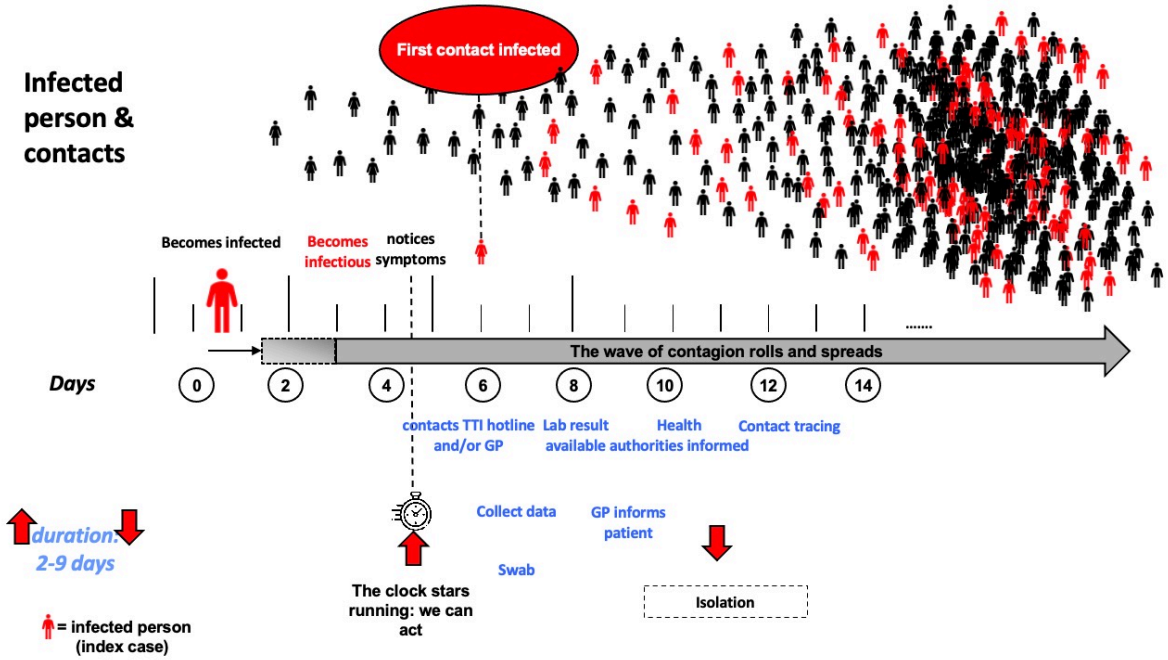
(2) rapid and comprehensive identification of other potential cases through contact tracing ("trace");

(3) immediate and consistent isolation of both infected and suspected cases and contacts before the virus can be transmitted ("isolate").

Early isolation: Figure 4 shows the typical TTI process in Germany. From the time people first experience symptoms, it takes an average of 4.6 days until they are reported to the public health department. If we add the incubation period until the onset of symptoms, interaction with the health office usually takes place 9 to 10 days after infection or 6 to 7 days after an affected person becomes infectious.

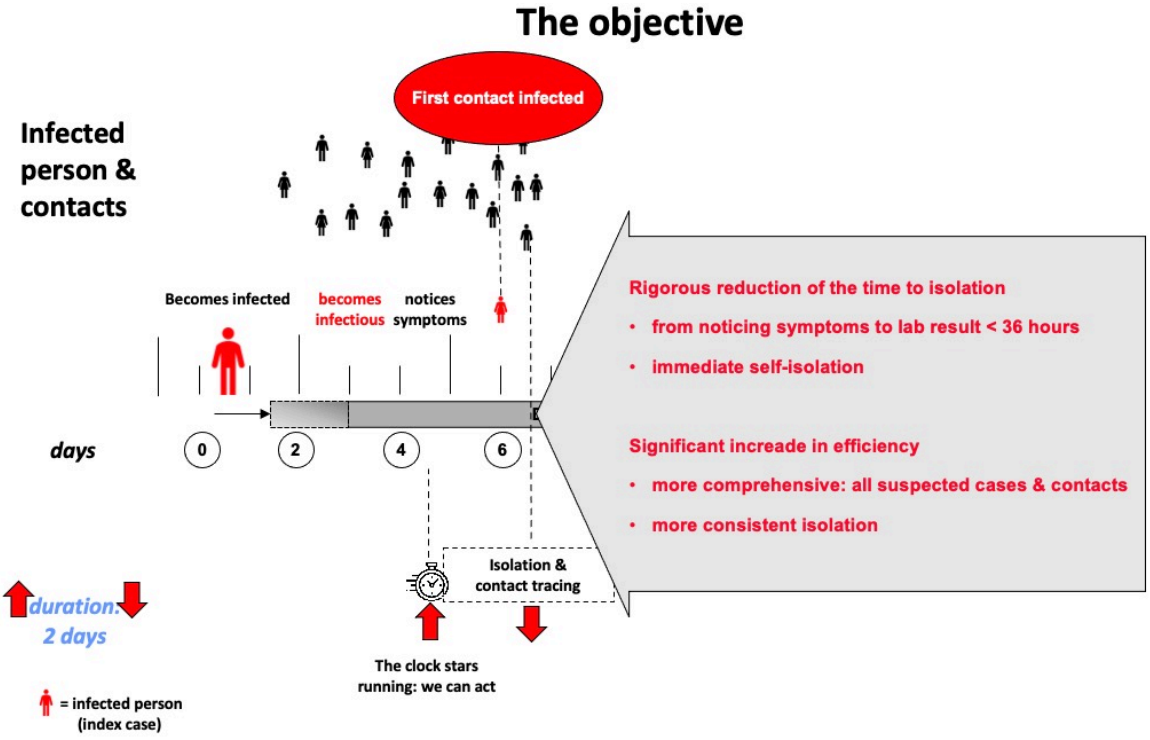
Rapid isolation is one of the most important levers for effectively limiting the incidence of infection. As modeling for SARS-CoV-2 shows, rapid isolation is a key tool in reducing the reproduction number significantly and, accordingly, in controlling outbreaks (Aleta et al., Nat Hum Behav 2020; Contreras et al. Nat Commun 2021; Kucharski et al., Lancet Infect Dis 2020; Maier et al. Science 2020).

Short time window for a successful isolation strategy: The slightest symptoms can already be signs of an infection. Given the kinetics of the virus, affected persons must therefore self-isolate and get tested immediately. Infected persons usually become infectious shortly after infection, usually as early as 1 to 2 days before the onset of symptoms, which on average do not appear until about 5 days after infection. Viral load and infectivity usually decrease significantly within the first two weeks of illness. Suspected cases must therefore be found and isolated as quickly as possible. To do this, all contacts of the infected persons who could have been infected before isolation must be identified and tested (the current process). Because of overdispersion (i.e., the fact that a small number of infected persons causes most of the infections), each infection must be assumed to be part of a larger infection cluster. For this reason, it is at least as important to systematically trace an infection back to its source and identify that source’s contacts (retrograde tracing). If both efforts are successful, the impact on the containment of the pandemic is significant (R. Albert et al., Nature, 2000). The NO-COVID approach relies on this consistent and rapid isolation strategy, especially in low incidence regions, to quickly establish green zones and subsequently protect them.



Note: incubation period and time to infectiousness may vary considerably; the same is true for the timing between public health actions

Figure 4: The TTI process in Germany: Time between infection with SARS-CoV-2, becoming infectious, and passing relevant information on to public health authorities. Own illustration.



Note: incubation period and time to infectiousness may vary considerably; the same is true for the timing between public health actions.

Figure 5: Potential of measures within the TTI process: acceleration of isolation by several days. Own illustration.

Speeding up and simplifying testing: Testing procedures can be changed in a number of concrete ways in order to further speed up the process of isolating infected persons, completing contact tracing and mandating quarantines for primary contacts. These ways include:

- **Reducing organizational and logistical obstacles to testing:** reduce waiting times on hotlines, standardize information, explain the need for certain measures, speed up the process of getting an appointment, quickly identify ways to get tested;
- **Increasing test availability;**
- **Obtaining test results quickly:** The time between the doctor performing a test and the arrival of the samples in the laboratory, as well as waiting times in the laboratory before analyses, must be considerably shortened;
- **Communicating test results quickly:** Test results from laboratories must be communicated to patients and health authorities significantly faster, ideally in real time.
- **Accelerating processes of health authorities and all (medical) institutions involved:** An essential aspect of TTI is the processing of data by health offices and all (medical) institutions involved, whose personnel capacities have reached their limits in the course of the pandemic. This can be optimized through improvements, simplification and digitalization of processes.
- **Significantly accelerating the essential processes in all facilities involved:** Overload, lack of digitalization and privacy hurdles lead to delays. The nationwide introduction of a uniform reporting software (SORMAS); the creation of DEMIS interfaces; and the use of anonymized, encrypted contact data transmission and electronic contact diaries (like the Luca app) could overcome these problems.
- **Reducing interruptions in chains of service**: Reduced capacities in all areas (testing facilities, laboratories, health offices) on weekends and holidays delay the entire TTI process. These capacities must be available every single day of the week during the pandemic. This requires increased staffing of health offices, especially in Red Zones with high incidences.
- **Improving support of quarantine and isolation:** Efforts should be made to improve and speed up processes, delineate clear responsibilities, ensure there are appropriately trained persons, help ensure those affected are adequately supplied with groceries and other items required for daily needs, and offer alternative quarantine options (e.g. hotels).
- **Initiating an exchange of best practice examples:** The situation on the ground varies a great deal from place to place. Accordingly, the effectiveness of testing and isolation strategies differs considerably between regions. Yet best practice standards have thus far hardly been exchanged and discussed. Doing this, however, is imperative.
- **Introducing analytical controlling:** Due to insufficient and late data transmission, differing systems or capacity bottlenecks, protocols and processes are currently not consistently evaluated. However, systematically evaluating them is very important.

Prophylactic testing and quarantine as a proactive tool: The above-mentioned improvements will achieve the main goal of NO-COVID: consistent reduction of infections. Rapid and extensive testing of potentially infected persons, their immediate and consistent isolation, and immediate contact tracing will most likely yield great success. In addition to the improvements in procedures outlined above, new paradigms for the TTI process should be introduced:

(1) **Testing willingly and proactively:** Every symptomatic person is tested; every person who desires to be tested is being tested. People should be encouraged to test themselves or to get tested immediately if they have the slightest symptoms or suspect that they may have been infected. Testing of suspected cases is done on the same day.

(2) **Isolating suspected cases as soon as a test appointment is made:** Upon registration for a test, every suspected case is instructed to isolate immediately until a negative result is available or quarantine has ended. At the same time, the person who is to be tested is requested to provide all contacts of the last few days. Labor law needs to be adapted/amended in order to make possible and encourage rapid, proactive isolation (see also TB 4 "Economy and labor market").

(3) **Extending testing strategy**: An interlocked testing strategy which uses different testing methods (antigen test, PCR) and expands the testing infrastructure, including the use of self-tests, enables faster and more frequent testing.

Summary: Using the measures and innovations listed here, an acceleration of the TTI process would, in principle, be immediately feasible and could have dramatic positive effects (Figure 5). Only through consistent implementation of these measures within the framework of the NO-COVID strategy can a significant contribution be made to avert a new wave caused by more rapidly spreading mutations (such as B.1.1.7), which threatens to begin in March 2021. Optimizing TTI processes is an important prerequisite to opening up economic and social life as quickly as possible.

Toolbox #4: The economy and the labor market

The claim of health-economy trade-off is wrong

The NO-COVID strategy requires the continuation of non-pharmaceutical measures with the aim of achieving sustainable control of the pandemic. In the public discussion, therefore, the impression is quite often given that the interests of health and the economy are in opposition to one another. This perspective has already been proven wrong in other pandemics, such as the Spanish flu in 1918 (e.g. Correia et al., SSRN 2020; Jordà et al., NBER 2020; Karlsson, Nilsson & Pichler, J Health Econ 2014). Strong containment measures can cause greater short-term damage to the economy than the pandemic itself. In the long-term, however, this can be economically overcompensated by the shortened period of the measures and the coping with the pandemic at an earlier stage. Whilst pandemics are limited in their comparability (e.g. different death and illness incidence in the economically productive population), initial studies concerning the Corona pandemic also show that measures for rapid management and containment of the pandemic are not taken at the *expense* of economic development, but can, on the contrary, contribute to the economy's recovery.

Studies from the US and Scandinavia, for example, have shown that only a relatively minor part of the decrease in consumption and the loss of jobs in the spring of 2020 can be attributed to the lockdown measures during the first Corona wave. Most of the economic decline can be ascribed to the high local levels of infection; i.e. consumption would plummet significantly even in the absence of closure orders, in some cases with a time lag (Andersen et al., arXiv 2020; Chetty et al., NBER 2020; Goolsbe & Syverson, J Public Econ 2021; Juranek et al., CESifo WP 2020, among others). If the risk of infection is high or the consumer experience is only accessible under high restrictions, individuals refrain from visiting stationary trade or services with close personal contact or from using public transport. In the light of this, moreover, classic stimulus policy measures can hardly stimulate private consumption (e.g. Chetty et al., *NBER* 2020; Dorn, Fuest et al., *ifo Schnelldienst 73(7)* 2020; Fuest, Neumeier et al*., ifo Schnelldienst digital* 2021). In addition, an uncontrolled pandemic increases the risk of absence from work due to illness. Therefore, numerous independent studies conclude that the control and containment of the pandemic is also in the interest of the economy and to secure jobs (e.g. Baqaee et al., *NBER* 2020; Dorn, Khailaie et al., *medRxiv* 2020; Holtemöller, *IWH Discussion P.* 2020; Jones et al., *NBER* 2020).

However, from an economic standpoint, not all measures to contain infections can be justified without qualifications. Figure 6 conceptually illustrates the theoretical relationship between economics, health protection, and a policy opportunity frontier as a function of the strength of intervention measures (Acemoglu et al., *NBER* 2020; Dorn, Khailaie et al., *medRxiv* 2020; Kaplan et al., *NBER* 2020). There is no trade-off until the economic optimum is reached. Temporary restrictions that lead to the optimum are in the long-term interest of both health protection and the economy. However, if the restrictions are very extensive and remain in place for too long, this can result in very high economic costs: in this case, human lives are saved, but only at the expense of the economy, with correspondingly negative consequences for the citizens (Fig. 6). Careful consideration must therefore always be given to both aspects in order to minimize any potential damage to both the economy and the healthcare system. For this reason, the No-COVID strategy calls for highly efficient pandemic defense measures to limit their duration.

The actual shape of the curve in Fig. 6 and the optimal set of measures, which is also in the interest of the economy, is ultimately an empirical question. Quantitative studies by the HZI and the ifo Institute (Dorn, Khailaie et al., *medRxiv* 2020) show in a case study for Germany that a perpetuation of measures, as was implemented in Germany in October and November 2020, but which did not achieve a clear reduction in the reproduction number (Rt) below 1, causes not only many deaths, but also the greatest economic loss. The study's simulations indicate that, in the medium term, it is economically more beneficial to use effective infection control measures and to temporarily restrict economic activity to push infections down in a controlled manner to an incidence that allows the public health service (ÖGD) to maintain full local control, contact tracing, and containment of infections.[4] The simulation results indicate that the measures of a lockdown and opening strategy should be selected to keep Rt in the 0.7-0.8 range.[5]

The stability of an infection level once openings have been reached also plays an important role in the economically optimal containment strategy. If a rise in infections can be expected with a high certainty, significant economic disadvantages arise because there is then a high degree of business uncertainty and thus the fear of renewed disruptions to economic activity (even in the absence of government-imposed closures) may occur. Current epidemiological studies suggest that a stable situation with low infections and sustainable openings can only be achieved when incidence is on the level of 10 or less (Contreras et al., *medRxiv* 2020).

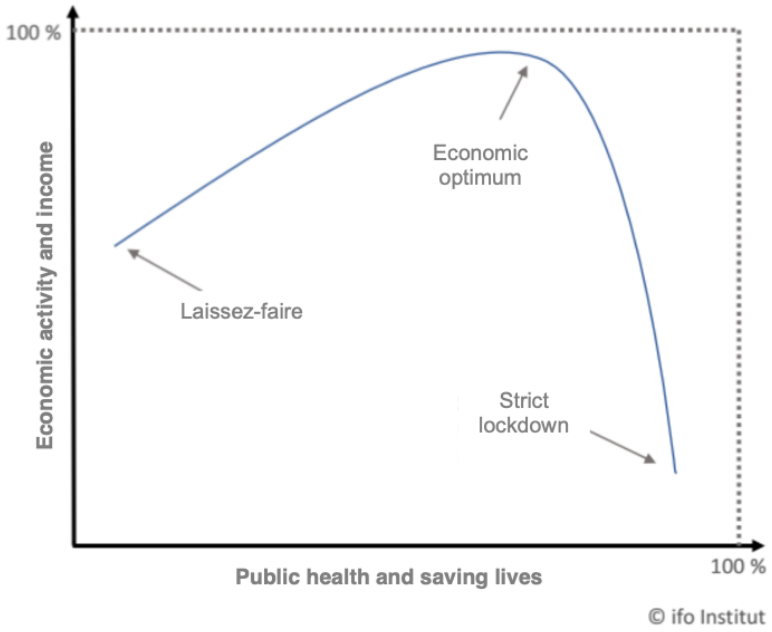


Figure 6: Policy trade-off between health and economy?

Major importance of vaccinations for the economy

Accelerating the vaccination process is of crucial importance for achieving herd immunity to end the pandemic (or to contain covid-19 disease with severe courses and long-term health damage). It is therefore also an important part of the No-COVID strategy for the sustainable

[4] For the simulations, the study applied an incidence of 2.5 per 100,000 inhabitants as the critical threshold above which all restrictive measures for economic activities are fully lifted.

[5] Measures that aim to achieve greater reductions, however, would result in a trade-off between both goals (Fig. 6).

reduction of case numbers. Due to the high costs of the pandemic and the necessary strong measures to contain it, investments that offer the prospect of speeding up vaccination are economically advantageous on nearly any scale, not to mention the associated health protection. According to current estimates (based on plausible assumptions), the overall societal benefit of an additional vaccination available at the beginning of 2021 is 1500 euros (1750 US dollars), while the current price paid per vaccination in Europe is 4-15 euros (Ahuja et al., *BFI WP* 2021). This argues for exploiting all available opportunities to accelerate vaccine production, including falling subsidies over time for additional vaccine doses delivered earlier (Fuest & Gros, *EconPol Opinion 44* 2021). The objection that this would not feasible due to the complexity of the production process or that manufacturers are already exhausting all possibilities is not convincing. Whether subsidies make a difference will only be known once they have been offered. If it is true that additional incentives do not increase supply, then no premiums will be paid. Therefore, there is only to win by doing so.

If there are concerns that the subsidies would lead to undesirable diversions of supply, for example at the expense of developing countries, participation in the subsidy programs could be made conditional on meeting existing supply commitments to these countries. In addition, supplied countries remain free to transfer their contingents to other countries at fair terms.

In addition, it is necessary to prepare and organize vaccination logistics and the vaccination schedule in a way that vaccination of the population can begin efficiently and without delay, as soon as large quantities of vaccine doses are made available.

This requires far-reaching concepts that go beyond the existing vaccination centers, GP doctors' practices and mobile vaccination teams (e.g. company physicians). Since not all people attend the scheduled appointment, overbooking of appointments must also be considered.

Minimize impacts on the economy through cost-effective measures

Lockdown measures result in significant costs for the economy, which amount to billions of euros every week in Germany. Entrepreneurs fear for their existence, many people are dependent on short-time work hours and state aid during the lockdown (e.g. Dorn, Fuest et al., *ifo Study* 2020). The lockdown restrictions of the hotel, hospitality and restaurant industry, the stationary retail trade as well as numerous social service sectors, as they apply in the second lockdown since mid-December 2020, lead to weekly value-added losses of almost 2.5 billion euros on average (ifo Institute 2021). The partial shutdown of further sectors of the economy would lead to considerable additional costs, which could be in the double-digit billions each week (Dorn, Fuest & Göttert et al., *EconPol Policy Brief 21,* 2020).[6] Depending on the scenario, even a two-month shutdown could result in growth losses of 7 to 11 percentage points. The decline in gross domestic product of 5.0 per cent for 2020 as a whole is equivalent to a loss of around 200 billion euros in GDP (compared to a forecast of plus one per cent without the Corona crisis)). In addition, there are high costs of government support measures and wage replacement benefits. These have so far largely avoided a major wave of insolvency with the danger of a negative spiral (Wollmershäuser et al., *ifo Schnelldienst - Konjunkturprognose Winter* 2020), but the danger of an exponential rise in insolvencies the longer the restrictions on economic activity persist.

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Due to the high economic costs of lockdown measures, closures of industrial production sites must only be considered as a last resort. To balance the interests of the economy, employment and health, infection control measures must be cost-effective. The high costs of lockdown measures justify extensive investment in other infection control measures that serve containment but impose few restrictions on economic activity. In addition to the rules for masks, hygiene, physical distance and aeration, it is cost-effective to invest in the following, among others:

- **Expanding TTI strategies:** These include new testing strategies with significantly more rapid antigen tests, RT-LAMP, PCR wastewater tests, local mass testing concepts, improved and earlier self-isolation or use of (voluntary) quarantine hotels (see TB "Test Trace Isolates", this paper);[7] for tracking solutions, more (data protection-compliant) applications as well as digital solutions must be created and used.
- **Immediate mobilization of resources for sufficient testing, laboratory and staff capacities as well as contact tracing:** As already started, the German Armed Forces and volunteer workers must be systematically involved and trained. There should also be exceptions for short-time workers from the affected sectors, so that they can work actively and earn extra money in the meantime in the fight against the pandemic. For mass tests, tests at critical border regions or mandatory daily (AG or LAMP) rapid tests or PCR tests in nursing homes or schools, additional resources are needed in terms of staff, laboratories and tests. This requires not only industrial cooperation and the rapid creation/reallocation of new capacities (e.g. PCR facilities from the veterinary sector), but also accelerated innovation and market introduction of new test types and procedures. An industrial strategy must also ensure that materials and raw materials are sufficiently available. For the mobilization of these resources, a high-level task force with political and business leaders would be useful.
- **Improved collection and evaluation of test data: T**o be able to intervene in an evidence-based and targeted manner in the case of infections in a regionalized zone strategy, improved monitoring with quickly available and informative test data is essential. This data should be digitalized immediately at the time of testing (e.g. app solution) and should also be quickly available to the science community (if necessary, voluntary data transfer can be relied on). Test and NPI strategies can then be evaluated quickly and local infection dynamics can be identified more effectively than now. In addition, some information needs to be collected to control biases in the regional and time-related comparison of infection figures (Dorn, Fuest, Gstrein et al., *ifo Schnelldienst digital* 2020). It is necessary that information such as age, test result, postcode (place of residence and work), occupation/industry, type and reason for the test are each assigned to a specific test ID. This way, regionally specific calculations can be made, e.g. how high positive rates are. By collecting the profession, sector, etc., it is likely that further important patterns can be identified (e.g. where previously undetected infection sites might be), which justify evidence-based and targeted local restrictions.

[7] Examples of comparative cost-effectiveness: (1) Full utilization of the current testing capacities of the laboratories reported by the RKI (week 5/2021) and the applicable tariffs according to the BMG's testing ordinance of 27.01.2021 would generate weekly costs in the low three-digit million range. (2) Voluntary 5-day isolation of 100,000 persons/week in quarantine hotels per week would cost up to EUR 25 million weekly, assuming hospitality costs of EUR 50 per day and person. Advantages: a) Avoidance of chain infections in the household during home isolation; b) Investment directly benefits the participating hotels.

- **Stimulate innovation dynamics:** A proactive strategy should include targeted subsidies and investments to generate further innovation, for example in the digital health or education. Companies (especially start-ups) that are active in key areas of pandemic response (e.g. testing, laboratories, vaccines, digital health systems, ventilation, hygiene, location tracking, etc.) could also receive specific incentives or subsidies (e.g. under tax law or with special research funding, accelerated approval and evaluation procedures, experimental market launches, etc.)
- **Labor law measures to support self-isolation and quarantine**: A preventive, proactive quarantine based on a positive, self-conducted rapid test can only work if it is treated like sick leave under labor law (especially protection of employment and continued payment of wages).

For further restrictions in the economy, the following tools for decision-making should be taken into account:

- **Working from home:** In order to minimize the negative consequences for the economy, working-from-home solutions should first be implemented as comprehensively as possible, wherever the job in question allows. Empirical research shows that about 56 percent of activities in Germany can be done from home (Alipour, Falck et al., ifo Schnelldienst 73(7) 2020). The costs of such a provision are limited, and working from home can contribute significantly to reducing the incidence of infection (Alipour, Fa-dinger et al., ifo WP 2020). Companies are urged to take appropriate IT precautions in their operations so that, wherever possible, work can be done from home when the local infection incidence requires it.
- **Individual transportation:** In addition to working from home, ways should be found to encourage the use of individual transportation wherever possible when travelling to and from work, so that contacts in public transportation are reduced to the minimum necessary.
- **Hygiene and testing protocols**: In addition, it is imperative that companies adapt their hygiene protocols to clinical hygiene standards. Suitable protective measures must be verifiably taken (e.g. individual workspaces; small and fixed working groups where necessary; FFP2 masks; ventilation technology; smart, adaptive test strategies including pool testing or wastewater tests – see also TB "Test-Trace-Isolate"). In addition, traffic light systems could regulate the flow of visitors in retail settings.
- **Compliance:** The experience of spring and summer 2020 showed that some companies and shops implemented hygiene protocols and contact tracking requirements consistently and invested heavily in them, while others largely disregarded them. Yet in certain sectors, all businesses nationwide were affected by lockdown, without taking individual conditions into account (e.g. all restaurants and hotels were closed). In order to continue to set the right incentives in the future, an efficient and more standardized implementation of hygiene standards must be part of decisions about imposing or lifting restrictions. A self-certification model and random inspections are both conceivable here. Those who cannot meet the standards must be closed down as soon as restrictions are imposed.
- **Ability to plan ahead:** Companies and employees need a stable environment which allows them to make plans. It would be highly uncertain and costly if every company had to close down every time a single infection of unknown origin was detected. This

uncertainty would result in a lack of investment, and some companies might be hesitant to begin or increase operations, even in a Green Zone. Employees would fear having to go on the *Kurzarbeit* scheme or furlough at short notice. For this reason, policies should be implemented here which are adapted to the regional conditions of the individual Green Zone, and which minimize the risk of an uncontrolled outbreak, while taking into account the proportionality of the economic impact on affected companies. There is no question that as soon as an infection of unknown origin appears, it is necessary and in the very interest of the companies to apply the standard social distancing, hygiene, masking and ventilation protocols as well as other, additional measures (e.g. a traffic light system in retail). If a rapid and uncontrolled increase in infections can be expected with a high degree of probability, this will also result in high economic uncertainty and impact on economic activity (even without government-imposed closures). Therefore, it may also be generally reasonable for industry to temporarily accept further restrictions. Current epidemiological research suggests that the infection level becomes unstable and uncontrolled at incidences in the range of 10 or more (Contreras et al., medRxiv 2020). In order to give companies an ability to plan ahead, within the Green Zone strategy, an incidence of 10 or more could serve as a reference point above which stronger government restricts on economic activity, up to and including temporary closures, can be expected. Locally, however, earlier restrictions may be proportionate if this would allow for the size of a local outbreak with many contacts to be contained immediately.

- **Intensity of value creation:** If lockdown measures and restrictions on economic activity ultimately do have to be implemented, decisions about closures should take into account not only the risk of infection, but also, in particular, losses to value creation. Since closing large factories and reopening them later is associated with high fixed costs, sectors with a low risk of infection relative to added value, e.g. highly automated factories, and sectors with very high added value per employee (especially manufacturing), should be allowed to continue production (Fuest, Lohse, et al. 2020). Manufacturing plants should remain open as long as there are no SARS-CoV-2 infections in the workplace, even if they are not in a green zone and the local incidence of infection is high.
- **Supply chains:** To be able to maintain production in companies with high added value relative to the risk of infection, government safety measures must also take into account (cross-border) supply chains. Economic losses could otherwise rise sharply, especially in German industry (even without closures) (Sforza & Steininger, CESifo WP 2020).
- **Border traffic:** Traffic from Red to Green Zones is limited to essential mobility (including commuter and freight traffic) with certain test and quarantine conditions (see TB "Green Zone", this paper). Particular challenges arise in the case of long-distance and especially air travel. The use of modern digital tools (e.g. digital test passports or health passports) would be very useful here. Airports and train stations also need to be appropriately equipped and surveilled so that random checks – at a minimum – can be used to monitor compliance with infection control measures and mobility restrictions between red and green zones. In particular, entry into the Schengen area from areas with a high incidence should be monitored in such a way as to prevent newly infected persons, especially those carrying virus mutations, from entering Europe. Traffic at border crossings should be organized in a way that avoids significant constraints on supply chains.

- **Evidence-based closures:** To better ensure that closures are targeted and effective, and to enable evidence-based decision-making about closures, more and better data must be collected (see above the point "Collection and evaluation of test data").