M.M.WARBURG & CO
BANK

ECONOMIC SITUATION AND STRATEGY January 22, 2021

Lockdown, R number, mutations: What policymakers and markets can learn about covid-19 with Apple and Google data

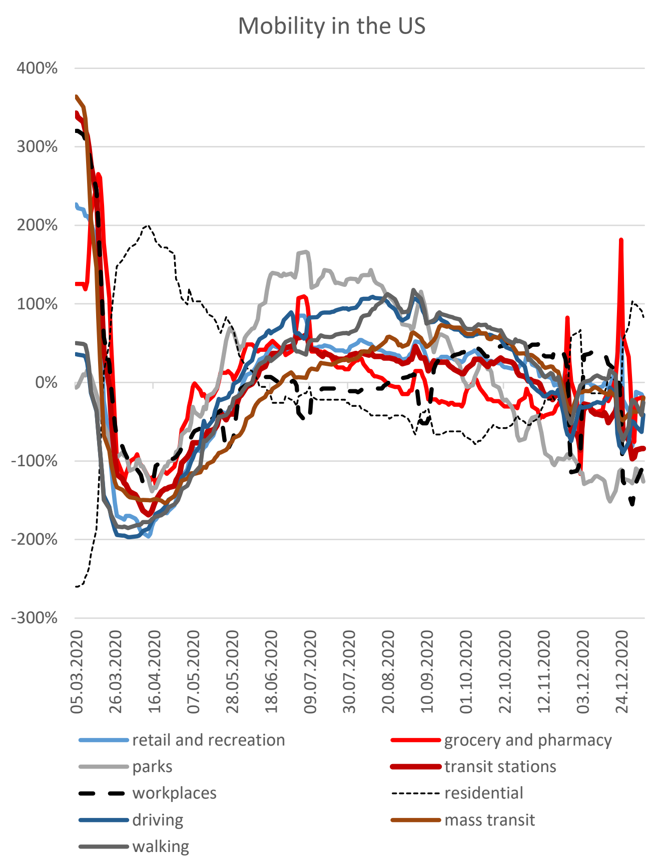
Listening closely, you could hear a sigh of relief on the markets yesterday after the new US president, Joe Biden, took the oath of office and the dust of the last four years started to settle. The expectation of somewhat more dependability and predictability from the US government is also likely to help the markets in the weeks and months ahead. Nevertheless, we should not assume prices will go on scaling one peak after the next without high volatility. After all, the world is still in the midst of a pandemic, and how that develops remains a huge and imminent threat to the market's vitality. The dominant (and plausible) working hypothesis now appears to be as follows. In the coming weeks, the incidence of infection, which has recently grown exponentially, can be brought back under control by means of lockdowns. Infection numbers would then have to start falling in early spring, and herd immunity should be sufficiently established through vaccination so that people will be able to spend next winter mostly without restrictions.

But is there an error in our reasoning? Is this scenario realistic? Have we overlooked something? For some months, the opinion developed that lockdowns do not produce the desired result and are therefore unnecessary. On the other side are those who point to mutations and therefore advocate a "zero-tolerance" super-lockdown strategy. What surprises us is how little this debate relies on data. The world is struggling with the worst pandemic in a century, people are falling ill and dying from it, companies face extreme challenges, but it seems that many decisions are ultimately being made from the gut. However, we do not want to fall into the political debate here, because that is not constructive and will not accomplish much. Instead, we have done something that economists and capital market experts can do relatively well. We have looked at available data and used every technique in the book to squeeze out tenable conclusions that may be interesting to both investors and policymakers.

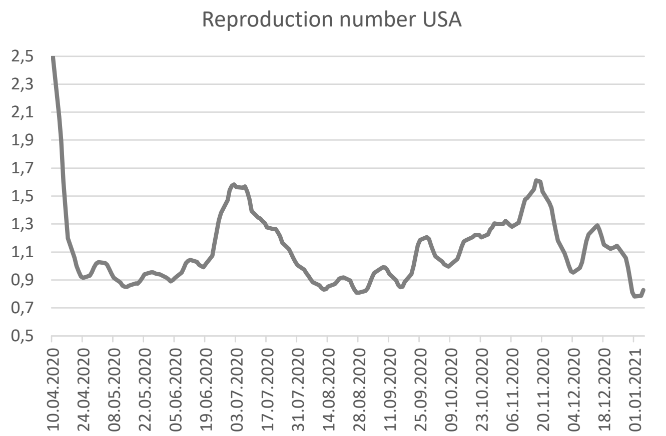
But first things first. It is generally accepted that the speed at which covid-19 spreads is directly related to the frequency of contact between people. Contact frequency is in turn a function of people's mobility. Excellent data is available from Google and Apple that provide a detailed picture of what type of mobility is involved. Are people going by public transportation or by automobile? Are they going to work or shopping, to the grocery store or the shopping center? Or are people taking walks in the park? All these data, going back day by day for the last year, are available.

It is a little surprising that not more attention focuses on this information. The chart below shows, for example, the mobility data for the United States adjusted for weekend effects. The comparatively severe lockdown of March 2020 is clearly discernible. In contrast to lower mobility at work or in public transportation, mobility is high in the residential area, which is logical since people must stay at home when there is a lockdown.

The low mobility of the last two months is partly due to the weather (people are generally less mobile in the winter than in the summer), but lockdowns are also playing a role here again.



This mobility may be used to estimate the severity of a lockdown and the associated contact frequency in order to explain infection incidence.

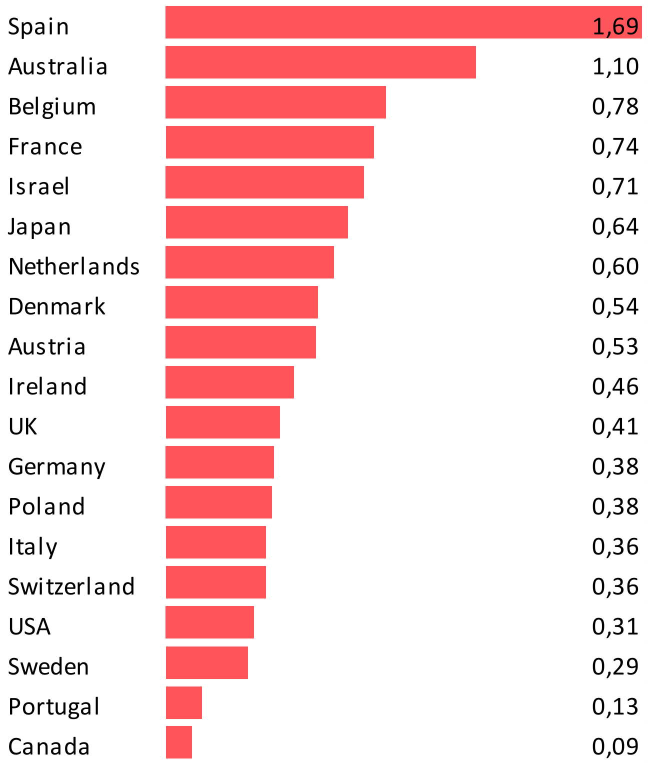


However, it is not enough to simply explain the number of new infections. The R number, which expresses the number of people infected by one infected person, is more informative for that purpose. The chart above shows, for example, the R number trend in the United States, and we have used the same method to calculate the R numbers for many other countries.

To understand better what effect mobility has on the R number, we have performed a regression analysis in which we measure the *change* of mobility over a certain period to explain the *change* of the R number. In this way, we can answer comparatively well whether lockdowns have any effect at all and what type of mobility restriction has which effect on the R number.

However, it does not make much sense to conduct such an investigation for just one country. For this reason, we have made these calculations for nearly 20 national economies. To start with, we can say that lockdowns have a significant influence on the R number in every country.

Change in the reproduction number when mobility changes by one standard deviation



In most countries, a reduction of mobility by one standard deviation leads to a decline of the R number by about 0.4-0.5 points (for comparison, mobility fell in the United States by significantly more than one standard deviation in March 2020).

The chart above refers to the R number that results from the change in the average of all of the country's mobility data – and in fact some days after mobility underwent the change.

The maximum effect usually occurred after four or five days (which incidentally also makes sense biologically, if one assumes an incubation period of four days), but may vary a little from country to country and may still be observed as highly significant even ten days later.

But why are there such large differences among the countries? We see a number of possible explanations. Mobility in Spain, for example, has been affected to a greater extent by lockdowns which concern the tourism sector. We may infer from this that travel and tourism in general are a considerable source of infection. That Portugal emerges on the other end of the chart may also have to do with its generally more restrictive handling of tourism in 2020 compared with Spain.

In view of its low sensitivity, Canada is a somewhat puzzling case. A possible explanation would be that a variation of mobility expresses itself less strongly in a sparsely populated country than in a densely populated one. That would perhaps also explain why many densely populated countries are in the upper part of the chart, but that is surely speculation to a certain extent.

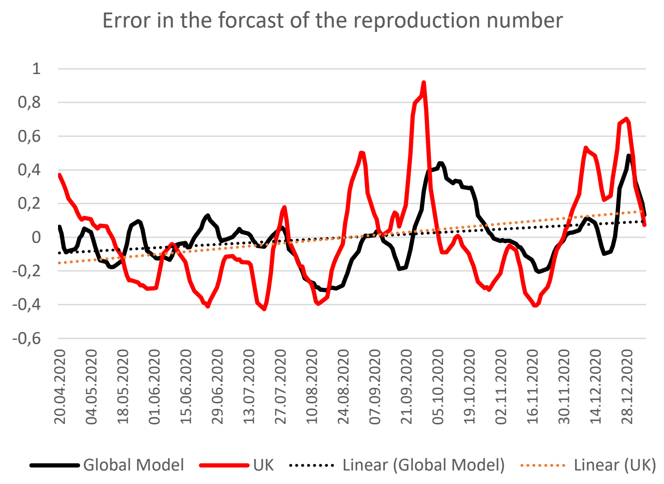
However, the connection between the type of mobility and the extent of the effect on the R number is not speculation. In the appendix below, we present a table that shows how the R number varies on average across all analyzed countries as a function of the investigated time lag and the type of change in mobility.

In particular, we find out there that a restriction of mobility by public transportation appears to have a heightened effect on the R number. This does not necessarily imply that the infection occurs directly in the subway or bus. But it strongly suggests that there are activities in the context of using public transportation that lead to contacts and those in turn cause the R number to rise sharply. Shopping and other leisure activities, which likewise exhibit high sensitivity in respect to the R number, are presumably connected with that.

Moreover, it is interesting to note that food shopping is not a pandemic driver, nor is the workplace. Strolling in the park is also unproblematic – anything else would have been surprising.

However, our analyses yield another interesting insight. Every good statistician examines the errors made by his models, since those errors provide indications of whether the model has been incorrectly specified. An attempt, for example, to explain a country's R number based on mobility using our models will inevitably generate errors from day to day. However, they should be distributed inconspicuously and exhibit no pattern. But that is absolutely not the case in Great Britain.

It has become increasingly difficult to estimate the R number trend there accurately in recent months. The R number is now about 0.3 points above the value that one would expect based on mobility. This effect, albeit significantly less pronounced, may also be observed worldwide. So, there is a systematic explanatory factor that has been missing in the equation. But there is a likely explanation. This could be (and probably is) a result of mutations that are more infectious than the "original" virus, whose properties have been the basis for evaluating the equations so far.



Our calculations thus furnish important insights for both policymakers and investors, which we summarize as follows. It may be clearly demonstrated that lockdowns work. However, different types of restrictions affect the R number differently. Outdoor activities are not problematic, nor does the workplace appear to promote infection on a large scale. Caution is advisable when engaging in leisure activities, shopping (except for food), travel, and tourism. The mutations have to be taken seriously. There is no reason to panic, but the effect is statistically measureable. It is therefore more important than ever that as many people as possible get vaccinated very quickly worldwide. If that does not happen, the stock markets will have to reconsider their still very positive scenario. But we remain optimistic for the time being.

Appendix: Effect of mobility change by one standard deviation on R number average across 19 countries

		same day	plus 1 day	plus 2 days	plus 3 days	plus 4 days	plus 5 days	plus 6 days	plus 7 days	plus 8 days	plus 9 days	plus 10 days	plus 11 days	
Google	Retail and leisure	0,13	0,18	0,21	0,22	0,21	0,19	0,16	0,15	0,15	0,18	0,22	0,25	0,25
	Food and drugstore	0,10	0,13	0,13	0,11	0,07	0,02	-0,02	-0,05	-0,04	0,00	0,06	0,12	0,13
	Parks	0,09	0,09	0,08	0,07	0,06	0,05	0,04	0,02	0,01	-0,01	-0,01	-0,02	0,09
	Public Transport	0,09	0,15	0,21	0,24	0,25	0,23	0,19	0,15	0,12	0,12	0,14	0,18	0,25
	Work	0,01	0,04	0,07	0,08	0,07	0,05	0,03	0,00	-0,02	-0,03	-0,01	0,01	0,08
Apple	Car	-0,05	0,03	0,10	0,16	0,22	0,26	0,28	0,29	0,29	0,29	0,28	0,27	0,29
	Public Transport	-0,08	-0,01	0,07	0,15	0,22	0,28	0,33	0,36	0,36	0,35	0,33	0,30	0,36
	Walking	-0,03	0,02	0,08	0,13	0,18	0,22	0,24	0,26	0,26	0,25	0,23	0,22	0,26
	Overall indicator	0,14	0,24	0,33	0,38	0,40	0,38	0,34	0,29	0,26	0,25	0,27	0,31	0,40

Market Data Overview

Stock marktes	As of 22.01.2021 15:34	Change versus 15.01.2021 -1 week	21.12.2020 -1 month	21.10.2020 -3 months	21.01.2020 -1 year	31.12.2020 YTD
Dow Jones	30987	0,6%	2,6%	9,8%	6,1%	1,2%
S&P 500	3853	2,3%	4,3%	12,2%	16,0%	2,6%
Nasdaq	13531	4,1%	6,2%	17,8%	44,4%	5,0%
DAX	13876	0,6%	4,8%	10,5%	2,4%	1,1%
MDAX	31567	1,7%	5,7%	16,2%	9,7%	2,5%
TecDAX	3356	2,9%	7,0%	9,6%	5,9%	4,5%
EuroStoxx 50	3594	-0,1%	4,2%	13,0%	-5,1%	1,2%
Stoxx 50	3181	-0,1%	5,4%	11,5%	-8,2%	2,3%
SMI (Swiss Market Index)	10935	0,5%	6,1%	9,5%	0,5%	2,2%
Nikkei 225	28631	0,4%	7,2%	21,1%	20,0%	4,3%
Brasilien BOVESPA	117014	-2,8%	1,0%	16,4%	0,0%	-1,7%
Russland RTS	1425	-3,4%	6,6%	24,6%	-12,8%	2,7%
Indien BSE 30	48879	-0,3%	7,3%	20,1%	18,3%	2,4%
China Shanghai Composite	3607	1,1%	5,4%	8,5%	18,2%	3,8%
MSCI Welt (in €)	2766	1,6%	4,7%	11,5%	4,9%	3,7%
MSCI Emerging Markets (in €)	1406	3,2%	12,0%	20,4%	14,1%	9,9%
Bond markets						
Bund-Future	176,80	-86	-106	109	459	-84
Bobl-Future	135,14	-12	-16	-57	110	-4
Schatz-Future	112,28	-3	-5	-15	38	0
3 Monats Euribor	-0,54	2	1	-4	-15	4
3 Monats $ Libor	0,22	-1	-3	1	-159	-2
Fed Funds Future, Dec 2017	0,06	0	-3	-2	-128	0
10 year US Treasuries	1,09	0	15	28	-68	18
10 year Bunds	-0,51	6	7	8	-23	6
10 year JGB	0,04	2	3	2	5	2
10 year Swiss Government	-0,46	1	3	7	20	4
US Treas 10Y Performance	703,36	-0,1%	-1,5%	-2,4%	9,1%	-1,8%
Bund 10Y Performance	681,44	-0,4%	-0,6%	-0,7%	2,5%	-0,5%
REX Performance Index	498,29	-0,2%	-0,4%	-0,4%	0,9%	-0,2%
US mortgage rate	0,00	0	0	0	0	0
IBOXX AA, €	0,06	4	6	1	-16	4
IBOXX BBB, €	0,55	2	0	-23	-27	-1
ML US High Yield	4,83	-7	-32	-94	-109	-15
Convertible Bonds, Exane 25	8407	0,0%	2,6%	6,8%	8,1%	0,9%
Commodities						
MG Base Metal Index	366,70	0,9%	1,6%	12,7%	21,5%	3,4%
Crude oil Brent	54,79	-0,7%	7,4%	31,0%	-15,3%	5,6%
Gold	1839,50	0,8%	-2,0%	-4,4%	18,1%	-3,1%
Silver	25,77	3,9%	-1,6%	2,8%	44,4%	-2,3%
Aluminium	1995,50	0,2%	-0,6%	8,9%	10,0%	1,1%
Copper	8014,25	1,0%	2,4%	14,9%	30,8%	3,4%
Iron ore	169,98	0,0%	9,6%	39,8%	79,3%	9,1%
Freight rates Baltic Dry Index	1837	4,7%	38,9%	36,5%	166,6%	34,5%
Currencies						
EUR/ USD	1,2160	0,3%	-0,1%	2,6%	9,4%	-0,9%
EUR/ GBP	0,8905	0,0%	-2,9%	-1,3%	4,8%	-0,5%
EUR/ JPY	126,28	0,4%	0,2%	1,6%	3,2%	-0,2%
EUR/ CHF	1,0775	0,0%	-0,3%	0,6%	0,3%	-0,2%
USD/ CNY	6,4821	0,0%	-1,0%	-2,5%	-6,1%	-0,7%
USD/ JPY	103,51	-0,4%	0,2%	-1,0%	-5,8%	0,2%
USD/ GBP	0,73	-0,5%	-2,4%	-3,6%	-4,3%	0,1%

Source: Refinitiv Datastream

Carsten Klude
+49 40 3282-2572
cklude@mmwarburg.com

Dr. Rebekka Haller
+49 40 3282-2452
rhaller@mmwarburg.com

Martin Hasse
+49 40 3282-2411
mhasse@mmwarburg.com

Dr. Christian Jasperneite
+49 40 3282-2439
cjasperneite@mmwarburg.com