



SHIFTING OUT OF LOCKDOWN

The Four Days On, Ten Days Off Model

By Professor Keith Willison and Matthew Lesh

BRIEFING PAPER

EXECUTIVE SUMMARY

- The COVID-19 lockdown was justified for clinical reasons, however it is broadly acknowledged that it is causing substantial economic, educational and social disruption and should be phased out as quickly as is safely possible.
- The UK has now passed peak infections, but it remains in the danger zone. There is concern that reducing the draconian lockdown measures could cause a second peak that overwhelms the healthcare system and necessitates a more damaging second lockdown. The public is also worried about loosening the lockdown, with many expressing that they would prefer to not return to work or send their children to school.
- It is now necessary to develop creative solutions that enable people to get back to work while avoiding a second peak of infections.
- In order to be effective, these solutions should allow for variation in local circumstances while ensuring broad safety of the public.
- One such solution that should be considered, along with other measures such as social distancing, ‘track, trace and quarantine,’ and hygiene, is the Weizmann Institute of Science’s ‘Four Days On, Ten Days Off’ cyclic strategy:
 - Populations would be divided into two groups of households. Each group would work or attend school for four days, Monday through Thursday, and then enter a 10 day period off. Each group works or attends school while the other group is off. Individuals in the two groups do not interact with each other.
 - The advantage of this approach is that it would limit social interactions, reduce pressure of public transport and enable greater social distancing in schools and workplaces by halving numbers.
 - Individuals who become symptomatic would be likely to do so during their ‘off’ period, limiting their ability to unintentionally spread the virus.
 - It would immediately allow a large number of people who are not able to work or study to return to 40% employment or education, reducing the impact of the lockdown while keeping people safe.
 - Extensive modelling has found it would maintain R_0 below 1, therefore reducing the probability of a second peak. The specific work/off work ratio can be varied in response to observations.

- If the Government wants to safely reopen the economy while avoiding a surge in infections that overwhelms the healthcare system, they should:
 - avoid excessively prescriptive guidance to business about how to safely operate;
 - allow businesses to develop innovative, sector and company-specific protocols;
 - encourage creative and innovative methods in how to operate such as the ‘Four Days On, Ten Days Off’ ; and
 - trial new approaches, such as the ‘Four Days On, Ten Days Off’ spearheaded by the Weizmann Institute, in the civil service and education sector.

ABOUT THE AUTHORS

Professor Keith Willison is the Chair in Chemical Biology at the Faculty of Natural Sciences, Department of Chemistry, Imperial College London.

Matthew Lesh is the Head of Research at the Adam Smith Institute.

It has been widely acknowledged that while clinically justified, the UK's COVID-19 lockdown is causing substantial disruption to people's lives.¹

On the economic front, millions of people have already been made unemployed or are likely to become so in the coming weeks and months. Thousands of businesses are running out of cash, with more and more likely to cease operations the longer the lockdown continues.² On the educational front, millions of school children are losing essential time in the classroom. There is strong evidence that the impact is not equal: students from more disadvantaged backgrounds are less likely to be receiving instruction at home.³ On the social front, the pathologies of loneliness, depression, anxiety and domestic violence are becoming increasingly widespread.⁴

The UK has now passed the peak of infections, but is not out of the danger zone. There are still thousands more confirmed cases per day, indicating continuing widespread community incidence of the virus. The next step will be to find a way out of the lockdown while preventing the virus from once again taking hold, potentially overwhelming the healthcare system and leading to calls for an even more damaging second lockdown. To do so, it will take the likes of continuing physical distance and hygiene, shielding the most vulnerable, 'test, trace and quarantine', border measures, mask wearing, expanded hospital capacity and improved treatment, and eventually vaccines. It will also take innovative solutions, rather than binary thinking, to safely phase out the lockdown.

This paper outlines the challenge ahead and the need for creative solutions. It proposes the 'Four Days On, Ten Days Off' approach developed by the Weizmann Institute, as a potential innovative solution for the public and private sector. It concludes that no single approach will be appropriate for every sector, industry, or even every organisation. Instead, organisations should be encouraged to develop and experiment with appropriate procedures.

THE CHALLENGE

The Government is reportedly developing a phased plan to exit the lockdown, involving a wide array of strategies across different sectors.⁵ The key priority, accord-

¹ Eamonn Butler and Matthew Lesh, "REOPENING BRITAIN: The Economic Urgency" (April 2020), <https://www.adamsmith.org/research/reopening-britain-the-economic-urgency>.

² Andy Verity, "Coronavirus: A fifth of smaller UK firms 'will run out of cash'" BBC News, April 1, 2020, <https://www.bbc.co.uk/news/business-52114414>.

³ University of Exeter, "Covid lockdown could leave disadvantaged children with "learning loss" of six months, experts warn" https://www.exeter.ac.uk/news/research/title_791543_en.html.

⁴ Mental Health Foundation, "Almost a quarter of adults living under lockdown in the UK have felt loneliness" <https://www.mentalhealth.org.uk/news/almost-quarter-adults-living-under-lockdown-uk-have-felt-loneliness>.

⁵ Robert Mendick and Christopher Hope, "How the Government plans to start ending lockdown" The Telegraph, April 28, 2020, <https://www.bbc.co.uk/news/business-52114414>.

ing to Prime Minister Boris Johnson, is to avoid a “second peak” of infections that overloads the healthcare system.⁶ If this is to be achieved, it will be necessary to be cautious while allowing as much activity to return to normal as quickly as possible.

The Government’s initial strategy was to accept some community spread, however this has now changed. The ‘Coronavirus action plan’ launched on 3 March stated that the Government’s strategy would be to ‘Contain’ that is, “*detect early cases, follow up close contacts, and prevent the disease taking hold in this country for as long as is reasonably possible (emphasis added)*”.⁷ This was followed by the move to the ‘Delay’ phase on 12 March, in which the goal would be to “*slow the spread in this country, if it does take hold, lowering the peak impact and pushing it away from the winter season (emphasis added)*”.⁸ In recent weeks the Government appears to have set a more ambitious goal to adopt a South Korean-style ‘suppression’ strategy, in which, once again, cases would be identified, tracked and quarantined.⁹

The new strategy is extremely ambitious considering the existing number of infections in the community. It is much easier to suppress a virus that has not taken hold significantly. The Prime Minister has stated that the first step is to continue lowering the ‘R0’ or the ‘reproduction rate’, which indicates how many people the average infected person passes the virus on to, to reduce infections in the community.¹⁰ This goal is complicated by the lack of precise knowledge about the current R0, or how long it will take for the number of cases to decline to the level where a suppression strategy is viable. Waiting until the case numbers fall to an extremely low level before phasing return to normality risks allowing lockdown to continue longer than is absolutely necessary. It would compound the economic, social and health impacts of the lockdown. It also risks a loss of public support for necessary measures.

It is important to remember that the lockdown is not a binary proposition. Few commentators suggest that there should be a sudden end to all forms of social distancing or a sudden return to “normal”. In any case, if the Government did propose such a strategy it is unlikely that the public would return to normal behaviour, particularly as the threat continues. Even if there were a very low number of infections, and a very strong tracking and tracing regime, it will take substantial time before people even feel comfortable enough to return to school, universities and workplaces. Nevertheless, there is emerging evidence from countries such as

6 GOV.UK, “PM statement in Downing Street: 27 April 2020” <https://www.gov.uk/government/speeches/pm-statement-in-downing-street-27-april-2020>.

7 UK Government, “Coronavirus (COVID-19) action plan” (March 2020), <https://www.gov.uk/government/publications/coronavirus-action-plan>.

8 GOV.UK, “COVID-19: government announces moving out of contain phase and into delay” <https://www.gov.uk/government/news/covid-19-government-announces-moving-out-of-contain-phase-and-into-delay>.

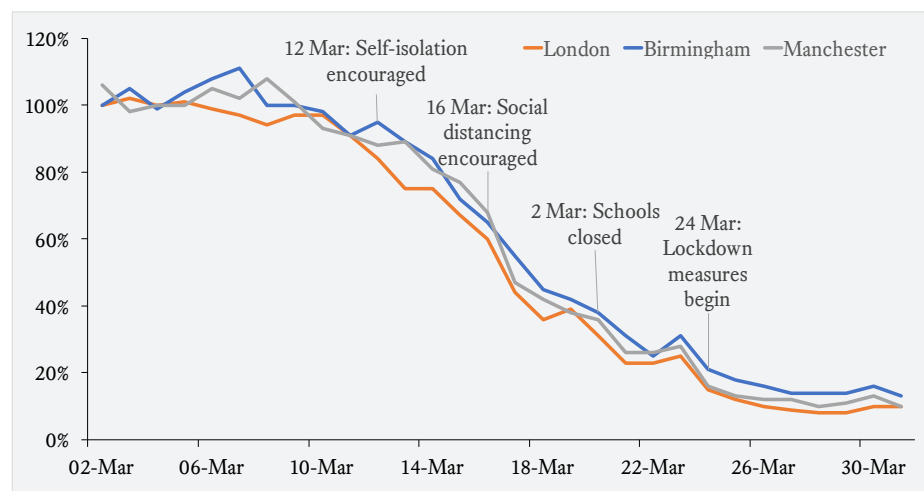
9 James Forsyth, “Boris Johnson’s cautious path out of lockdown” *The Spectator*, April 28, 2020, <https://www.spectator.co.uk/article/boris-has-found-a-path-out-of-lockdown-but-it-wont-be-smooth>.

10 GOV.UK, “Prime Minister’s statement on coronavirus (COVID-19): 30 April 2020” <https://www.gov.uk/government/news/prime-ministers-statement-on-coronavirus-covid-19-30-april-2020>.

Denmark, Czech Republic, and Germany, that easing lockdown measures has not led to a spike in cases.¹¹

There remains strong support for the closure of restaurants, pubs, schools and stadiums.¹² A YouGov poll found that just one-in-four would feel safe returning to work.¹³ Most would continue to feel uncomfortable going to bars, restaurants or large events.¹⁴ Additionally, there is strong evidence that Britons began distancing before the beginning of mandated lockdown on 24 March (See Figure 1). Furthermore, following the introduction of lockdown many more businesses than the Government expected came to shut down and a lot fewer people sent their children to school than was expected.¹⁵ This points to the complexity of trying to direct human behaviour, and highlights the critical need for organisations to develop new procedures to ensure that people feel safe.

FIGURE 1. CITYMAPPER MOBILITY INDEX, LONDON, BIRMINGHAM AND MANCHESTER, MARCH 2020



Source: Adam Smith Institute/Citymapper

¹¹ The estimate for Germany's R0 on one day included, within the range of possibilities, 1 at the higher end. It has since reduced to R= 0.78 (95% prediction interval: 0.66-0.90) on 2 April, see https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Situationsberichte/2020-05-02-en.pdf?__blob=publicationFile & <https://www.theguardian.com/world/2020/apr/30/danes-and-czechs-say-easing-lockdowns-has-produced-no-covid-19-surge>

¹² Toby Helm, Robin McKie and Lin Jenkins, "Fearful Britons remain strongly opposed to lifting coronavirus lockdown" The Guardian, May 3, 2020, <https://www.theguardian.com/world/2020/may/02/fearful-britons-oppose-lifting-lockdown-schools-pubs-restaurants-opinion-poll>.

¹³ Caroline Wheeler, Nicholas Hellen, Tim Shipman and Chris Smyth, "Coronavirus lockdown: set free healthy over-70s, say doctors" The Times, May 3, 2020, <https://www.thetimes.co.uk/article/coronavirus-lockdown-set-free-healthy-over-70s-say-doctors-lxhvf8vzb>.

¹⁴ Ipsos MORI, "Majority of Britons uncomfortable returning to large sport or music events, public transport and bars or restaurants post lockdown" <https://www.ipsos.com/ipsos-mori/en-uk/majority-britons-uncomfortable-sport-music-bars-coronavirus>.

¹⁵ Fraser Nelson, "Boris is worried lockdown has gone too far, but only he can end it" The Telegraph, April 9, 2020, <https://www.telegraph.co.uk/politics/2020/04/09/boris-worried-lockdown-has-gone-far-can-end/>.

It will be necessary to build support from the general public as well as the educational and business sectors, for any measures. This will mean building new processes in careful consultation with all stakeholders. At the absolute most, the Government should seek to guide rather than dictate the appropriate measures.

The next steps must consider three key elements:

- (1) Epidemiological: Minimises the risk of a second peak that overwhelms the healthcare system;
- (2) Economic: Enables the maximum possible return to business and educational normalcy while keeping individuals safe; and
- (3) Social: Provides reassurance in response to safety concerns and ensures broad public support in the new measures.

There will be no silver bullet in achieving these goals. No single approach can be expected to be successful. Nor should a ‘top-down’ strategy be adopted. We should not assume that a solution that works for a particular industry, or even a specific business, will work for others. We should be open to creative, varied, bottom-up solutions to the challenge we now face. Excessive state-direction also risks too much risk-taking, rather than too little, if companies do the minimum necessary in guidelines rather than considering the maximal steps they can take.¹⁶

A CREATIVE SOLUTION: FOUR DAYS ON, TEN DAYS OFF

It is necessary to develop creative solutions that can achieve the difficult goals of sustainably reopening the economy while avoiding a second peak and providing public reassurance. One such model, ‘Four Days On, Ten Days Off’, is proposed by Professor Uri Alon and Professor Ron Milo of the Weizmann Institute in Israel in collaboration with academic economists and public health and political policy experts.¹⁷

THE MODEL

While the modelling behind the proposal is relatively complex, the conclusion is relatively simple: the population should be divided into two groups of households. Each group should work or attend school for four days, Monday through Thursday, and then enter a 10-day period off (See Figure 2). Each group works or attends school while the other group is off. Individuals in the two groups do not interact with each other. This cycle repeats.

¹⁶ Chris Berg has discussed this tendency, see <https://www.wsj.com/articles/SB10001424052702304444604577337923643095442>

¹⁷ The detailed plan is available in pre-publication form: <https://medium.com/@urialonw/adaptive-cyclic-exit-strategies-from-lockdown-to-suppress-covid-19-and-allow-economic-activity-4900a86b37c7> and a short version for public policy makers is also available here: <https://docs.google.com/document/d/1uWimqAgOf0624lWkwCzi4e1VFU7OOpKXeZ4UncfaEOU/edit>

FIGURE 2. THE TWO WEEK 4-10 CYCLE

cycle of 4 work days and 10 lockdown days for each group

	Mon.	Tue.	Wed.	Thr.	Fri.	Sat.	Sun.
week 1	work	work	work	work	lockdown	lockdown	lockdown
week 2	lockdown	lockdown	lockdown	lockdown	lockdown	lockdown	lockdown

The return of the school system to activity in two groups enables return to work in the economy. The school system is central because of its importance both for education and for work: as long as children are at home, many parents cannot go to work.

The school system enters a routine where half of the students study Monday-Thursday and the other half in the following Monday-Thursday. This also enables smaller classes, which facilitate physical distancing. A cyclical model is being adopted by Austria, where students will be split into two groups, one attending Monday to Wednesday and the other Thursday to Friday, then swapping the following week.¹⁸ Denmark has reopened primary schools with split classes, and Germany plans to do the same.¹⁹

This distancing effect will also manifest itself in laboratories and companies, which apply the 4-10 regime. It will be up to their operations managers to establish the most effective site-specific solutions. It also provides other advantages, such as limiting the numbers of people on public transport.

The benefit of two non-overlapping groups is that complex and longer term operations such as experiments and fabrication can be conducted sequentially by the two teams. In the 10 day lockdown time workers and students will be able to contribute to split-time activities from home.

It is possible for people who can work from home to continue to do so, while their children are educated four days a week in the physical environment of school and given instructions from their teachers for activities for the other six school days. This would be a substantial improvement on the status quo of zero days per week of schooling.

Additionally, it is expected that essential workers would continue as currently. Selected sectors with low risk of infection can also work continuously. All non-essential workers join their household group and work only during the 4 days of their group. Individuals at high-risk would continue ‘shielding,’ that is, avoiding all social interactions.

Intermittent work cycles are easy to explain and enforce, and the adaptive steps create trust and certainty because adaptation requires data from testing. This is a

¹⁸ “Austria will reopen schools with split classes next month,” Reuters, April 24, 2020, <https://www.swissinfo.ch/eng/reuters/austria-will-reopen-schools-with-split-classes-next-month/45714214>

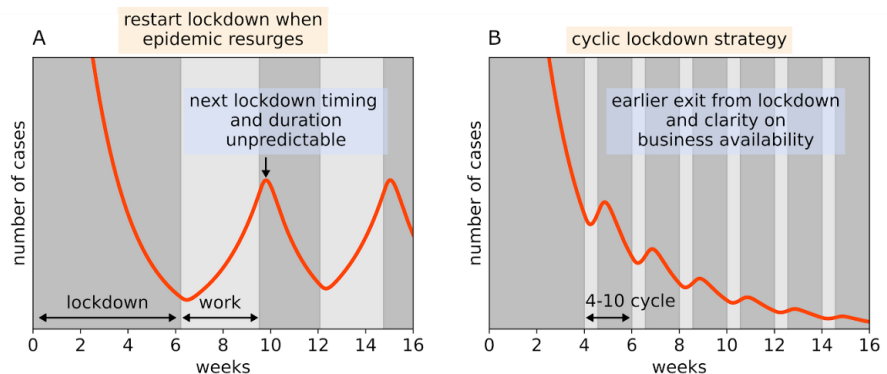
¹⁹ Dan Worth, “Reopening schools: lessons from Denmark and China,” TES, 28 April, 2020, <https://www.tes.com/news/coronavirus-reopened-schools-show-new-normal>

very important psychological driver and vital for our worried population. The idea of local arrangements is also important; it encourages buy-in and team building within organisations as well as neighbourhoods.

THE EPIDEMIOLOGICAL LOGIC

The specific schedule of four working days and then ten lockdown days is selected because it suppresses the epidemic and causes a decrease in the number of cases, as shown in the graph (See Figure 3B). The overarching goal is to prevent a second wave of the epidemic (See Figure 3A) that would require a full lockdown with serious economic, health and social consequences. This is achieved by ensuring the replication number (R_0) is maintained below 1, to avoid a resurgence of the epidemic. By creating two separate groups that do not interact it limits the ability to transmit and also ensures people spend a large amount of time not interacting with a large number of people, avoiding infecting others.

FIGURE 3. CYCLIC WORK-LOCKDOWN STRATEGY CAN CONTROL THE EPIDEMIC, PREVENT RESURGENCES AND OFFER PREDICTABLE PART-TIME EMPLOYMENT²⁰



a) Exit from lockdown carries the risk of resurgence of the epidemic, with need to re-enter prolonged lockdown. b) A cyclic work-lockdown strategy prevents resurgences by keeping the average $R < 1$. It thus allows an earlier exit from lockdown, and provides a clear part-time work schedule. Transmission rates provide R in lockdown and work days of $R_L = 0.6$ and $R_W = 1.5$ respectively.

The Weizmann plan proposes exit strategies from lockdown that provide sustainable, albeit reduced, economic activity. They use mathematical models to show that a cyclic schedule of 4-day work and 10-day lockdown, the 4-10 cycle, (Fig 3B and Fig 2), or similar variants, can, in certain conditions, suppress the epidemic while providing further employment and education. Their mathematical models are freely available.²¹ It has been tested and found effective using SEIR models and stochastic network-based simulations.

The 4-10 cycle uses the timescales of the virus against itself. Imagine that a worker gets infected with COVID-19 on the first day at work. By day four, he or she is be-

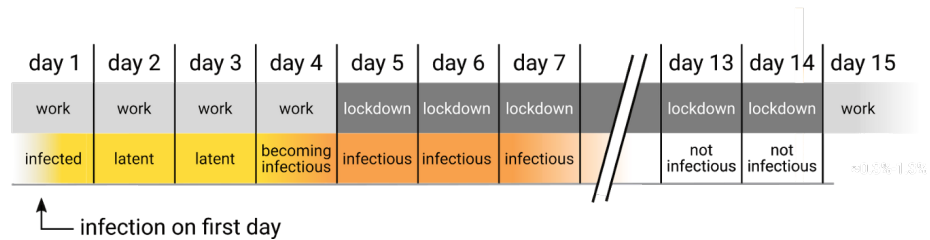
²⁰ Karin, O et al (2020) Adaptive cyclic exit strategies to suppress COVID-19 and allow economic activity.

²¹ https://colab.research.google.com/drive/1HmYVBzxf68rnB1z_LeSBHNHffrrvcna
Stochastic: https://github.com/omerka-weizmann/2_day_workweek/blob/master/code.ipynb

coming infectious and is fully infectious from day 5 onwards, but by then he or she is at home on 10 day lockdown and can only infect his immediate household group. By the end of 10 days at home he or she is either unlikely to be infectious or facing serious symptoms requiring hospitalization. If the worker has had a mild infection, as most people do, they will start a new 2 week cycle and go to work but will not be excreting virus particles.

FIGURE 4. THE CYCLIC EXIT STRATEGY IS AIDED BY PLACING PEAK INFECTIOUSNESS IN THE LOCKDOWN DAYS

Those infected at work reach peak infectiousness during lockdown days



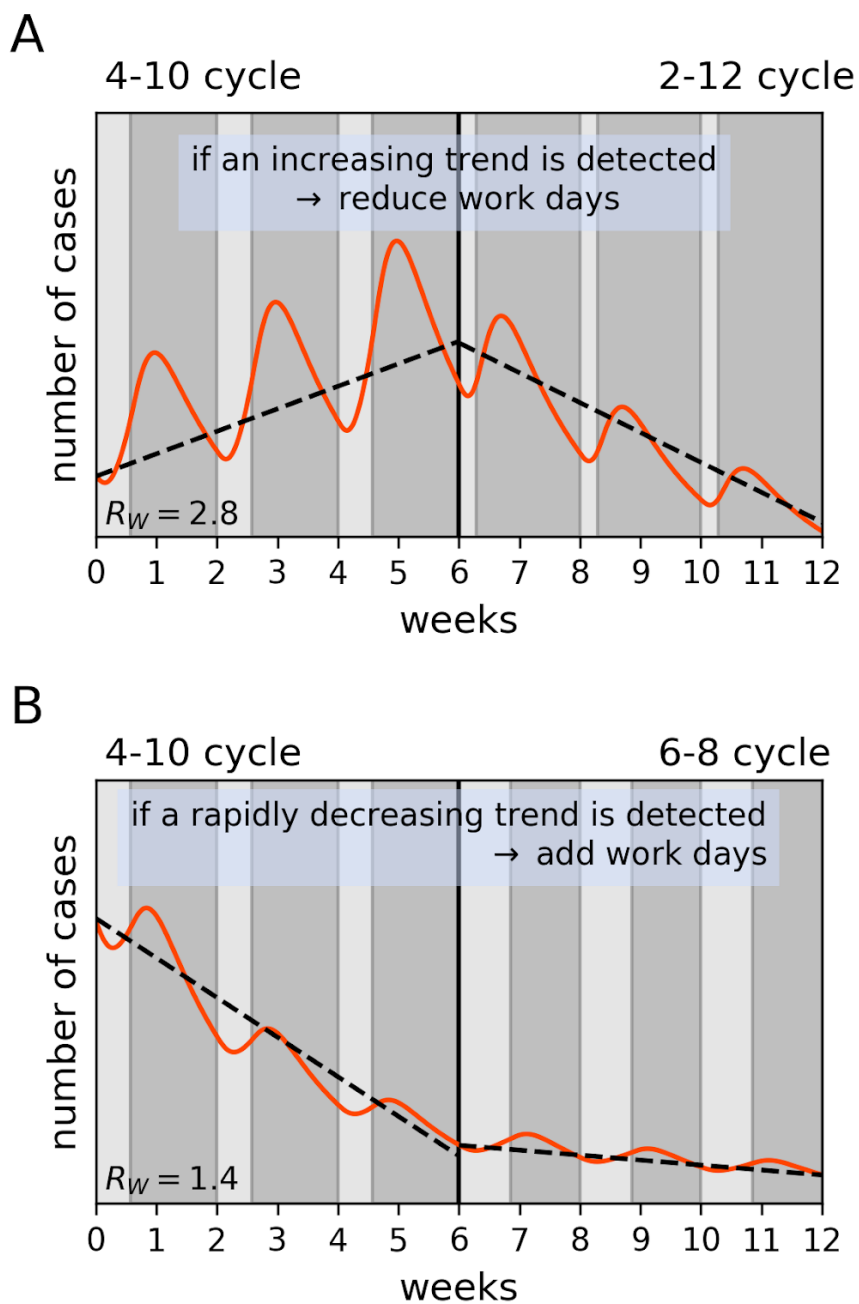
SARS-CoV-2 has an average latent (non-infectious) period of about 3 days. A 14-day cycle in which people enter lockdown after 3 or 4 work days benefits from this property. Even those infected on the first day of work spend most of their latent period at work and reach peak infectiousness during lockdown. This reduces the number of secondary infections.

If the worker becomes ill they can stay at home to recuperate. The approach is adaptive, so if after a month, which equals two 14-day cycles, cases of COVID-19 are on the increase then a mitigating 2-12 cycle can be trialled. If, however, the number of new cases in the local area is declining then more work days can be added e.g. a 6-8 cycle; 6 days at work followed by 8 days at home.

The graph in Figure 3B shows a prediction from the modelling. Remarkably the 4-10 cycle results in a diminishing infection rate over a 2 month period and no 'second spike'. This is because the 4-10 cycle reduces the reproduction number R_0 by a combination of reduced exposure time and an anti-phasing effect in which those infected during workdays reach peak infectiousness during lockdown days.

The number of workdays can be adapted in response to observations and measured changes in R (See Figure 5). Interested readers can use the GUI listed above to generate their own model version of Figure 3B; by varying the infection rates at home and work and the cycle period.²² Throughout, full epidemiological measures need to continue, including hygiene, physical distancing, compartmentalization and extensive testing and contact tracing.

²² See 'graphical user interface': <https://cyclic-strategy.herokuapp.com/>



(a) If average R is above 1, cases will show a rising trend, and number of work days in the cycle can be reduced to achieve control. (b) Number of work days per cycle can be increased when control meets a desired health goal.

This cyclic exit strategy is a conceptual framework, which, when combined with other interventions to control the epidemic, can offer the beginnings of predictability to many economic sectors. It could be trialed in some sectors and geographies before it is considered for wider adoption.

It would also serve a temporary stopgap, to allow for a safer return to work while other mechanisms to avoid spread (such as test, trace and quarantine) are further developed. As discussed, over time the work week could be varied depending

on the current level of transmission. In either case, this would be much less of a sledgehammer approach compared to entering and leaving a full lockdown. It would immediately allow a large number of people who are not able to work or study to sustainably return to 40% part-time employment or education, therefore substantially reducing the impact of the lockdown while keeping people safe.

CONCLUSION

The lockdown is already having devastating effects on most parts of the UK economy. It is vital that we have plans to prevent a long-term economic catastrophe while shielding as much of the population as possible from the ravages of the COVID-19 virus. Balancing the two goals is a complex political problem which can only be helped by open discussion of the policy options underpinning the final plans. These plans must also be understandable to the public because each of us will be implementing our own personal version in the coming weeks.

This paper discusses the need for imaginable solutions, such as those proposed by the Weizmann Institute which contains new analysis and ideas and scalable options for schools and companies to towns and regions. The options themselves emerge from a complex, hybrid analysis of the biology of systems at many levels; from the properties of the tiny virus all the way up to human behaviour. Systems biology is the application of mathematical and computational techniques to biological problems. When conducted properly, systems biology uses known numbers and rigorous mathematical tests to build models to describe and solve a biological problem.

If the Government wants to safely reopen the economy while avoiding a surge in infections that overwhelms the healthcare system, they should:

- avoid excessively prescriptive guidance to business about how to safely operate;
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- encourage creative and innovative methods in how to operate such as the ‘Four Days On, Ten Days Off’ ; and
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