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Quarterly Economic Bulletin

Julian Hodge Institute of Applied Macroeconomics

HODGE BANK

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Commercial Lending

Commercial Deposits

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Hodge Bank specialises in providing key products and services to commercial clients. This includes the provision of funding facilities for property developers where the Bank caters for the specific requirements of a client through speed of response and flexibility of approach, rather than the adoption of a "one size fits all" strategy.

These projects are not restricted to the principality however, with clients located across the UK. The Bank has seen its business continue to grow and its client base expand during the last year. Demand for its products and services remains very high in what is still a competitive market place.

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IS RECOVERY BEGINNING

Forecasters protect themselves by being gloomy. This is because their clients want the future to be bright and will tend to act on bright forecasts. The forecasters who provide those will then be blamed if things go wrong, as the firm will have overspent assuming the best. A gloomy forecast, if things turn out better, will not be remembered in the firm's delight at events. This imparts a gloomy bias to forecasts.

The virus crisis is no exception. Yet it is an unusual crisis, in being mainly created by government deliberate suppression of the economy. In principle the lifting of the lockdown removes that suppression, so automatically regenerating activity. This is quite unlike a typical recession brought on by say a commodity shortage price shock, or a consumer- or firm-led collapse in demand and confidence; in these cases the government has no control. It can try to offset these things; but its success is hard to predict.

On this occasion the government can remove the cause because it is the cause. It is true that in addition people are fearful of the situation and may therefore spend less, while firms may also conserve cash. However, much of this fear is the result of government warnings about high chances of dying from the virus. As deaths come down and lockdown easing goes ahead, these warnings should be toned down and popular sentiment will become braver, as well as more impatient of restraint. Pre-Covid-19, people behaved robustly towards risk; but the crisis has changed that behaviour towards great timidity. This looks unlikely to last as lockdown is eased around the world and deaths continue to fall. Just as people go back to driving normally after accidents, so with attitudes to health risk as this episode winds down and the extreme alarmist forecasts of deaths prove to be false. Our forecast for Covid-19 deaths is shown below. By the end of June daily average deaths should be close to zero. In this respect it is following the standard logistic path of an epidemic, including the effects of government and personal reactions. Our causal model of the epidemic supports this dying-off behaviour.

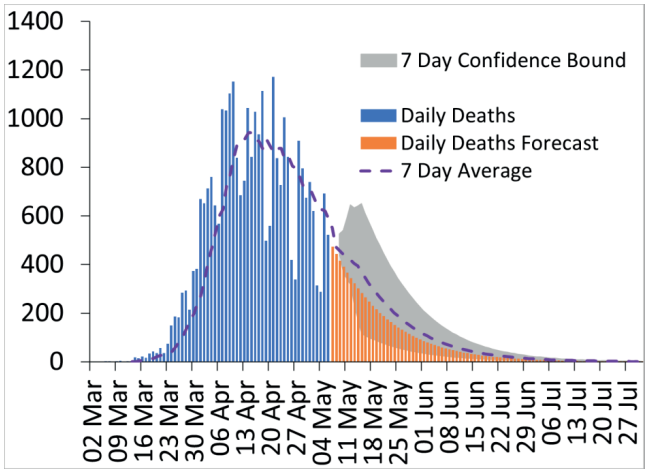
Some forecasters build in a second bad wave of infection, starting in the autumn. However, we think this is unlikely because the fatal strains of the virus have been essentially eliminated in the first wave by the deaths of those infected. The other damaging non-fatal strains will have been killed off by antibodies in the surviving infected. The virus strains that survive will be those that caused less antibody creation and so created weaker symptoms. The death rate per infection of the common flu is around 0.1%; this flu virus coexists with us and we do not react to outbreaks by stopping our lives. So it will be with new waves of Covid-virus outbreak, evolutionary biology suggests.

Even if there is an outbreak worse than this, we assume it will be responded to not by lockdown but by track-trace-quarantine targeted on particular groups and related social behaviour. This is all without assuming a vaccine or a cure- both of which are possible if unlikely things to appear soon.

Table 1: Summary of Forecast

	2017	2018	2019	2020	2021	2022	2023
GDP Growth[1]	1.8	1.3	1.4	-6.6	6.2	2.9	3.1
Inflation CPI	2.6	2.4	1.8	1.7	2.0	2.0	2.0
Wage Growth	2.8	3.0	3.5	3.0	3.2	3.1	3.3
Unemployment (%)[2]	4.4	4.2	4.1	7.2	5.6	3.5	2.8
Exchange Rate[3]	77.4	78.6	78.1	78.9	77.9	77.7	77.6
3 Month Interest Rate	0.4	0.7	0.8	0.4	1.9	4.5	5.0
5 Year Interest Rate	0.6	1.0	0.6	0.4	2.6	5.0	5.0
Current Balance (£bn)	-68.3	-82.9	-83.8	-64.3	-54.1	-45.5	-40.3
PSBR (£bn)	53.7	39.3	43.2	239.1	101.9	51.0	7.6

[1]Expenditure estimate at factor cost
[2]U.K. Wholly unemployed excluding school leavers (new basis)
[3]Sterling effective exchange rate, Bank of England Index (2005 = 100)



It is for these reasons that our forecast here is close to a V-shape. Q2, April-June, is where the lockdown is at its most severe. Q3 will see a rebound, and Q4 a further one. By the end of the year the recovery will be total.

The fiscal and monetary policy response

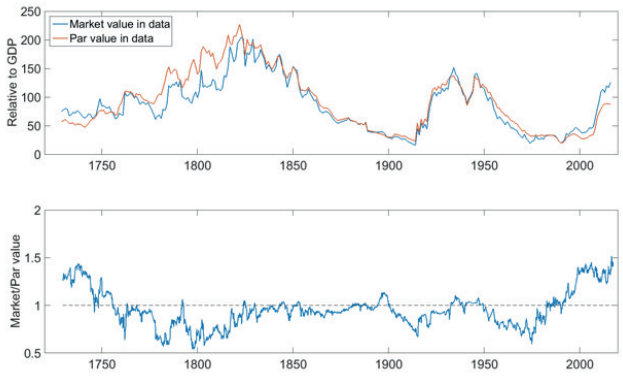
A key element in recovery will be policy. Fiscal policy is in bail-out mode currently, issuing huge amounts of debt. Monetary policy is in massive QE expansion mode. Effectively the Bank is buying all the debt the government is issuing, creating a false market in gilts; the government is borrowing from itself not the market. This QE needs to be wound down and gilts sold to the market at yields as close as possible to today's 0.4%, to keep long term interest costs to the taxpayer as low as possible. Maturities of issued debt need to be lengthened for the same reason. The time to do all this is in the rest of this year as recovery proceeds. The market in gilts should be able to absorb this debt; given the environment of insecurity that will prevail until the economy has fully recovered, private lenders will pay for safety.

By the end of the year this will change. Confidence will have returned and with it the huge quantity of money printed and

lent out will start to fuel inflation. As we go into 2021, it will be necessary to tighten monetary conditions against this.

How fiscal policy copes with wars and other crises- and now the coronavirus

To get an understanding of how far the public finances can stretch to cope with national crises, it is helpful to look at UK debt history. The two charts above come from Martin Ellison and Andrew Scott's Voxeu article chronicling UK debt history https://voxeu.org/article/323-years-uk-national-debt



One can see that twice in UK history has the market value of debt/GDP spiked: once in 1830 after the Napoleonic wars, and once in 1945 after the Second World War. The first spike was to 200% of GDP, the second to about 150% of GDP. The chart below it is also instructive. It shows the ratio of market/par value of debt. When this is high interest rates are low, a sign that the government is in a strong position to borrow, probably because the private sector is struggling. Notice how this ratio has surged in recent years, with the financial crisis.

Now look at how the bond market developed as Britain borrowed in the second half of the 18th century. The Market/par ratio remained at or above unity, as the government built up debt. By the early 1800s the market/par ratio had fallen sharply. The private economy was resurgent and interest rates rose, devaluing the public debt.

One can see a rather similar pattern over WWII debt. As it was accumulated during the war, the market/par ratio remained a bit below unity. By 1950, the ratio had fallen sharply; interest rates had risen as the economy recovered, devaluing the debt.

How were these huge debt ratios paid off? After Napoleon, income tax was introduced. After WWII, inflation devalued debt while also taxes were raised.

Application to the coronavirus crisis

Apply this to the coronavirus situation. With lockdown threatening a recession lasting three months or more, the government support package has been put at £400 billion as a rough round number, about 20% of GDP. If lockdown were to go on for longer, as we now think it will not, that number would spiral upwards. To understand how high the number could go, we need to do some basic arithmetic on the government accounts.

National income or GDP breaks down into tax (40%) and disposable income (60%): assume that 50% accrues to non-taxpayers. Imagine now that GDP falls by 10%. This reduces tax takings by 4% of GDP, and also reduces disposable income. But as disposable income falls, the government pays tax credits (benefits) to the 50% not paying tax: assume their 50% of income falls by 5% of GDP and the tax credit rate is 80% as now promised in the government package. Then government benefits rise by 4% of GDP. The total rise in the fiscal deficit is thus 8% of GDP when GDP falls by 10%. Now consider a lockdown lasting six months: that is half a year's GDP, a 50% fall on the year 2020 say. The resulting fiscal deficit would be 40% of GDP. On top of the UK's existing public debt/GDP ratio of around 80%, this would take the UK ratio to over 100% of GDP, much on a par with the situation post WWII.

However, the government is greatly assisted by two interlocking factors. Interest rates today are nearly zero, with the yield on ten-year gilts around 0.4%. At the same time central banks are bound to help out during the crisis by buying gilts and printing money, keeping interest rates at this zero floor.

This implies that the government can borrow for next to nothing during the crisis and for very long maturities. But afterwards interest rates will rise as the economy recovers, and this rise will lower the repayment burden sharply. To give an arithmetical example, with the UK government's current average debt maturity of 16 years, if the government borrowed £100 billion at today's rates of 0.4% pa, its market value at post-crisis interest rates of say 5% pa would be only £50 billion. This implies that future taxpayers are faced with a much reduced burden of debt to pay off: one can calculate the tax rate needed to pay the debt off as £50 billion times the new interest rate of 5%.

The longer the maturity at which the government borrows, the more favourable this arithmetic, which explains why the UK debt office has typically favoured long-maturity gilts. Indeed if it were to reissue all UK debt as indefinitely lasting coupon-paying perpetuities, then £100 billion of that issue would at a post-crisis interest rate of 5% fall in value to only £8 billion. If we translate this into the need to pay off 100% debt to GDP contracted by the end of the virus crisis, it turns out the necessary tax rise is just 0.4% of GDP. This could be raised quite easily- just 1.3 pence on the standard rate of income tax.

Another way of explaining this favourable arithmetic is to focus on the interest cost of all this debt after the crisis. The 100% of GDP in debt that would have been raised and rolled over before and during the crisis would have required an interest rate of around 0.4% pa. So the interest on it that must be paid by future taxpayers is very low.

One can see from this the powers governments have as monopoly raisers of taxes and printers of money. During crises when people have nowhere else to put their savings, governments can borrow easily as the only safe deposit show in town- the taxpayer sits at their back as repayment guarantee. Meanwhile the central bank can print money, driving down rates of return on all assets, cheapening the cost of public borrowing.

What all this implies is that a sovereign government with a reliable taxpaying public is in a powerful position to cope with the financial fall out from wars and other fiscal crises.

Nevertheless one must remember that to have a reliable taxpaying public one must have a functioning economy. That is why the most vital need in this crisis is to find a way to get people back to work, so the economy can revive.

How to handle fiscal and monetary policy after the crisis

Now turn to the moment the economy is released from the virus lockdown and starts to recover. Some commentators have argued for continued monetary and fiscal stimulus, to push the economy all the faster to normal. They have suggested that this would run no risks with inflation.

However, this is bad advice. It is true that inflation has been quiescent for a decade while there have been substantial fiscal deficits in spite of austerity programmes while money has been printed on a massive scale by central banks through their QE programmes. Essentially highly expansionary monetary policy has failed to prevent a world of moderate deflation. Yet it was a series of mistakes made by central banks that led to this outcome. First, they fed a credit boom in the 2000s; then as bank balance sheets weakened with rising non-performing loans, they allowed Lehman to go bankrupt, precipitating the banking crisis. After the huge consequential bailouts, when bank credit needed to expand rapidly to create recovery, central banks brought in draconian new rules for banks that stopped them lending. Their ensuing QE programme duly failed to trigger the upsurge in bank credit and broad money that was intended. Instead it drove interest rates down to zero and drove up other asset prices.

In the aftermath of the coronavirus crisis it is vital these mistakes are not repeated.

Coming out of the crisis, the government will hold large chunks of private equity. And banks will hold large portfolios of credit in private firms that have survived the crisis. In practice the draconian regulations restraining bank credit creation will have been lifted. To prevent a huge surge in money and credit growth, the government must sell off its private equity stakes and central banks must sell off their massive holdings of government bonds to contract the money supply. This is necessary to prevent a serious inflation from taking hold.

With the government still running fiscal deficits until the economy recovers, there will continue to be substantial fiscal stimulus. With demand surging relative to a supply still getting going, prices will rise. Provided money is kept under control, interest rates will rise as well, and we will gradually return to a normal monetary environment, with interest rates around 5% and inflation controlled at around 2-3% in line with the targets that central banks are committed to.

The final question to be answered is: how should fiscal policy progress after the crisis?

Some illustrative figures can help us with our thinking. Plainly the UK government will emerge with a large debt/GDP ratio after the crisis package has been rolled out. Our forecasts are that it will cost £300 billion overall, on top of existing debt of around 80% of GDP (which is around £2000 billion), which we can assume is being refinanced at current low interest rates as far as possible. That would together imply a total debt of £1900 billion at par having been issued by the end of 2020, 95% of GDP. Let us assume as above that this debt will be rolled over into very long maturity at current low interest rates and that by 2022 interest rates have risen to about 5%, with gradually tightening monetary conditions. This would imply that at market value debt would only be some 10% of GDP. What we are seeing here is that debt interest being so low on the debt that was issued, its being discounted at interest rates some ten times higher than at issue, its market value is greatly reduced.

These figures reveal that ‘fiscal reentry’ is reasonably manageable after the crisis. There will be those that will focus on the new high nominal debt/GDP ratio and urge austerity to bring it down. But they will be missing the point, again imposing short-run fiscal rules that make no long run sense in the light of the very low long run interest rates at which the public debt will have been issued.

If we consider the steady state spend and tax situation post-crisis, it will look something like this:

Ongoing public spending: 40% of GDP

Ongoing debt interest: 0.4% of GDP (on the par debt issue of 95% of GDP, issued at an interest rate of 0.4%)

Ongoing required tax revenue: 40.4% of GDP

Fiscal adjustment required via higher taxes: to raise current tax/GDP ratio from around 40% to 40.4%.

This rise in tax is fairly trivial, and should be deferred, in the light of the economy's need for support and reform. From this new starting point, we can continue to focus on the reforms that need doing in the post-Brexit economy. The issues remain the same. How to get to free trade and better post-EU regulation. And how to reform the tax and spending programmes of the government to favour a more dynamic economy.

The Conservative Budget - after coronavirus and Brexit

No budget is yet scheduled for when the UK has left the EU at year end and the economy will have recovered from the virus recession, as we currently forecast. However, it is necessary to focus on what should be in the next set of Budget plans.

In its election manifesto the Conservative party committed itself to following a fiscal rule for balancing the current budget by 2023. While that may have made sense as a tactical election decision to create clear blue water between it and the reckless spending promises in the Labour manifesto, it creates a problem for post-Brexit fiscal policy in the current economic context. The true cost of borrowing is now negative: in other words lenders are offering to pay the government to borrow from them. Furthermore, the reforms Brexit will bring in on trade, regulation and immigration promise faster future growth in the long term- even if most officials and the many private sector economists who backed Remain still take an opposing gloomy view. Finally, there is a need for fiscal policy to give the economy a boost not just to put a firm end to Brexit uncertainty, but also to cut taxes to stimulate entrepreneurs, to raise essential spending on public services, and, last but not least, to push interest rates higher to a range where monetary policy can get traction again.

For all these reasons we need fiscal policy to become much more expansionary over the next decade. The tactical issue of how to square this with the manifesto commitment can in fact be dealt with quite easily, since the fiscal rules include the 'golden rule' that investment can be funded by borrowing. What is 'public investment' is in the process of being redefined potentially in ongoing technical discussions within the ONS and Treasury. It has never made sense to limit it to infrastructure and other physical investment in this age where 'human capital' is ever more important: human capital is the discounted present value of people's productivity. Much current government spending contributes to or directly creates human capital, notably the two big departments, health and education. Arguably most if not all public spending does, since its aim is to empower, train, and keep safe the country's population, so enhancing their ability to work and produce.

By redefining current spending on a par with investment spending, we can shift the focus of 'fiscal limits' to where they belong: the long term sustainability of the plans for debt, spending and tax. In other words are these plans consistent with solvency and the health of the long term government balance sheet? All these policy areas are at the heart of democratic decision-making, so to try and short-circuit decisions on them by imposing ad hoc short-termist operating rules is both lazy and damaging in the long term.

Let us therefore get back to the substantive issue of what fiscal policy should be and why.

The most serious aspect of the situation we are in relates to the crisis of monetary policy, as noted above. Western central banks including our own Bank of England, allowed a big credit boom before the financial crisis. Then when it predictably hit the buffers of resource constraints and caused big bank losses, instead of injecting enough liquidity into the banks to make sure of their survival, they feebly- and apparently under political pressure- allowed Lehman to go under, and so caused the financial crisis. Then, just when they needed to get banks up on their feet, lending strongly for the recovery, they hit banks with a huge regulative whammy, requiring big rises in expensive equity capital. The recovery and credit growth duly stalled and the deflationary threat took over, with interest rates down to zero. Since then central banks have twisted and turned, rolling out Quantitative Easing (a gigantic programme of printing money to buy government and corporate bonds) , which has made it an easy financial world for governments and big companies, and a tough world for SMEs (loans to them force extra high capital needs) and savers. The result has been weak growth and rising monopoly power, with falling productivity growth. The coronavirus crisis has made matters worse, with interest rates glued to zero, and monetary policy reaching the limits of its powers.

It is a terrible mess and a dreadful record. How to get out of it? With monetary policy powerless until interest rates get back up to normal levels where world savings do not dwarf world investment, we need a period where fiscal policy is highly expansionary, to shift the world balance back towards a savings shortage and drive up rates. Fortunately this is the approach of Donald Trump and looks likely to be that of Boris Johnson too. Unfortunately not yet elsewhere as yet, though there are now signs that German and so EU thinking is finally moving in this direction.

Now turn to what this Conservative government could do and the long term prospects this could help unleash.

Our calculations suggest the government could spend or cut taxes by an extra £100 billion a year (about 5% of GDP) quite safely by borrowing more. The programme could comprise:

Spend £24 billion a year on public services and infrastructure.

Cut corporation tax by 10% : £32 billion p.a.

Abolish the very top additional 5% rate : £1 billion p.a.

Cut the top rate of income tax to 30% : £15 billion.

Cut the standard rate of income tax by 5% : £28 billion.

According to the Liverpool supply side model of the UK, every 2% off the average tax rate, or equivalent cost reductions via public spending, gains 1% on GDP in the long run by making the economy more competitive. On this basis we could assess that this programme would raise growth by about 1% a year over the next decade and a half. This would come on top of the gains from Brexit itself which we put at about 0.5% per annum. By achieving higher interest rates, the government would reduce the market value of its large existing, mostly long term, debt to a rather low percent of GDP as set out above.

What would this programme do to the long term government balance sheet? By the end of the 2020 decade the debt/GDP ratio would be well below today's level that is getting close to 100%, and would be around the 60% ratio usually regarded as safe. The government, with a much higher GDP, would be spending 40% of GDP on programmes including debt interest, with tax revenues running at around a higher 41%. All this is highly sustainable.

It may well seem that the aftermath of the Covid virus crisis would not be a good time to launch such a bold programme. On the contrary, such economic uncertainty needs to be confronted with a strong fiscal stance, to ensure it does not become self-reinforcing. Rishi Sunak needs to scotch all talk of new taxes, pledge to underpin the economy with any necessary borrowing in the short term, and chart a new course along the lines above to unleash this country's economic potential in the long term.

THE UK ECONOMY

Vo Phuong Mai Le

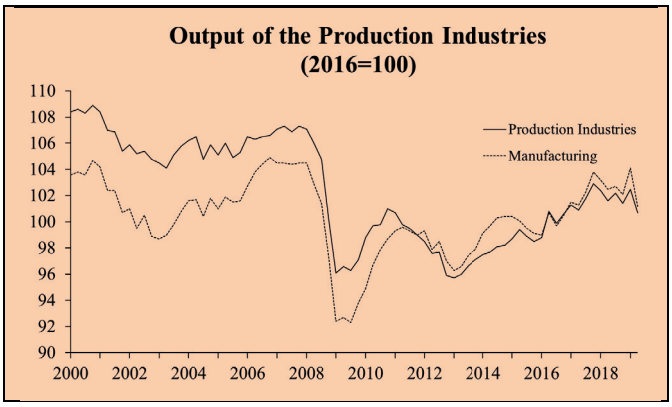
UK economic conditions have deteriorated significantly. UK economic growth fell by 2.0% in Q1, after Q4 2019's no growth. This was the biggest fall in activity since Q4 2008. With a strict lockdown forcing businesses to close and consumers to stay home, the economy contracted even more deeply in April. Real GDP fell by 10.4% in the three months to April 2020. The recent surveys indicated a further decline in output in May across all sectors, but at slower a pace. The Markit Construction Purchasing Managers' Index (PMI) was 28.9 in May, after 8.2 in April. The Markit Services PMI Business Activity Index was 29.0 in May compared with 13.4 in April. The Markit Manufacturing PMI was 40.6 in May compared with a record low of 32.6 in April. The downturn in Q2 will be even bigger given the fuller impact of the lockdown.

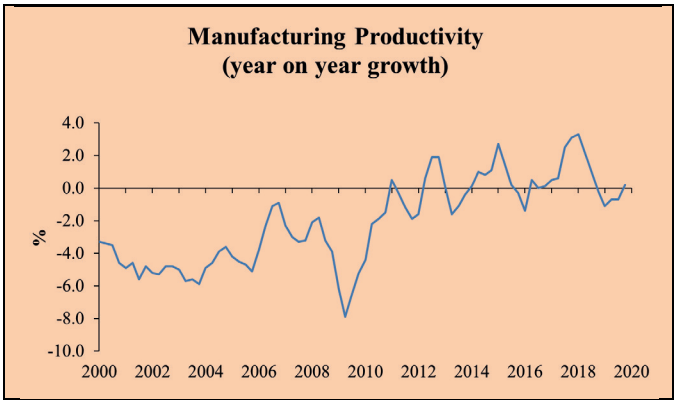
On the expenditure side, the quarterly GDP fall was driven by a collapse in both domestic and foreign demand. Private consumption fell by 1.7% (compared to 0.1% in Q4 2019) driven by declines in expenditure on spending, restaurants and hotels, and clothing and footwear. Investment fell 1% (following -1.6% in Q4 2019) due to falls in dwellings and government spending. Net trade subtracted -1.91 percentage points from the quarterly growth (after adding 1.48% in the previous quarter), as both exports and imports collapsed sharply, -10.8% (after 4.1% in Q4) and 5.3% (after -0.8% in Q4) respectively.

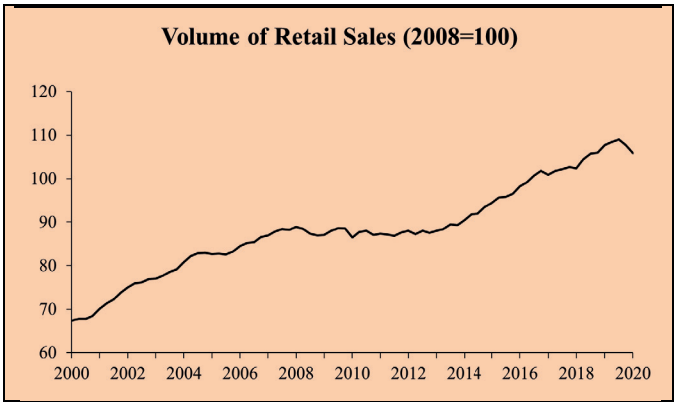
Labour market, costs and prices

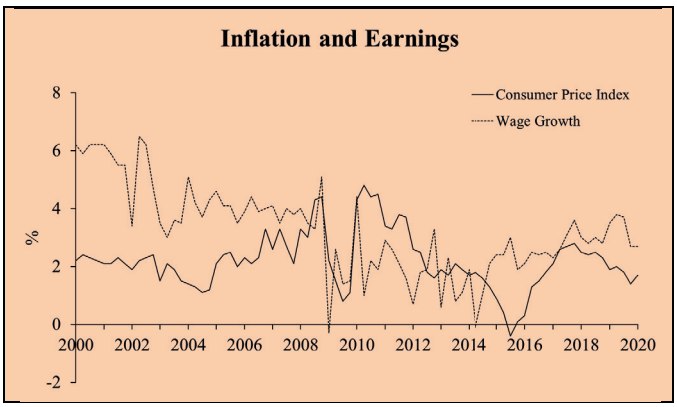
Despite the support from the government's furlough scheme to maintain employment, the labour market deteriorated markedly. According to the ONS, in May the unemployed claimant count rose 23.3% month-on-month to 2.8 million and employment was down around 600,000 from March. The number of vacancies fell to a record low, the estimated decrease was around 60% between May and March 2020. The employment rate in the three months to April was 76.4%, down 0.1% from the previous 3 months. The unemployment rate was 3.9%, largely unchanged from the previous quarter; however, this is being kept down by the furlough scheme.

The annual CPI inflation rate was 0.5% in May, down from 0.8% in April. This was driven mainly by a decrease in transport (-1.7% after -1.0% in April), clothing and footwear (-3.1% after -2.9% in April), and housing, water, electricity, gas and other fuels (-1.2% after -1.1% in April). The only positive contribution came from food (1.8% compared t0 1.3%) and non-alcoholic beverages (2.6% after 2.5% in April). May's core inflation stood at 1.2%, down from 1.4% in April. This is well below the target rate of 2% and it is expected to remain low without the upward pressures from the labour market and aggregate demand.





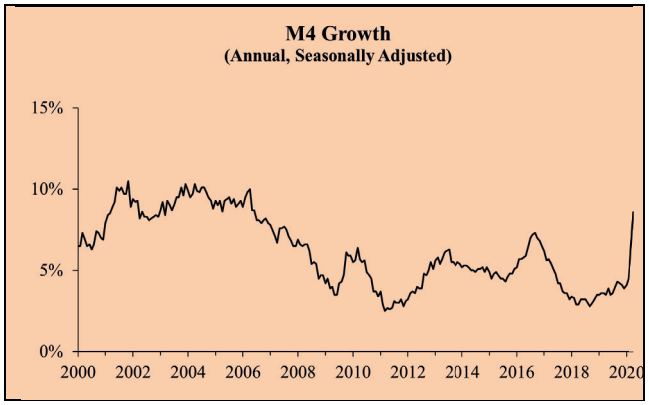


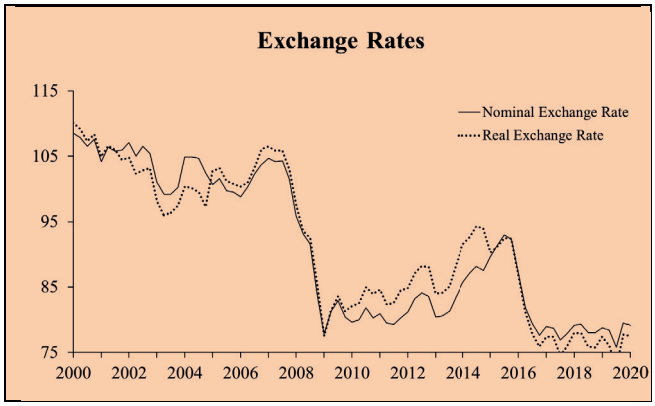


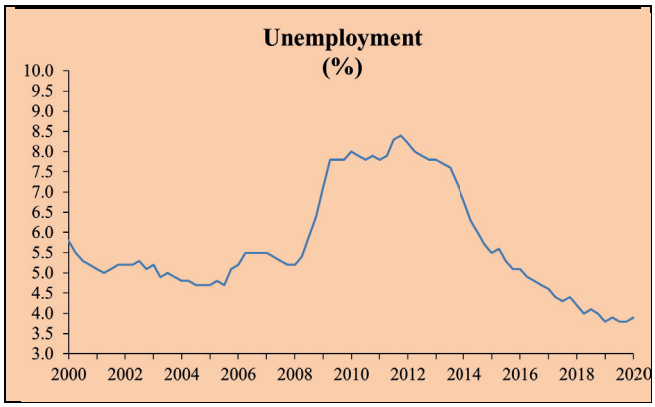
Fiscal and Monetary Developments

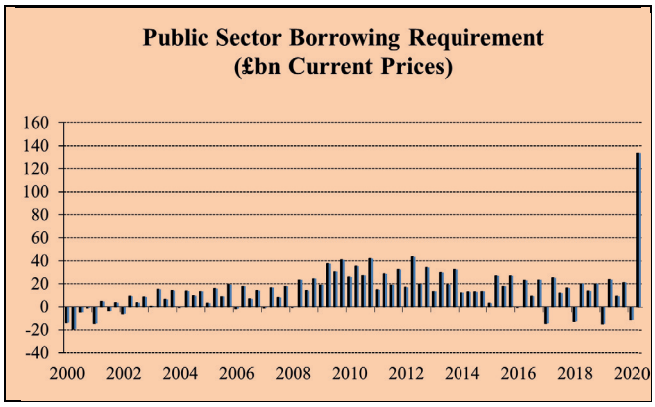
The government has pushed up the public borrowing in the current fiscal year to deal with the covid crisis. This has forced the government into substantially higher spending, both on public health and largescale support for businesses and individuals. In the full fiscal year 2019/2020, the public sector borrowed £62.7 billion, compared to £40.2 billion in 2018/2019. Public debt has also risen. Public debt, excluding Bank operations, as a percentage of GDP was 84.3% at the end of April 2020, up from 72.3% on April 2019.

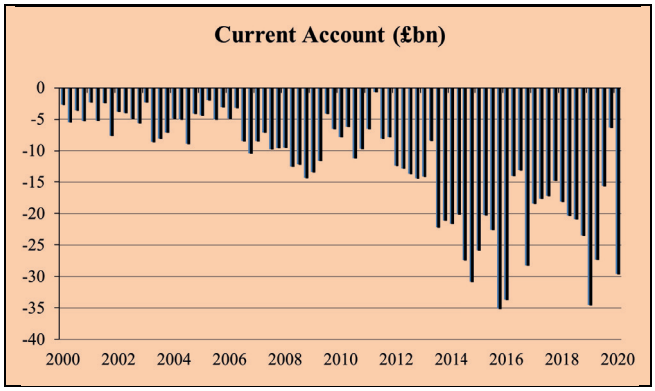
Given the economic conditions and weak inflation, the Bank of England has continued with easing in monetary policy. In March it decreased its bank rate from 0.75% to 0.25% and increased its holdings of UK government and corporate bonds by £200 billion. Furthermore, in the May meeting, it made monetary policy more accommodative by decreasing it further to 0.1% and in June it raised the government bonds purchases by an additional £100 billion to a total of £645 billion. As a result of this, the annual growth rate of broad money accelerated from 4.6% in February to 7.5% in March and 9% in in April. The annual growth rate of credit also rose from 4.5% to 6.7% in March and 6.4% in April.











UK FORECAST DETAIL

Prices, Wages, Interest Rates and Exchange Rate Forecast (Seasonally Adjusted)

	Inflation %[1] (CPI)	Short Dated (5 Year) Interest Rates	3 Month Int. Rates	Nominal Exchange Rate (2005=100)[2]	Real Exchange Rate[3]	Real 3 Month Int. Rates %[4]	Inflation (RPIX)	Real Short Dated Rate of Interest[5]
2018	2.4	1.0	0.7	78.6	76.9	-1.4	3.3	-1.0
2019	1.8	0.6	0.8	78.1	75.9	-0.9	2.5	-1.1
2020	1.7	0.4	0.4	78.9	77.0	-1.8	2.2	-1.2
2021	2.0	2.6	1.9	77.9	76.3	-1.0	2.8	1.0
2022	2.0	5.0	4.5	77.7	76.6	2.2	2.8	3.0
2023	2.0	5.0	5.0	77.6	76.8	2.9	2.7	3.0
2018:1	2.5	1.0	0.5	79.0	78.1	-1.6	3.7	-1.3
2018:2	2.3	1.0	0.7	79.3	77.9	-1.9	3.4	-1.2
2018:3	2.2	1.0	0.8	78.0	75.9	-1.3	3.2	-1.0
2018:4	2.1	1.0	0.8	78.0	75.8	-0.7	3.0	-0.8
2019:1	1.8	0.9	0.9	78.8	77.4	-0.5	2.4	-0.9
2019:2	2.0	0.7	0.8	78.4	76.0	-0.5	3.0	-1.1
2019:3	1.8	0.4	0.8	75.8	72.7	-1.4	3.0	-1.4
2019:4	1.4	0.5	0.8	79.5	77.7	-1.3	1.7	-1.2
2020:1	1.7	0.4	0.7	79.2	77.5	-1.4	2.2	-1.4
2020:2	1.5	0.3	0.4	79.0	76.9	-1.8	1.8	-1.6
2020:3	1.7	0.3	0.3	78.7	76.8	-1.8	2.2	-1.7
2020:4	1.8	0.5	0.3	78.6	76.8	-2.4	2.4	-1.5
2021:1	2.0	1.8	1.5	77.6	76.0	-1.1	2.7	-0.2
2021:2	2.0	2.0	1.7	78.2	76.5	-1.1	2.8	0.0
2021:3	2.0	2.5	2.0	78.0	76.5	-1.2	2.8	0.5
2021:4	2.1	4.0	2.5	77.7	76.3	-0.5	3.0	2.0
2022:1	2.0	5.0	4.0	77.5	76.2	1.0	2.6	3.0
2022:2	2.1	5.0	4.5	78.0	76.8	2.1	2.9	3.0
2022:3	2.0	5.0	4.5	77.8	76.7	2.5	2.8	3.0
2022:4	2.1	5.0	5.0	77.4	76.6	3.1	3.0	3.0
2023:1	2.0	5.0	5.0	77.3	76.5	2.9	2.8	3.0
2023:2	1.9	5.0	5.0	77.9	77.0	2.9	2.6	3.0
2023:3	2.0	5.0	5.0	77.7	76.9	2.9	2.7	3.0
2023:4	2.0	5.0	5.0	77.3	76.8	3.0	2.8	3.0

[1] Consumer's Expenditure Deflator
[2] Sterling Effective Exchange Rate Bank of England
[3] Ratio of UK to other OECD consumer prices adjusted for nominal exchange rate
[4] Treasury Bill Rate less one year forecast of inflation
[5] Short Dated 5 Year Interest Rate less average of predicted 5 year ahead inflation rate

Labour Market and Supply Factors (Seasonally Adjusted)

	Average Earnings (1990=100)[1]	Wage Growth[2]	Unemployment (New Basis) Percent[3]	Millions	Real Wage Rate[4] (1990=100)
2018	266.6	3.0	4.2	1.1	142.8
2019	275.0	3.5	4.1	1.1	145.3
2020	283.3	3.0	7.2	2.3	147.2
2021	292.3	3.2	5.6	1.7	148.9
2022	301.4	3.1	3.5	1.0	150.5
2023	311.3	3.3	2.8	0.7	152.4
2018:1	264.6	3.0	4.3	1.2	142.6
2018:2	263.4	2.6	4.3	1.2	141.5
2018:3	268.0	2.7	4.1	1.1	143.2
2018:4	270.2	3.5	3.9	1.0	144.0
2019:1	273.4	3.4	3.9	1.0	144.9
2019:2	273.5	4.0	4.0	1.1	144.4
2019:3	275.5	3.7	4.2	1.2	146.0
2019:4	277.6	2.7	4.3	1.2	145.9
2020:1	280.8	2.7	4.4	1.2	146.4
2020:2	282.0	3.1	9.4	3.1	146.7
2020:3	283.8	3.0	7.8	2.5	147.8
2020:4	286.7	3.3	7.3	2.4	148.0
2021:1	289.4	3.1	6.6	2.1	147.9
2021:2	290.8	3.1	5.8	1.8	148.3
2021:3	292.9	3.2	5.3	1.6	149.6
2021:4	296.1	3.3	4.7	1.4	149.8
2022:1	298.0	3.0	4.2	1.2	149.4
2022:2	300.2	3.2	3.8	1.1	150.0
2022:3	301.9	3.0	3.2	0.9	151.1
2022:4	305.6	3.2	3.0	0.8	151.4
2023:1	307.6	3.2	2.8	0.7	151.2
2023:2	310.4	3.4	2.8	0.7	152.2
2023:3	312.1	3.4	2.8	0.7	153.2
2023:4	264.6	3.1	2.8	0.7	153.1

[1] Whole Economy
[2] Average Earnings
[3] Wholly unemployed excluding school leavers as percentage of employed and unemployed, self employed and HM Forces
[4] Wage rate deflated by CPI

Estimates and Projections of the Gross Domestic Product[1] (£ Million 1990 Prices)

	Expenditure Index	£ Million '90 prices	Non-Durable Consumption[2]	Private Sector Gross Investment Expenditure[3]	Public Authority Expenditure[4]	Net Exports[5]	AFC
2018	165.5	792330.9	445721.1	307723.0	201029.6	-41308.9	120833.9
2019	167.8	803514.4	450773.6	292071.6	205398.3	-40522.1	104207.0
2020	156.8	750778.9	422139.3	240438.5	206633.2	-38602.0	79830.1
2021	166.0	794785.5	447070.2	256907.5	207875.4	-32873.3	84194.3
2022	170.7	817684.4	453552.8	270703.1	209119.3	-29141.1	86549.7
2023	176.0	842924.6	460358.0	287932.7	210372.2	-26815.4	88922.9
2018/17	1.3		1.0	2.3	0.2		-4.6
2019/18	1.4		1.1	-4.7	2.2		-12.4
2020/19	-6.6		-6.3	-15.3	0.6		-4.1
2021/20	6.2		6.1	8.3	0.6		6.1
2022/21	2.9		1.4	5.4	0.6		2.7
2023/22	3.1		1.5	6.4	0.6		3.0
2018:1	164.1	196509.2	110809.6	74693.2	51591.3	-10814.1	29770.8
2018:2	164.9	197427.5	111248.1	77339.0	49253.6	-10094.0	30319.2
2018:3	166.2	198930.2	112094.9	75498.8	49822.6	-10001.3	28484.8
2018:4	166.6	199464.1	111568.4	80192.1	50362.1	-10399.5	32259.0
2019:1	167.5	200481.1	112289.5	83278.3	52683.0	-18452.8	29316.9
2019:2	167.1	200009.6	112720.4	81082.1	50775.9	-13738.5	30830.3
2019:3	168.3	201443.7	113162.0	72473.6	51076.1	-12057.3	23210.7
2019:4	168.4	201579.9	112601.6	55237.5	50863.3	3726.5	20849.0
2020:1	164.9	197481.6	111026.5	70478.2	52999.1	-16221.6	20800.6
2020:2	145.3	173993.2	99094.4	48913.3	51084.8	-6531.1	18568.2
2020:3	151.8	181697.2	101536.5	58727.3	51380.8	-10262.3	19685.1
2020:4	165.1	197607.0	110482.0	62319.7	51168.6	-5587.1	20776.2
2021:1	165.8	198469.1	112273.3	69471.6	53317.1	-15598.6	20994.3
2021:2	165.9	198582.2	111099.5	62447.0	51391.3	-5280.0	21075.6
2021:3	166.0	198749.7	111236.0	64731.7	51690.8	-7856.1	21052.7
2021:4	166.2	198984.5	112461.4	60257.2	51476.2	-4138.6	21071.7
2022:1	170.2	203806.3	113844.9	72296.8	53636.7	-14337.1	21635.0
2022:2	170.6	204301.5	112653.2	65760.7	51696.9	-4213.9	21595.4
2022:3	171.0	204732.4	112904.5	68325.5	52001.0	-6870.6	21628.0
2022:4	171.1	204844.3	114150.2	64320.0	51784.8	-3719.4	21691.3
2023:1	175.5	210062.6	115552.6	76575.3	53958.6	-13803.9	22220.0
2023:2	175.9	210596.7	114342.1	69796.9	52005.6	-3364.9	22183.0
2023:3	176.3	211021.8	114598.1	73035.0	52313.0	-6676.5	22247.8
2023:4	176.4	211243.5	115865.2	68525.5	52095.0	-2970.1	22272.1

[1] GDP at factor cost. Expenditure measure; seasonally adjusted
[2] Consumers expenditure less expenditure on durables and housing
[3] Private gross domestic capital formation plus household expenditure on durables and clothing plus private sector stock building
[4] General government current and capital expenditure including stock building
[5] Exports of goods and services less imports of goods and services

Financial Forecast

	PSBR/GDP %[1]	GDP[1] (£bn)	PSBR (£bn)	Debt Interest (£bn)
			Financial Year	
2018	1.9	2092.5	39.3	22.4
2019	2.0	2127.5	43.2	24.0
2020	12.4	2030.1	239.1	25.0
2021	4.7	2203.2	101.9	27.4
2022	2.2	2316.3	51.0	31.0
2023	0.4	2436.6	7.6	33.8
2018:1	-2.4	520.8	-12.5	4.6
2018:2	3.9	521.1	20.1	5.4
2018:3	2.6	523.1	13.7	5.5
2018:4	3.8	528.3	20.2	5.4
2019:1	-2.8	520.1	-14.7	6.1
2019:2	4.5	532.3	23.8	6.0
2019:3	1.8	531.3	9.4	6.0
2019:4	4.0	536.5	21.3	6.0
2020:1	-2.1	527.5	-11.2	6.0
2020:2	28.6	467.1	133.6	6.1
2020:3	14.3	487.2	69.9	6.2
2020:4	8.0	534.4	42.6	6.3
2021:1	-1.3	541.4	-7.0	6.3
2021:2	8.0	541.9	43.2	6.5
2021:3	3.6	544.7	19.6	6.7
2021:4	8.3	549.2	45.4	7.0
2022:1	-1.1	567.4	-6.1	7.1
2022:2	5.3	569.2	30.0	7.4
2022:3	1.5	573.3	8.4	7.7
2022:4	4.7	577.8	26.9	8.0
2023:1	-2.4	595.9	-14.3	7.8
2023:2	2.8	598.5	17.0	8.2
2023:3	0.4	603.3	2.1	8.4
2023:4	-2.4	520.8	-12.5	4.6

[1] GDP at market prices (Financial Year)

THE WORLD ECONOMY

US

The economy contracted at the sharpest rate since Q4 2008 due to the lockdown orders in March to contain the pandemic. Real GDP fell 1.25% in Q1 after an expansion of 0.425% in Q4 2019. This decrease reflected negative contributions from domestic demand. Private consumption declined 1.7% in Q1, after rising 0.45% in Q4 2019. Investment fell 2.6% after -1.5% in Q4. The only positive contribution came from net trade, which added 0.34% to the quarterly growth (compared to 0.38% in Q4) as a fall in imports at -3.9% (after -2.1% in Q4) dominated the decline in exports of -2.2% (compared to 0.5% in Q4).

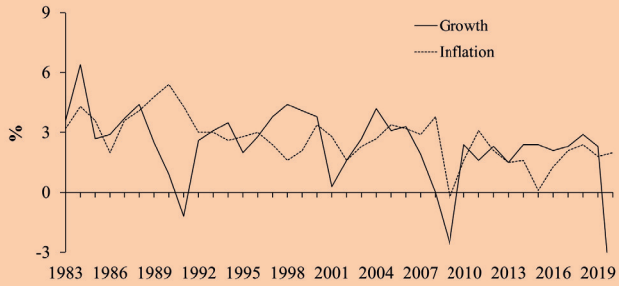
In line with these economic conditions, labour market conditions deteriorated sharply. The unemployment rate jumped from 4.4% in March to 14.7% in April and 13.3% in May. The total nonfarm payroll employment had fallen by 1.4 million in March, and another 20.7 million in April but then increased by 2.5 million in May. This widely-unexpected improvement reflected the beginning of the easing of lockdown measures. Employees' real average hourly earnings growth rate on a year earlier fell to 3.7% in May, down from 4.7% in April.

Given the weak labour market and depressed consumer confidence, the annual inflation rate fell to 0.1% in May down from 0.3% in April and 1.5% in March. Core inflation decreased to 1.2% from 1.4% in April. Inflation is expected to remain weak in the near future.

Both monetary and fiscal policies expanded unprecedentedly to cushion the economic downturn. The Federal Open Market Committee decided to lower the target range for the federal funds rate by 0.5 percentage points to 0%–0.25% at its meeting in March. Its forward guidance indicated that the Fed would keep the rate low until it is confident that the economy is on track to achieve its maximum employment and price stability goals. It supported the financial markets by resuming its Quantitative Easing programme, announcing purchases of $700 billion in Treasury securities and government-guaranteed mortgage-backed securities. In addition, the Fed opened several facilities to support large employers with $300 billion worth of credit through a special back-stop in the commercial paper market and through purchases of corporate bonds from US companies. Alongside monetary policy, there is also a fiscal stimulus of $2 trillion to help households and businesses, and to increase the ability of state and local governments to deliver critical services during the pandemic.

The economic outlook for Q2 appears even weaker as the full effect of the pandemic and the Black Lives Matter demonstrations will be felt, although this will be partially offset by the fiscal and monetary stimulus and further reopening in many states. The recent data and surveys show signs of some stabilisation toward the end of Q2. The Institute for Supply Management manufacturing index was 43.1 in May, up from 41.5 in April. The index remained below the 50-threshold and thus the manufacturing sector continued to contract, but at a slower pace. With higher consumer confidence and improved labour market

U.S.: Annual Growth Rates of Real GNP and Consumer Prices

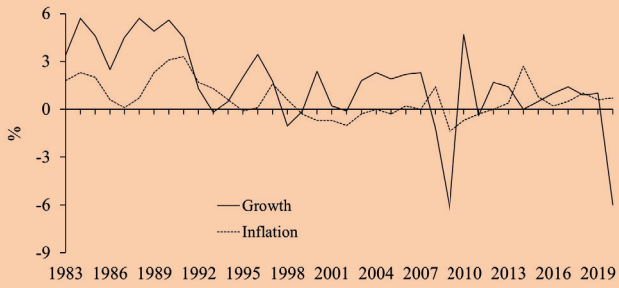


US

	2015	2016	2017	2018	2019	2020
Real GDP Growth (% p.a.)	2.9	1.6	2.2	2.9	2.3	-6.5
Inflation (% p.a.)	0.1	1.3	2.1	2.4	1.8	2.0
Real Short Int. Rate	–1.1	–1.6	–1.5	0.1	0.1	-0.3
Nominal Short Int. Rate	0.2	0.5	0.9	1.9	2.1	1.7
Real Long Int. Rate	0.3	0.5	0.4	0.9	0.1	0.3
Nominal Long Int. Rate	2.2	2.5	2.4	2.9	2.1	2.3
Real Ex. Rate (2000=100)[1]	93.0	94.0	94.5	94.8	95.0	95.0
Nominal Ex. Rate[2]	103.08	101.91	101.68	100.96	104.31	106.53

[1]The real exchange rate is the domestic price level relative to the foreign price level converted into domestic currency. A rise in the index implies an appreciation of the real exchange rate.
[2] The series for the USA is a trade weighted index (1990=100)

Japan: Annual Growth Rates of Real GNP and Consumer Prices



Japan

	2015	2016	2017	2018	2019	2020
Real GDP Growth (% p.a.)	1.3	0.6	2.2	0.3	1.0	-6.0
Inflation (% p.a.)	0.8	–0.1	0.5	1.0	0.5	0.5
Real Short Int. Rate	0.1	–0.4	–0.8	–0.9	–0.8	–0.5
Nominal Short Int. Rate	0.2	0.1	0.1	0.0	-0.1	0.0
Real Long Int. Rate	–0.5	–1.0	–1.1	–0.9	–0.5	–0.6
Nominal Long Int. Rate	0.3	0.0	0.1	0.1	-0.1	-0.1
Real Ex. Rate (2000=100)[1]	56.0	58.4	58.3	57.8	56.3	54.2
Nominal Ex. Rate	121.11	108.61	112.10	110.40	109.02	108.90

[1]The real exchange rate is the domestic price level relative to the foreign price level converted into domestic currency. A rise in the index implies an appreciation of the real exchange rate.

conditions retail sales bounced back in May, rising by 18%, after falling 15% in April.

Japan

The Covid-19 pandemic pushed the economy into its first recession since 2015. Real GDP shrank 0.6% in Q1 2020 after a big fall of -1.8% in Q4 2019. The downturn was driven by the slump in private consumption (-0.8% compared to -2.8% in Q4) and net trade subtracting 0.2 percentage points from growth, after adding 0.5% in Q4. Exports of goods and services fell 6% (after -0.1% in Q4), imports meanwhile fell -4.9% following -2.6% in Q4.

To revive the economy, the Bank of Japan dramatically eased its monetary policy. Although the Bank left the bank rate unchanged at -0.1%, it opened up more facilities to accommodate the monetary expansion. It engaged in more Quantitative Easing. Its loan support program, to help lenders lend to businesses at low interest rate, amounts to 110 trillion Yen (equivalent to around 20% of GDP). It will also continue to directly purchase more corporate paper and bonds until March 2021, later than the deadline of September 2020. It would not set a limit on the amount of Japanese government bonds it would purchase in order to cap the 10-year bonds yield at 0%.

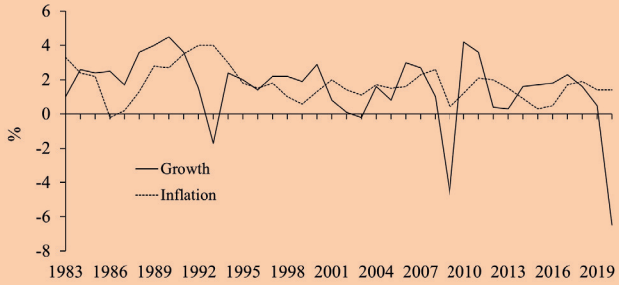
According to recent surveys and data, the economy is likely to contract in Q2 for the third consecutive quarter. Industrial activity dropped 9.1% in April (after falling -3.7% in March). This was the sharpest rate since March 2011. Exports fell 28.3% year-on-year in May, after -21.9% in April. Although the consumer confidence index in May rose to 24.0 in May from 21.6 in April, it remained below the 50-threshold, indicating that consumers are pessimistic about their overall income prospects.

Germany

Despite having no national lockdown, the Covid-19 pandemic exerted more negative impact on the already struggling economy. Real GDP shrank 2.2% in Q1 (compared to 0% in Q4 2019). This was the sharpest contraction since the financial crisis and driven by weak domestic and foreign demand. Private consumption dropped 3.2% after no growth in Q4. Fixed investment fell for the fourth consecutive quarter (-0.2% in Q1 after -0.4%). Net trade subtracted 0.8 percentage points from GDP as exports declined 3.1% (-0.6% in Q4) and imports dropped 1.6% (0.1% in Q4).

Labour market conditions worsened. The unemployment rate rose to 6.3% in May (from 5.8% in April and 5.0 in March), the highest rate since December 2015.

Economic activity in the second quarter is expected to contract further and faster. Industrial production fell -17.9% month-on-month in April after -8.9% in March. Exports contracted at the sharpest rate ever in April. It declined 24% month-on-month following March's drop of 11.7%. Business confidence in May remained pessimistic with the Ifo Business Climate index at 79.5 (compared with 74.3 in April). To fight this economic downturn, in June the government approved a €130 billion programme that consists of tax cuts, direct payments to households and increased government spending.



German

	2015	2016	2017	2018	2019	2020
Real GDP Growth (% p.a.)	1.7	1.9	2.5	1.5	0.5	–6.5
Inflation (% p.a.)	0.3	0.5	1.5	1.8	1.4	1.4
Real Short Int. Rate	–0.6	–2.0	–2.1	–1.7	–1.8	–1.9
Nominal Short Int. Rate	–0.1	–0.3	–0.3	–0.3	–0.4	–0.4
Real Long Int. Rate	–0.9	–1.7	–1.3	–1.1	–1.9	–2.1
Nominal Long Int. Rate	0.6	0.1	0.3	0.4	–0.3	–0.4
Real Ex. Rate (2000=100)[1]	94.7	95.0	94.3	96.5	95.6	94.1
Nominal Ex. Rate	0.90	0.90	0.89	0.85	0.89	0.92

[1]The real exchange rate is the domestic price level relative to the foreign price level converted into domestic currency. A rise in the index implies an appreciation of the real exchange rate.

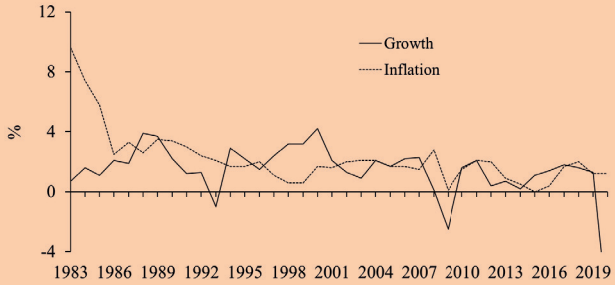
France

Even before the pandemic the economy suffered from a contraction in Q4 2019. The response to Covid-19 by imposing a strict lockdown sent the economy falling at the sharpest rate ever on record. Real GDP shrank 5.3% in Q1, after -0.1% in Q4 2019. Private consumption fell by 5.6%, compared to 0.3% in the previous quarter. Fixed investment fell 10.5%, compared to the 0.1% expansion in Q4 2019. Net trade contributed nothing to the quarterly growth (after 0.1% in Q4) as exports fell 6.1% (down from -0.4% in Q4) and imports declined 5.7% (after -0.7% in Q4).

The economic outlook for Q2 showed further contraction as domestic demand continued to suffer with business closures, rising unemployment and lockdown negatively impacting on private consumption and investment. Industrial output contracted 20.1% in April (after -16.2% in March), the sharpest rate ever recorded. However, as the economy opens up for more activities, output has started to rebound slowly. In addition, to mitigate the negative effects on the economy, the government committed to a rescue package of €110 billion to support the economy. The Markit Flash Composite Purchasing Managers' Index rose to 32.1 in May, after 11.1 in April. This shows that private sector activity contracted at

a slower rate in May. After a big collapse in April to 68, the business confidence index rose to 70 in May.

France: Annual Growth Rates of Real GNP and Consumer Prices



France

	2015	2016	2017	2018	2019	2020
Real GDP Growth (% p.a.)	1.0	1.1	2.4	1.7	1.3	–8.1
Inflation (% p.a.)	0.0	0.2	1.0	1.9	1.2	1.2
Real Short Int. Rate	–0.3	–1.3	–2.1	–1.7	–1.8	–1.9
Nominal Short Int. Rate	–0.1	–0.3	–0.3	–0.3	–0.4	–0.4
Real Long Int. Rate	–0.7	–0.9	–0.6	–0.5	–1.2	–1.5
Nominal Long Int. Rate	1.0	0.7	0.8	0.8	0.2	0.0
Real Ex. Rate (2000=100)[1]	96.2	96.0	95.3	97.4	96.3	94.5
Nominal Ex. Rate[2]	0.90	0.90	0.89	0.85	0.89	0.92

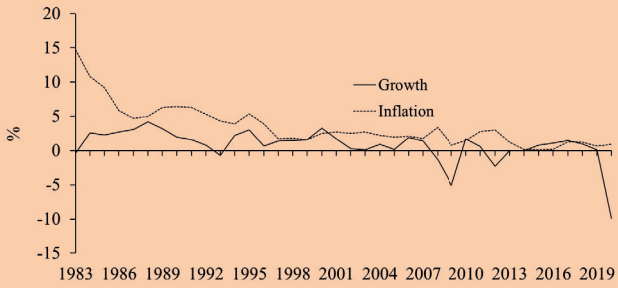
[1]The real exchange rate is the domestic price level relative to the foreign price level converted into domestic currency. A rise in the index implies an appreciation of the real exchange rate.

Italy

Covid-19 and its prevention policies pushed the economy into recession. Real GDP fell by 5.3% in Q1 after a fall of 0.3% in the previous quarter. The contraction was due to collapses in both domestic and foreign demand. Consumption fell by 5.1% (-0.2% in Q4), while investment fell by 8.1% (-0.1% in Q4). Exports decreased by 7.5% (they rose 0.3% in Q4) and imports fell by 6.3% (-1.7% in Q4).

Available data and surveys indicated more contraction in Q2. The manufacturing PMI plunged from 40.3 in March to 31.1 in April, before recovering to 45.4 in May. This means that the manufacturing sector continued to contract, although the pace was slower as the economy was only partially opened up from lockdown. Business investment and private consumption continued to decline as May's consumer confidence index (94.3 from 100.1 in March) and business sentiment index (71.2, down from 87.2 in March) dropped further in May. To support and mitigate the consequences of Covid-19 on the economy, in May the Italian government approved an extra €55 billion stimulus scheme on the top of the €25 billion of measures passed in March. The scheme includes grants and tax breaks for businesses, financial support to SMEs, income support for employees and the self-employed, and funding for laid-off workers.

Italy: Annual Growth Rates of Real GNP and Consumer Prices



Italy

	2015	2016	2017	2018	2019	2020
Real GDP Growth (% p.a.)	1.0	0.9	1.7	0.8	0.2	–9.9
Inflation (% p.a.)	0.1	–0.1	1.2	1.2	0.7	0.9
Real Short Int. Rate	0.0	–1.5	–1.5	–1.0	–1.4	–1.4
Nominal Short Int. Rate	–0.1	–0.3	–0.3	–0.3	–0.5	–0.4
Real Long Int. Rate	0.4	0.1	1.1	1.6	0.9	0.1
Nominal Long Int. Rate	1.6	1.7	2.1	2.6	2.1	1.3
Real Ex. Rate (2000=100)[1]	102.1	102.0	101.2	102.8	104.5	105.2
Nominal Ex. Rate[2]	0.90	0.90	0.89	0.85	0.89	0.92

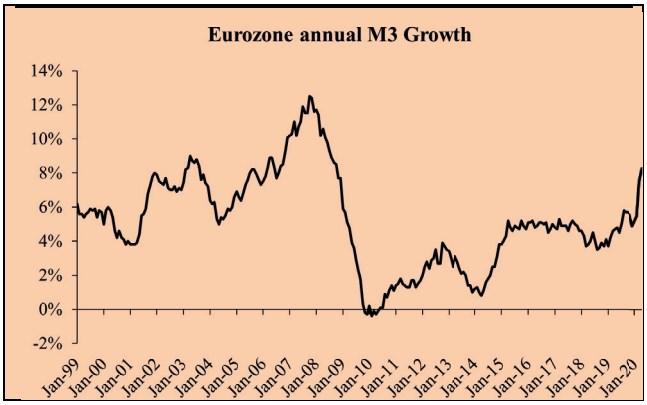
[1]The real exchange rate is the domestic price level relative to the foreign price level converted into domestic currency. A rise in the index implies an appreciation of the real exchange rate.

Euro-zone monetary policy

Beside the fiscal stimulus approved by national governments, at the EU level a €540 billion package of safety net for workers, businesses and member states was approved in April. The EU also redirected other EU funds to help its member states. This includes €37 billion from structural funds, up to €800 billion through the EU Solidarity Fund and €3.1 billion from the 2020 budget.

The Harmonized Index of Consumer Price Inflation rate has been on a downward trend since January. It was 0.1% in May, down from 0.3% in April. The decrease was mainly due to lower energy price inflation. The annual core inflation stood at 0.9%, unchanged from April. The inflation remained consistently lower than the target of 2%. The inflation is expected to stay low due to weak demand.

Faced with a sharp contraction across all the member states, low inflation and low inflation expectations, the European Central Bank implemented a very accommodative monetary policy stance. In June it added a further €600 billion to the existing €750 billion emergency quantitative easing program, bringing the total to €1350 billion. It extended the time horizon of the net purchases under this program to at least until December 2021 and would reinvest the proceeds from these purchases until at least 2022. In addition, it maintained rates on the main refinancing operations, the marginal lending facility and the deposit facility at 0.0%, 0.25& and -0.50% respectively.


Eurozone annual M3 Growth
14%
12%
10%
8%
6%
4%
2%
0%
-2%
Jan-99
Jan-00
Jan-01
Jan-02
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WORLD FORECAST DETAIL

Growth Of Real GNP

	2017	2018	2019	2020	2021	2022
U.S.A.	2.2	2.9	2.3	–6.5	6.0	2.5
U.K.	1.8	1.4	1.4	–6.4	6.0	2.9
Japan	2.2	0.3	1.0	–6.0	2.3	1.0
Germany	2.5	1.5	0.5	–6.5	5.8	2.0
France	2.4	1.7	1.3	–8.1	2.1	2.0
Italy	1.7	0.8	0.2	–9.9	6.4	1.9

Growth Of Consumer Prices

	2017	2018	2019	2020	2021	2022
U.S.A.	2.1	2.4	1.8	2.0	2.0	2.0
U.K.	2.6	2.4	1.8	1.7	2.0	2.0
Japan	0.5	1.0	0.6	0.7	0.5	0.5
Germany	1.5	1.8	1.4	1.4	1.5	1.7
France	1.0	1.9	1.2	1.2	1.3	1.5
Italy	1.2	1.2	0.7	0.9	1.0	1.3

Real Short-Term Interest Rates

	2017	2018	2019	2020	2021	2022
U.S.A.	–1.5	0.1	0.1	–0.3	0.0	0.0
U.K.	–1.7	–1.4	–0.9	–1.8	–1.0	2.2
Japan	–1.0	–0.7	–0.8	–0.5	–0.4	–0.4
Germany	–2.1	–1.7	–1.8	–1.9	–2.0	–2.0
France	–2.2	–1.5	–1.7	–1.7	–1.8	–1.9
Italy	–1.5	–1.0	–1.4	–1.4	–1.6	–1.7

Nominal Short-Term Interest Rates

	2017	2018	2019	2020	2021	2022
U.S.A.	0.9	1.9	2.1	1.7	2.0	2.0
U.K.	0.4	0.7	0.8	0.4	1.9	4.5
Japan	0.0	–0.1	–0.1	0.0	0.1	0.1
Germany	–0.3	–0.3	–0.4	–0.4	–0.3	–0.1
France	–0.3	–0.3	–0.5	–0.4	–0.3	–0.1
Italy	–0.3	–0.3	–0.5	–0.4	–0.3	-0.1

Real Long-Term Interest Rates

	2017	2018	2019	2020	2021	2022
U.S.A.	0.4	0.9	0.1	0.3	0.8	1.0
U.K.	–1.5	–1.0	–1.1	–1.2	1.0	3.0
Japan	–0.6	–0.5	–0.6	–0.6	–0.5	–0.4
Germany	–1.3	–1.1	–1.9	–2.1	–1.9	–1.7
France	–0.6	–0.5	–1.2	–1.5	–1.4	–1.3
Italy	1.1	1.6	0.9	0.1	0.1	0.2

Nominal Long-Term Interest Rates

	2017	2018	2019	2020	2021	2022
U.S.A.	2.4	2.9	2.1	2.3	2.8	3.0
U.K.	0.6	1.0	0.6	0.4	2.6	5.0
Japan	0.1	0.1	–0.1	–0.1	0.0	0.1
Germany	0.3	0.4	–0.3	–0.4	–0.2	0.0
France	0.8	0.8	0.2	0.0	0.1	0.2
Italy	2.1	2.6	2.1	1.3	1.4	1.5

Index Of Real Exchange Rate(2000=100)[1]

	2017	2018	2019	2020	2021	2022
U.S.A.	94.5	93.5	96.3	96.2	95.5	94.9
U.K.	75.5	76.9	75.9	77.0	76.3	76.6
Japan	58.3	57.8	56.3	54.2	51.4	48.0
Germany	94.3	96.5	95.6	94.1	92.2	90.0
France	95.3	97.4	96.3	94.5	92.1	89.4
Italy	101.2	102.8	104.5	105.2	103.8	101.7

[1] The real exchange rate is the domestic price level relative to the foreign price level converted into domestic currency. A rise in the index implies an appreciation in the real exchange rate.

Nominal Exchange Rate (Number of Units of Local Currency To $1)

	2017	2018	2019	2020	2021	2022
U.S.A.[1]	101.68	100.96	104.31	106.53	105.84	104.43
U.K.	1.29	1.34	1.28	1.26	1.28	1.30
Japan	112.10	110.40	109.02	108.90	109.50	109.30
Eurozone	0.89	0.85	0.89	0.92	0.91	0.90

[1] The series for the USA is a trade weighted index (1990=100); the series for the UK is $ per £

* Forecasts based on the Liverpool World Model

Anupam Rastogi

The Covid-19 crisis is a health crisis and it is different from credit or liquidity crisis we have seen before. We know enough about the financial and economic system to understand that conventional responses like stimulus or tax cuts are inappropriate. Just to put in historical perspective, the Spanish Flu, which also led to a lot of social distancing, didn't seem to leave a lasting economic scar on nations. But the modern economy is very different — more dependent on delicate supply chains, more reliant on webs of debt and credit, more weighted toward services rather than manufacturing and agriculture.

The response of governments can be placed in four buckets. First, fiscal stimulus like more government spending or tax cuts. Second providing credit enhancement to businesses so that they can borrow and get on with their businesses. Third, buying back assets whose value is lower than their book value to free up bank balance sheet. Fourth, reduce cost of capital by reducing bank rates.

The financial impact of lockdown has turned out to be expensive on government treasuries and the solution to the health crisis remains clouded, not to speak of patience of people wearing thin, countries have started opening up their economies at a different pace.

Poorer countries are starting to reopen while new infections and deaths are growing, rather than slowing. This is against health experts and nations are ready to see and cope with a rise in cases and deaths. The number of people who could eventually die in crowded slums across the developing world may rise substantially but that would be lower than people dying of hunger and pushing millions into poverty. Policy makers understand, but do not pronounce, that many of their people, especially the estimated 1.6 billion across the world, who toil in the informal sector, are suffering more from containment measures than from the virus itself. Hundreds of millions of people have lost their jobs and poverty rates across the world are soaring.

While leaders in wealthier countries face similar trade-offs, the dilemma for leaders in developing countries is especially stark. Each week that the reopening is postponed creates more poverty, increases chances of social unrest and violence. Reopening — too soon — may cause new outbreaks but they are ready to take this risk now.

Crawling out of the malaise caused by this health crisis will require new norms at the work place but we have to live with it for the next eighteen months or so. How rapidly we shall be able to restart and go back to our December 2019 lifestyle is anyone's guess. Lower return on capital is almost certain and compensation on labour may not rise due to heightened unemployment and technology driven increase in productivity.

India

India's GDP in the first quarter of 2020 was an 11-year low of 3.1%, illustrating the nature of the national lockdown, even though the country was under lock down for less than a fortnight during that period. Growth was dragged down by lower consumption as well as investment demand. GDP growth in FY20 is lowered to 4.2%, which is the lowest in the last 11 years. More than two months of lockdown and a gradual easing of restrictions from June 1 will impact the Indian economy more severely than envisaged earlier. We expect the economy to shrink 3% in FY 2022 and rebound to 7.5% in the next fiscal year. Moody's has downgraded India's rating to Baa3 from Baa2 with negative outlook in line with Fitch and S&P ratings.

The India Manufacturing Purchasing Managers' Index stood at 30.8 in May compared with 27.4 in April on a seasonally-adjusted basis. This suggests a sharp deterioration in business conditions continuing in May. But, for the one-year business outlook, manufacturers remained optimistic. Confidence was supported by expectations for a return to growth once all coronavirus-related restrictions are lifted.

Weather forecasts for normal monsoon rains are in farmers' favour at least, giving hope that the rural sector can help support the millions of people and migrant workers who returned to their villages from the cities.

Headline inflation remained at 5.9% in April and reflects a pickup in food-price growth, which accelerated to 8.6% in April.

Merchandise exports contracted by 60% and imports plunged 58% in April amid shutdown. Exports have made a turnaround after mid-April. Till then, there were supply and logistical challenges, with disruption in port operations and restriction on exports of several formulations.

India's strict lockdown has given way to a sudden easing from June 1 and is like a diluted version of the Swedish strategy. India has used the Covid-19 crisis to reform its economy. Many difficult decisions related to land and labour which could not be taken earlier are taken in one swoop. Prime Minister Modi has focused on converting the situation into an opportunity. By announcing a wholesome economic package to support all categories of businesses, he has emphasized on reviving local production.

Hence, it is clear that instead of a single comprehensive strategy to tackle survival, reduce damage and reinvigorate growth, the government has made announcements that cover a number of sectors, attempting both short-term as well as medium-term strategies. The government has tried to implement a number of ideas that have been languishing for a long time.

Between March 27 and May 22, the RBI reduced the policy repo rate by 115 basis points. The repo rate stands at 4%, and the reverse repo rate at 3.35%.

India's rescue package also includes the promise, for example, of roughly $40 billion in collateral-free loans to small businesses that would be completely guaranteed by the government.

People who believe their business will recover can take on a loan for payments that they have to make; banks will be happy to cover them, since they're being underwritten by the government. Instead of the government figuring out who to pay to reopen the economy, banks and businesses will make the decision. While we'll have to see how it works in practice — any delays in the rollout and the whole thing will fall apart — the idea is sound.

The focus on liquidity support and risk underwriting instead of across-the-board spending, India's debt might remain under control instead of exploding. The prime minister himself is a fiscal hawk and, hence, purse strings have been loosened only a little.

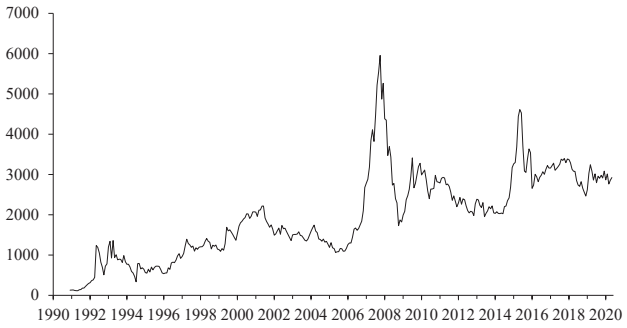
If the package is looked at from the point of view of providing livelihood and employment to the large number of informal workers, it is the agricultural reform component that appears to be well-thought through.

Credit guarantees from government, deficit financing by the RBI and a Hold-To-Maturity of government bonds hike for banks are the only solutions that can get the wheel of credit and investment rolling.

Labour laws barring the Minimum Wages Act, Industrial Safety Rules and Employees Compensation Act have been suspended. Land can now be bought by industries directly from farmers.

Finally, Prime Minister Narendra Modi has incentivized shifts from China to India in supply chains caused by the

China: SSE Composite Index



Sino-American Trade War, setting aside land and lobbying over 1,000 multinational corporations to 'Make in India'.

The stock market has recovered sharply from its low of March 2020. Many of the reform measures have been priced in and risk of another increase in Covid-19 cases is being ignored by the market.

	18–19	19–20	20–21	21–22	22–23
GDP (%p.a.)	6.8	4.2	-3.0	7.5	6.0
WPI (%p.a.)	3.9	3.6	3.8	4.5	5.0
Current A/c(US$ bill.)	-70.0	-22.0	0.0	-35.0	-35.0
Rs./$(nom.)	79.5	73.0	78.0	79.0	80.0

China

China is flexing its muscles and would like to be acknowledged as growth driver to the world economy displacing the US. Not surprisingly, the US is in no mood to relinquish this position. However, the US response has been opening too many fronts at the same time rather than tackling China and keeping strong alliances with other nations. There is a possibility that China may become insular, and other emerging markets will the find life harder. Unfortunately, if the U.S.-China dispute intensifies, they can expect collateral damage in the short-term. For the time being, the US blinked after taking a very strong stand on Hong Kong. Access to the US capital market by Chinese companies has been watered down considerably and China, in turn, has mellowed down. The Premier, Li Keqiang, used his post-NPC press conference to set a conciliatory tone toward the U.S., calling for mutual respect and saying 'decoupling' would harm the world.

It seems that for the time being a new Cold War is averted between the U.S. and China. China sees President Trump as a lame duck and would like to wait for five months before a new administration takes over. China, slowly but surely, will impose strict security rules on Hong Kong, which will end the city's independence and would usher into a Greater Bay Area development, which encompasses Guangdong-Hong Kong-Macau, to develop its own silicon valley. In our opinion, China may delay development of its plan for a few

months but it would not stall it as it wants to take on Silicon Valley of the US.

China's economic recovery shows signs of stalling. The country's factories have reopened for work in the past three months as the coronavirus-related restrictions have eased. But now they are not having enough orders from overseas customers. Not surprisingly, the new-export-orders sub index, a gauge of external demand, continued to remain deep in contractionary territory. It was 35.3 in May compared to 33.5 in April. Exports still account for a substantial part of the Chinese growth equation. In turn, policy makers have promised stimulus measures to boost the economy. The announcements have fallen short of efforts compared to previous less severe downturns as China is worried about bad debts accumulating in its banks caused by previous massive stimulus.

The government's official non-manufacturing PMI climbed to a four-month high of 53.6 in May, boosted by a strong recovery in the country's construction activity. China's PMIs showed a recovery, but the gauge declined to 50.6 from 50.8. In the midst of confusing signals, China did not set a GDP growth target for 2020. However, Chinese President Xi Jinping said China's annual economic growth target could have been set around 6% which according to us, is an aspiration and defy slowing down of GDP growth rates of the past. We maintain our growth forecast of the last month. The government announced a range of fiscal measures to bolster the economy, equal to about 4.1% of China's GDP.

China's consumer price index, the main gauge of inflation, grew 3.3% year on year in April, moderating from the 4.3% gain in March. In the first four months of this year, CPI went up 4.5% year on year on average. Falling food prices are going to reduce yearly inflation further as pork price inflation declines.

China's exports unexpectedly rose in April aided by stronger shipments to South East Asia. In the coming months, however, the Covid-19 pandemic's damage to global demand would assert itself. Imports fell in the month of April. Exports rose 3.5% in dollar terms in April from a year earlier, while imports dropped 14.2%. The trade surplus was $45.3 billion in April.

An important battle between China and the US is fought in the currency market. Rather than a dollar-centric world, we could see a bipolar world, with China establishing some form of financial hegemony over Asia. This is a hidden agenda of China's Belt and Road Initiative.

For the time being, China is allowing the yuan to become weaker against the USD to make China more competitive, and make life harder for U.S. exporters. China plays the currency game from Hong Kong and the USD is supreme there. While the U.S. doesn't directly control Hong Kong's status as a financial centre, Washington has demonstrated its extensive reach over the dollar system, with penalties against Korean, French and Lebanese financiers for dealing with sanctioned parties. Putting the ability of Chinese banks to

Korea: Composite Index

conduct dollar-denominated activities at risk would be deleterious to China's ability to operate financially overseas, posing a challenge for the largely dollar-denominated Belt and Road global infrastructure initiative. Chinese determination that Hong Kong is no longer autonomous could mark the beginning of a squeeze on China's international financial operations, for which Beijing has no equivalent ability to retaliate.

The Federal Reserve has signed liquidity swap with 14 central banks. The list has natural U.S. allies such as Mexico, Brazil, Australia, New Zealand, Singapore and South Korea. China and Russia are not included in this list. The attempt is to isolate China.

The offshore yuan steadied near a record low of 7.15, after China signalled with a stronger-than-expected fixing that it wants to avoid rapid depreciation.

	18	**19**	**20**	**21**	**22**
GDP (%p.a.)	6.6	6.1	0.0	5.5	5.5
Inflation (%p.a.)	2.2	2.3	2.0	2.0	1.8
Trade Balance(US$ bill.)	50.0	40.0	20.0	40.0	40.0
Rmb/$(nom.)	6.8	7.1	7.3	7.2	7.2

South Korea

South Korea eased social restrictions and shifted to "everyday life quarantine" in the month of May after the number of daily new cases of COVID-19 fell to single digits, with the number of domestic infections sometimes nearing zero.

The government is struggling to boost domestic demand by aggressively pouring taxpayer money into the retail services and household consumption sectors, the nation's GDP growth depends heavily on export performance. We are maintaining our forecast for South Korea's GDP to contract one percent as the Covid-19 impact plays out in full on international trade. South Korea is preparing for a third supplementary budget as April exports suffered the worst slump in 11 years while jobs vanished at the fastest pace since 1999.

The Bank of Korea (BOK) expects the country's economy to contract 0.2% in 2020, which would be the first contraction since 1998 in the wake of the Asian financial crisis. The Bank expects the Korean economy to rebound

3.1% in 2021. The South Korean economy grew 1.3% year-on-year in the first quarter of 2020 compared to a 2.3% expansion in the previous period. But, GDP growth in the first quarter fell 1.4% from the previous three months, the lowest in more than 11 years.

The Bank has cut the key rates by 25 basis points to a record 0.5%, working in tandem with the government to extend liquidity to businesses hit by the coronavirus pandemic. Success in containing Covid-19 hasn't ended a growth slowdown. Exports are plunging and consumers remain wary of travel or shopping. The BOK had previously pledged unlimited liquidity through June via repurchase agreements and began lending to securities firms for the first time in its 70-year history. The BOK will accelerate outright purchases of government bonds to soak up the public debt issuance needed to cover the cost of the third supplementary budget. This would be a 'stealth' quantitative easing, that is sustained BOK purchases of government bonds without a formal announcement. South Korea joins the United States, Australia, UK and New Zealand in bond-buying operations to nurse the economy through the pandemic.

Exports in April plunged 24.3% on year and the statistic of May will match April's slide. Double-digit drops will last for at least a couple more months. The auto sector was among the worst hit.

Optimism over South Korea's relatively successful containment of Covid-19 has sent its stock benchmark to its 100-day moving average for the first time since the health crisis hit global financial markets. The Kospi index has recovered 37% from a low in March and is hovering around the key resistance of 100-day moving average.

	18	19	20	21	22
GDP (%p.a.)	2.7	1.8	-1.0	2.0	2.2
Inflation (%p.a.)	1.5	0.4	-0.5	0.2	1.2
Current A/c(US$ bill.)	86.0	80.0	68.0	70.0	70.0
Won/$(nom.)	1130	1200	1230	1260	1260

Taiwan

Taiwan implemented epidemic prevention measures early, which ensured manufacturing activities have not been disrupted. Therefore, Taiwan may be able to escape contraction even though the coronavirus pandemic has hurt domestic consumption and the job market. Strong global demand for electronics may be able to compensate the blow for the trade-reliant island.

Gross domestic product (GDP) rose by 1.59% in the first quarter of 2020 from a year earlier. The impact of the pandemic will be known from the second quarter figures. The government has said the pandemic has hit the island's consumption, especially the services sector and tourism, but global demand for electronics helped offset some of the impact due to the growing need for telecommuting as more

Taiwan's merchandise and services exports are expected to decline by 3% in 2020. Taiwan's exports for April stood at US$25.2 billion, down 1.3% from a year earlier and imports fell 9.9% from a year earlier to US$23 billion, with a trade surplus of US$2.2 billion.

In the first four months of this year, Taiwan's exports rose 2.4% year-on-year to US$103.9 billion, while imports grew 2.7% to US$92.1 billion, with a trade surplus of US$11.8 billion. There is marginal increase in trade surplus from a year earlier.

Taiwan's success in containing the virus outbreak and keeping the economy on an even keel has kept the currency strong. The Taiwan dollar has climbed about 0.5% in 2020, the best performing currency in Asia compared to 5% drop in the South Korean won.

Taiwan Semiconductor is planning to build a multibillion-dollar chip plant in Arizona to ensure supply chain security. TSMC has negotiated with the US government to manufacture semiconductors and produce sensitive components domestically for national security reasons. However, America's trade war with Beijing could undermine local firms if they must choose sides. China hasn't eased up pressure during the pandemic.

The approval rating for Taiwan's President Tsai Ing-wen reached its highest level since she took office in May 2016, as she was sworn-in for a second term and called upon China, who has taken an aggressive posture in international disputes to assert its dominance, to "find a way to coexist."

	18	19	20	21	22
GDP (%p.a.)	2.6	2.0	-1.0	2.0	2.2
Inflation (%p.a.)	1.2	1.0	-1.0	1.0	1.0
Current A/c(US$ bill.)	68.0	70.0	71.0	70.0	60.0
NT$/$(nom.)	29.8	31.0	30.0	30.5	31.0

Brazil

Brazil's response to Covid-19 at best can be described as chaotic and, hence, the country is suffering more than its competitors in the short-term. Scars of this pandemic will be felt over a long time as well. Other than the U.S., Brazil is

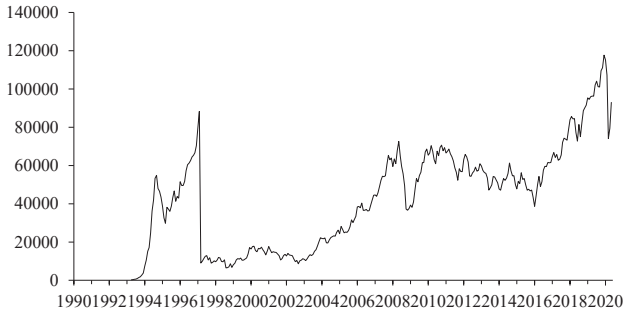
the only country where more than 1,000 people are regularly dying each day from the pandemic.

The government lowered its 2020 economic outlook and expects GDP to contract 4.7% in 2020. According to economic policy secretary Adolfo Sachsida, -4.7% decline in GDP would be the biggest annual fall since records began in 1900. The disruption to production and consumption are profound and we continue to maintain our forecast of contraction of 5.5% and no growth in 2020 and 2021 respectively. A substantial part of GDP, lost during isolation, will not be recovered and the country will take long time to return to its pre-crisis levels of December 2019. At present economic activity of Brazil is at the same level as 2012. The contraction in economic activity has been far worse in the second quarter, as the outbreak of pandemic and public quarantine measures taken by provincial governments only gained steam in the second half of March.

Brazil's 12-month inflation slowed in the month through mid-May as social distancing implemented to control the spread of the coronavirus and lower prices for fuel and airfare.

Consumer prices fell 0.59% in the period from April 16 through May 15, the biggest monthly deflation since Brazil introduced the real as its currency in 1994 according to the country's Institute of Geography and Statistics (IBGE). On an annual basis, consumer prices rose 1.96% in the 12 months through mid-May, compared to 2.92% in the 12

Brazil: Bovespa



months through mid-April. We forecast one percent inflation in 2020 and 2021 as well. The central bank has cut its benchmark lending rate to a record low of 3% in May, and another cut is expected in its meeting in June.

As the supply chains are shifting and new sources are being developed, Brazil is making waves in the commodities world with reduced iron ore shipments and increase in agribusiness exports. A sharp increase in iron-ore prices by Brazil, prevented a worsening of the trade dispute between China and Australia, because of Australia's importance as a supplier of iron ore to China's steel mills, which have returned to full production. Most of Brazilian beef found home in China.

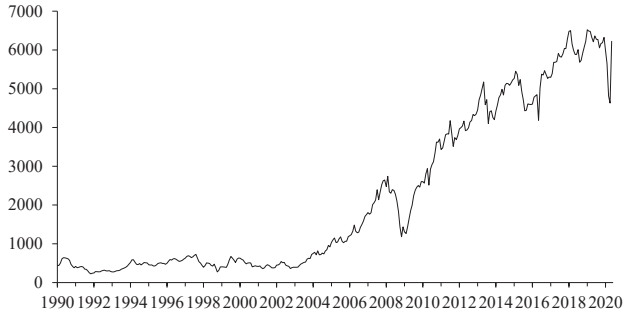
The dollar did not pierce 6.00 reais as reopening of economies going to improve trade volumes and domestic political tensions have ebbed. This was followed by central bank president Roberto Campos Neto's reaffirmation that the bank stands ready to dip into its large pool of foreign exchange reserves and would continue intervening in the market if needed. A flattening of yield curve between short- and long-term rates is a sign of improving investor sentiment and easier financial conditions.

	18	**19**	**20**	**21**	**22**
GDP (%p.a.)	1.1	0.8	-5.5	0.0	2.5
Inflation (%p.a.)	3.8	4.3	1.0	1.0	2.0
Current A/c(US$ bill.)	-14.6	-36.0	-40.0	-40.0	-36.0
Real/$(nom.)	3.8	4.2	5.5	5.7	5.8

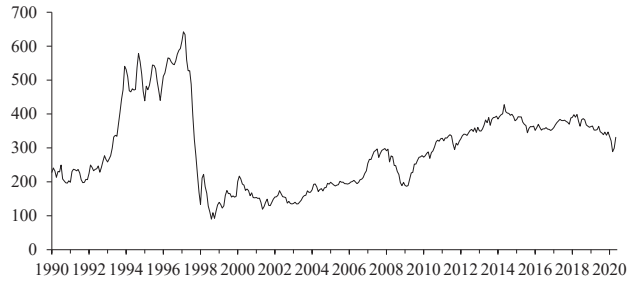
Other Emerging Markets

Hong Kong: FT-Actuaries

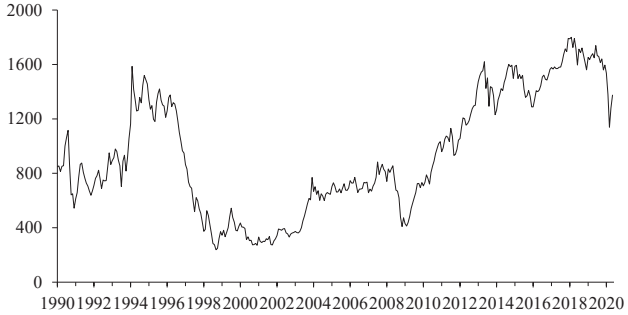
Indonesia: Jakarta Composite



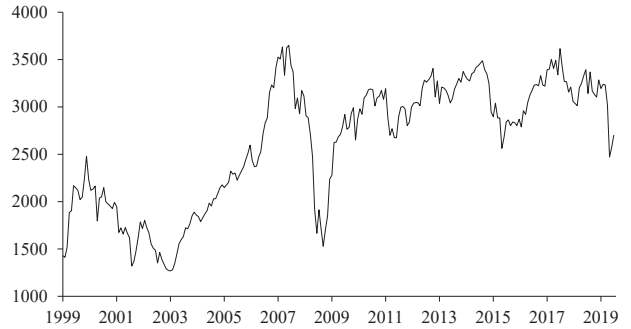
Malaysia: FT-Actuaries (US$ Index)



Thailand: Composite Index



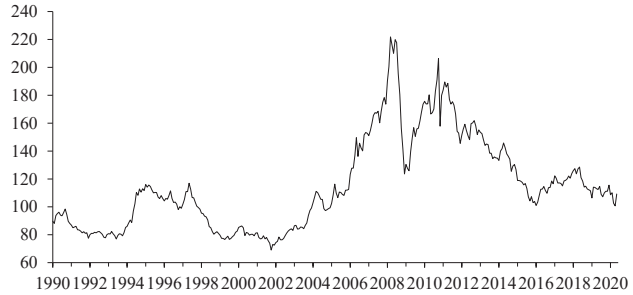
Singapore: Straits Times Index



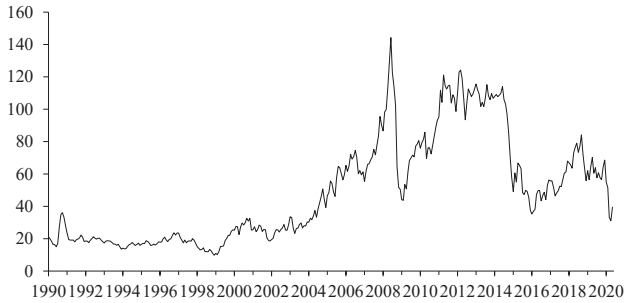
Philippines: Manila Composite

COMMODITY MARKETS

Commodity Price Index (Dollar)
(Economist, 2015 = 100)

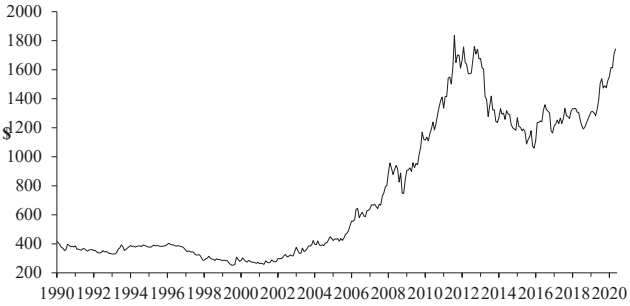


Oil Price: North Sea Brent (in Dollars)

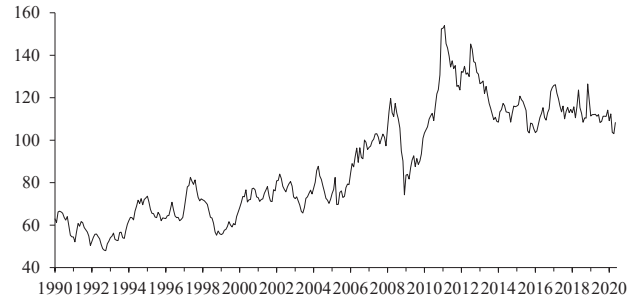


Commodity Price Index (Sterling)
(Economist, 2015 = 100)

Gold Price (in Dollars)



Commodity Price Index (Euro)
(Economist, 2015 = 100)



MODELLING CORONA VIRUS BEHAVIOUR

David Meenagh

Patrick Minford

We apply the logistic function, which is how epidemic behaviour plays out in the data of infections, to the data for deaths from Covid-19, for the UK and Sweden, which we chose because it followed different policies, especially on lockdown. We have then set out a causal model of the Covid virus behaviour based on evolutionary biology and the optimising reactions of households. We have estimated and tested this by indirect inference, matching its simulated logistic behaviour to that found in the data. Using these model estimates, our policy finding is that the general public health policies pursued in Sweden were more effective than their UK equivalent in their effects on the death rate from infections; while the UK lockdown was no more effective than Swedish advisory policies in reducing the virus' spread, but at much lower cost in loss of GDP.

1. Introduction

In this chapter we explain the causal model of coronavirus behaviour and estimate it and test it empirically by its ability to match the behaviour of infections and deaths observed in the UK and Sweden. We then use the model to evaluate the effectiveness of the contrasting government policies in those two countries for dealing with the virus.

When expert epidemiologists disagree so much about the progress of the coronavirus, as we will explain, why should economists suggest a way to model the virus and forecast its virus' progress? There are three main reasons. The first is that economists are familiar with the way the whole family of 'epidemic' processes will show up in the data, so that its likely progress can be directly estimated; this is the 'logistic' S-shaped descriptive model we will set out shortly. The second is that we can formulate a more general causal model, drawing on economic and evolutionary theory. The last is that the economic damage of the main medical intervention so far, lockdown, is so massive that we need to get estimates of how other less expensive policies would impact on the virus' progress, so that likely virus progress can be reliably juxtaposed against likely economic cost, to get the resulting policy judgement right.

2. Describing the data – the logistic curve

The charts of the progress of infections shown in Figure 1[1] - plotted on a log (i.e. proportional) scale — show a common and coherent pattern, which comes from an

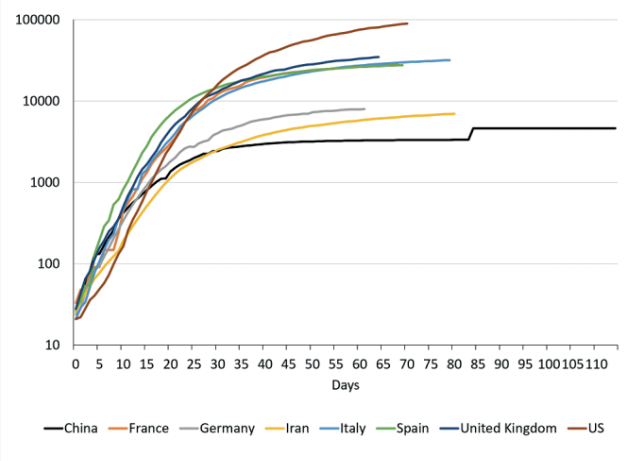


Figure 1: Confirmed Deaths by Day Since Total Passed 20

underlying 'logistic stock-flow' model of the virus; such a model is widely used to project how innovations spread through a population — whether it is new ideas, new technologies, or as here infections. Imagine that you have a population free of the virus, ranged from those with easy infectability at the one end to some at the other with great immunity. Enter the virus, with a mechanism of transmission from person to person via coughing, touching etc. In the initial slow stage, the virus will take time to infect a substantial group. In the second rapid stage, there will be a high speed of infection as the susceptible will quickly catch it and pass it on to other susceptible people of whom many are available. At this point the virus' reproductive rate (R0) will be high, with each infection leading to several others in a short time. The progress will look 'exponential' (an exponential curve grows without limit) but it is not, because there is a further stage.

As the stock of infected people accumulates, the virus needs to spread to people with greater natural immunity. The rate of infection (the flow of new infections) and that R0 rate will slow. As the stock of infected people reaches the last tranche of people with the highest immunity, the rate will gradually fall to a stop. In the end the whole infectable population will have the virus or have had it.

These three stages — initial infection, rapid spread through widely available cases, and finally slowing in the face of saturation — must occur regardless of the epidemiological details. These details show up in the estimated parameters of

[1] Source of data: Johns Hopkins University Center for Systems Science and Engineering

the describing logistic curve, which therefore is a representation in the data for all epidemics and similar population-penetrating processes, whatever their causal details. The logistic parameters are: the maximum penetration, the rate of infection and the point of inflection where saturation starts to set in. The problem for epidemiological models is that so little is known about this virus. But with the logistic curve we can observe for many countries what these estimated parameters, that reflect this unknown virus' character, are. From this diverse experience we can estimate the likely progression here in the UK, and also the effects of lockdown, the policy now being fiercely debated. Batista (2019) and Golinski and Spencer (2020) have estimated logistic models for various countries.

We fitted a logistic curve to UK and other country reported cases and deaths from COVID-19 from 31/01/2020-08/04/2020.

The logistic function is of the form:

$$f(x, a, b, c) = \frac{c}{1 + e^{-(x-b)/a}}$$

where ξ is time, and the three parameters are:

α is the infection speed.

β is the day when the maximum number of new infections occurred.

χ is the total number of recorded infected people at the end of the infection,

Table 1 shows the estimated parameters of the best fitting logistic curves for various countries.

	a	b	c	Deaths Population	c/Population (%)
UK	4 43	36	15694	66460340	0 0236
	(0.08)	(0.20)	(303)		
China	6 70	26	3165	59020000	0 0054
(Hubei)	(0.10)	(0.12)	(0.9)		
US	4.49	0.41	34345	326687500	0 0105
	(0 06)	(0.17)	(572)		
Italy	6 26	38	21982	60421760	0 0364
	(0.12)	(0.20)	(245)		
Spain	4 86	30	18843	46796540	0 0403
	(0 12)	(0 19)	(246)		
France	4 51	52	18336	66977110	0 0274
	(0.08)	(0.16)	(248)		
Germany	4 42	29	3859	82905780	0 0047
	(0 11)	(0 23)	(77)		
Iran	7 52	39	4986	81800270	0 0061
	(0.22)	(0.39)	(94)		

Note: Population data from World Bank (2018 figures). Data up to 14/04/2020 - NB later series than used above for UK

Table 1: Logistic Curve Estimation (standard errors in parentheses)

But we can do more by building the structural (i.e. causal) model of virus behaviour that underlies this logistic 'reduced form'. This structural model, if empirically reliable, can give us an understanding of how policy interventions affect the virus' progress. However, we need a means to establish the model's empirical reliability. For this we use the method of indirect inference where we check the model's capacity to generate the reduced form logistic behaviour we observe in the data. This fairly unfamiliar method gives us substantial power to discriminate against inaccurate or misspecified models. Hence our account of the virus' logistic progress is not intended to replace the careful modelling of the detailed causal processes driving the virus epidemic; rather it is intended to describe the data behaviour of the virus' progress. A structural model of the virus' behaviour, which we develop below, can guide us on the effects of policy interventions such as lockdowns. Medical interventions, such as drugs and vaccines, require specifically medical research, which is being energetically pursued by clinical companies in search of a vaccine and effective drug treatments. But so far none have been found or used except experimentally. Apart from financing and encouraging this pursuit, governments have intervened in two main ways: first by attempted denial of entry of the virus into uninfected populations, through testing, tracing and quarantining and second by lockdown of infected populations. The first has been used by Singapore and South Korea rather effectively. Other countries tried it for a time, the UK among them, but ineffectively, with general popular interaction releasing the virus into general circulation in spite of their efforts. The second intervention of lockdown then has had a plainly visible impact, namely in slowing the early rate of infection and delaying the point of inflection in time. Against this background, structural model estimates can give us practical guidance on what will happen from what has happened so far. This guidance can help to assess orders of magnitude for future cases and deaths which is important when one major clinical group, at Imperial College London, have predicted that deaths would have reached half a million had lockdown not occurred and will reach nearly 50,000 even with the lockdown in place since late March.

3. The rationale of a causal model

We now develop a structural model of the coronavirus' behaviour. Our intention is to test and estimate this model by indirect inference, in which we compare the model's simulated behaviour with actual data behaviour and evaluate the match statistically. We will fit it to data for the UK and Sweden, with the aim of identifying differential policy effects between the two countries, both in terms of lockdown and general public health protection; in both policies differed starkly enough for us to identify the effects with moderate precision. In future work these methods could be extended to other countries to evaluate the effects of the wide variety of policies they all followed.

In our structural model we treat the coronavirus as having an optimised strategy for infecting a population it has been donated by chance to infect. We can think of this optimisation as having been crafted by natural selection over a long period of evolution; in other words today's virus has evolved to survive because its strategy has been optimised

for survival. These ideas belong partly to evolutionary biology (Nesse et al, 2010) and partly to recent DSGE modelling in macroeconomics (Le et al, 2011) where agents are treated as if they are optimising strategic decision-makers; here the virus is treated as an optimising agent, whose strategy has been selected by mutation and evolution. We think of the virus as having mutated by natural selection over previous episodes of contact with populations. However, we are currently modelling a particular episode's population that constitutes a new environment, with differences from the previous ones. We divide this environment into elements the virus cannot control but must simply react to, due to the 'surprises' in the current population: these include the death rate, which will reflect the particular make-up of the population (e.g. more or fewer old and unhealthy people), and detailed shocks introduced for example by other diseases present and policies adopted by governments. The virus adopts reactions to these elements that reflect behaviour that has proved optimal for evolution to maximise surviving viruses: this maximand is its 'utility'.

Furthermore, following the suggestion of Cochrane (2020), we will include people in the model who also act strategically to avoid the costs the virus generates

We must first go through the biology of susceptibility, infection and recovery, which is used in S-I-R models (Atkeson, 2020) usually with fixed parameters that define a mechanical progress of the virus. S people are those Susceptible to being infected. If infected, they become I people. Having been infected, they then after some time either die or develop powerful enough antibodies to kill the virus; or finally they may recover without killing the virus, so that the virus continues in them in a coexisting state, and they remain susceptible to further infection; those who die or recover and kill the virus are denoted R (Recovered) people.

Hence the virus' utility rises with the expected number infected who have not either died or killed off the virus in recovery. These represent all living clusters of the virus; so we assume it is aiming for as many living virus clusters as possible at any future point of time. As it is infinitely lived, with time preference and risk-aversion, it gives value to all these future clusters, discounted by its time preference and in logs, reflecting its risk-aversion (diminishing marginal utility of its 'consumption'). It plans on an infinite life, surviving to infect a future population that may be donated to it. We assume there is some cost of the speed of infection; we think of this as due to increasing infection 'effort' which in turn represents the rising risk of policy resistance by the population the faster the infection rate, e.g. the faster development of vaccine or drugs, which will kill the virus. The biology of the actual infection speed implies that the higher the infected proportion of the population, the slower it is, and we add the effects of social reaction and policy intervention, such as shifts in lockdowns. These effects and the existing rate of infection increase the cost to the virus of achieving infection.

The usual epidemiological model treats infection rates as exogenous to the virus. It then introduces population characteristics, and calculates the interaction of the infection rates with these characteristics in an essentially mechanical way (Atkeson, 2020, surveys these S-I-R group models). In these models, the key parameter is the rate at which the infected I group who have not recovered or died (the R group) pass the virus on to the uninfected susceptible group, S; this parameter can be directly controlled by lockdown and other measures controlling people's interactions. However, this is to treat the virus as unresponsive to circumstances, which would plainly endanger its survival chances. The optimising framework we use here assumes the virus responds in the best way for its ultimate success in surviving. Beenstock and Xieer (2020) point out there are large variations in contagion rates across countries and over time.

It may seem puzzling that a virus, lacking consciousness, can 'respond'. However, this 'response' is simply the result of evolution in the behaviour of surviving mutations. Any given virus at one time will consist of many surviving strains, each infecting in a different way. For example, we know that a rather weak strain, producing weak symptoms, spreads quickly via 'superspreaders'. On the other hand, the highly virulent strain that hospitalises people tends to die out, as people either recover with strong antibodies or die. When people self-isolate, the virus stops spreading in the blocked channels but continues to spread via channels still open, such as superspreader chains. This is pre-programmed reactivity from the virus, picked up in our model as optimising behaviour. As we will see, in our model here, the contagion rate is affected by both known and unknown factors, responding to these as stochastic elements. Our approach allows us to estimate a complete structural model of virus behaviour, and test it powerfully (see Monte Carlo experiment below) against a reduced form of the data behaviour which we know to be a logistic curve process. By estimating model parameters and the exogenous shocks, we can identify, from different countries' estimated behaviour, policy effects on death rates, and on the parameters of the virus' response to the environment. This allows us to estimate the effects of a range of policy interventions - such as the huge variety adopted across many different countries -rather than simply those directly controlling people's interactive behaviour. The model tells us that the daily infection rate responds inversely to the current self-isolation efforts of the population, and the existing (lagged) share of infected population, offsetting these in order to keep the costs of infection smooth over time, while still ensuring that the population gets steadily infected, ensuring new infections indefinitely.

We now insert household behaviour into the model. We will assume that household utility is reduced by infection but also by the personal inconvenience of avoiding infection by self-isolation. This rises directly with the extent of it, and rises indirectly the more uninfected people there are, as this lowers the personal risk of infection from participating, which raises the net costs of self-isolating (the economic costs net of the gain in lower infection risk). There is also a

preference error. Households determine a social reaction strategy including social distancing, self-isolation and hygiene in response to the infection rate.

The model is fitted to deaths. Unfortunately, we do not have data on the actual infections, because tests have not been good enough to estimate these reliably. However, the model gives us estimates of total infection rates, the death rate, infection growth rates and the reporting ratio that are consistent with the actual data. We report these below.

This structural model of the virus' progress is thus derived from the virus' own programming by its evolved biology, by government policies such as lockdown and by households' social actions to contain the disease. The intuition is that as the infected population share gets higher, infection becomes harder and the infection rate drops.

4. Basic calibration to available data from surveys

In recent weeks, survey data has become available on the numbers in total infected by the virus in the UK and Sweden, according to antibody tests which check whether people were infected two to three weeks before, this being the period to antibody production. This data combined with data on deaths gives us a strong estimate of the death rate per infection, the Infection Fatality Rate (IFR), a key parameter of the model.

One widely-held hope among virologists opposed to lockdown, such as Prof Carl Heneghan at Oxford and Anders Tegnell the state epidemiologist in Sweden was that a majority of the population had contracted the virus without getting more than weak symptoms. This would imply that there was close to herd immunity. This hope has been dashed by available surveys of specific Covid-19 antibody prevalence in several countries, which turns out to be low, in the range of 5%–7%, here, in Sweden and in Spain, with big cities like London, Stockholm and Madrid reaching 20% or less. Outside big cities large numbers of small areas have had prevalence close to zero. The latest medical research finds that only seriously infected people develop antibodies — https://www.biorxiv.org/content/10.1101/2020.05.21.108308v1.full — and that that another 40-60% of the population already have general immunity to coronaviruses — https://www.cell.com/action/showPdf?pii=S0092-8674%2820%2930610-3- — and so may have repelled weak infections. So our models are effectively analysing what causes serious Covid-19 infection in a population without specific defence against it.

If we take a figure of 7% for end-May in both the UK and Sweden, this would imply an IFR of 0.0054 in Sweden, and one of 0.0083 for the UK. We calibrate our models with these two rates, and search for estimates in the region of these.

5. Results of testing the model on data for the UK and Sweden

To understand how the model works, consider the hurdles faced by the virus, all of which are reflected in its utility function. First, there is the death rate, inherited from its evolution through whatever species it has inhabited. Second, there is the measure of how far speed of infection provokes increasing resistance from people with increasing immunity. This parameter is largely set by the population structure - the proportions of types, such as by age, fitness and existing health — since the faster the infection rate, the higher the proportion of people with immunity that the virus will be attempting to infect. Third, there is the measure of how far the proportion of uninfected people in the population stimulates the rate of spread. This is policy-related, in that targeting or lock down arrests the spread to the uninfected. Fourth, there is the household parameter, measuring how households react to the risk of getting the virus by self-isolating, social distancing, hygiene etc. Finally, there is the constant, which measures the population proportion that will eventually be infected. This is partly related to population structure, partly to government policy and household reactions in stopping the spread via lockdown, track/trace/isolate, and self-isolation.

These factors determine the speed with which the virus spreads and also the extent to which it will spread in the end. The model is matched to the logistic data behaviour of deaths.

The viral rate of spread depends directly on how many are uninfected and a joint ratio of the parameters measuring the stimulus of the uninfected population share (reducing lockdown and reactivity) relative to the resistance from population immunity and reactivity as infection increases. The higher this ratio, then when many in the population are uninfected, the spread is faster. The measure is similar in both countries. Hence in both the virus spread fast, and has by now infected about 7% of the population according to the model. Effectively lockdown and social resistance are close substitutes in their effect on virus prevalence.

	UK	Sweden	Global
Death rate per infection	0.0084	0.0052	0.0015
Lockdown parameter	4.11	0.151	2.55
Resistance	59.53	40.59	79.02
Social reaction	0.17	2.95	0.62
Spread speed	0.07	0.07	0.04
% Population Infected to Date	7	7	7
% population infected long term	7	7	7
Reported/Actual Infections (inverse)	0.0499 (20)	0.0442 (23)	0.0337 (30)
P-value	0.93	0.82	0.70

Table 2: Structural Model Parameter Estimates

The death rate is lower in Sweden, at 0.0052 vs 0.0084 in the UK. This lower death rate is presumably associated with general public health policies that were more effective in protecting vulnerable groups with the high death rates; the UK's problems with personal protective equipment supplies in hospitals and with care home conditions have been well publicised.

Both of the predictions of the number of infections are around 7% of the population long term — low prevalence in line with the latest surveys of antibody presence. The models both imply that actual infections are a large multiple of reported ones: about 20 times here and 23 times in Sweden. This is lower than the results from SIR estimates fitted to data on tests by Dimdore-Miles and Miles (2020), who find that total including asymptomatic cases relative to tested/reported cases are likely to be considerably higher, with a ratio in the UK of 250. Their results are also consistent with recent estimates from the University of Manchester based on local authority data that 'over 25%' will have been infected across the UK, taking account of unreported cases — https://www.manchester.ac.uk/discover/news/over-25-of-the-uk-likely-to-have-had-covid-19-already

Rather similar findings — of high UK prevalence by end March — are made in a recent SIR model study of Italian and UK data by the Oxford group led by Prof Sunetra — https://www.medrxiv.org/content/10.1101/2020.03.24.20042291v1.full.pdf.

However, as we have seen, these predictions are out of line with the latest survey evidence on prevalence.

Our results on the infection rate are reasonably in line with the latest ONS pilot survey of currently newly infected people, testing positive on a swab test, which it estimates at 0.17%–0.4% of the population. [2] The model currently predicts about 2400 daily reported cases which lasting for a total period of 21 days would imply about 51000 existing known cases in the population, just under 0.1% of the population.

Our results fit well statistically as can be seen. The match of the model to the logistic estimates is good with P-values (the probability that the data does not reject the model); 0.78 for Sweden and 0.93 for the UK.

Nevertheless, there is randomness and uncertainty at work. The error term measures the variability in the model's behaviour, which comes from biological and other (mostly policy) shocks to the rate of infection. The consequence of these shocks for the behaviour of deaths is that the simulated histories for the UK vary substantially and are far from the smooth progressions imputed by the logistic curve.

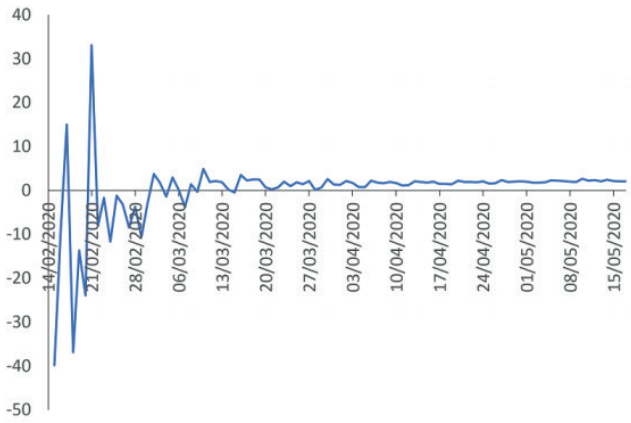


Figure 2: Innovations for the ε_t process

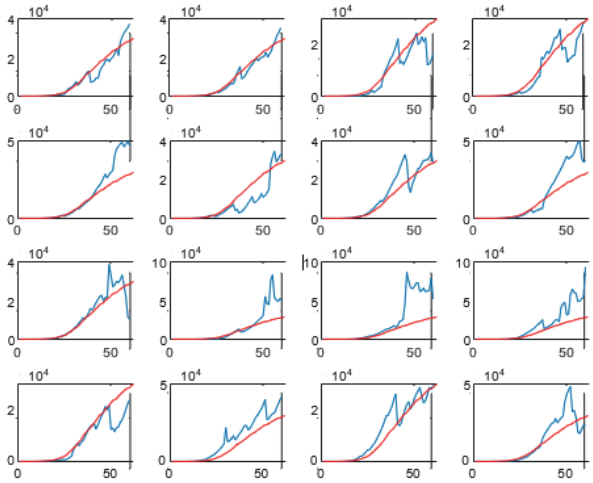


Figure 3: Illustrative Simulations of Deaths

Shown below are the simulated 2.5% probability bounds on the logistic parameters for the UK, which arise from this variability. Faced with spikes like these, it is not surprising that governments were driven to use drastic lockdowns to make sure of suppression. Fitting a logistic function to the deaths data results in the parameters shown in Table 3. The bounds shown come from the simulated variation from the structural model — not from the logistic estimates on the data, which are rather tightly estimated, as listed in section 2. They are indicating that a wide variety of logistic models could emerge from the structural model with some probability. The logistic model estimated on the UK deaths data is highly probable with a P-value of 0.8, as we have seen.

2 https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/datasets/coronaviruscovid19infectionsurveydata

	Actual	Lower 2.5%	Upper 2.5%	Mean
a	10.2775	2.2953	20.8867	8.3010
b	47.4228	30.8611	77.5785	46.2417
c	38738.1847	18601.3551	89002.1526	40782.6827

Table 3: The auxiliary model estimates and bounds are for the logistic curve, as fitted for UK data.

We also fitted the model to data for a 'global' average of all countries which had deaths of more than 1500 — 25 in all. Our main policy focus is on Sweden and the UK, because they provide us with a benchmarking ability. The global model estimates are of interest as an additional test of the model's plausibility. The countries included spanned a huge variety of government policies, but according to the model this should not make much difference to outcomes since social reaction substitutes closely with government policy, effectively offsetting it in the resulting equilibrium. This is what we find. The parameter measuring government reaction lies above Sweden and below the UK; the parameter mirrors this, lying below Sweden and above the UK. According to the model, there is more natural resistance in these countries than in either the UK or Sweden, with a high parameter. The rate of spread is correspondingly slower. The global model is calibrated so that a similar long term proportion of people should be infected globally as in the UK and Sweden.

We now go on to consider the implications for policy of the model estimates.

5. 1 The Herd immunity puzzle

The progress of the virus should stop naturally at the point of herd immunity. It has generally been thought that this point is reached when about 60% of the population has been infected. However, what our model estimates are indicating is that this point is being reached at much lower infection rates, more like 7%. How could this be the case? A key parameter is the reaction of people to the infection as it grows, the parameter.

This parameter triggers social distancing when the virus strikes a community, much as a herd of antelope reacts by running as a group when a predatory lion pack is spotted. If this parameter is put at zero, the herd immunity estimate is close to the usual 60%. But, as suggested by Cochrane, social responses bring it right down. The population is responding to information rationally as it arrives, in a rational expectations equilibrium.

6. Policy implications of the model estimates

We can now discuss the experience of the two countries and the different estimates we get from them for these factors. From this we can learn a fair amount about the effectiveness and costs of different government policies. Our main focus in the policy discussion that follows is on the UK, using Sweden as the main identifying benchmark, for outcomes of alternative policies, of no lockdown but instead information and advice on social distancing, together with other general public health policies.

Comparing the UK and Sweden we find that the parameter of natural resistance to the virus' rate of progression (γ) is much the same; but the Swedish IFR is substantially lower. This will be related to the effectiveness of controlling the access of the disease to vulnerable groups, like the ill and elderly; the better the protection against infection within hospitals and care homes, the less this access. In the UK, problems with PPE in the NHS and care homes have been well publicised.

Also the Swedish estimate, reflecting social reaction, is much higher than in the UK, where it is close to zero, while the parameter reflecting government-imposed policies like lockdown is around zero in Sweden, much lower than in the UK. These two parameters are of course close substitutes, since the social reaction compensates for lack of policy reaction.

Our interest in policy lies particularly in the effect of the UK lockdown. According to our model, this is found in the policy-reaction parameter. However, as we have seen, the higher this parameter the lower the social reaction parameter; there is strong substitution. It is the two together that determine the equilibrium progress of the virus, both its end infected share of the population and its rate of spread. The model suggests that there is no difference in the behaviour of the virus between the two economies.

We can illustrate this clearly from the data for both, that follows.

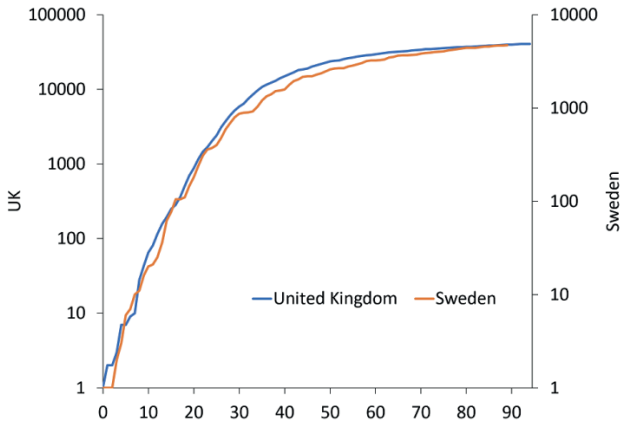


Figure 4: Cumulative Confirmed Deaths (log scale)

The implication is that lockdown achieved nothing extra compared with what a decentralised social reaction strategy, as pursued in Sweden, would have achieved. We could assume that the Swedish and UK relative policy costs are reflected in the relative Consensus Forecasts fall in their 2020 GDP: for Sweden this is about 6%. but for the UK it is 9% in 2020, about £180 billion, According to the model

lockdown saved no deaths but cost the UK economy a GDP loss of some £60 billion. Plainly relying on social responses as in Sweden would have been far more cost-effective than lockdown, for much the same outcome in deaths. We do not need to appeal to any cost per life saved as in transport policy where typically £11 million per life saved is used as a benchmark[3]; the point is that lockdown has cost a lot for no lives saved.

However, the Swedish experience suggests other policies there, of a general public health nature, succeeded in reducing deaths.by lowering the death rate. Had Swedish health policies been applied in the UK, the population infected would have been the same but the death rate 0.003% lower at 0.056%. UK deaths would have been about 26000, some 14000 less than the current total.

Current UK policy aims to lift the lockdown but introduce stringent test/trace/isolate policies of localised lockdown — 'whack-a-mole' — stopping localised outbreaks fast. However, the Swedish experience suggests that decentralised social reaction will do the same job without this heavy-handed government action. All that the government needs to contribute is any information it can provide, such as from surveys and local hospital reports: the people will do the rest. Given that there are random shocks to the model, we can think of these as random starts of mini-waves; however, they provoke social reactions which bring the case and deaths outcomes back to the equilibrium path.

Policy must also look to the future, and any possible entirely new wave of infection from a mutated virus. We can predict how the virus' behaviour will evolve, towards that of a normal flu. Future waves should have a lower IFR, the more deadly strains having partly died out with their hosts. This suggests that we can use our estimated model for future waves, but updated for a much lower death rate, like that of a normal flu at around 0.1%, an eighth of what the UK has experienced in the current wave.

7. Conclusion

In this chapter we have fitted the logistic function, the reduced form of epidemic behaviour, to the data for deaths from Covid-19, for the UK and Sweden, which we chose because it followed different policies, especially on lockdown; we also fitted it to a global average, to test the model's generality. We have then set out a structural model of the Covid virus behaviour based on evolutionary biology and social household behaviour. We have estimated and tested this by indirect inference, matching its simulated logistic behaviour to that found in the data. We have used these model estimates to assess the effects of the different policies pursued in the two countries. Our basic policy finding is that the general public health policies pursued in Sweden were more effective in reducing deaths than UK public health policies ; and that the UK lockdown was no more effective in reducing deaths than the Swedish reliance on voluntary socially aware behaviour, whereas the economic cost of the UK policy was enormously bigger.

[3] The J-value (cost per life saved by safety measures) used by the US Dept of Transportation is between £4 and £10 million per life saved through road safety measures, with the UK value being around £9 million. https://www.bristol.ac.uk/media-library/sites/policybristol/PolicyBristol-Report-April-2018-value-human-life.pdf

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The Institute embraces the original Liverpool Research Group in Macroeconomics, which is now based at Cardiff Business School and is pursuing a research programme involving the estimation and use of macroeconomic models for forecasting and policy analysis. It is grateful for financial support to the Jane Hodge Foundation, the Economic and Social Research Council, Esmee Fairbairn Charitable Trust, the Wincott Foundation and Cardiff Business School.

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