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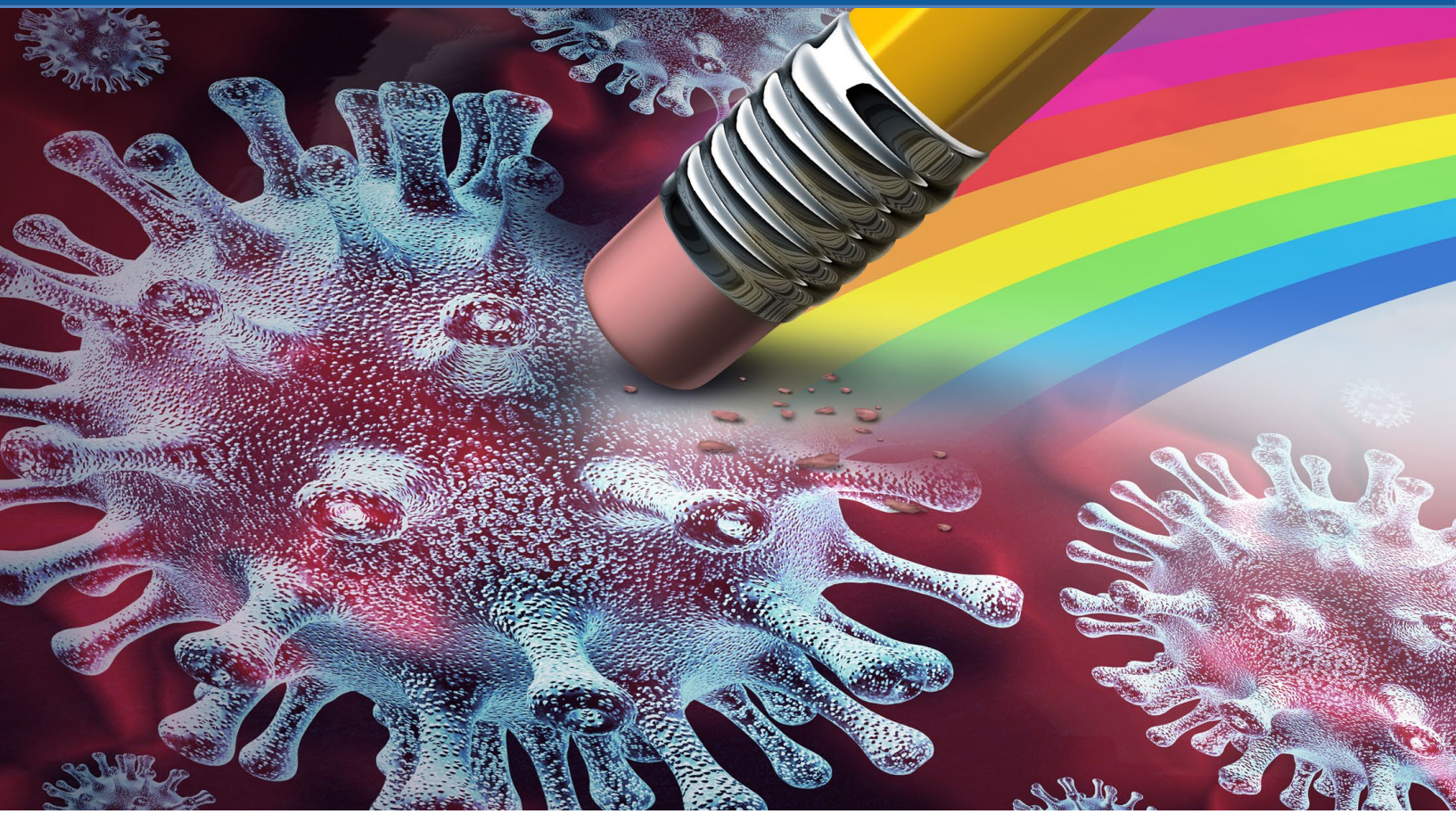

June 2020

# COVID-19 Country Recovery Watch

## Through the Lens of Alternative Data

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# Executive Summary

Citi Global Data Insights (CGDI) team is a newly formed team which is part of the Research & Global Insights group at Citi. We aim to provide clients insights from alternative data by deploying the latest data science and machine learning techniques.

We believe the COVID-19, or Coronavirus, pandemic will announce the coming of age of the alternative data and AI industry in a way that will profoundly reshape the global research and investment industry. With the majority of the world's population both isolated at home and connected online at the same time, we will see a surge in digital footprint that no one could have ever predicted. This surge is being captured in our browsers, on websites, in apps, and via our payment mechanisms, and that data is creating a real-time view of the world's economies. This is not a new packaging of old data; this is new information which is digital, real-time and powerful.

With many countries now gradually easing their lockdown, all eyes are on recovery in terms of speed and to what extent one can expect. However, since the virus is still not fully contained, any major second wave of outbreak could easily derail a recovery that is fragile at this stage. Collaborating with our colleagues from the Citi Quantitative Risk and Stress Testing (QRS) team, we showcase their agent-based analysis which quantify the likely timing of full quarantine lifting and corresponding likelihood of a second wave[1].

Armed with the knowledge from the analysis from QRS, this report is designed to provide a framework for assessing country economic activities through the lens of alternative data. We demonstrate how alternative data can be used effectively to identify any green shoots as the global economic recovery starts to get underway. Amongst other data sources, we have also invited LUCA to illustrate the insights that can be derived from the mobility data at their fingertips.

In terms of country focus, we select a number of countries in Europe and the US as they became the epicenters of the outbreak immediately after Asia, and have now relaxed their respective lockdowns, ideal for assessing impact of lockdown and signs of recovery. This established framework can then be utilised as a recovery dashboard which we will update regularly.

If you are interested in receiving such updates or would like the same analysis conducted for other countries/regions, please do not hesitate to reach out to us.

Citi Global Data Insights Team (cgdi@citi.com)

[1] The COVID-19 infection spread analysis presented by QRS (which is part of Citi Risk Division) in this report is for illustrative purposes only and does not represent the official views of Citi Risk

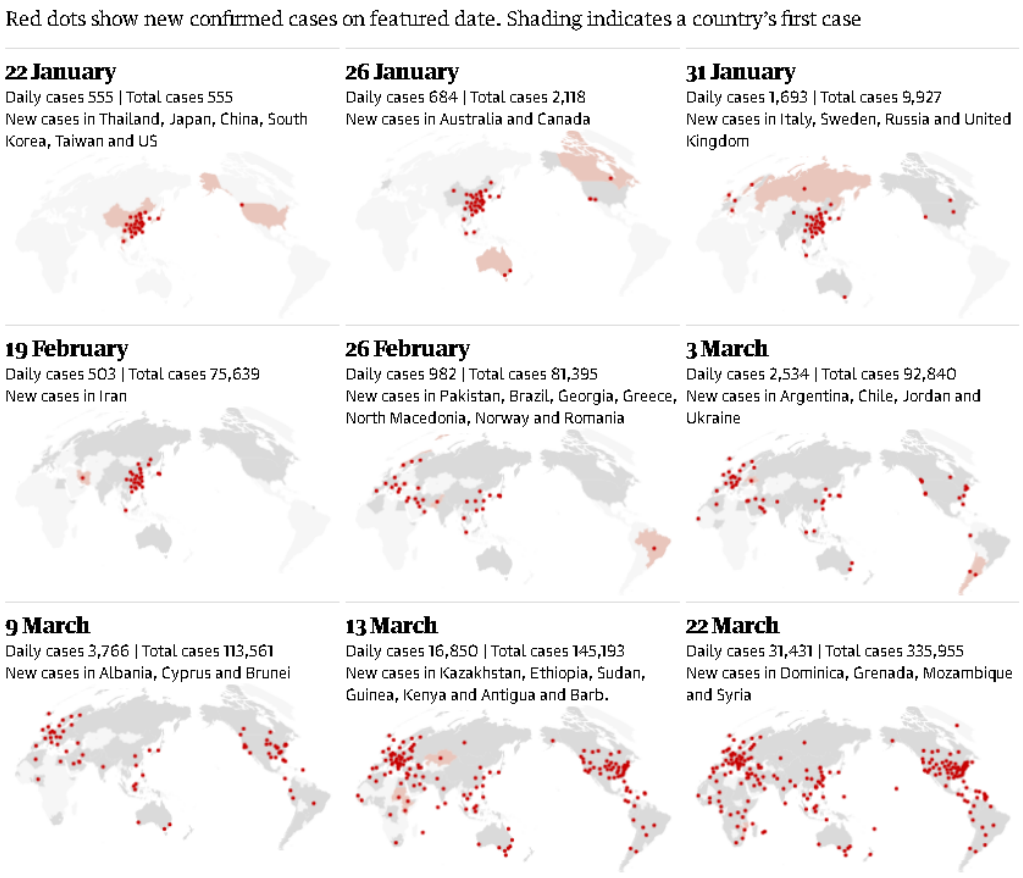
# COVID-19 Global Impact

## World in Lockdown

We have yet to cross the half way line but the year 2020 is already set to go down in the history books as the one marked by the most economic damaging pandemic that the human race has ever seen. With approximately 30% of the global population in lockdown in March and April, 227 countries and territories infected, over 6 million confirm cases and 360,000 deaths, COVID-19 had effectively brought the world to a stand-still over the past two months. Governments across the globe have had to balance issues of public health, capacity of their healthcare systems, and the dire but expected economic consequences of shutting down their economies.

The speed of transmission of COVID-19 has been relentless beyond expectations. Figure 1 shows how fast Coronavirus has spread globally – the confirmed cases grew from 555 on 22nd January to over 80,000 in late February and further increased by 4 fold a month later.

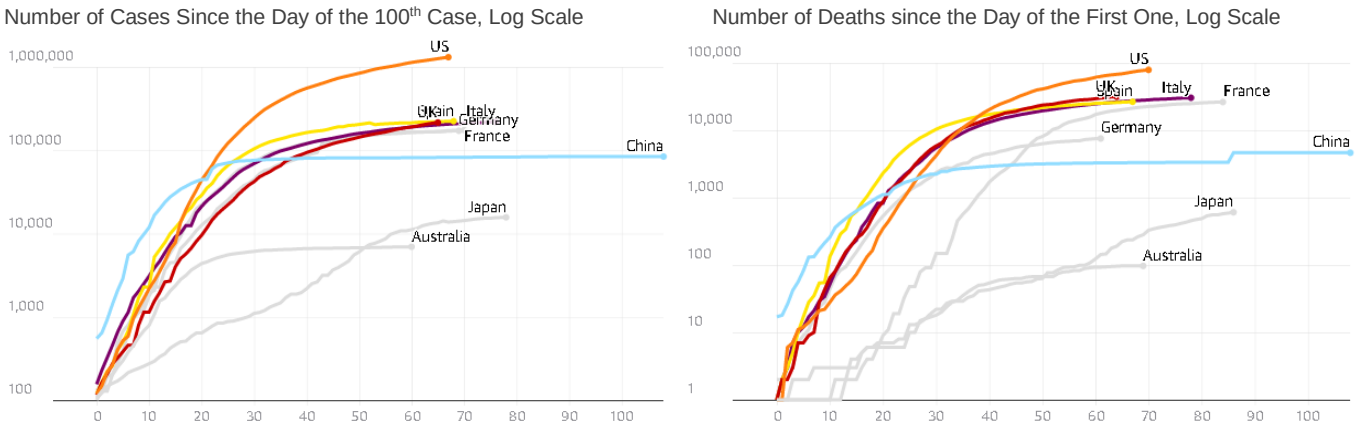
Figure 1. How Coronavirus Spreads Around the World




Source: John Hopkins CSSE

With total cases growing exponentially, the number of deaths also accelerated, thrashing the belief that Coronavirus was just another form of influenza. Figure 2 demonstrates that the six countries which had borne the brunt the most from this virus are US, UK, Spain, Italy, France and Germany as of the 9th of May. The epicentre of the Coronavirus pandemic had firmly shifted from Asia where the virus was originated to Europe and US. As the goal of the report is to examine the lockdown impact and the subsequent recoveries, we will use these 6 countries as the primary focus of our analysis in this report where possible.

Figure 2. COVID-19 Cases and Mortality, as of 9th May 2020

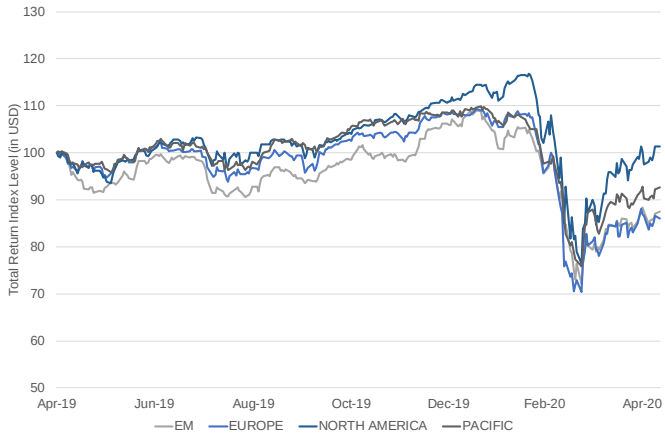



Source: John Hopkins CSSE

The mounting infections and deaths triggered governments of the most affected countries to take drastic actions by shutting down the borders and imposing draconian measures on their citizens to shelter in place, stay home and observe social distancing rules. With the consequences of global travel and transport coming to an almost complete halt, these policies sent shockwaves across financial markets worldwide. Equity markets globally as measured by MSCI indices shed over 30% in 15 days, marking the fastest time in history between hitting new highs and plummeting into technical bear markets (20% fall or more from their peaks). Also, for the first time ever, the oil price traded into negative territory, registering US$ -37.63 a barrel in mid April as demand for oil dried up, on top of excess supply triggered by the price war between OPEC and Russia. Both markets have recovered to a large extent as governments of the most affected across the global rushed to put in place market calming measures.

Figure 3. Markets in Meltdown

MSCI Index Performance



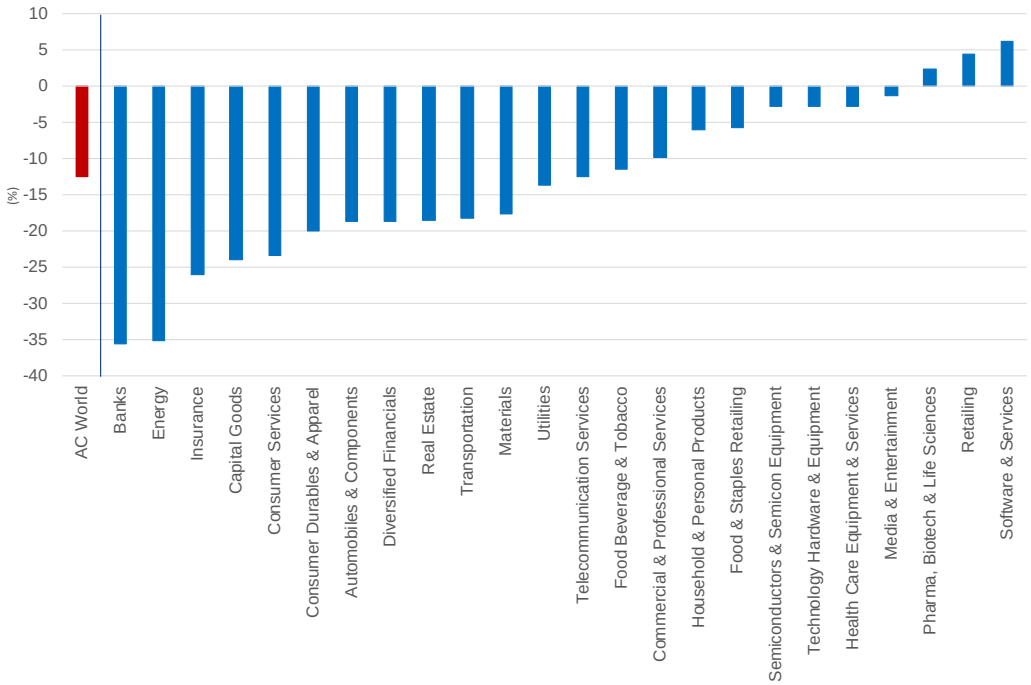

Source: MSCI, CGDI

WTI Crude Oil Cushing Spot


Source: Bloomberg, CGDI

The negative sentiment affected most of the industry groups within MSCI AC World, as depicted in Figure 4. The expectation of a sharp recession or even a depression sank banks and energy stocks by over -35%. Only three industry groups registered positive YTD returns, namely, pharma, retailing and software & services. The outperformance of retailing was driven by food delivery companies as lockdown sent demand of such services soaring, while restaurants rushed to adjust to new operating models focusing on takeaways and deliveries.

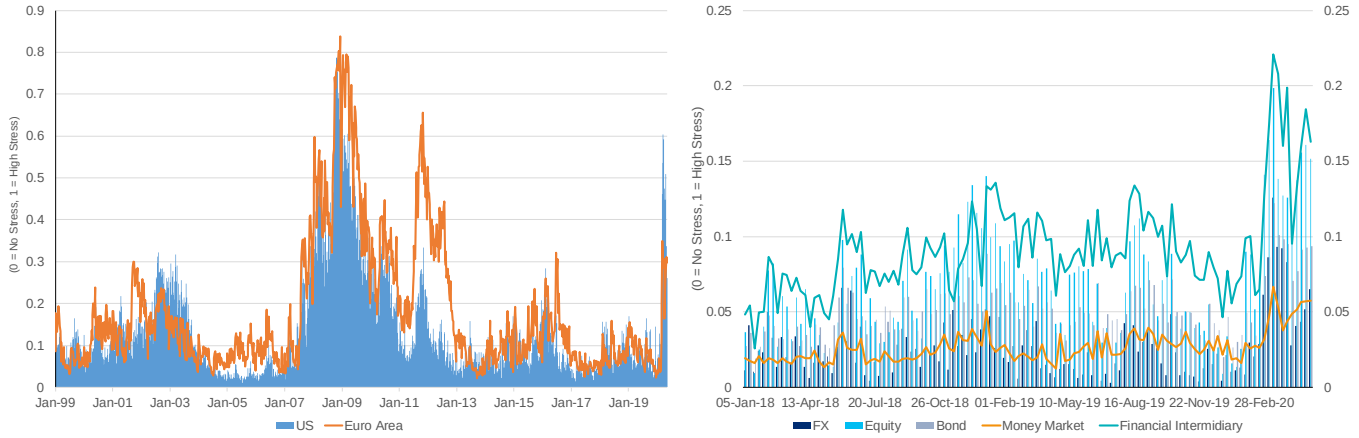
Figure 4. MSCI AC World YTD GICS Industry Group Performance*




Source: MSCI, CGDI
* Performance represents total returns in USD as of 11th May 2020

The waning confidence in the markets also showed through in the ECB's Composite Indicator of Systemic Distress[2] (CISS) where the distress level in the US and Euro Area jumped significantly. The US in particular witnessed a level of systemic distress not seen since the Global Financial Crisis, as shown in Figure 5. Zooming into various asset classes, while the distress levels of all raised markedly, financial intermediaries stood out as the main recipient of panic followed by equity and bond markets.

Figure 5. ECB's Composite indicator of Systemic Distress




Source: European Central Bank, CGDI

In order to stabilise the markets and reinstall investors' confidence, many countries pledged enormous stimulus packages, in conjunction with monetary easing policies to reduce the strain on the financial system. Figure 6 shows the timeline of lockdown and the magnitude of 'life support' offered by the most affected countries in terms of confirmed infection cases to mitigate the economic impact from lockdown.

Sourced from Bruegel Think Tank, the stimulus pledged can be categorised into the following three types as depicted in Figure 6:

- **Immediate Fiscal Impulse**

  Additional government spending such as medical resources, keeping people employed, subsidising SMEs, public investment and foregone revenues such as the cancellation of certain taxes and social security contributions.

- **Deferrals**

  Several governments have decided to defer certain payments, including taxes and social security contributions. These measures improve the liquidity positions of individuals and companies but do not cancel their obligations.

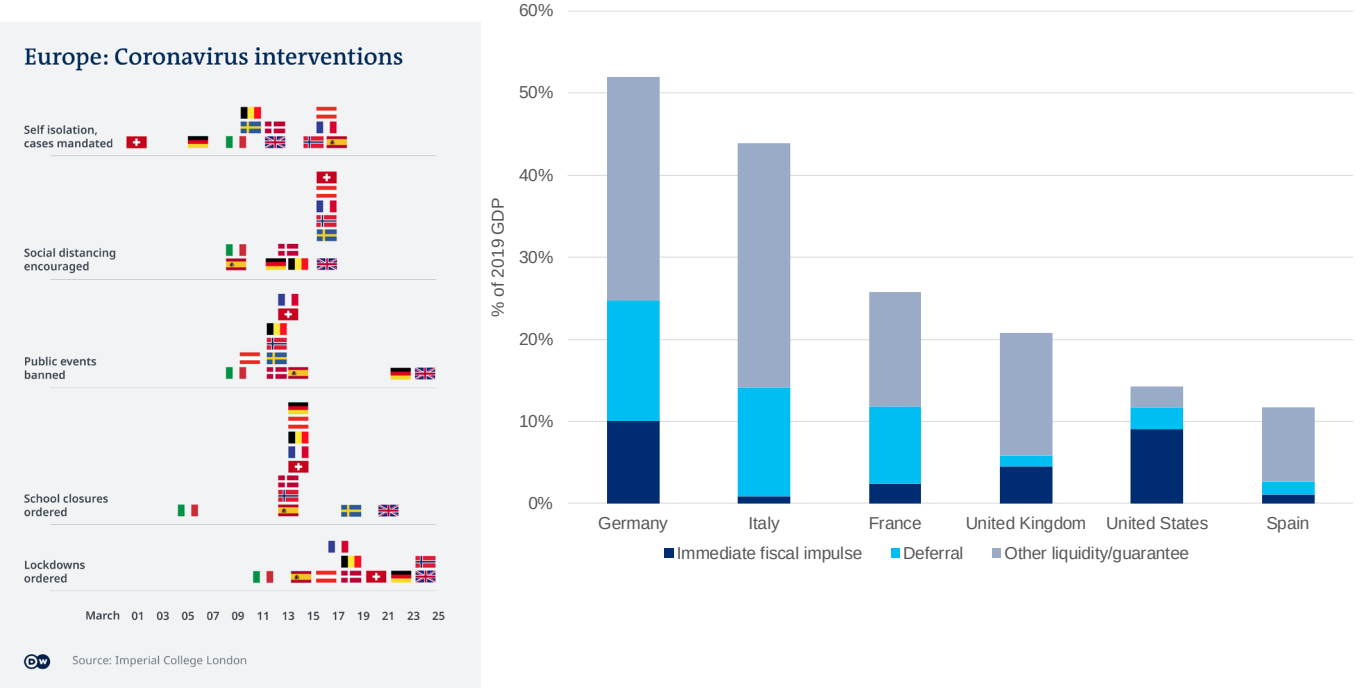
[2] For methodology, see https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1426.pdf

- **Other liquidity provisions and guarantees**

  These measures include export guarantees, liquidity assistance, and credit lines through national development banks.

Amongst the six most affected countries, Germany lead the pack by committing a comprehensive stimulus package totalling over 50% of its 2019 GDP. In terms of the immediate fiscal support, the US and Germany are on par at roughly the 10% level of their respective GDPs. On the contrary, Spain and Italy have mainly used other liquidity provisions and guarantees as the tool to prop up their economies.

Figure 6. Lockdown Timing and Stimulus Pledged* as % of 2019 GDP




Source: Imperial College London
* As of 16 April 2020

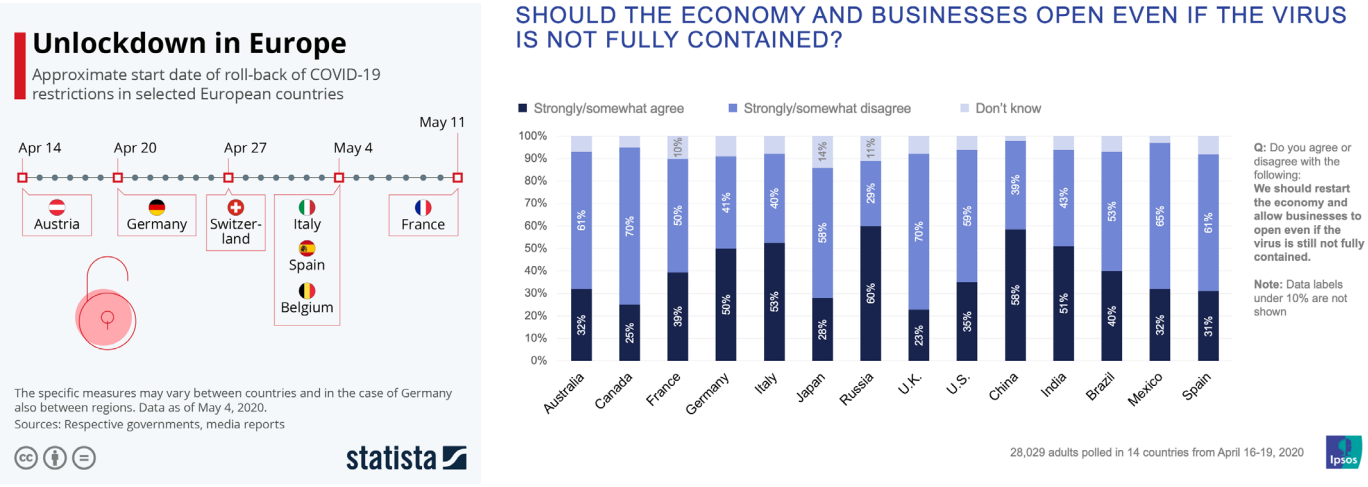
Source: Bruegel, CGDI

With most of these countries now starting their easing of lockdown as they declare the peaks of pandemic in their respective countries have passed, the key question is how quickly can they restart their economies and what shape of recovery can they expect? For the remainder of the report, we will focus on the six most affected countries in Europe and the US, and where possible utilise alternative datasets for these countries in our analysis. Where appropriate, the data on China is also presented as a comparison since the country is further along the recovery curve than Europe and the US.

## Time to Recover but What Shape? V, U or W?

The speed and scale of lockdown was unprecedented in many countries and was undoubtedly a sharp shock to their respective economies. As lockdown is being eased, how soon the recovery can take hold and make meaningful economic improvements hinges on how people behave while Coronavirus is not yet fully contained. Figure 7 shows a survey from Ipsos where the majority of people in the countries highlighted think the economy and businesses shouldn't open at all in such a situation. Only in Germany, Italy, Russia, China and India, do higher percentages of people surveyed think the opposite should happen.

Figure 7. Lockdown has been Eased but Should Businesses Open?




Source: Statista, Ipsos

For sustained recovery to occur, public opinions need to be shifted positively. Elimination of the possibility of a second wave would play a key part in determining what shape the recovery would take. A V-shape indicates a symmetrical down and up pattern with an equal speed, while a U-shape denotes a more gradual recovery. To avoid a W-shape recovery, the prerequisite in such a scenario must be the absence of a major second wave. But how do we quantify the likelihood of a second wave?

Collaborating with our colleagues from the Citi Quantitative Risk and Stress Testing (QRS[3]) team, in the next section we introduce an agent-based analysis framework developed by QRS, and they demonstrate how such analysis can be deployed to examine the effects of timing of quarantine lifting and predict the likelihood of a second wave in the six countries of focus.

[3] Citi Quantitative Risk and Stress Testing (QRS) provides key insights by deploying the latest data science and state-of-the-art risk analytics.

# COVID-19 Analysis and Calibration

## Introducing Agent-based Analysis (ABA)[4] by Citi QRS Team

With advancements in processing speed and computing power, mathematical techniques such as Agent-based Analysis (ABA) have made previously difficult pandemic forecasting more feasible and easily scalable. ABA include simulations of a large number of agents driven by simple behavioral rules that can reflect key features of population dynamics, including contagion effects and recovery from illness for different social groups, ages and geographies.

In particular, ABA can be used for forecasting the evolution of the COVID19 pandemic across multiple locations within the US and internationally. They can help fill the gap in forecasting robustness as these analyses collect and process relevant population data in a coherent and rule-based manner. While ABA may not completely replace more traditional epidemiology analytics, we believe they could be a powerful tool to combine rule-based population behavior with computer analysis and data science when speed and robustness of estimates are critical for information gathering and decision making.

The analysis implemented here relies on daily socioeconomic, demographic, epidemiological, geographic and behavioural time-series data at the city/county level in the US and country level outside the US. Forecasting the evolution of pandemics is highly nonlinear and complex, often leading to volatile and uncertain estimates during the onset and evolution of the epidemic. ABA, as compared to other epidemiological analyses, require limited calibration and provide a full distribution of population characteristics of contagion, active cases[5] and recoveries.

The key factors driving the ABA estimates are:

- Infection transmission rate
- Number of contacts
- Quarantine start date (early vs late)
- Quarantine lifting date
- Quarantine lifting type (abrupt vs. gradual)
- Viral shedding time (the time to being contagious)
- Increased number of testing over time (which impacts the reported number of cases)

[4] The COVID-19 infection spread analysis presented by QRS (which is part of Citi Risk Division) in this report is for illustrative purposes only and does not represent the official views of Citi Risk.

[5] Active cases are defined as (total infections – deaths – recovered) cases

- Naturally immune fraction of the population (currently kept at 0% for the results presented herein)

These key factors are represented by a variety of parameters. More precisely, the daily probability of contagion is defined as:

$$\text{Prob}(Contagion) = 1 - (1-TR)^{Ninf}$$

- TR is the transmission rate
- Ninf = DC * Q * FC is the number of infected contacts per day, where
  - Average Daily contacts (DC)
  - Quarantine Factor (Q)
  - Fraction of infected Population (FC) changes daily

This probability represents the chance of an individual agent catching COVID in any given day. It is a composite probability that factors in the (potentially) multiple daily contacts and the fact that to not catch COVID, you need to successfully not catch it in each interaction.

Other key parameters are:

- Starting day of the Quarantine (QStart), the later in the curve, the less effective in "flattening the curve"
- Days to go from no Quarantine to full implementation (QImplement).
- Fraction of asymptomatic or unrecorded cases (Unreported)
- Fraction of Active cases that are Severe or Critical from literature (Observed)
- Age-cohort dependent (Mortality)

Figure 8. Range of ABA Parameters

| Variable | Estimate | Description |
|---|---|---|
| **DC** | By age and location | Average daily contacts |
| **Q** | 0.25-0.75 | Fraction of daily personal contacts |
| **FC** | Changes daily | Fraction of daily infected contacts |
| **TR** | 0.03 | From literature |
| **QStart** | 4-20 days, best fit around 10 days | Starting date of quarantine |
| **QImplement** | 2-10 days, best fit around 4 days | Days from no quarantine to full implementation |
| **Unreported** | Best fit around 85% | Fraction of active asymptomatic or unrecorded cases |
| **Observed** | From literature | Fraction of active cases that are severe or critical. |
| **Mortality** | By age | Mortality rate by age group |

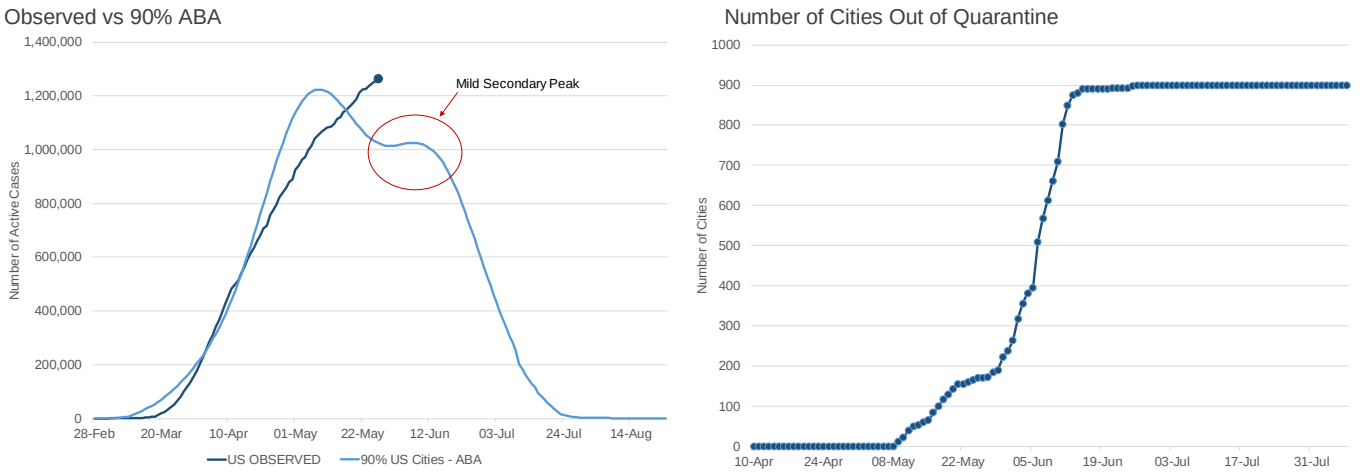
Source: Citi QRS

The ABA of the COVID-19 pandemic looks to answer the following:

- What is the likelihood that 90% of the US will lift the quarantine restrictions by the end of June or July?
- What is the likelihood of secondary peaks occurring as results of the above?
- What drivers can affect the predictions and to what extent?

The ABA approach provides direct answers to the aforementioned questions through the simulations of millions of agents representing the US population. Figure 9 shows the estimated number of active cases for 90% of the US population vs observed cases. The ABA results shown here were produced in March and April 2020 during the early stages of the quarantine in the US. Analysis results are compared to available data as of mid May.

Figure 9. ABA-Projections: US

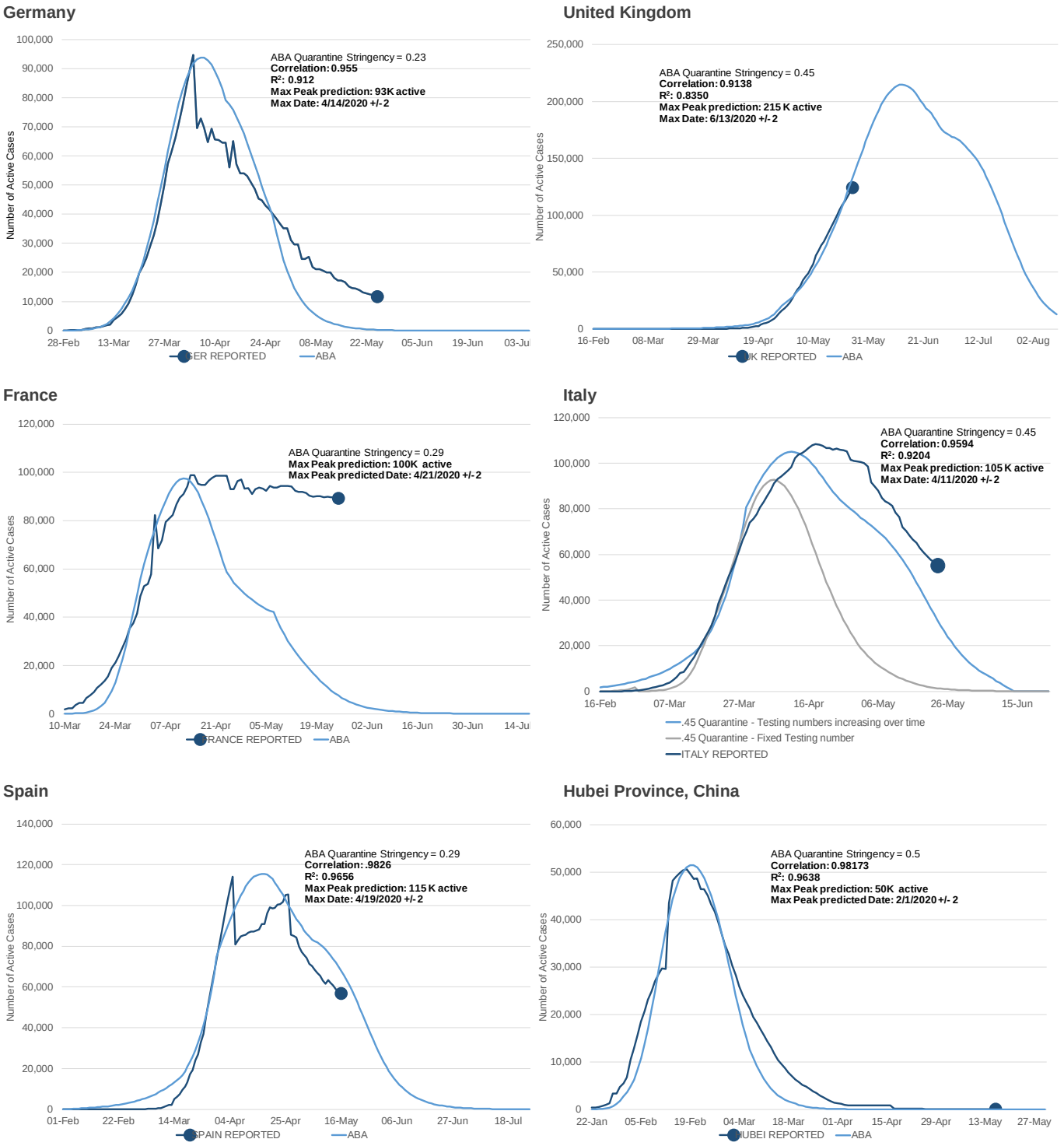



Source: QRS

Overall, the analysis has shown to be accurate and robust, especially for shorter prediction windows. The exhibit also shows the predictions of a mild secondary peak through June as lockdown restrictions are lifted and economic activities resume. The result was almost 98% correlated to the reported data for an 8-12 week period ahead prediction. When the objective is to identify the peaks of infection and their decline for reopening the economy, the average accuracy of the analysis remains within +/- 3 weeks. Based on the estimated infections, active and recovered cases, we estimate the number of cities and fraction of the population out of quarantine over time, which is based on matching curves to 580 cities with observed data combined with an intercity spreading at 50km/day. Lifting of the quarantine is assumed to occur strictly after 14 days of a decline in active cases with no additional political or economic considerations. Figure 9 also shows the estimated number of US cities out of quarantine for different dates.

The same analysis is then applied to other countries and compared to the available data. Figure 10 shows a comparison of the ABA simulations on active cases and the reported cases for France, Italy, Spain, Germany and the United Kingdom. The ABA results are scaled to the number of reported active cases from tested cases to adjust for the number of cases that go unreported due to limited testing.

Figure 10. ABA Projections




Source: Citi QRS

Hubei Province (Wuhan, where the virus first emerged from) in China is added as a benchmark and it follows the ABA simulations with a relatively low quarantine ratio (50% of normal spreading). Quarantine appears to have been implemented very early in the spreading period. The analysis shows a quarantine implemented gradually over 16 days and the release of the quarantine occurs at 14 days of consecutive decline in active cases.

The Italy case shows a marked increase in testing that inflates the right side of the curve (see curves with and without increase testing in graphs on the previous page). Actual measured active cases follow the prediction for moderate to strong quarantine fraction (45% of normal spreading). Implementation of quarantine in the ABA approach follows a 16 day timeframe (consistent with published data). Quarantine start is early both for published data and for our analysis. ABA predicts a small to negligible number of cases by mid June, 2020.

The Spain case follows the ABA simulations also with relatively low quarantine fraction (29% of normal spreading). The analysis shows a quarantine implemented relatively fast, over a 9 day period. Release of the quarantine in the analysis occurs at 14 days of consecutive decline.

The French situation represents an anomaly amongst all observed countries. Active cases have been stable at approximately peak level for over two weeks (no other country has shown this pattern). Specific investigation is required into the French peculiarities of reporting cases to determine the root causes.

The Germany case follows an ABA simulation with a more stringent quarantine (23% of normal spreading). The analysis shows a quarantine implemented gradually over 23 days consistent with published data. The release of the quarantine in our analysis occurs at 14 days of consecutive decline. The observed jumps and jaggedness of active curves are probably due to reporting and sampling issues. Measured cases are above our prediction as of mid May by 15K cases. The ABA approach projects a relatively small cases by mid June 2020.

The case for the United Kingdom indicates a relatively lax quarantine with elevated transmission rates and the total cases seem in general agreement with our estimates. Factoring the current estimates, cases in the UK should reach relatively small levels by early August.

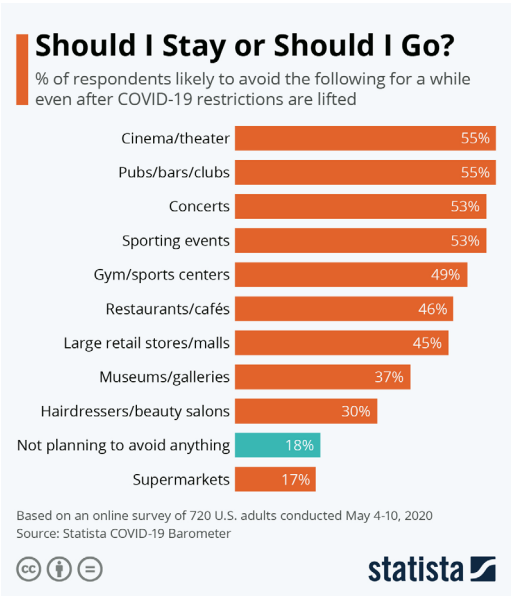
The ABA can also be utilised to predict mortality rates, of which the technical details are available in the appendix.

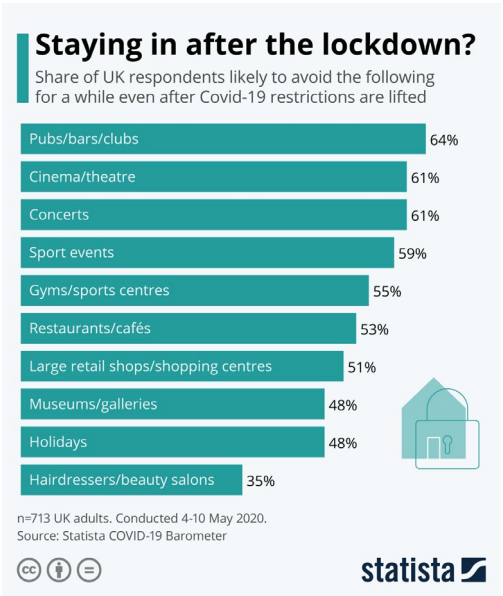
It is comforting that no major second wave of infections has been predicted by ABA for our countries of focus, provided that the assumptions made in the analysis continue to hold. The results provide an encouraging backdrop for potentially more sustained recoveries in these countries, which we will assess using alternative data in the following section.

# Assessing The ‘New Normal’

Two recent surveys conducted by **Statista**[6] showed that even when COVID-19 restrictions are fully lifted, over 50% of respondents in the US indicated that they would likely avoid going to cinemas/theater, pubs/bars/clubs, concerts and sporting events. In the UK, the stance taken by the respondents is even more conservative in that the majority of people would avoid any enclosed space altogether, apart from museums/galleries, holidays and hairdressers/beauty salons. The intentions uncovered here suggest a new reality, where social distancing and fear of infections are likely to stay, at least for a while, and this is bad news for those who hope for a rapid economic recovery.

Figure 11. Post Lockdown Intentions



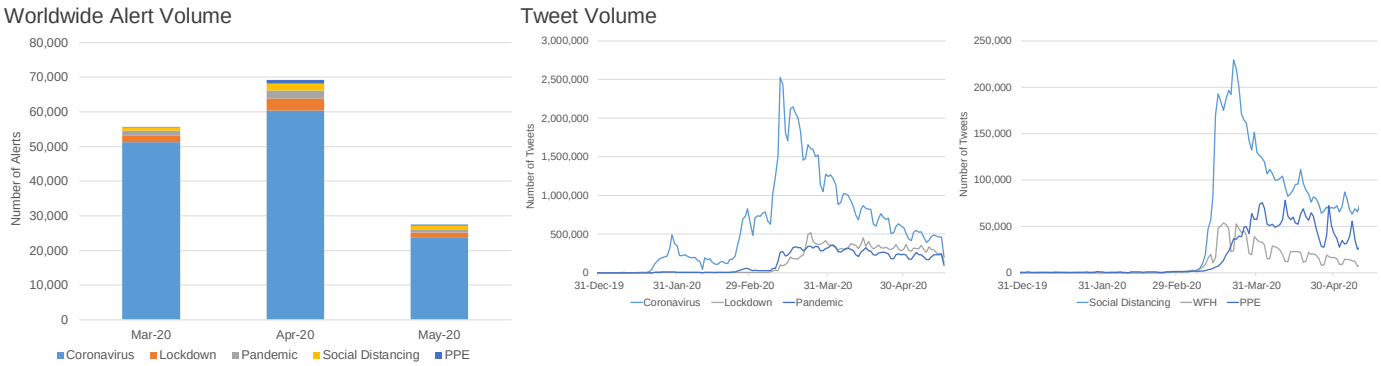

Source: Statista

The data from **Dataminr**[7] in Figure 12 also show how the general public have learned to live with the new reality of co-existing with Coronavirus. Based on their data sources, both alert volume and tweet volume of COVID-19 related terms exhibit substantial declines in May after the initial sharp increases in late February. This implies a change in general perception from regarding Coronavirus as a complete unknown to gradually accepting it as a part of daily life that needs to be mindful of – the ‘new normal’.

[6] https://www.statista.com/

[7] https://www.dataminr.com/

Figure 12. Dataminr Social Media Volume




Source: Dataminr, CGDI

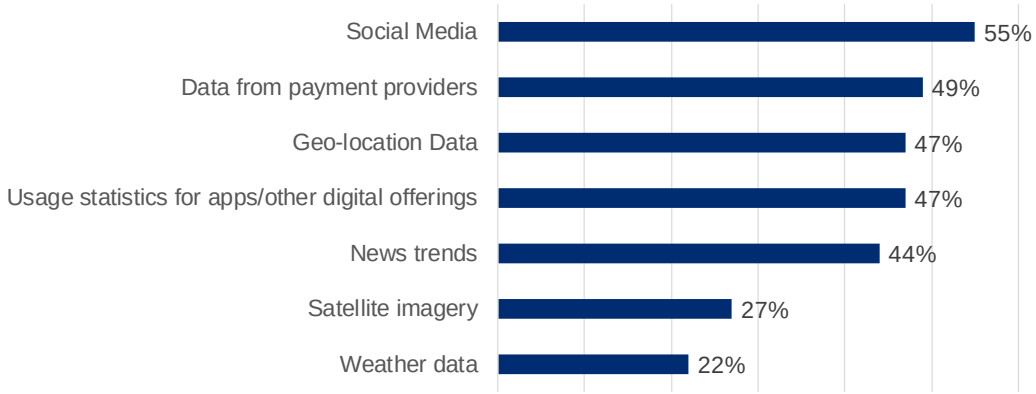
Armed with the knowledge of public intentions in the new normal, how do we assess to what extent it is affecting the economic activities on the ground? This is where we think alternative data sources would prove extremely valuable in providing an up-to-date (some even near real-time) picture vs what the traditional sources would entail.

## The Coming of Age of Alternative Data

Our behaviour is now reflected in our digital footprint and this is the first global crisis where our ability to monitor such footprint using Big Data and AI is possible. We have the connected systems and platforms that allow us to study these digital patterns of behaviour and understand the impact on the economy, on companies, and on markets.

In early 2017, 80% of investors surveyed by Greenwich Associates 'wanted' to have greater access to alternative data sources and now over 80% of hedge funds are 'using' these sources as found in a recent Lowenstein Sandler survey. According to the global AI in Financial Services Survey conducted by Judge Business School, Cambridge University and World Economic Forum, the most widely used alternative data type is Social Media where 55% of the correspondents who said they used non-traditional datasets to generate insights are using such data, followed by payment data, geo-location and web/app usage stats etc.

Figure 13. Most Widely Used Alternative Data Types




Source: Judge Business School, Cambridge University and World Economic Forum

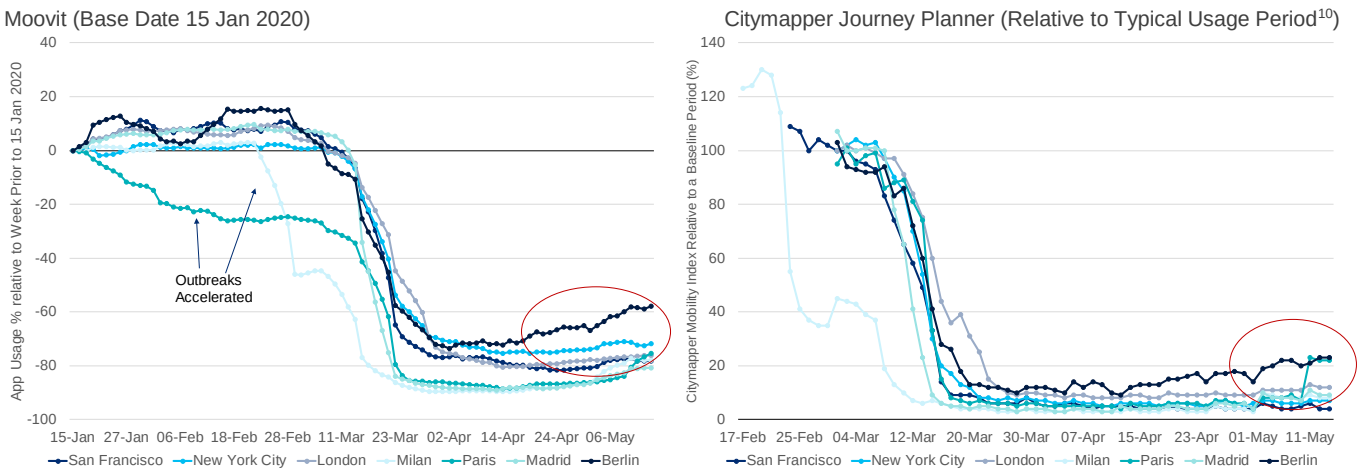
In the following section, we seek to utilise many of the alternative data categories mentioned above and demonstrate how information can be gleaned from these datasets to provide a gauge of how quickly or slowly the economy is likely to recover.

## Mobility

Mobile phones undoubtedly are one of the must-haves in our daily life, and they hold a great deal of information about how we live our life – where we go, what we do and for how long etc – thanks to location tracking, internet services and apps available at our disposal, all conveniently embedded in one device.

**Moovit**[8] and **Citymapper**[9] are both transportation related apps, with the former being a public transit app and the latter a journey planner. As European countries and the US have started to come out of lockdown since the end of April or the beginning of May, we expect to see upward trends in their usage as people spend more time on public transport. Figure 14 shows their usage in the capital cities or the most affected cities in Europe and the US. It is clear that the declines in their usage in mid March had been very steep and very fast, especially for Milan, Paris and Madrid as the lockdown was swiftly enforced by their governments to reduce the spread of Coronavirus.

Figure 14. Transportation App Usage




Source: Moovit, CGDI, Haver Analytics

Source: Citymapper, CGDI, Haver Analytics

Zooming in on the recent readings from both apps, Berlin and Paris have exhibited the most positive upward trends following the easing of lockdown in their respective countries. Usage of public transport in Milan and Madrid appears to remain relatively muted, suggesting that people are still hesitant in commuting via public transportation since coming out of closures, while New York City and San Francisco show moderate usage increases.

[8] https://moovit.com/

[9] https://citymapper.com/

[10] Typical Usage Period is defined as 4 weeks between Jan 6th and Feb 2nd, 2020.

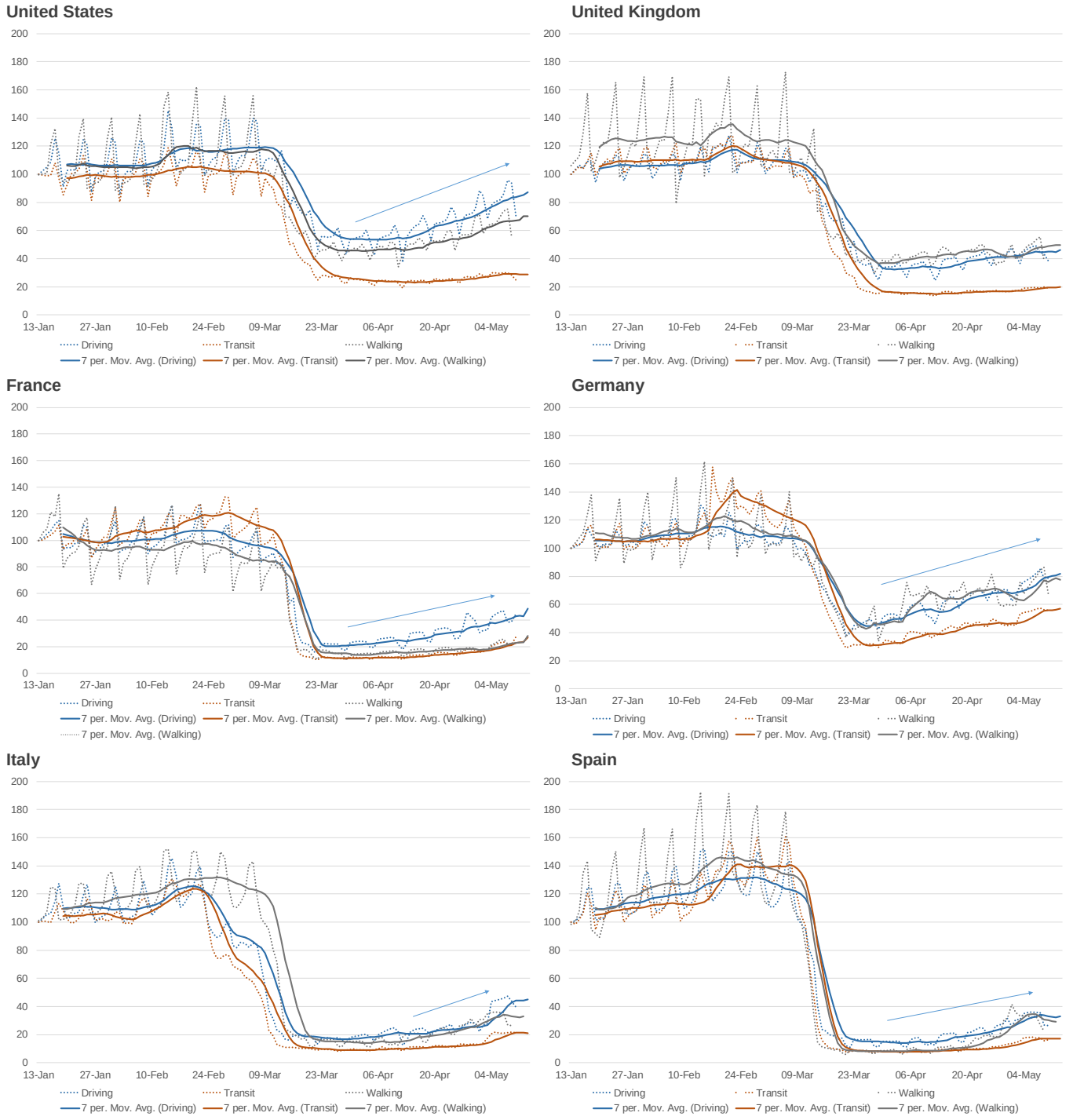
The analysis derived from the data of these two apps provide interesting insights of utilisation of public transport in the countries of interest but the key question is: can we expect the utilisation rate to be back to the baseline level? If the public opinions uncovered through the surveys mentioned in the earlier section are to be the guide, we can expect people to avoid using public transport when they can and perhaps switch to another form of commuting such as driving and walking so that they can maintain social distancing much more easily.

To answer this question, we look at **Apple Mobility Trends**[11] data which is generated by counting the number of requests made to Apple Maps for directions and aggregate to the country level. Figure 15 overleaf shows the trends in driving, transit and walking of the six most affected countries[12]. All countries barring the UK are exhibiting significantly higher percentages of people driving, and most show an increase in walking as well. Another interesting observation is that the lockdown in Spain and Italy appeared to have been enforced more stringently as all three activities were down to sub-20 levels in both countries, while lowest points for countries like Germany, the UK and US were anchoring around 40. But what is consistently observed across these countries is that public transport has been largely avoided if alternatives are available, as the gap between transit and the other two forms of mobility has widened significantly.

[11] https://www.apple.com/covid19/mobility

[12] The day of the week effect is clearly present in the data but since we care more about the trends rather than the intra-week changes, we have used 7-day moving averages in the analysis.

Figure 15. Apple Mobility Trends Relative to 13 Jan 2020 (Index = 100)



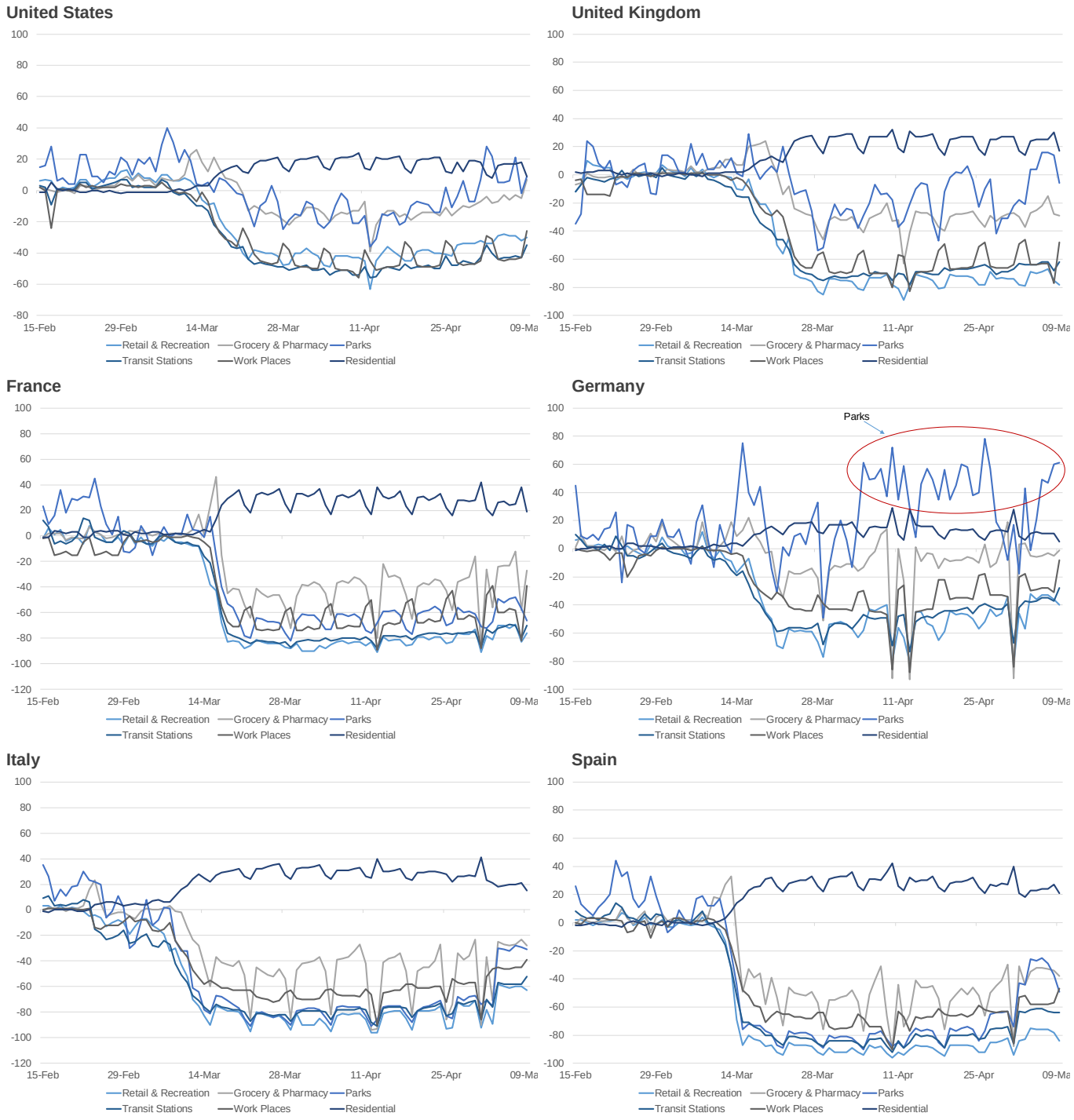

Source: Apple Mobility Report, CGDI

Unsurprisingly, **Google** also has a mobility dataset which forms the basis of their **COVID-19 Community Mobility**[13] Reports. These reports are created with data from users who have turned on the Location History setting and then aggregated and

[13] https://www.google.com/covid19/mobility/

anonymised. Their take on people's movements is different from Apple's in that they focus on where people are travelling to rather than the means of transport they take.

Figure 16. Google Mobility: Visits and Length of Stay Relative Changes Compared to the Baseline*




Source: Google Mobility Report, CGDI
*median value, for the corresponding day of the week, during the 5-week period Jan 3–Feb 6, 2020

Specifically, they categorise the destinations of travels to be retail & recreation, grocery & pharmacy, parks, transit stations and work places, apart from remaining in their residence[14]. A consistent pattern that stands out amongst these countries is that there was a step jump in 'Residential' category which signified the start of lockdown and people adhering to the call of sheltering in place/staying home.

In other categories, Germany is a clear outlier in that the data suggest people spent substantially more time in parks compared to other countries considered. Also Good Friday, Easter Monday in April and Labour day in May appear to have caused irregularities in the Germany data, possibly due to the fact that many groceries and pharmacies were closed during these days unlike in other countries. Since the lockdown was eased in Italy and Spain earlier this month, we can see that the time spent at work places has creeped up in both countries, although remain subdued.

Another way of obtaining mobility information and potentially developing deeper insights is through data from telecoms. As an example, in March the European Commission had been encouraging big telecoms of their member states to share aggregated locations data for modelling the spread of the virus through contact intensity. To demonstrate further insights that can be derived from such data, we have invited LUCA to showcase the depth of their mobility data analysis in the following section.

## LUCA[15] by Francisco Celeiro

*We use our Smart Steps technology platform to extract insights on global trends relating to different groups of people to help organizations to optimize their value proposals.*

*Our Crowd Analytics products use anonymized and aggregate data that provide more knowledge on the sector under study. Plus, we also help our customers get value through customized analysis and APIs to consume these insights.*

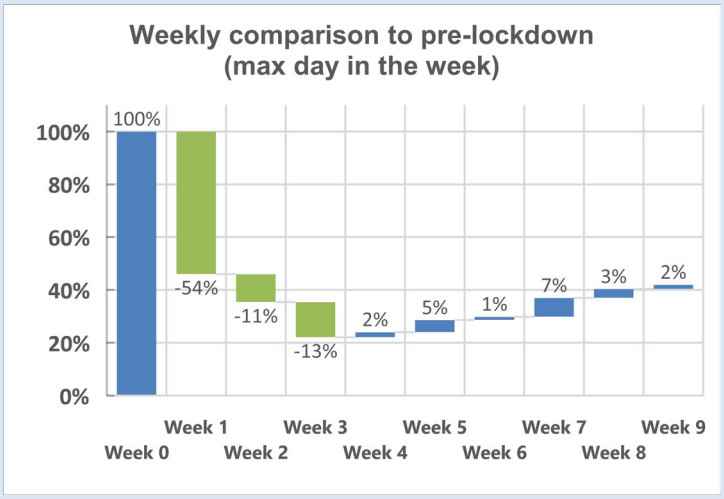
*We count with an unprecedented sample of data: thanks to the thousands of devices that generate millions of data points each day on our network, the sample of data is much more significant than that obtained by traditional sources of data. Locating profiles: specific locations in order to capture the desired target and get to know the profile of any audience. Understanding and optimizing the impact of any marketing campaigns in order to target regular and potential clients combining web behavior with real life mobility.*

*Within these moments of uncertainty, we provide population mobility insights that better describe the relative activity over time: before, during and after the lockdown. We generate these insights by specific areas of analyses as well as macro trends for business guidance, at national or local level.*

[14] There is an obvious day of the week effect but for the ease of readability of the charts, we have not added moving averages to show trends.

[15] https://www.luca-d3.com/

Figure 17. Spain: Travellers between Provinces




Source: LUCA

- *Spain national lockdown started on the 16th of March*
- *During first lockdown week we noticed a 54% interprovincial mobility reduction*
- *The lowest level of interprovincial mobility was observed during week 3 of lockdown with a 76% reduction compared to pre-lockdown*
- *On the 4th of May (Week 8) officially started the back to normal national plan, with interprovincial restrictions still in place*

*Methodology*

- *Real Data, through the extraction and anonymization of data from the Movistar mobile network;*
- *Analysis and aggregation, by applying mathematical models, you can obtain profiles and behavioral patterns of the travelers;*
- *Observation periods, weeks defined from Mondays to Sundays;*
- *Key indicator, max daily value observed in each week compared with pre-lockdown reference week (from 9/mar/20 to 15/mar/20) max daily volume observed between the 50 Spanish Provinces;*

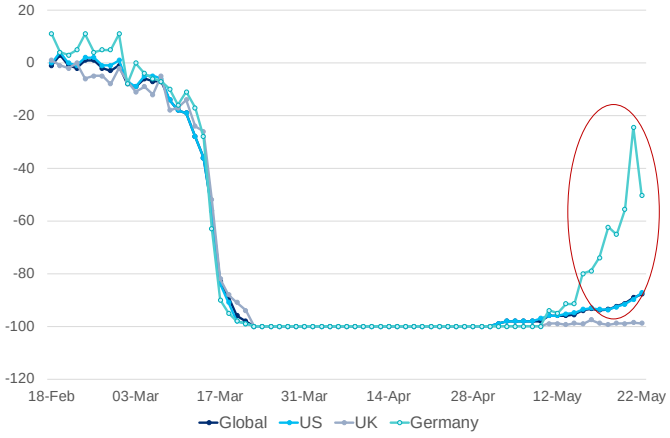
## Ground Truth

One of the hardest hit industries in COVID-19 pandemic is restaurants as they were ordered to close[16] at the beginning of lockdown and will probably be the last to reopen, due to the risk of the virus spreading rapidly in largely enclosed, indoor premises. Restaurant booking sites such as **Opentable**[17] recorded -100% YoY changes in cities or countries where full lockdown was imposed. As the economy starts to open up again, booking activities can provide an insightful assessment of how much the restaurant trade will recover.

Figure 18 shows three countries which currently have different lockdown easing policies in place, alongside the data for global. Earlier in May Germany relaxed the restrictions on restaurants so long as social distancing rules were observed and new hygiene requirements were adhered to. In contrast, restaurants in the UK are not expected to be allowed to reopen until July at the earliest, while in the US the state governments can decide individually when the restaurants within their respective state can reopen.

Figure 18. Opentable Reservation Data

Global YoY Reservation Change (%)




States that Show Stronger Signs of Recovery (> -80%)

| | Reservation YoY Change % | Trend |
|---|---|---|
| South Carolina | -57.91 | |
| Oklahoma | -58.82 | |
| Arizona | -61.67 | |
| Rhode Island | -63.04 | |
| Texas | -64.16 | |
| Alabama | -65.27 | |
| Florida | -67.68 | |
| Kansas | -69.17 | |
| Indiana | -69.46 | |
| Tennessee | -71.49 | |
| Ohio | -71.67 | |
| Kentucky | -71.91 | |
| Missouri | -75.59 | |
| Utah | -75.84 | |
| Nebraska | -76.1 | |
| Georgia | -76.91 | |
| Louisiana | -78.51 | |

Source: OpenTable, CGDI

The patterns in the chart above indeed echo the divergence in policies. The YoY booking rates strongly recovered from -100% to almost -20% in Germany earlier in May but suffered a sharp reversal as new daily virus cases rose above 1000, eroding consumer confidence, deterring customers from visiting restaurants. The UK remains flat lined, hovering around the -100% mark, and the US exhibits a gradual increase in restaurant bookings. Opentable also provides the state by state details and we can see in Figure 18 that 17 states have shown stronger signs of recovery, registering less than -80% declines according to the latest readings.

[16] Unless offering takeaways, restaurants were ordered to close until further guidelines issued from governments.

[17] https://www.opentable.com/state-of-industry

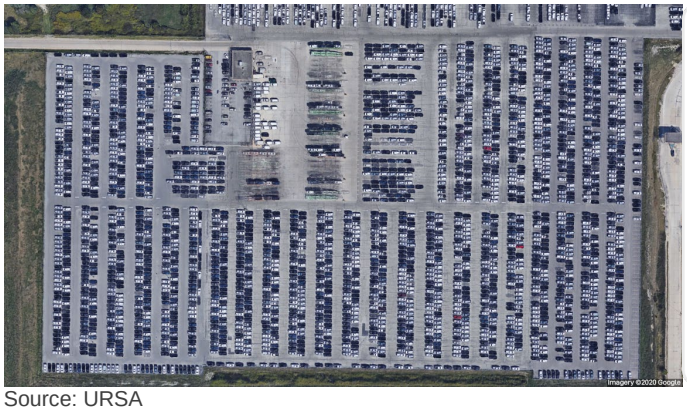
Another way to monitor the economic activities on the ground is to utilise satellite data and derive insights by comparing the images from before, during and after the lockdown. **Ursa**[18] uses synthetic aperture radar (SAR) technology[19] to determine how much man-made objects cover a given area and analyse that observation across time. For example, their global auto manufacturing analysis includes 43 facilities located in the US (9), Spain (2), France (4), UK (6), Germany (7), Italy (3), China (10), South Korea (1) and Japan (1).

They examine how full the parking lot is adjacent to the car factory with finished cars. A lot full of finished cars suggests an operating factory, while an emptying lot could be a sign of a shutdown. Without further supply, the inventory is then drawn down.

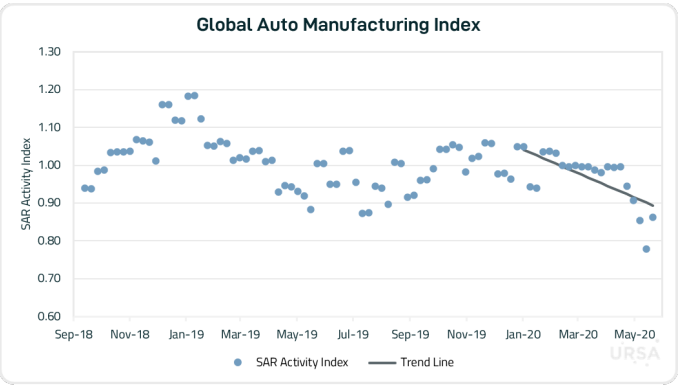
Ursa has created an index where each dot on the right-hand graph in Figure 19 represents a unique satellite observation. A score above 1 means more activity than on average is observed during the time period (from Sept 2018 to present), while a score below 1 indicates the opposite is true.

Figure 19. URSA Global Analysis on Auto Manufacturing

GM lot in Roanoke, VA, USA



SAR Activities




Source: URSA

Ursa's index of manufacturing activity since September 2018 has shown some seasonality, which is expected to mirror the seasonality of car sales. The activity index declined from January to March 2020, just like in Q1 2019, but the more notable development has been the sharp downturn since mid April which was driven by US facilities, as the wave of lockdowns across the country peaked. As of mid May, the activity index remained depressed, with the lowest readings registered during this period.

Auto sales have been regarded as one of the leading barometers that measure the health of an economy. By utilising the global auto manufacturing activity index, it can tell us the likely magnitude of the bounce-back of the economies globally.

[18] https://www.ursaspace.com/

[19] According to Ursa, SAR works in any weather, day or night and also SAR is good at detecting man-made objects, like cars and trains.

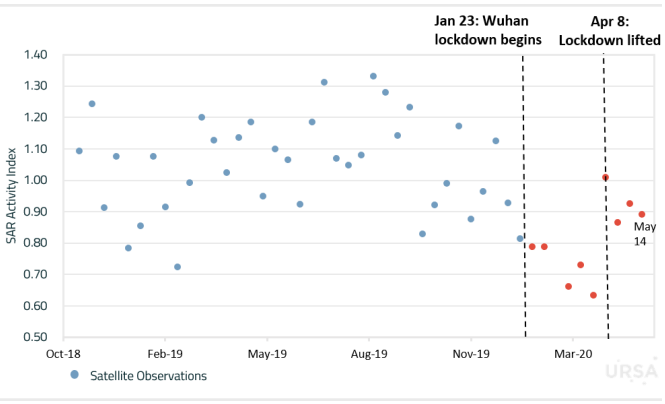
The same SAR technology can also be applied to railway stations. When a train station's rail yard is full, this indicates activity whereas the scarce presence of trains would suggest the opposite.

Ursa has analysed SAR images of Wuhan North Railway Station, going back to November 2018. Using their SAR Activity Index, they noted that train activity falling after travel restrictions began January 23, 2020 in Wuhan and it remained at a 16-month low through March 2020 as depicted in Figure 20.

Figure 20. URSA's Analysis on Wuhan in Hubei Province, China

Wuhan North Railway Station

SAR Activities



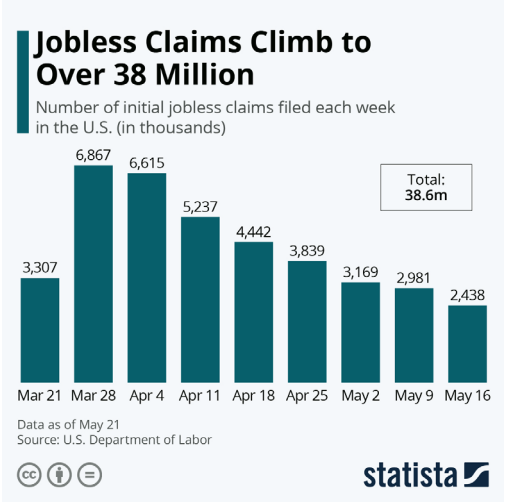

Source: URSA

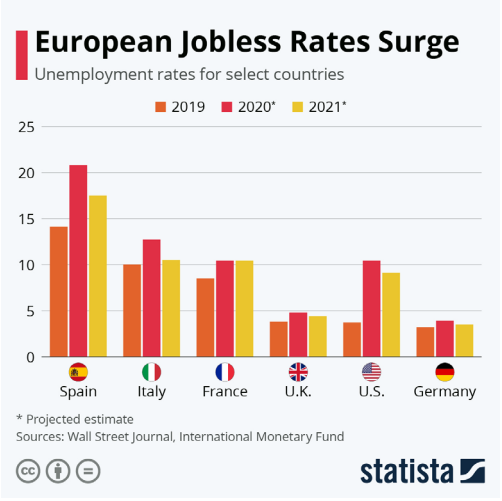
On the 8th of April, the Chinese government lifted the lockdown in Wuhan, and the impact was immediately apparent as activity jumped on the same day at the Wuhan North Railway Station. The uptick could signal a return to more normal economic activity in Hubei Province. However, in the images subsequently taken on 20th April, 2nd May, and 14th May, it showed a decline in the SAR activity index as new infections were confirmed after weeks of zero cases. It is worth noting though that the readings remain above the lockdown levels.

## Job Hiring Activities

At the height of Coronavirus pandemic, many jobs were lost or furloughed in Europe and the US. The weekly jobless claims in the US broke the all-time record in late March with over 3.3 millions of people filing for unemployment benefits. The situation in Europe is particularly concerning for Spain, where according to IMF's forecast[20] the unemployment rate is expected to reach over 20% in 2020 and remain above 15% in 2021.

Figure 21. Unemployment in Europe and the US




Source: Statista

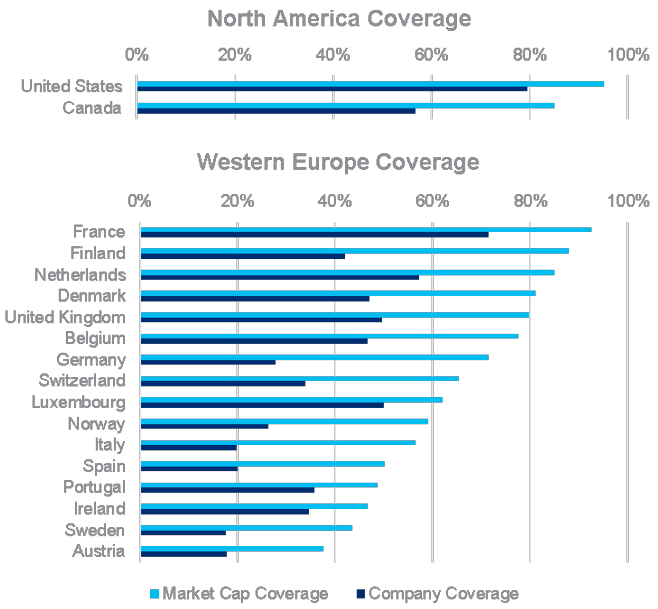
As the economy starts to recover, it can be expected that hiring activities should reflect increasing needs for labour again and thus job postings should give us a good overview of hiring intentions from companies. In order to quantify these, we have partnered with **LinkUp**[21] which web scrapes 3.5 million job postings daily from companies' career websites. While the data is more US centric, the coverage by market cap (using S&P Global BMI as the universe) in a couple of regions outside the US or North America is respectable. For example, in Europe their data cover more than 70% of the market as measured by market capitalisation in 7 countries as shown in Figure 22.

[20] As of 22nd April 2020

[21] https://www.linkup.com/

Figure 22. LinkUp Job Postings Data Coverage

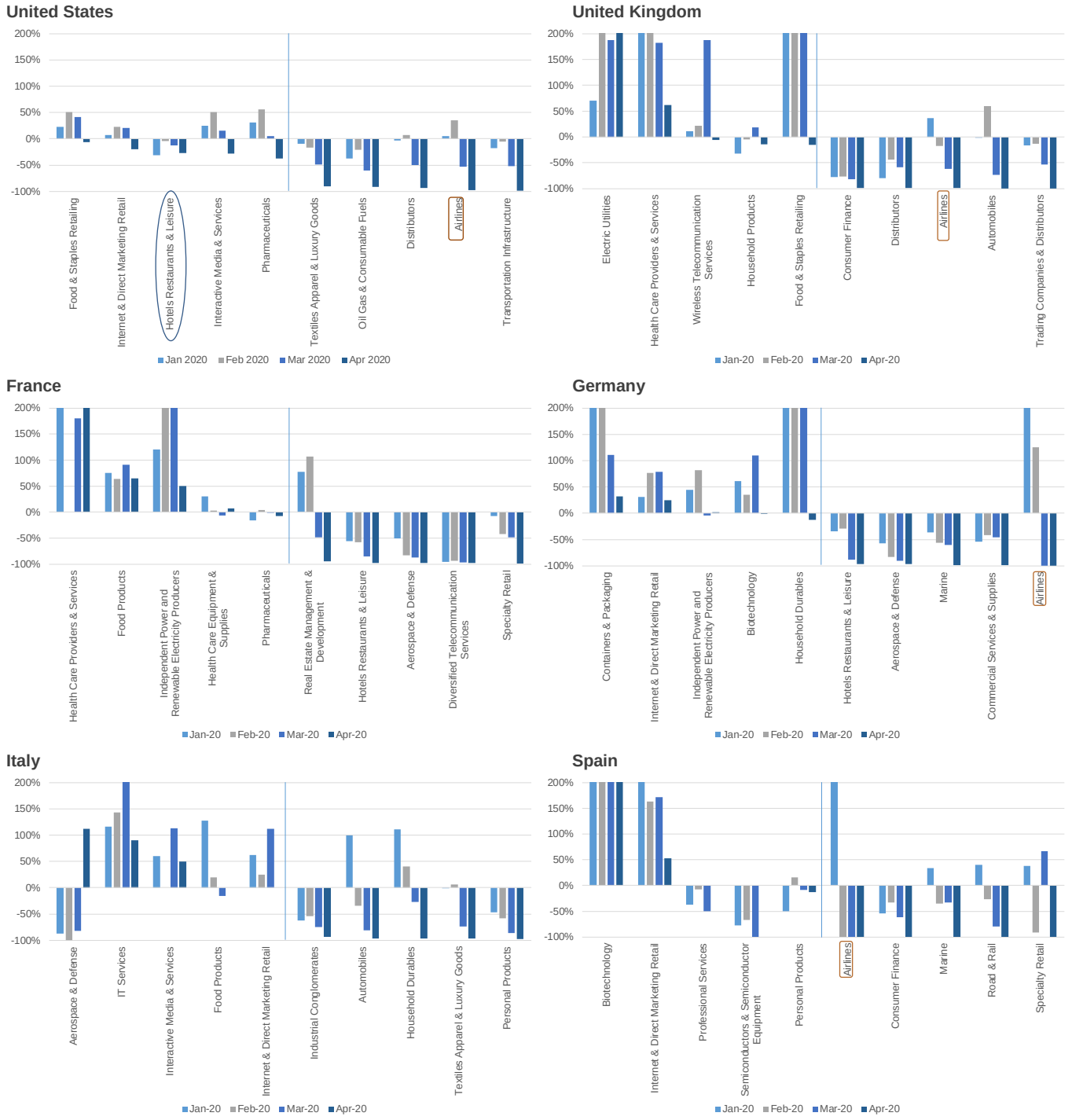
| Region | Company Coverage | Mkt Cap Coverage | Historical Coverage (Median, years) |
|---|---|---|---|
| North America | 80.08% | 96.26% | 6.0 |
| Western Europe | 42.32% | 77.48% | 2.0 |
| Australia | 39.18% | 73.43% | 2.7 |
| Japan | 9.92% | 51.22% | 0.2 |
| Asia | 4.98% | 34.03% | 1.7 |
| Latin America | 13.03% | 28.03% | 0.8 |
| CEEMEA | 7.85% | 23.43% | 2.2 |
| Total | 31.70% | 79.18% | 4.6 |




Source: LinkUp, CGDI

Since the data are collected on the company level, we can aggregate them up to arrive at the industry level which unveils the large divergence amongst industries within a given country. Figure 23 shows the top 5 least affected (LHS) vs most affected (RHS) industries based on YoY change in April 2020.

Figure 23. Job Postings YoY Change Apr 2020: Top 5 Least Affected and Most Affected Industries



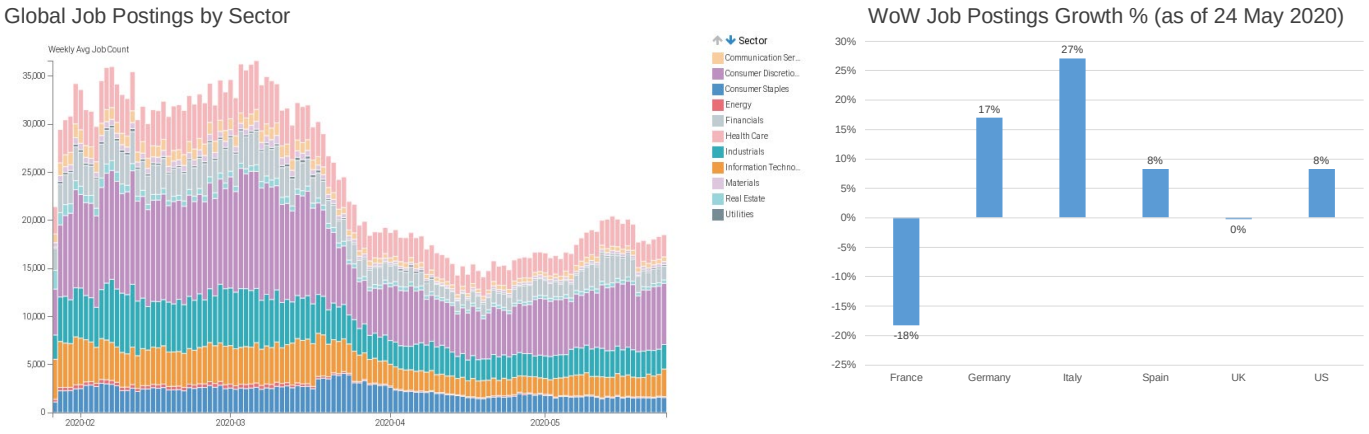

Source: LinkUp, CGDI

Not surprisingly, food related industries and pharmaceuticals have fared the best while consumer discretionary and airlines industries have borne the brunt in the pandemic. One interesting observation is that in the US, Hotels Restaurants & Leisure came through as the third lest affected industry which appears to be counter-intuitive. Upon further investigations, it turns out that hiring activities of this industry were driven mainly

by restaurants transforming their operating models to takeaways and deliveries and thus hiring people accordingly.

As recovery starts to take shape, one can expect the fortune of these industries to revert to some extent, depending on how the new normal will resemble the old one. Keeping an eye on the job posting activities can certainly help identify the turning point and assess the persistence of such trends. Figure 24 illustrates some improvements in job postings growth on a global basis and for the six countries in question, most WoW growth figures are positive except for UK and France.

Figure 24. Job Posting Trends




Source: LinkUp, CGDI

## Web/App Traffic

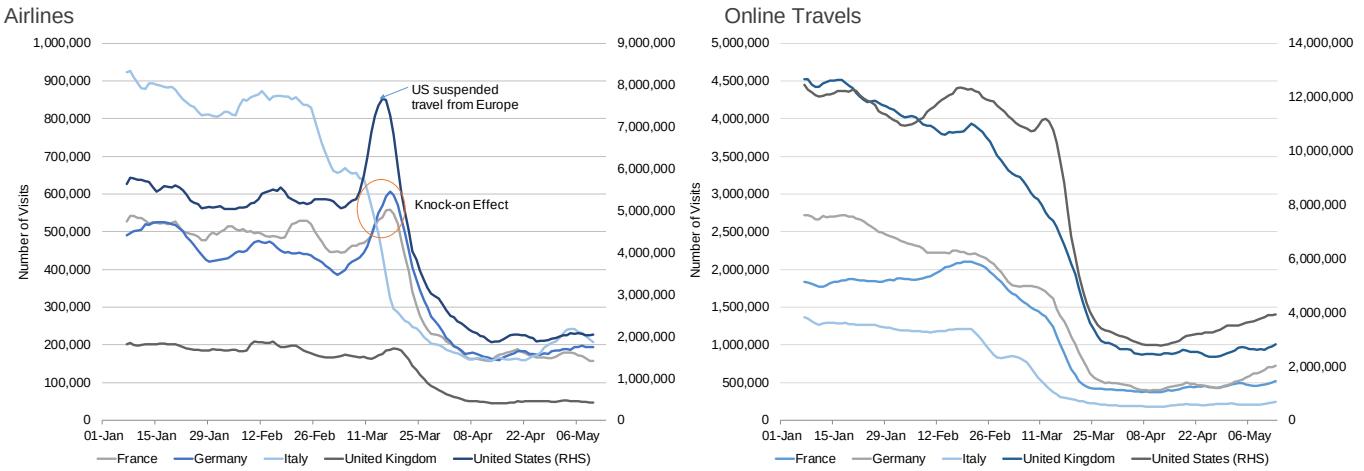
Web browsing and activities on apps are also fertile grounds for spotting the green shoots as they provide an in-depth view of people's everyday life. **SimilarWeb**[22] is one of the providers that track such browsing activity and provide aggregation to show intensity of interest in different categories and companies. Overall, they track 80 million websites and 3 million mobile apps, spanning across 60 countries, and calculate activity metrics on a daily basis. For consumer related industries, buying behaviour is well known to be closely linked to websites and apps people use and browse, and for how long. This is the type of market intelligence that reflects the changes in consumer behaviour as a consequence of the COVID-19 pandemic.

Some caveats to bear in mind with the data are that the number of websites which are included in the categories defined by Similarweb might not be consistent across countries. Even if the number of websites captured is the same, the URLs are local to the individual countries which makes it meaningless to compare the visit volumes between countries. However, we can still compare changes in trends of website traffic and relative to their own history.

[22] https://www.similarweb.com/

Below we examine the categories that have witnessed significant changes in consumer behaviour since the beginning of the lockdown. Airlines and online travel sites are clear losers in the face of adversity caused by the current pandemic. The negative impact was especially apparent when US government announced the suspension of travels from Europe on the13th of March where there was an initial spike in web traffic of US Airlines, and to a lesser extent in Germany and the UK too. What followed were steep declines of web traffic in both broader categories across these countries as borders were subsequently closed. However, recent observations from Online Travels suggested that there were signs of steady rebound in the US and Germany, albeit still well below the pre-lockdown levels.

Figure 25. Web Traffic for Airlines and Online Travels (7-day moving average smoothing)

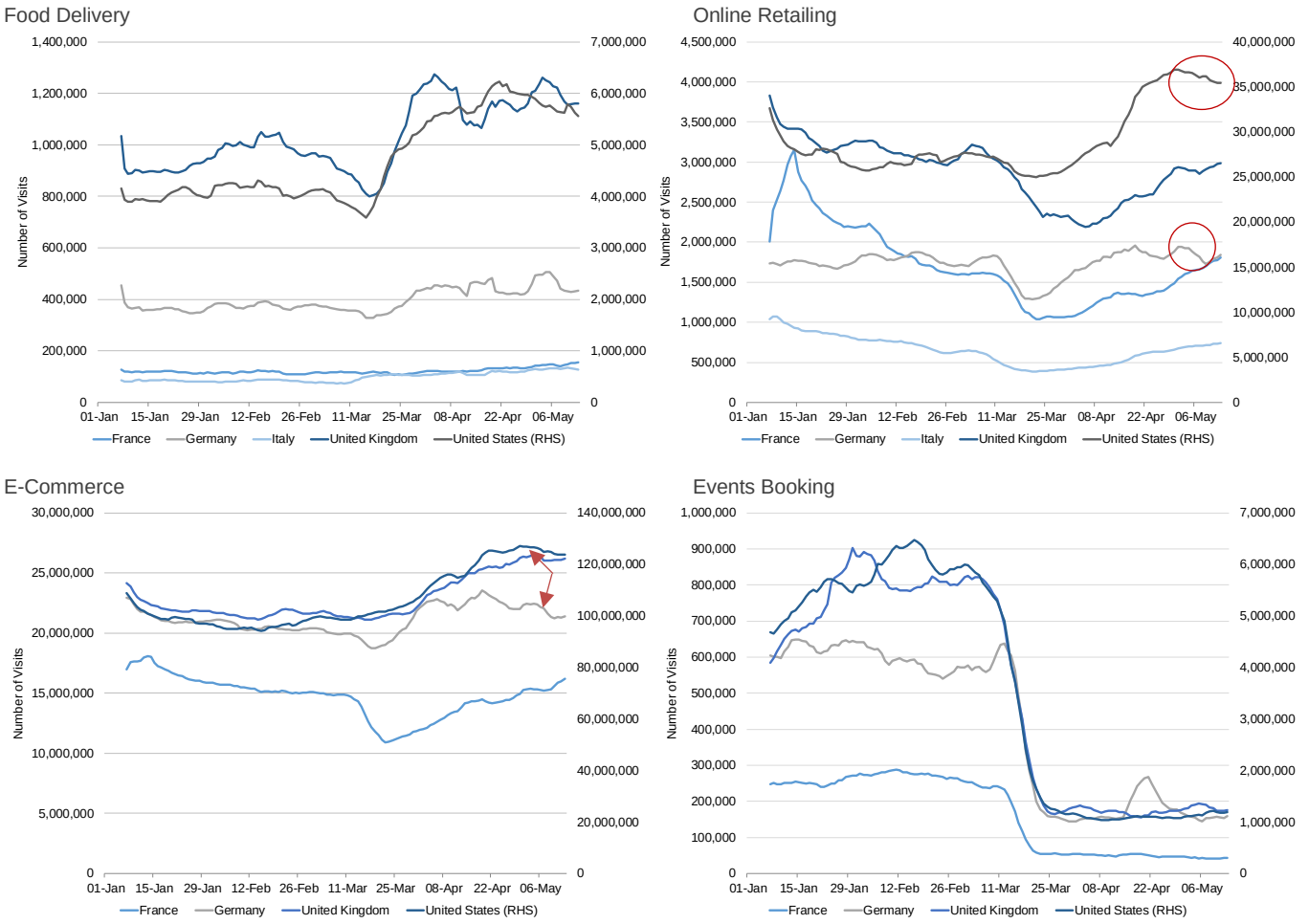



Source: SimilarWeb, CGDI

During lockdown, Food Delivery, Online Retailing and E-Commerce websites replaced physical visits to restaurants and shops as people confined themselves at home. All three categories saw substantial increases in the number of visits after lockdown was introduced. Food delivery enjoyed strong upsurges in web traffic especially in the US, UK and Germany, while France and Italy saw relatively muted rises. For Online Retailing, the up trends were consistent for all six countries but then they started to diverge as Germany and the US eased their lockdown earlier in May, allowing shops to reopen, resulting in this category to have experienced noticeable declines since.

Similar observations can be made in E-Commerce where upward trends were evident at the beginning of lockdown but as easing started, reversals could be seen in both Germany and the US. Events Booking is another category that has been hit hard by the lockdown. As large public gatherings remain prohibited, the traffic through these websites has yet to show any signs of recovery.

Figure 26. Web Traffic (7-day moving average smoothing)

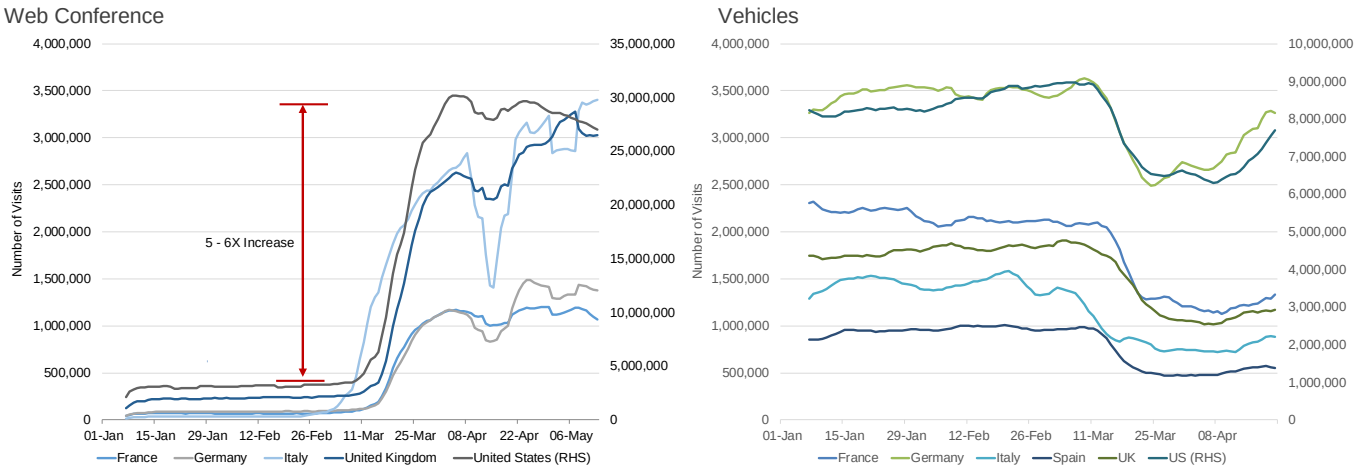



Source: SimilarWeb, CGDI

Another consequence of lockdown was the sudden increase in the number of people working from home and the prolonged duration of such practice was unprecedented. As meetings and conferences moved virtually, the demand for web conferencing shot up exponentially. As shown in Figure 27, the traffic on web conferencing sites in the US increased by six fold as lockdown started. Even though there has been a notable decline since the second half of April, the volumes through those sites remain five times higher than prior to lockdown. Demand for such services still persists in the other countries as well.

Many employers have confirmed their employees would not immediately need to return to the office to work, as they have to adapt the work place for social distancing and evidence suggests that work quality had not been negatively affected during lockdown. There have been growing calls for more flexibilities allowing employees to work from home more often. If this is indeed to become reality after lockdown is completely lifted, it is reasonable to expect the demand for web conferencing to continue and as such the web traffic to these sites would not revert to pre-pandemic levels.

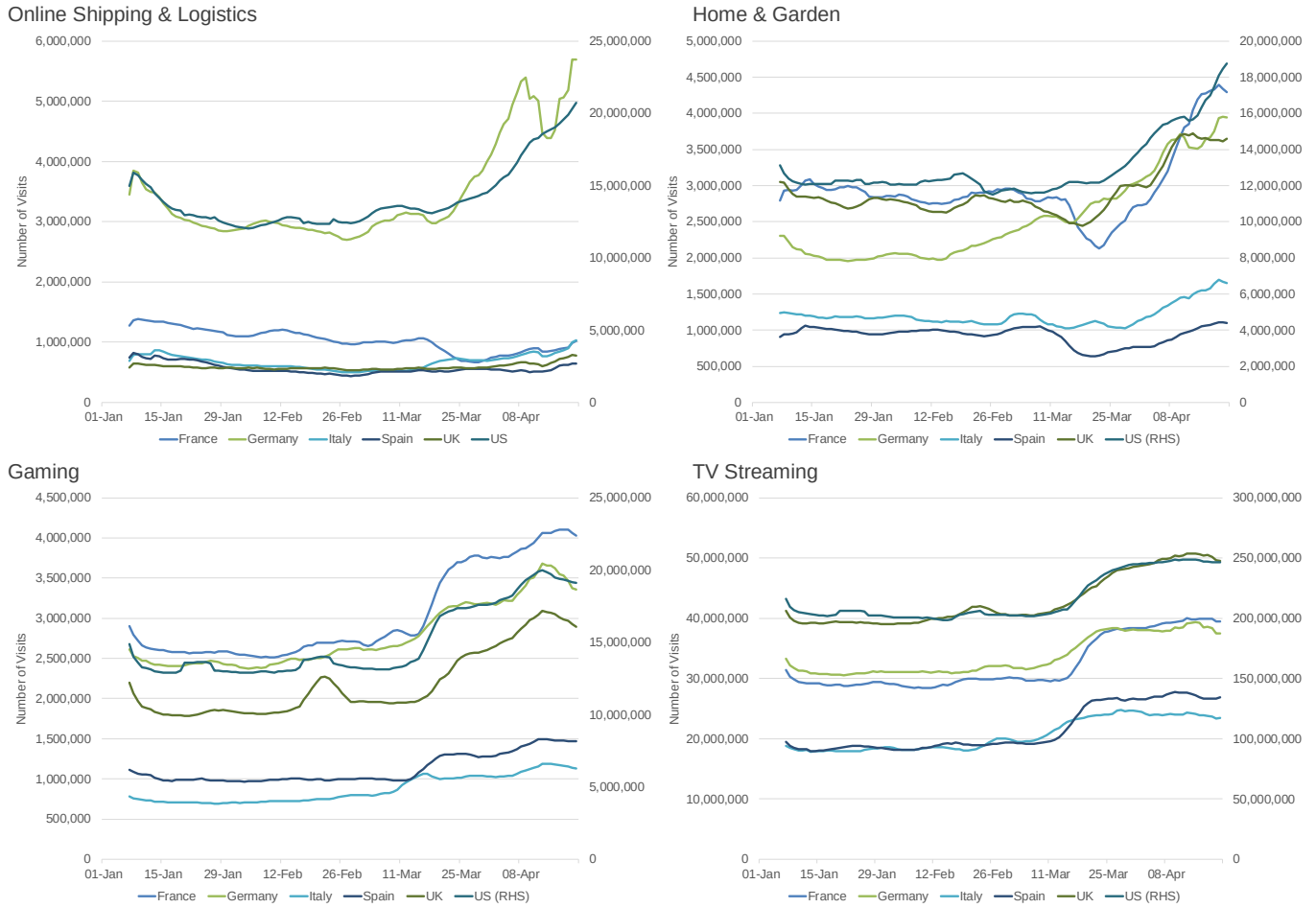
Figure 27. Web Traffic (7-day moving average smoothing)




Source: SimilarWeb, CGDI

In the mobility section, we noted that there appeared to be the tendency of people preferring to drive or walk, rather than taking public transport to travel places. This should be good news for the auto sector if the demand persists post lockdown. Indeed as depicted in Figure 27, vehicle websites including cars and motorcycles have already seen visit volumes recover by more than 50% of the drop in the US and Germany.

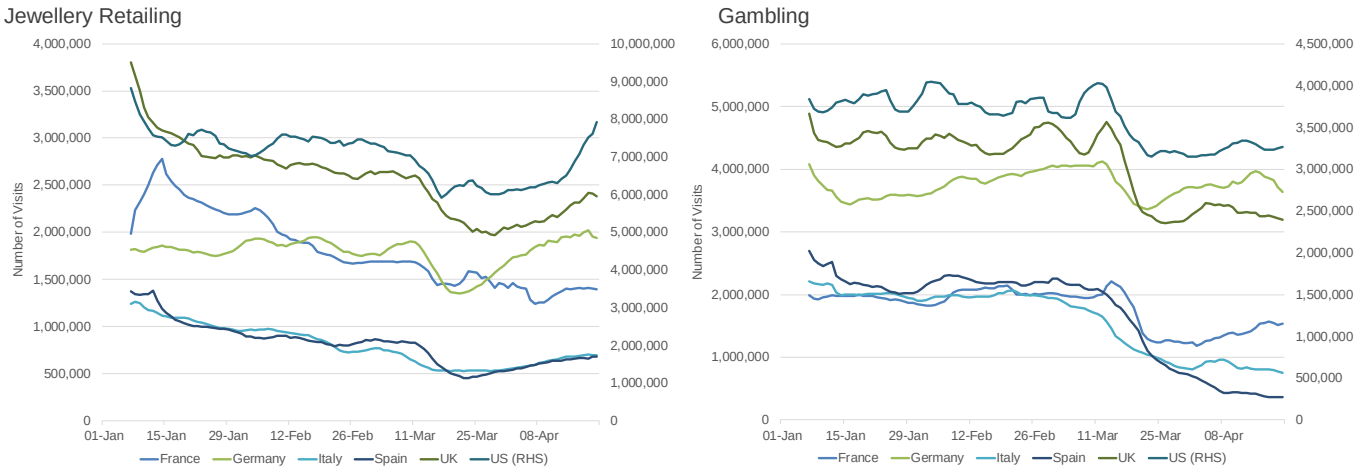
Figure 28. Web Traffic (7-day moving average smoothing)




Source: SimilarWeb, CGDI

Four more categories that have enjoyed significant increases are Online Shipping & Logistics, Home & Garden, Gaming and TV Streaming. As general public confined themselves mostly at home and 'lived' their life mostly online, it is not surprising to see people visited delivery websites for their daily needs and spent time on home & garden improvements, gaming and streaming services on TV. The key question to contemplate here is whether or not these elevated upward trends would revert back to where they were prior to lockdown, since working from home is likely to become a new norm going forward regardless.

Figure 29. Web Traffic (7-day moving average smoothing)




Source: SimilarWeb, CGDI

Two further categories we examine here relate to consumer confidence. Jewellery Retailing and Gambling appear to be at the opposite ends of the spectrum in terms of consumption but they are both closely linked to consumers' perception of the future. Luxury goods spending tends to go up when consumers feel more certain about their own income and economic outlook. Gambling typically increases in the face of uncertainties as the possibility of improving one's financial situation by winning big becomes more enticing.

Figure 29 demonstrates that in the US and Germany, the interest in jewellery retailing has rebounded to above the pre-lockdown level, perhaps driven by the positive sentiment from their governments as both have committed to deliver enormous stimulus packages[23] and their economies have been allowed to reopen, while France is the only country amongst the six that displays a clear downward trend. In contrast, the number of visits to the gambling sites has decreased broadly since lockdown but interestingly France is the only country that shows a clear upward trend while the others exhibit either downward trends or flat lined. Taken altogether, it would suggest that consumer confidence in France is relatively fragile compared to the other nations discussed here.

In addition to website traffic, SimilarWeb also monitors the usage of apps on mobile phones. The app usage can unveil important trends as well now that apps on mobile phones have become an intrinsic part of modern life. We have analysed many categories based on the website traffic and checking the corresponding apps usage data[24], they do indeed largely support our earlier observations.

One App category worth highlighting is Online Education. Schools were ordered to close nationwide as lockdown began which gave rise to prolonged home-schooling in many countries. With parents juggling working from home and educating their children, online

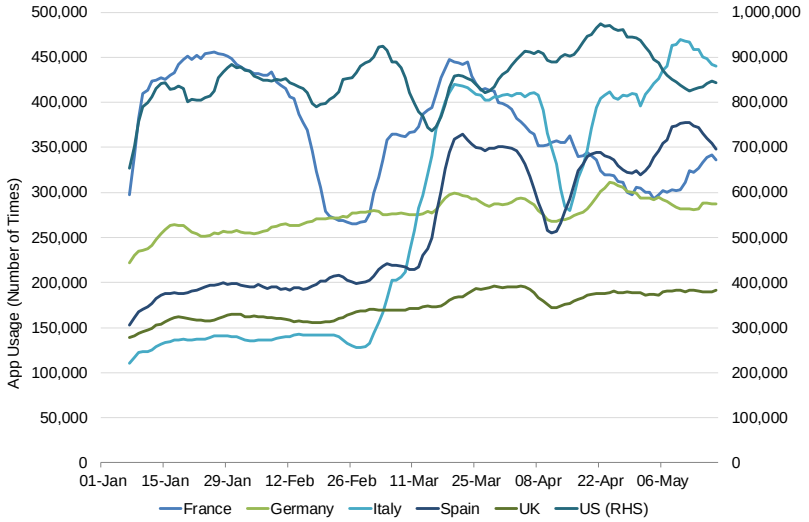
[23] As highlighted on page 8 of the report.

[24] We use Google App store data for our analysis as the app data from Apple is only available on a monthly frequency.

education providers were given the golden opportunity to expand and attract new customers.

With that said, it is intriguing to see in Figure 30 that there are clear inconsistencies across countries examined. In Italy and Spain, such apps have attracted a rapidly growing user base since lockdown, while the pace of expansion in Germany and the UK has been moderate. The US experienced an initial surge but has now declined to the pre-lockdown level as the economy restarts. The oscillating pattern exhibited for France has been quite unusual as the usage seems to be unaffected by school closures, perhaps reflecting online education might not be their key resource for home-schooling.

Figure 30. App Usage: Online Education (7-day moving average smoothing)




Source: SimilarWeb, CGDI

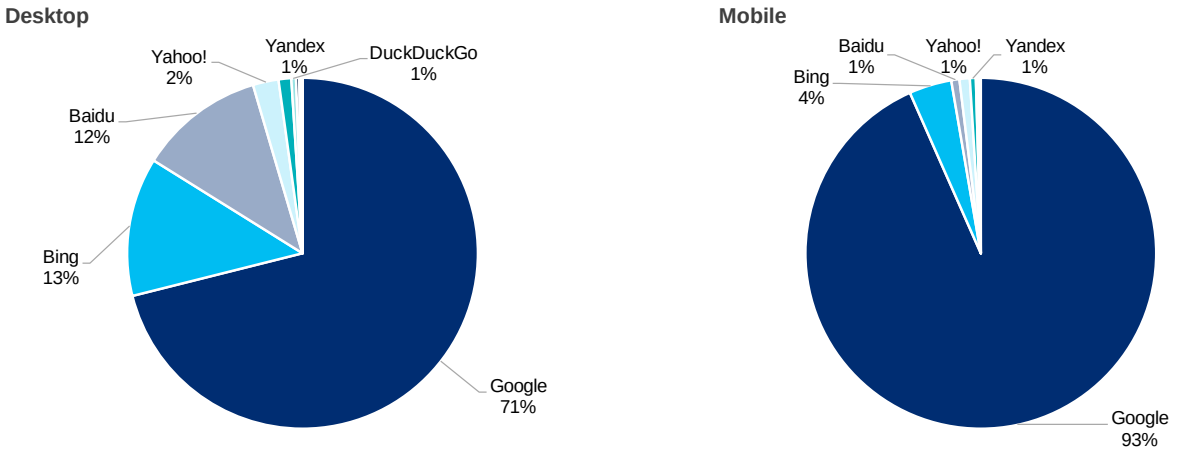
Another interesting anecdote in education is that the interest in teaching has gone up as lockdown continues, apparently owing to the growing respect for teachers through lengthy home-schooling. At the same time, with school reopening and social distancing measures being enforced, there might be higher demand for teachers too as the class size inevitably needs to be reduced and higher staffing levels are required. The increases in both supply and demand should come through the job postings data discussed earlier. It would be interesting to see what the net effect of COVID-19 looks like – while in the short term, it is clearly negative for school-aged children. In the medium term, better quality recruits in teaching coupled with smaller class sizes should raise education standards of a country.

## Digital Footprint

So far we have shown how web traffic can be used to gauge consumers' appetite towards different consumption categories. However, if we wish to conduct analysis on a global basis, without the pre-specified categories with corresponding URLs mapped, such information may not be as straightforward to obtain. Another way to delve into consumers' minds is to examine their digital footprint where the search terms used are the main focus here.

Google Trends is the best known source for search volume as it is the most widely used. In fact, its market share as a search engine in desktop and mobile devices dwarf its competitors by a huge margin.

Figure 31. Search Engine Market Shares (May 2020)




Source: NetMarketShare, CGDI

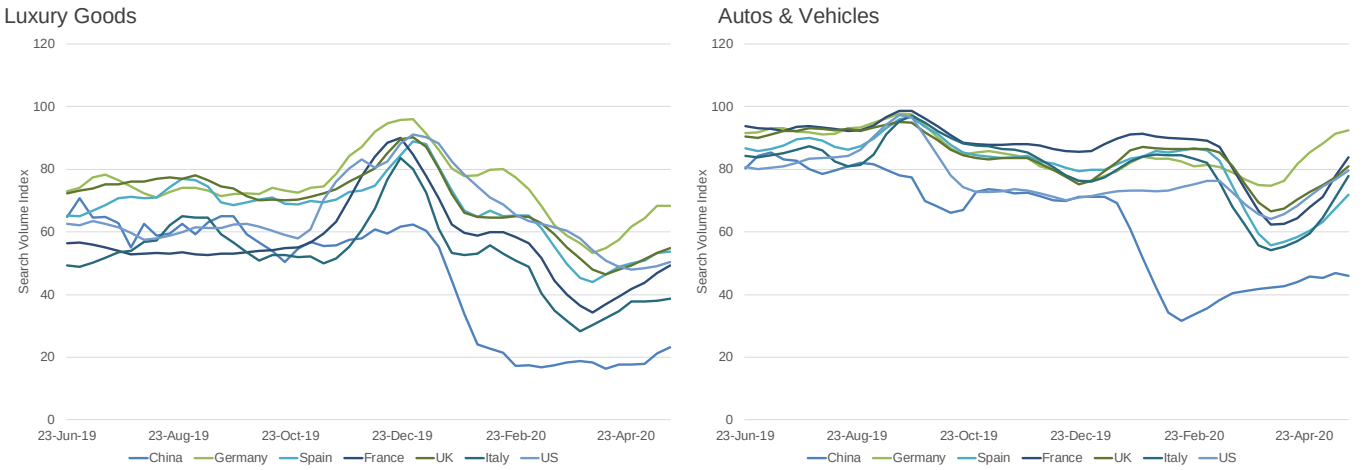
**Google Trends**[25] provides an index that ranges between 0 and 100 through normalisation, to represent the search interest of a keyword or topic. The topics are multiple keywords that relate to the chosen topic. The index given by Google Trends indicates the relative search interest of a given keyword i.e. the search volume of the keyword divided by the total search volume of all other keywords, after that the signal is normalized. This means comparing search interest for more than 5 terms can be challenging as Google does not provide the underlying raw search volume. To overcome this issue, we have developed a proprietary process which normalises the trends data and facilitates direct comparisons over as many terms as computing power allows.

As discussed earlier, luxury goods can also serve as a barometer of consumer confidence which is key to any economic recovery. To assess the interest in the luxury brands, we pull the weekly data for the Luxury Goods category and the Autos & Vehicles category from Google Trends – also mentioned earlier to be another leading indicator of economic health.

The charts below show similar patterns for luxury goods compared to the data we extracted from SimilarWeb in that after the initial sharp drops, the interests in luxury goods in most of the countries examined have recovered fully with some even going above the pre-lockdown levels. Interests in autos and vehicles also bounce back strongly to just below the previous levels in all but one country – Germany, of which the latest reading suggests +15% increase in search volumes.

[25] https://trends.google.com/trends

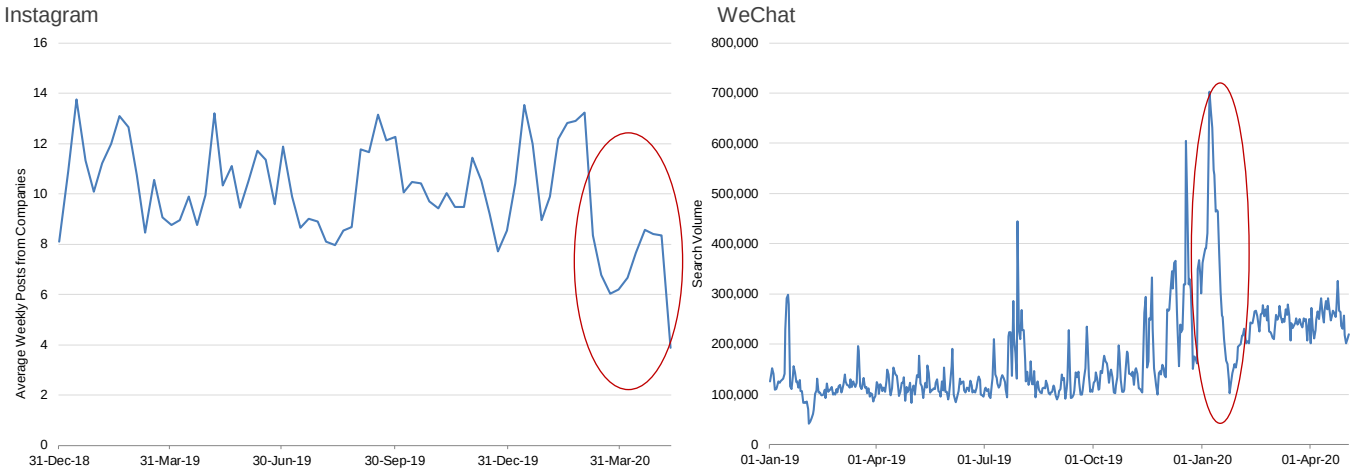
Figure 32. Google Trends Search Volume Index (4-week moving average smoothing)




Source: Google Trends, CGDI

Other sources we can utilise for measuring luxury goods demand include **Instagram**[26] and **WeChat**[27]. Instagram represents an effective way to connect with generations Y and Z who have become increasingly important to luxury brands. As it is blocked in China, the data are mainly for assessing European and US consumer demand. WeChat, on the other hand, is the largest social media platform in China with over 1.1 billion monthly active users in 2019. It can be used to measure luxury brand engagement with the Chinese consumer base.

Figure 33. Luxury Goods




Source: Instagram, WeChat, CGDI

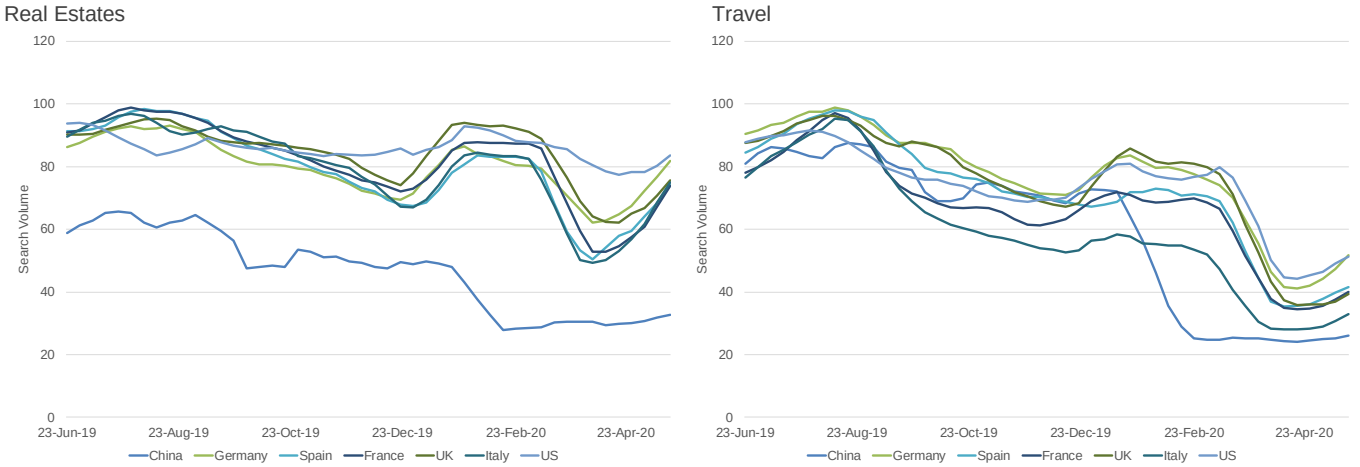
Based on the 55 luxury brands selected, the average posts on Instagram decreased by -50% in mid March, then rebounded somewhat and dropped again, coinciding with the swing of public confidence in the Coronavirus situation being under control in both Europe and the US. For WeChat, we pull the search volume of luxury goods companies by using their names as the keywords, with some being in Chinese. The search volume

[26] https://www.instagram.com/

[27] https://www.wechat.com

of each keyword is then aggregated to create a total search volume representing the interests. We can see from Figure 33 that there was a steep decline in search volumes at the height of outbreak in China. Since reopening, it has recovered fully and in fact the interest has persisted at a higher level than the full-year average in 2019.

Figure 34. Google Trends (4-week moving average smoothing)




Source: Google Trends, CGDI

Utilising Google topic categories, we can also examine the impact COVID-19 has on Real Estate sector. Most countries highlighted in Figure 34 have seen interest in the sector recover to nearly 100% of the pre-lockdown levels. China is the exception here as the search volumes in real estate remain suppressed despite a gradual but positive trend can be seen on the chart. We look at Travel category as well, as one can argue Google Trends captures broader travel intentions, complementing the more precise web traffic data from SimilarWeb. The pattern depicted in Figure 34 confirms our earlier finding where search volumes fell dramatically as the fear of Coronavirus took its toll and lockdown started. However, the trends seem to suggest the worst is over and the interest in travel has resumed somewhat in many of these countries.

## Flight Frequency

Airlines industry has been hit hard in this pandemic and many CEOs of airline companies have voiced their concerns that the industry could be profoundly damaged by Coronavirus crisis. With social distancing, quarantine requirements and the drastic reduction of business travellers, even when lockdown is fully lifted, it is questionable how airlines can expect to recover if much at all. Numerous airliners have been seeking financial bailouts from their respective governments as they struggle to survive.

Although flight frequencies would not necessarily be the first area on our list to spot signs of recovery, as regarded more as a secondary effect, they are nonetheless useful to monitor in conjunction with some other indicators we discussed in the earlier sections.

Using the flights map from **Flightradar24**[28], the impact on frequencies of flights are clear for all to see in Figure 35[29]. Exactly one month apart, Coronavirus grounded many planes, greatly reduced the frequencies of cross Atlantic flights and also between Europe and Asia.

Figure 35. World Flights Map

As of 29 February 2020 As of 29 March 2020


Source: flightradar24

To gain more detailed insights into the industry, we have partnered with **FlightAware**[30] for our analysis. FlightAware is a digital aviation company and operates the world's largest flight tracking and data platform. It receives data from air traffic control systems in over 45 countries, FlightAware's network of ADS-B ground stations in 195 countries, Aireon global space-based ADS-B, and datalink (satellite/VHF) via every major provider.

Extracting data from FlightAware's API, we construct the flights data on a country level in the following way: all flights in a week with a given origin airport in a selected country are counted. If the destination airport is in the same country as the origin airport then the flight is categorised as a domestic flight. And if the destination airport is in a different country than the origin airport, the flight is categorised as an International flight. For each country, we can then obtain the weekly total numbers of domestic and international flights.

Figure 36 shows the flight frequencies for both international and domestic departures in the six countries of our focus. As expected, the pictures are equally abysmal for the airliners, regardless of countries they are in or whether international or domestic.

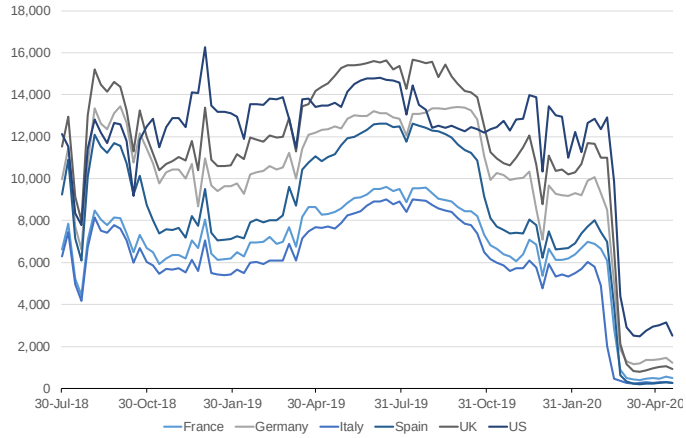
[28] https://www.flightradar24.com/

[29] Flights tracked via satellite-based ADS-B have blue icons.

[30] https://uk.flightaware.com/

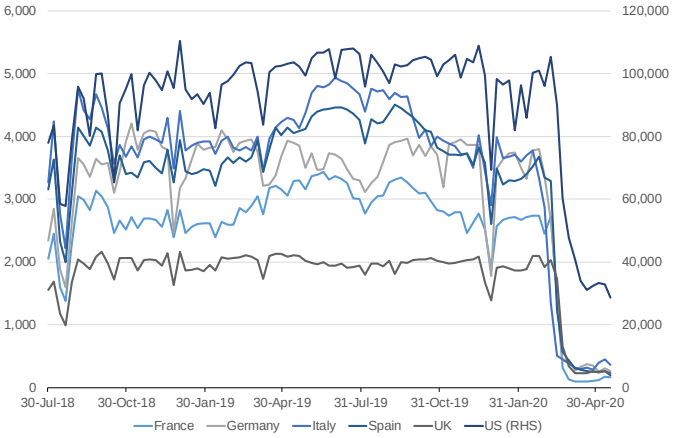
Figure 36. Number of Flights (weekly)

International Departure




| YoY Change | France | Germany | Italy | Spain | UK | US |
|---|---|---|---|---|---|---|
| 06-Jan-20 | 4% | 0% | 8% | 1% | 2% | 0% |
| 13-Jan-20 | 0% | -1% | -2% | -6% | -2% | -1% |
| 20-Jan-20 | 0% | -4% | 0% | -6% | -2% | -2% |
| 27-Jan-20 | 0% | -5% | -2% | -6% | -4% | -16% |
| 03-Feb-20 | -1% | -5% | -3% | -4% | -8% | -6% |
| 10-Feb-20 | 6% | -1% | 4% | 3% | -2% | -5% |
| 17-Feb-20 | 1% | -3% | 0% | -3% | -2% | -7% |
| 24-Feb-20 | -1% | -2% | -4% | 0% | -2% | -5% |
| 02-Mar-20 | -5% | -10% | -17% | -6% | -7% | -9% |
| 09-Mar-20 | -15% | -19% | -67% | -12% | -9% | -6% |
| 16-Mar-20 | -59% | -52% | -92% | -51% | -45% | -28% |
| 23-Mar-20 | -87% | -82% | -94% | -92% | -82% | -68% |
| 30-Mar-20 | -94% | -88% | -96% | -97% | -91% | -77% |
| 06-Apr-20 | -94% | -88% | -96% | -97% | -93% | -78% |
| 13-Apr-20 | -95% | -90% | -96% | -98% | -94% | -82% |
| 20-Apr-20 | -95% | -89% | -96% | -98% | -94% | -80% |
| 27-Apr-20 | -94% | -89% | -97% | -98% | -93% | -78% |
| 04-May-20 | -94% | -89% | -96% | -98% | -93% | -78% |
| 11-May-20 | -93% | -88% | -96% | -97% | -93% | -77% |
| 18-May-20 | -94% | -90% | -97% | -98% | -94% | -81% |

Domestic Departure




| YoY Change | France | Germany | Italy | Spain | UK | US |
|---|---|---|---|---|---|---|
| 06-Jan-20 | 4% | 4% | 6% | 1% | 2% | 3% |
| 13-Jan-20 | 4% | 0% | -5% | -5% | 3% | 5% |
| 20-Jan-20 | 4% | -4% | -6% | -4% | 0% | 5% |
| 27-Jan-20 | 4% | -1% | -5% | -6% | 0% | -9% |
| 03-Feb-20 | 2% | -8% | -8% | -4% | -5% | 3% |
| 10-Feb-20 | 13% | -13% | -1% | 6% | 1% | 4% |
| 17-Feb-20 | 4% | -8% | -4% | -1% | 1% | 4% |
| 24-Feb-20 | 6% | -4% | -17% | 0% | 2% | 3% |
| 02-Mar-20 | -5% | -10% | -25% | -7% | -7% | -3% |
| 09-Mar-20 | -5% | -31% | -64% | -10% | -3% | 3% |
| 16-Mar-20 | -49% | -62% | -87% | -66% | -18% | -13% |
| 23-Mar-20 | -89% | -89% | -88% | -84% | -68% | -42% |
| 30-Mar-20 | -96% | -88% | -90% | -89% | -83% | -49% |
| 06-Apr-20 | -96% | -91% | -91% | -91% | -87% | -51% |
| 13-Apr-20 | -97% | -90% | -93% | -93% | -89% | -66% |
| 20-Apr-20 | -97% | -89% | -92% | -94% | -89% | -70% |
| 27-Apr-20 | -97% | -90% | -93% | -94% | -87% | -68% |
| 04-May-20 | -96% | -94% | -91% | -94% | -89% | -68% |
| 11-May-20 | -94% | -92% | -89% | -94% | -88% | -68% |
| 18-May-20 | -95% | -93% | -91% | -95% | -89% | -72% |

Source: FlightAware, CGDI

With more countries coming out of lockdown, there has been some anecdotal evidence of returning customers in the form of flight bookings in Europe. For the US, the numbers of both international and domestic flights remain at depressed levels after a short-lived rebound towards the end of April. In fact, the international flight frequency has hit the bottom again while the domestic one has reached a new low, reflecting airlines cutting down flights further to save costs as most planes are nearly empty.

## Sentiment

In a crisis moment like this, general public and business sentiment can play a big part in how the recovery will shape up. To understand how the sentiment has been changing since earlier in the year, we have partnered with **Amenity Analytics**[31] which develops cloud-based text analytics solutions using natural language processing (NLP) and machine learning.

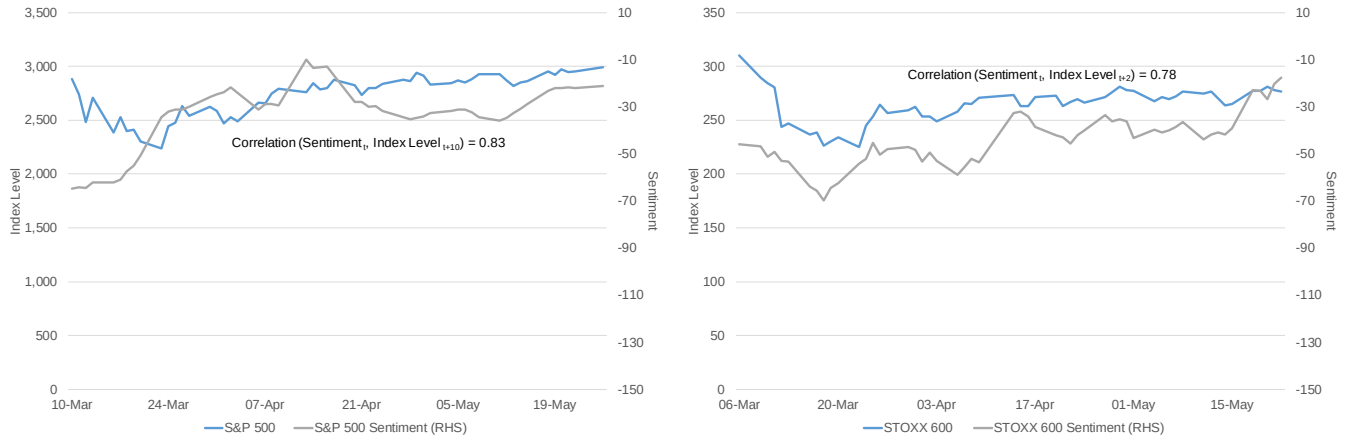
Specifically on their COVID-19 sentiment, the analytics are built on a model that captures company-specific mentions in news and earnings calls and discerns how

[31] https://www.amenityanalytics.com/

COVID-19 influences business fundamentals. They analyse how companies are impacted by extracting meaningful text and transform the embedded sentiment into scores. For the S&P 500 and STOXX 600 sentiment, they leverage their thematic approach to sentiment to construct the sentiment series. By analyzing text at the aspect level we can aggregate extractions over different time periods, company groups, and document types. For the SPX and STOXX time series Amenity analyses news and earnings calls for the index members and aggregate the extractions to create a sentiment score for the index on any given day. They normally present the rolling net sentiment score which uses a 7 day rolling window to calculate the average sentiment.

In Figure 37 we show that the rolling sentiment did appear to drive stock markets somewhat from mid March onwards as the rolling sentiment scores for S&P 500 and STOXX 600 lead their corresponding indices by up to 10 days and 2 days respectively.

Figure 37. Rolling 7-day Sentiment vs Market Indices




Source: Amenity Analytics, CGDI

The longer lead-lag relationship in S&P 500 sentiment vs the index level might seem puzzling but we think that's due to the indecisiveness of the initial US response to deal with COVID-19, compared to the mostly swift actions from European countries. Using S&P 500 and STOXX 600 as proxies for the US and European markets, we can see that although the absolute level of sentiment in Europe is negative, its trend has turned positive since mid May and carries strong positive momentum, while the US plateaued towards the end of April, experienced a small uptick in sentiment earlier in May but then the upward trend has stalled.

Figure 38. Net Rolling Sentiment on Sector Level as of 27th May 2020

| | Net Rolling Sentiment | Since 1 Mar |
|---|---|---|
| Communication Services | -14.95 |  |
| Consumer Discretionary | -42.20 |  |
| Consumer Staples | -12.18 |  |
| Energy | -53.08 |  |
| Financials | -41.34 |  |
| Health Care | 1.86 |  |
| Industrials | -49.15 |  |
| Information Technology | -19.60 |  |
| Materials | -42.14 |  |
| Real Estate | -23.12 |  |
| Utilities | -0.44 |  |

Source: Amenity Analytics, CGDI

On the sector level, we can see that only Health Care sector has positive sentiment but in terms of the trends, there is also positive momentum to be found in Consumer Discretionary, Industrials and Real Estate. The less negative sentiment of these pro-cyclical sectors suggests that recovery has started to take shape.

## ESG

The last dimension we think that is relevant to gauge the recovery is ESG. Our colleagues in Global Insights have written extensively on the changes caused by COVID-19 in their report: Sustainable Tipping Points - 'Systemic Capitalism': Building a sustainable future post COVID-19. For our purpose, it might not be immediately apparent but for example environmental topics such as air quality can be our near real-time indicator as to how well the economy has recovered through the pollution it has caused as a bi-product.

There are several ways to analyse how ESG has been affected by COVID-19. The first approach is to leverage the data from AI-based ESG vendors such as **TruValue[32] Labs** (TVL)[33]. TVL uses machine learning, NLP and AI to evaluate companies' ESG performance based on SASB[34] framework. TVL covers 16,000+ public and 3000 private companies globally in 13 languages.

TVL has built multiple NLP algorithms that pick up COVID-19 specific data which captures when COVID-19 is being talked about in relation to companies within unstructured text. They then score how positive or negative the COVID-19 content is within each article which ranges from -20 (most negative) to 20 (most positive) with 0 being neutral. Scores are calculated on a company level but also get aggregated onto country, region, SICS industry, SICS sector levels and SASB categories.

Since the beginning of the year, they have observed massive growth in volume denoting the emergence of following SASB material issues specific to COVID-19: Employee Health &

[32] https://www.truvaluelabs.com/

[33] For our whitepaper on AI-based vendors, please refer to The Rise of AI in ESG Evaluation.

[34] https://www.sasb.org/

Safety; Labour Practices; Access and Affordability; Product Quality and Safety; and Supply Chain Management

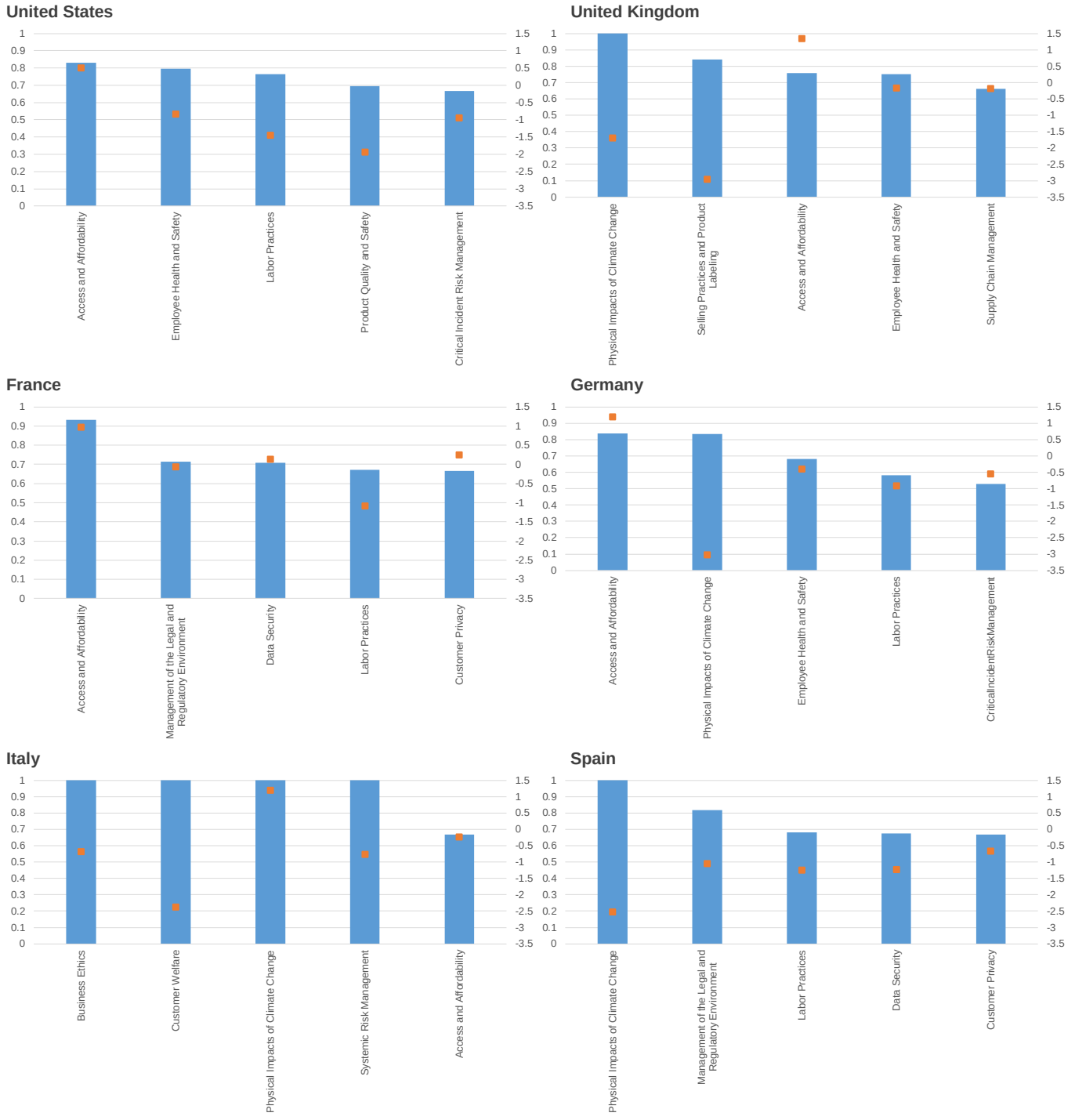
TVL has also created the following five sub-signals which capture general discussions of COVID-19 and its impact on:

- **Social Impact**: quality of living, access to education, social distancing, mental health, depression, access to healthy food, and related topics
- **Labour** : employees, layoffs, working from home, paid sick leave, unemployment, and related topics
- **Economy**: broader economy
- **Supply Chain**: supply of goods, production halts, manufacturing stoppages, and other related issues
- **Response**: R&D or efforts to create vaccines or to shift manufacturing to produce test kits, ventilators, sanitizer, or any other unusual, crisis-specific goods, services, or products

In Figure 39, we can see that all six countries of our focus have witnessed newsfeeds being inundated with COVID-19 related contents. In the case of Italy, Spain and UK, some SASB categories have reached 100% of all documents TVL take in relate to COVID-19. Ordered by percentage of documents on COVID-19, most countries barring Italy and Spain have the social category of 'Access and Affordability' carry positive sentiment.

The definition of 'Access and Affordability" according to SASB is a company's (can be aggregated up to country level) ability to ensure broad access to its products and services particularly in the underserved markets and population groups. It includes management issues related to universal needs such as healthcare, financials, utilities, education and telecommunications. The fact that most countries show positive scores in this category demonstrates in this pandemic providing access to essential needs and across population has been broadly speaking successful. Scores are negative for Italy and Spain due to both countries having their healthcare systems right on the brink of collapse as the spread of the Coronavirus proved to be very challenging for their governments to control initially and even now they are still reeling from it.

Figure 39. % COVID-19 Documents (Bar Chart, LHS) and SASB Category Scores (RHS)

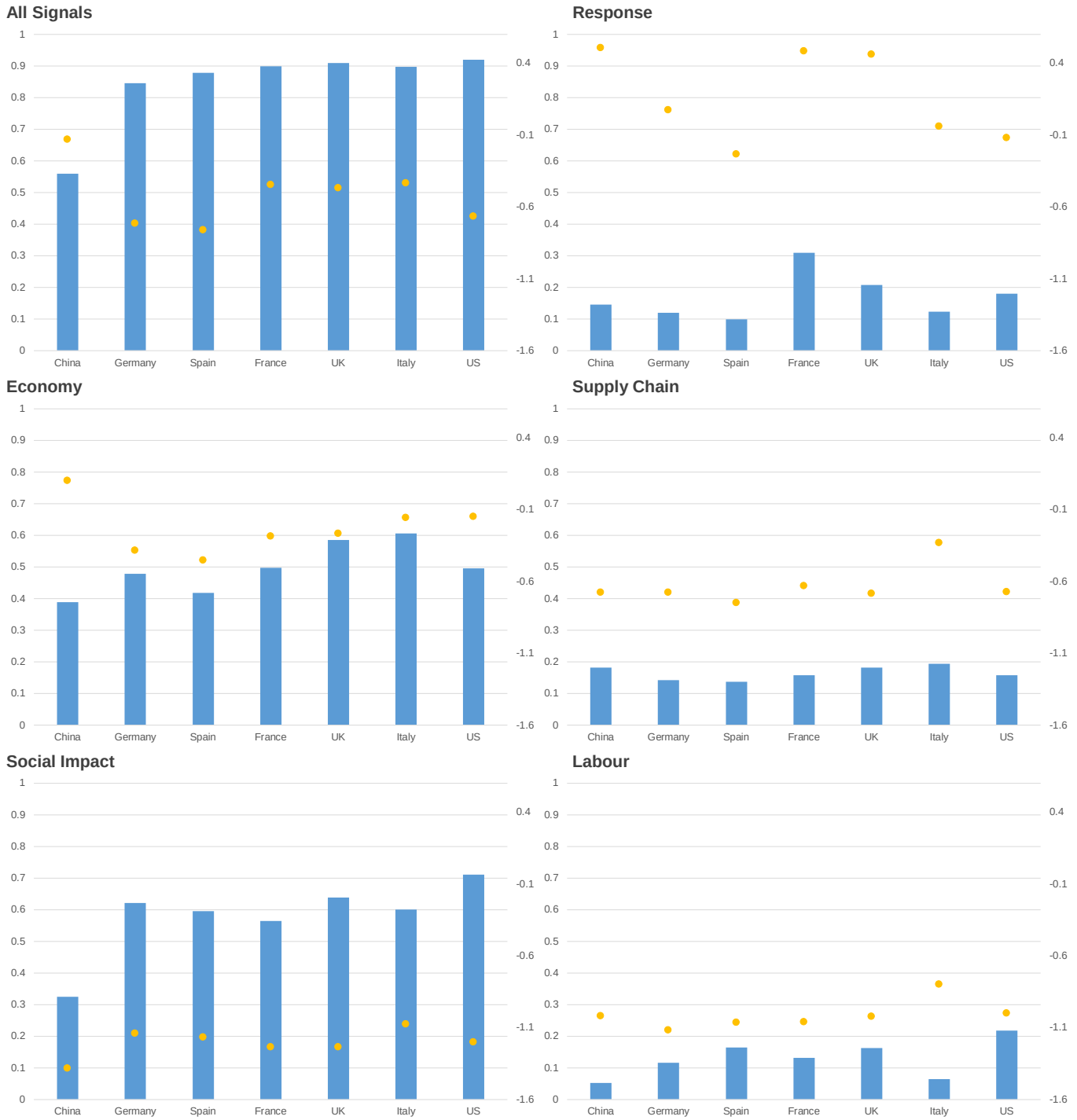



Source: TruValue Labs, CGDI

Focusing on the five sub-signals directly linked to COVID-19 coping mechanisms, we add China into the mix as it is seen as a country where recovery is well under way. Interestingly in terms of overall sentiment, China enjoys the highest score compared to the other six countries even though all of them are negative which suggests the pandemic is perceived to be not yet over and there is risk that it would continue to wreak havoc on the economy if it remains not fully under control.

Social impact and economy are the two topics that have the most discussions relating to the Coronavirus, with the latter displaying the least negative sentiment, while the 'response' topic attracts the highest sentiment amongst all. This demonstrates that how local governments responded and communicated their actions to the general public would have positive effects on general sentiment, which could help recovery.

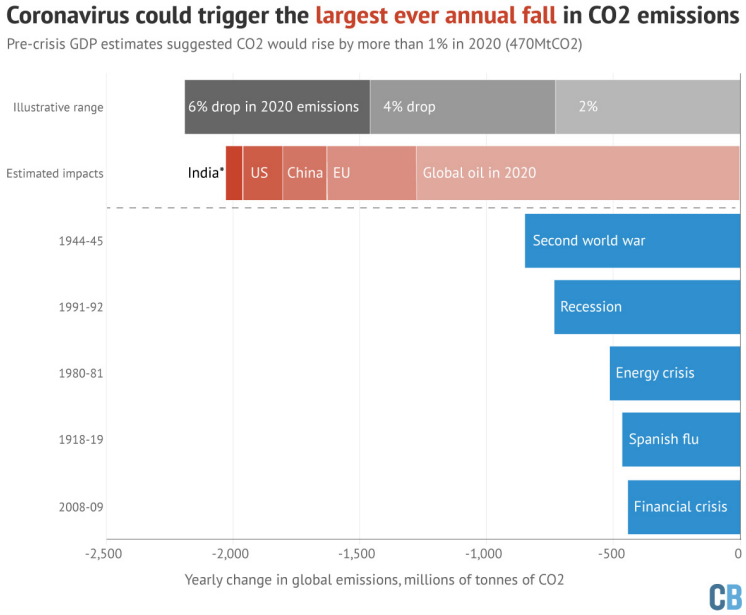
Figure 40. % COVID-19 Documents (Bar Chart, LHS) and General Sentiment (RHS)




Source: TruValue Labs, Citi Global Data Insights

Another approach is to consider air quality directly. Ironically, Coronavirus is the best news for the environment as manufacturing facilities and factories halted, flights grounded and many vehicles locked down, all of which contributed to the sizeable reduction in carbon emission. Major cities that suffer from the world's worst air pollution have seen reductions of deadly particulate matter by up to 60% from the previous year. In Figure 41, the five largest falls in annual global $CO_2$ emissions ever recorded are shown in blue bars, in millions of tonnes of $CO_2$.

Figure 41. COVID-19 Impact on Pollution




Source: Carbon Brief analysis of emissions data from the Carbon Dioxide Information Analysis Centre (CDIAC) and the Global Carbon Project; analysis of assessments from ICIS and the US Energy Information Administration; analysis of daily data from India's Power System Operation Corporation (POSOCO).

Based on **Carbon Brief**'s estimates[35], the grey bars illustrate how far emissions would fall in 2020 under a 2%, 4% or 6% reduction compared to 2019 levels. The red bars show estimated emissions impacts of the coronavirus crisis in 2020 on the global oil sector, the EU carbon market, China, the US and India, with the latter only accounting for changes in the power sector.

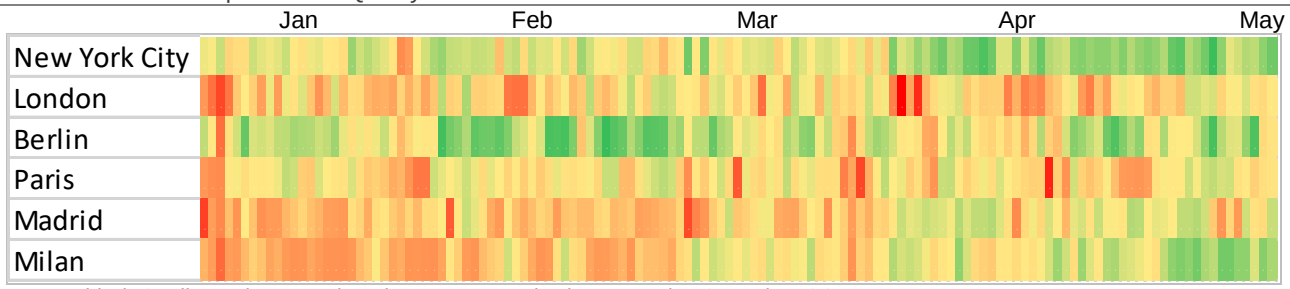
Air quality can be a measure for the scale of recovery as it, sadly, reflects the consequence of increased economic activities in an undesirable way. The more economic activities are resuming, the worse air quality can be expected to deteriorate. To assess the current levels, we use the near real-time air quality data hosted on **World Air Quality Project**'s website[36] which collects data directly from environment agencies across the globe.

[35] The full article is available on https://www.carbonbrief.org/analysis-coronavirus-set-to-cause-largest-ever-annual-fall-in-co2-emissions

[36] https://waqi.info/

Examining the cities within the six countries that are most affected by COVID-19, we show how the air quality has changed since beginning of the year[37] in Figure 42. It is evident that lockdown has effectively 'cleaned' the air of these cities.

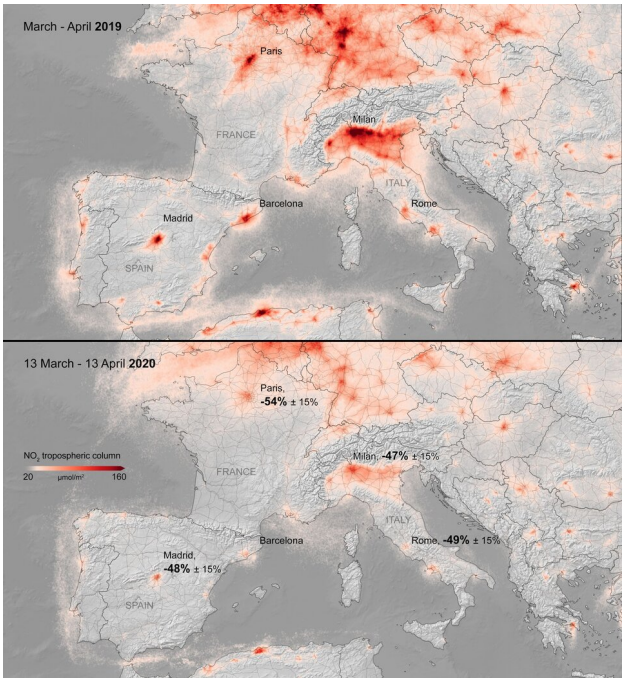
Figure 42. COVID-19 Impact on Air Quality




Source: World Air Quality Project, Local Environment Agencies in Respective Countries, CGDI

Such observations can also be made via satellite images. **European Space Agency**[38] (ESA) demonstrated how air quality had improved by comparing images of nitrogen dioxide concentrations from March to April in 2020 vs 2019. Based on their calculations, the reductions of such concentrations were -54% for Paris, -47% for Milan and -48% for Madrid as a result of lockdown.

Figure 43. Satellite Images: Nitrogen Dioxide Concentrations in Europe



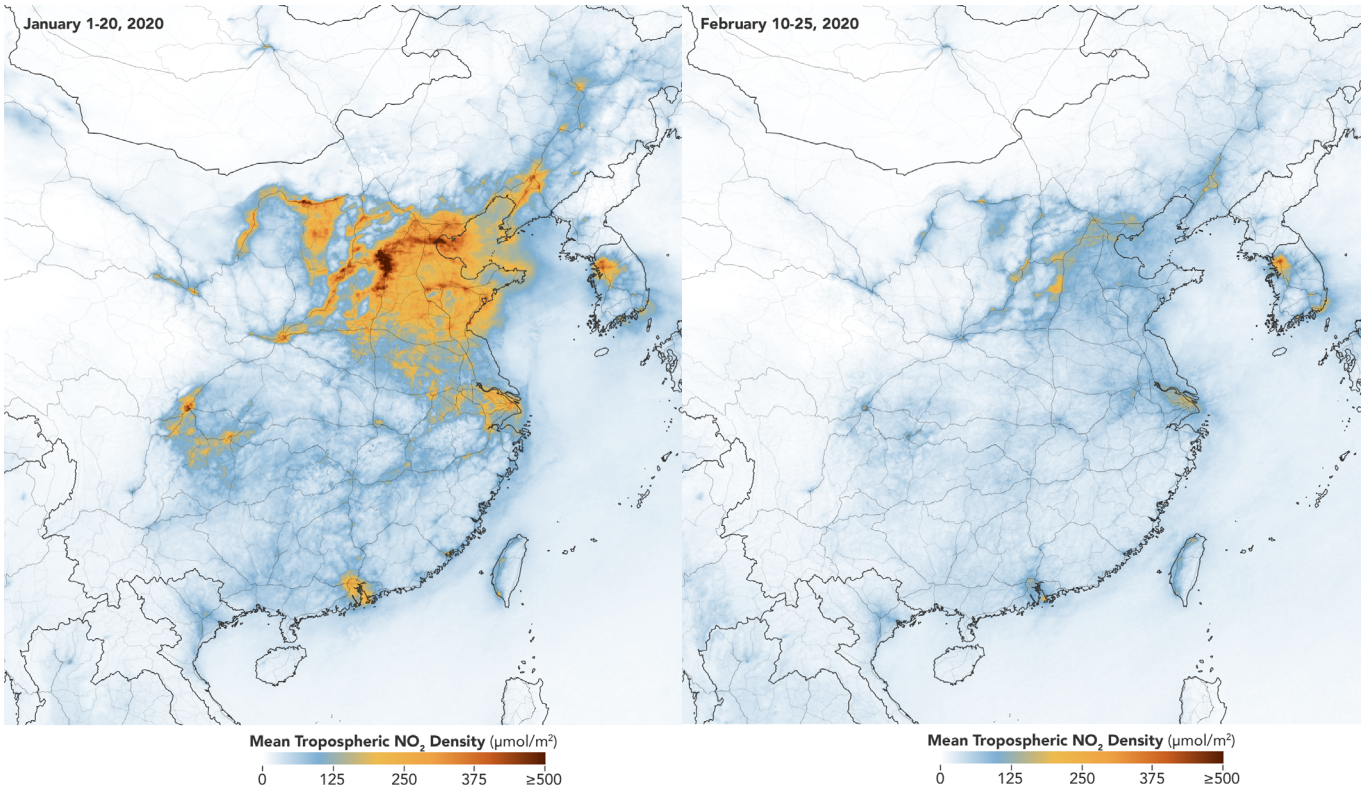

Source: European Space Agency

[37] Based on measurement of particulate matter PM2.5

[38] http://www.esa.int/

Images taken by **NASA**[39] on China also show stark contrast of air quality readings before the country went into lockdown vs during lockdown.

Figure 44. Satellite Images: Nitrogen Dioxide Concentrations in China




Source: NASA

The three approaches discussed in this section show that certain aspects of ESG have been impacted by COVID-19 with some temporary and others perhaps long-lasting. These aspects can be used to measure the scale and the speed of recovery – how much the 'new normal' would resemble the old world.

[39] https://www.nasa.gov/

# Bringing It All Together

## Country Recovery Dashboard

Throughout the report, we have discussed many interesting alternative data sources that can help to identify the direction and to some extent quantify the magnitude of the recovery, as more countries are coming out of lockdown and looking to rebuild their economies. However, to fully utilize the market intelligence extracted from these datasets, we think it is imperative to collate them together and create a country recovery dashboard as illustrated in Figure 45. A dashboard such as this can provide a quick overview of how potential recovery is shaping up from different corners of a country and also facilitate cross-country comparisons.

As a starting point, we use the observations at the height of lockdown in each country and then compare the subsequent data points as lockdown starts to ease to denote whether the scenes on the ground are improving/unchanged/declining.

Figure 45. COVID-19 Country Recovery Dashboard

| | US | UK | France | Germany | Italy | Spain |
|---|---|---|---|---|---|---|
| **COVID-19 Status** | | | | | | |
| Current Infection Curve |  |  |  |  |  |  |
| **Government Response** | | | | | | |
| Lockdown start date | 19-Mar* | 23-Mar | 17-Mar | 23-Mar | 09-Mar | 16-Mar |
| Lockdown easing | 13-Apr* | 01-Jun | 11-May | 20-Apr | 18-May | 04-May |
| | | | | | | |
| **Assessing the New Normal** | | | | | | |
| ***Mobility*** | | | | | | |
| Moovit | | | | | | |
| CityMapper | | | | | | |
| Apple Mobility | | | | | | |
| Google Mobility | | | | | | |
| ***Economic Activities on the Ground*** | | | | | | |
| Restaurants booking (Opentable) | | | | | | |
| Job Postings Growth | | | | | | |
| Flights | | | | | | |
| ***Web/AppTraffic*** | | | | | | |
| Airlines | | | | | | |
| Travels | | | | | | |
| Retailing | | | | | | |
| E-Commerce | | | | | | |
| Web Conference | | | | | | |
| Vehicles | | | | | | |
| Luxury/Jewellery Retailing | | | | | | |
| | | | | | | |
| ***Digital Footprint*** | | | | | | |
| Luxury Goods | | | | | | |
| Autos & Vehicles | | | | | | |
| | | | | | | |
| **General Sentiment** | | | | | | |
| Newsfeeds and Earnings Calls | | | | | | |
| | | | | | | |
| **ESG** | | | | | | |
| COVID-19 Overall Sentiment | | | | | | |
| Response | | | | | | |
| Economy | | | | | | |
| | | | | | | |
| Air Quality** | | | | | | |
| | | | | | | |

improving
unchanged
declining

Source: CGDI
* No nationwide lockdowns. The dates here indicate when the first states implemented and eased lockdowns
** As the interest here is recovery, the green denotes worsening air quality whereas the red indicates the opposite

To be clear, there are question marks in several social and labour aspects of the data in that the behavioural changes we have seen might be temporary but some might be permanent. For example, working from home could potentially become a norm post COVID-19 as there was evidence that work quality did not deteriorate and in fact improved. This pandemic could also prove to be the tipping point for food delivery to become the mainstream and further consolidate online shopping/e-commerce being the preferred way of consumption, substituting physical store visits for virtual experience. Another big unknown is how the airlines, travel and restaurants industries would shape up as they have to adhere to strict social distancing rules even when restrictions are lifted. Finally, the over-arching assumption to the assessment is there is no major second wave from COVID-19 as indicated by ABA earlier. Otherwise, whatever green shoots we are seeing now are likely to be short-lived.

With the above caveats in mind, based on the current readings of the dashboard, UK is the last one to come out of lockdown although there are a few signs of improvements according to web traffic of the categories highlighted. Germany seems to be best positioned for recovery, even with retailing, e-commerce and web conferencing showing declining trends. These observations can simply reflect the shopping habits and preferred working practice in Germany.

As lockdown continues to ease, we will add more metrics to the dashboard so that we can capture the latest changes to the trends and will look to publish the dashboard on a regular basis going forward.

# Conclusion

COVID-19 pandemic is a public health crisis but one with far reaching damage to the economy that is unprecedented. It has profoundly changed our way of life, from how we travel, where we shop, how we interact with each other to the way we work, etc; some might be temporary while others could well be permanent. All of these changes will have significant consequences on many industries and companies within these industries. The great uncertainties surrounding how economies across the globe would recover once out of lockdown bring about a strong case for utilising alternative data sources as they can provide a near real-time view of economic activities on the ground.

In this report, we have also collaborated with our colleagues from QRS team as they apply agent-based analysis to the spread of Coronavirus, which shows great accuracy in terms of predicting active cases and is also capable of forecasting the likelihood of a second wave. With no material second wave in sight, we then go onto introduce the following data categories and discuss how they can be helpful in determining the current state of play in different industries within the economy and identifying any potential changes in general public's behaviour.

- Mobility, where we also introduce analytics from LUCA
- Ground Truth
- Job Postings
- Web/App Traffic
- Digital Footprint
- Flight Frequency
- Sentiment
- ESG

Clearly, there are many more categories which we have not utilised here but the purpose of the report is to set a framework for assessing the new normal and measuring economic recovery on a country level. We will look to include more alternative data sources and also provide deeper insights on industries/companies as appropriate in our future notes.

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# Appendix

## Predicting Mortality by Citi QRS

As an additional subsequent level of agent-based analysis (ABA), we looked at the predicted mortality rates for selected countries and compared them to the reported data. This metric is less likely to be affected by reporting error and changes in the amount of testing compared to the number of reported cases, as the latter increases dramatically when mild or asymptomatic cases get detected by widespread testing, while the former is not affected by this effect.

In order to adequately forecast mortality, we had to calibrate the ABA on mortality rates from peer-reviewed sources in literature, which are from cases in Wuhan, Hubei Province, China, and are age-specific. There are potential pitfalls in this method, as the composition of the age cohorts for China, in terms of comorbidities, is likely different from Europe and the USA, but the results of the simulations have proven sufficiently accurate to be of value as depictd in Figure 46.

The predicted mortality and observed mortality for the French epidemic show a very high level of matching (correlation of over 99% between forecast and reported data as of 27 May) and a predicted total number of fatalities of approx. 31,000.

The German results show a high correlation between observed and predicted (95.4%) with the observed mortality being actually somewhat lagging behing what the analysis estimates as the final tally (prediction is approx. 9,000 fatalities). Figure 46 shows the results of this simulation.

The Italian data for mortality correlate with the ABA prediction at approximately 98% with a predicted total of just under 35,000 fatalities. Here, as in Germany, we also see a slight temporal delay of the real world data as compared to the predictions.

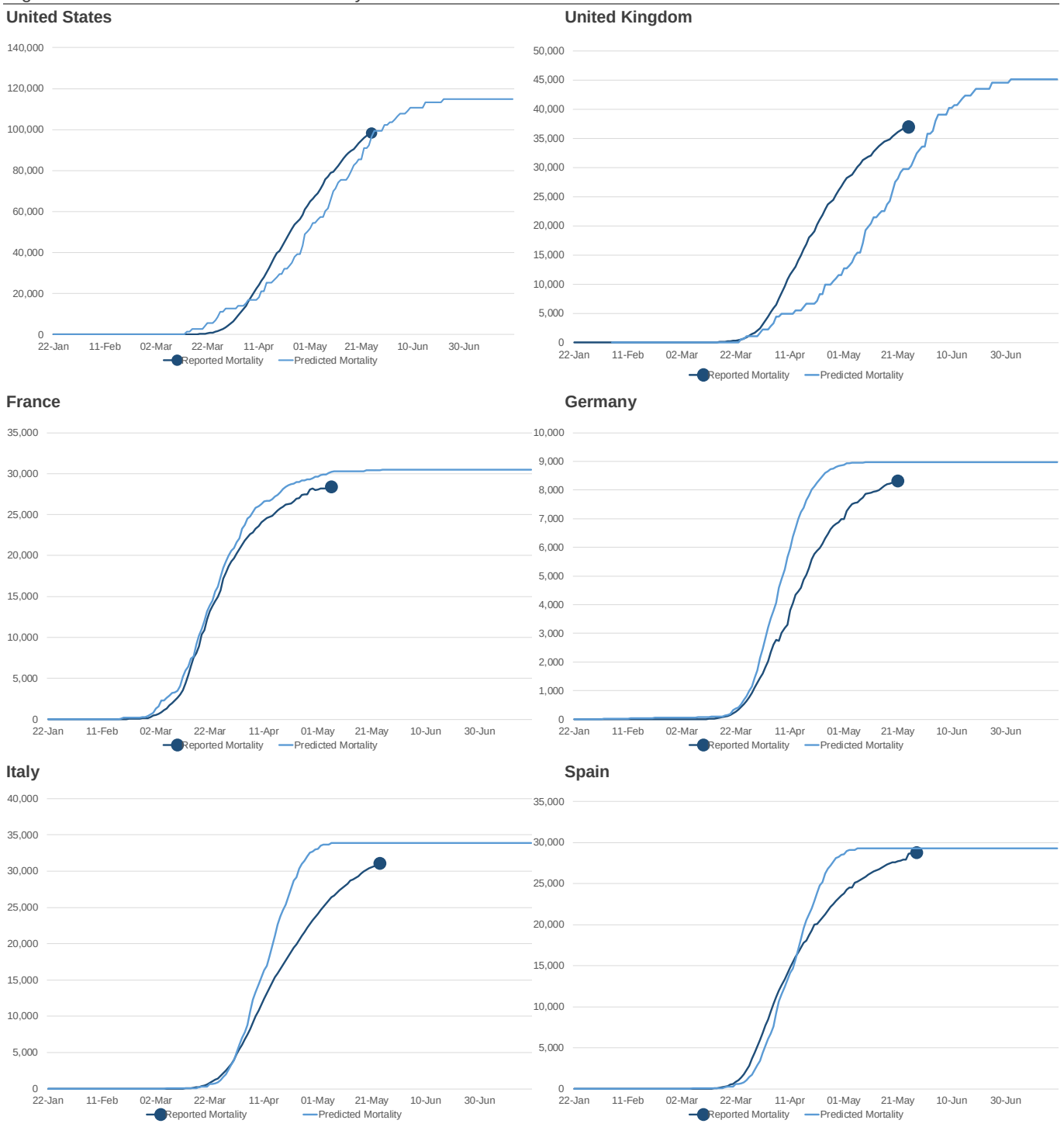
For Spain, the correlation is very high (99%) and the predicted cases are close to the current reported value (total number of fatalities is projected at under 30,000).

The UK case presents a somewhat lower correlation with the forecast (95%) with a predicted total number of fatalities exceeding 45,000. The mortality curve for the UK showed an initially faster spike that requires more investigation (it is not converging to the predictions).

In the case of the USA, the ABA is projecting a toll of about 115,000+ fatalities with a correlation of 99% as of 27 May 2020 between the forecast and the reported data.

Although the ABA approach results are insightful and provides us with a common framework for understanding the evolution and severity of the COVID-19 pandemic, there are several limitations. As observed in Figure 46, the underlying data on case reporting may vary by city, county and country and may not follow exactly the actual infection transmission patterns, which may be driven by local idiosyncratic characteristics. However, the framework is flexible enough to account for these issues, and we anticipate this can be improved as data become more robust and the parameters are refined.

Figure 46. Predicted vs Confirmed Mortality




Source: QRS

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