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## The Distributional and Budgetary Consequences of the UK lock-down


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# The Covid-19 Crisis Response Helps the Poor: The Distributional and Budgetary Consequences of the UK lock-down

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*Abstract*

We nowcast the economic effects of the Covid-19 pandemic and related lock-down measures in the UK and then analyse the distributional and budgetary effects of the estimated individual income shocks, distinguishing between the effects of automatic stabilisers and those of the emergency policy responses. Under conservative assumptions about the exit strategy and recovery phase, we predict that the rescue package will increase the cost of the crisis for the public budget by an additional £26 billion, totalling over £60 billion. However, it will allow to contain the reduction in the average household disposable income to 1 percentage point, and will reduce poverty rate by 1.1 percentage points (at a constant poverty line), with respect to the pre-Covid situation. We also show that this progressive effect is due to the increased generosity of Universal Credit, which accounts for only 20% of the cost of the rescue package.

## 1. Introduction

The objective of this paper is to nowcast the effects of the Covid-19 lock-down on the UK economy, in terms of lost income, budgetary impact, and distributional consequences.

On Monday March 23, 2020, the UK Government followed a long list of countries and enforced drastic lock-down measures to limit and delay the spread of Covid-19. These included home confinement but for a limited list of exceptions, bans of public gatherings of more than two people, and closure of all retailers selling non-essential goods (essential shops include food retailers, pharmacies, hardware stores, corner shops, petrol stations, shops in hospital, post offices, banks, newsagents, laundrettes and pet shops). Schools were ordered to close a few days before, taking effect on that same Monday. The first phase of strict lock-down continued until May 13, when the Government allowed workers unable to work from home to return to their workplace provided social distancing was ensured at work, among other measures (HM Government, 2020).

There are no doubts that the effects of this forced breaks imposed on the economy, for the UK as well for the other countries following similar trajectories will be massive. Expert forecasts – reviewed in Hughes et al. (2020) – vary around a central estimate of around 2% GDP loss for each month of strict lock-down (see also OECD, 2020). The Office for Budget Responsibility's own forecasts lie on the pessimistic side, with a projected drop in the second quarter GDP of 35%, for a three-month lock-down (OBR, 2020).

In order to cushion the effects of the lock-down, the Government has introduced emergency income-support measures. These include a Coronavirus Job Retention Scheme, covering 80% of the wage costs of furloughed employees up to a maximum of £2,500 a month, a Self-Employment Income Support Scheme, allowing to claim a taxable grant worth 80% of trading profits up to a maximum of £2,500 a month, plus modified conditions for Universal Credit and Local Housing Allowance, among other auxiliary measures. The furlough scheme was extended at the end of the first phase of the lock-down until the end of October, with part-time working allowed from August.

The OBR forecasts that the impact of reduced economic activity and increased spending on the public budget will amount to around £220 billion (OBR, 2020), or 12% of GDP, split between £130 billion of lower receipts (a reduction of 15% with respect to the Budget), and almost £90 billion of increased spending (+9% with respect to the budget).

In this paper we go beyond these aggregate estimates, characterise the groups most affected by the lock-down, identify who benefits from the emergency support measures and by how much, and the consequences in terms of poverty and the government budget. We do this by using UKMOD, the EUROMOD-based tax-benefit model for the four UK nations developed at ISER, University of Essex.[1] Tax-benefit microsimulation models apply the fiscal legislation to an observed input population, typically coming from survey data (the Family Resource Survey for UKMOD). The most recent input data for UKMOD is for the financial year 2017/18. To model the effects of the lockdown, these data need to be updated. Lacking timely data on sectoral activity and employment, we employ an input-output (IO) model based on the supply-use tables published by the Office for National Statistics and referring to 2016, parameterised with the results of a consensus analysis of the opinions of a large number of UK-based economists. We allow the lock-down measures to impact final demand by sector, and also model supply-side constraints originating from the government guidelines. An important result from our IO model is that 75% of the effect originates from demand-side constraints originating from restrictions preventing final consumers from physically visiting sellers in lock-down, reduction in the demand from importers, or difficulties to get the goods and services through the border. Supply-side constraints, due to social distancing and smart working measures reducing the output of intermediate

[1] See https://www.iser.essex.ac.uk/research/projects/ukmod.

goods and services, which producers sell to other producers, account for only 25% of the overall macro effect of the crisis according to our estimates.

Overall, our baseline scenario predicts a loss of 7.3 million jobs (22.3% of the total), once the economy is in the lock-down equilibrium. This is in line with other forecasts indicating a contraction of 25% of GDP approximately after a two-month lock-down (e.g. Pichler et al., 2020). In our analysis we assume that the economy rapidly adjusts downwards to the Covid-19 shock, consistently with the preliminary evidence available. We also assume that the first phase of the crisis lasts for 2 months, followed by a further two months where the shock is reduced to 50%, and another four months where the shock is reduced to 25%. After that, we make the conservative assumption –in terms of the estimated impact of the crisis– that the economy goes back to the previous equilibrium.

The IO model allows us to differentiate the employment effects of the lock-down by industry. To distribute the income shock to workers within industries, we estimate individual relative probabilities of transitioning from employment to non-employment, on LFS data. We then analyse the effects of the estimated individual income shocks with UKMOD.

We show that the rescue package will add a net £26 billion bill to the £35 billion cost that the crisis would have entailed for the public budget, totalling £61 billion. However, it will allow to contain the reduction in the average household disposable income to 1 percentage point, and will reduce poverty rate by 1.1 percentage points (at a constant poverty line), with respect to the pre-Covid situation. We also show that this progressive effect is due to the increased generosity of Universal Credit, which accounts for around one fifth of the cost of the rescue package.

In our analysis we assume that there are no behavioural responses to the income shocks, with respect to labour supply behaviour. This is of course a simplification, which however is probably less dramatic than one would expect given the size of the shocks. This is because the crisis unfolded very rapidly and the emergency measures caught the economy entirely by surprise, being unconceivable just a few weeks before they were implemented. Moreover, they are coercive in nature and left very limited room for individual adjustment. Finally, they are generally understood to be limited in time. Hence, we argue that behavioural responses can be largely ignored, at least during the acute phase of the crisis.

Our paper belongs to a growing number of exercises trying to understand the distributional consequences of Covid-19.[2] Other contributions include Figari and Fiorio (2020), who perform the analysis on Italy, Beirne et al. (2020) for Ireland, O'Donoghue et al. (2020) also for Ireland, and we are aware of ongoing work in other countries. Figari and Fiorio use a legislation-based approach to identify what occupations should be affected by the regulation. Beirne and co-authors consider arbitrary employment scenarios. O'Donoghue et al. also start from a scenario analysis for sectoral shocks, and then distribute these shocks based on an income generation model.

The rest of the paper is structured as follows. Section 2 describes our dynamic IO model. Section 3 presents our parameterisation and quantification of the macroeconomic shock for the UK. Section 4 discusses the estimation of the employment transition model. Section 5 applies UKMOD and derives our main results. Section 6 summarises and concludes.

## 2. The macro model

Attempts to predict the macro-effects of the lockdown are more numerous than those looking at distributional consequences. Most exercises rely on aggregate macro models (e.g. Eichenbaum et al., 2020), with fewer making use of input-output (IO) models, often also fairly aggregated (e.g. to two sectors as in Bodenstein et al., 2020). IO models are typically of the Leontief (1936) or Gosh (1958)

[2] Gender issues of the Covid-19 epidemics are discussed, but not estimated, in Alon et al. (2020).

type. In the Leontief model, output depends on final demand, and a shock to demand for one sector reverberates its effects upwards in the production process through sectoral interdependencies. In the Gosh model, output depends on value added, and a shock to productivity in one sector reverberates its effects downwards in the production process through sectoral interdependencies.[3]

In both cases, standard applications assume that no substitution among inputs is possible in the production of any good or service (Christ, 1955): production is then scaled up or down to meet final demand or supply constraints using the same optimal production plan, with a fixed mix of inputs in nominal terms.

Applications of the Leontief model to disaster impact assessment have led to the so-called Inoperability IO model, which follows a very similar logic (Dietzenbacher and Miller, 2015). The Inoperability model assumes that, when an entire sector or sub-sector is shut down or drastically impacted, the demand for that sector is picked up by imports. As such, the assumption that there is only one process used for the production of each output is maintained.[4] An alternative to assuming perfect substitutability between domestic intermediate inputs and imports is to consider a Cobb-Douglas specification with constant returns to scale both for production functions (supply side) and utility functions (demand side), as in Acemoglu et al. (2016).[5] This assumption ensures that income and substitution effects exactly offset each other, and the optimal mixes of intermediate inputs and final demand depend only on technological and utility parameters respectively, and not on prices nor quantities. Acemoglu et al. show that, under those assumptions, demand shocks are only propagated upwards and supply shocks only propagated downwards.

Both approaches allow in principle for contemporaneous demand and supply shocks, but are not particularly well suited for analysing the disruptions caused by Covid-19. Starting from the Inoperability model, the assumption that imports can compensate for shortfalls of intermediate inputs looks unsatisfactory, given that imports are also affected, either by lock-down measures in the producing countries or by trade restrictions. The Cobb-Douglas assumption is also problematic in the Covid context, as it implies constant expenditure shares. This means, for instance, that if a company routinely uses low fare airlines to allow its managers to visit production facilities, and airlines cease to operate, it will hire a private plane to allow at least some managers to visit some plants, some of the time, so that the proportion of the budget that goes to travelling remains unchanged. This seems implausible in the current circumstances.

Most contributions trying to predict the effects of Covid-19 on the economy follow the standard IO literature without optimisation. They typically deal with the problem of reconciling demand and supply shocks by computing the effects of the two shocks separately, and then considering the biggest of the two. This is for instance the approach of del Rio-Chanona et al. (2020), who construct their own measure of supply shocks for the US based on detailed occupation-specific considerations, while taking the Congressional Budget Office scenarios for the demand shocks.[6] Dorn et al. (2020) supposedly follow a similar approach in providing growth estimates for Germany, although they do not fully describe their

[3] The dual nature of the demand-driven Leontief model and the supply-driven Gosh model and their mathematical equivalence between the Leontief and Gosh model has been proposed (Dietzenbacher, 1997) and, while debated (de Mesnard, 2009), is generally accepted in the literature (see also Manresa and Sancho, 2019).

[4] Again, the implicit assumption that prices do not change or that they are perfectly offset by changes in quantity is made.

[5] To be noted, Acemoglu et al. do not estimate production function and utility parameters, but rather use their theoretical framework to inform a reduced form econometric specification, estimated using past shocks (variation from the exogenous components of imports from China, changes in federal government spending, total factor productivity shocks and variation in foreign-industry patents).

[6] The OECD (2020) works out its scenarios in an even simpler manner, by either looking at supply shocks (i.e. reductions in production) or demand shocks (i.e. reductions in sales), without working out their effects throughout the IO matrix.

methods. On the other hand, Pichler et al. (2020) allow for a reorganisation of production plans by adopting a hybrid Leontief + linear production function, where they distinguish between essential and non-essential inputs in production based on ad-hoc survey of market analysts. They also allow substitutability in household final demand by estimating consumption functions. Here we develop an IO model that – although less sophisticated than Pichler et al. (2020), also considers the joint effects of demand side and supply side shocks. Interestingly, we get to similar results in terms of the macroeconomic effects of the crisis.

Let $y = [y_i]$ be the total output of each industry, $Z = [z_{i,j}]$ the matrix of intermediary inputs supplied by industry *i* to industry *j*, and $f = [f_i]$ the final demand for each industry. We have

$$y = Z + f, \quad (1)$$

where *y* is supply (production), and *Z* + *f* is demand (sales). Inventories (included in the final demand) guarantee that the accounting identity production = sales holds, from which we obtain the familiar expression

$$Z = Ay \quad (2)$$

where *A* is a matrix of technical coefficients, assumed to remain constant. In a standard IO approach, a change in the final demand $\Delta f$ is transmitted upwards and leads to a change in total production equal to

$$\Delta y = (1 - A)^{-1} \Delta f, \quad (2)$$

while a change in production of $\Delta y$ is transmitted downwards and leads to a change in final demand equal to

$$\Delta f = (1 - A)\Delta y. \quad (2')$$

There is however no way to allow contemporaneous demand and supply shocks to all industries. The fundamental problem is that if the equation demand = supply is to hold, one of the three terms *A, y* or *f* needs to be endogenously determined. We solve this problem by allowing *A* to change endogenously. Ideally, this could be rationalised under the assumption of constant elasticity of substitution (CES) production functions, to be separately estimated by sectors. CES production functions nest the three cases of Leontief (no substitutability), Cobb-Douglas (constant shares) and linear production functions (full substitutability). However, CES production functions are not simple to estimate on UK data, and estimates for many sectors do not converge (Richiardi and Valenzuela, 2020). We therefore proceed by making the extreme assumption of full substitutability. While this assumption might work for some inputs, that are dependable at least in the short term (think of air travels), it is clearly inadequate for others, which are essential in the production process (for instance, iron ore for metalwork). We defend it with two arguments: first, Covid-19 restrictions mostly involve the production and consumption of non-essential goods and services; second, our approach puts us on the safe side, by providing a lower bound of the estimated effect of the lock-down on the UK economy.

Our modelling assumptions are best described in dynamic terms. We assume a linear production function in intermediate inputs *z*, imports *m* and labour *l*:

$$y_i^S = \sum_{j=1}^{J} z_{j,i} + m_i + l_i. \quad (3)$$

Production is sold to other industries and final customers (including households, government, foreign markets and inventories):

| $y_i^D = \sum_{j=1}^{J} z_{i,j} + f_i.$ | (3) |
|---|---|

Because of the disruptions caused by Covid-19, final demand is reduced to $\widehat{f_i} = \alpha_i f_i$.[7] We assume that in a first period production plans are potentially affected by disruptions in supply, but otherwise continue unchanged even in the face of reduced final demand. Disruptions in supply, due to either an inability of firms to buy all the intermediate inputs originally planned, or to a diminished productivity of labour, reduce production to $\hat{y}_i{}^S = \beta_i y_i^S$. In absence of supply-side constraints, a reduction in final demand leads to over-production, which goes to inventories.[8] On the other hand, in absence of demand effects, a reduction in supply leads to under-production. We make the assumption that intermediate customers are served first, so that under-production leads to a reduction in sales to final customers.

Now, the subsequent dynamics is very different depending on whether there is over- or under-production in any given industry. In the first case, production is reduced to bring it in line with sales, meaning that the demand of all intermediate inputs is proportionally and uniformly reduced. This triggers further effects, as it worsen supply constraints in industries that are net buyers from industry *i*, and worsen demand constraints in industries that are net sellers to industry *i*.

Note that the symmetry between demand and supply shocks is broken because production is not allowed to expand in presence of supply-side constraints. Note also that supply-side constraints interact with final demand constraints by making the adjustment faster: if supply is reduced at the same time when demand is reduced, the economy remains closer to an equilibrium, although at a lower level of activity.

Finally, our model maintains the original input mix as far as demand shocks are considered. It's only supply shocks that affect the composition of intermediary inputs.

## 3. Scenario assumptions and the size of the employment shocks

Equipped with our dynamic IO model, we need scenario parameters for the supply and demand shocks. We get these from a consensus analysis of an ad-hoc survey of 2,644 economists with UK affiliations and complete personal profiles in RePEc, realised between April 24 and May 1, 2020. The questionnaire asked for the expected change, at the industry level, in (i) household demand (which we assumed representative of all final demand with the exclusion for the demand for exports), (ii) supply of intermediate goods and services, and (iii) exports. Final demand is affected because consumers face limitations to buy certain goods or services. For instance, in strict lock-down beers can be ordered take-away from the local pub, and cars can be bought online without visiting a dealer, but fewer people are doing this. Supply is constrained due to the social distancing measures that producers have to put in place, or because productivity goes down due to working from home arrangements. In some sectors, distinguishing between reduction in demand and reduction in supply is difficult. This is particularly true for services requiring a personal contact: for instance, consumers can't buy a haircut in lock-down, while hairdressers cannot sell it. The distinction is more meaningful in manufacturing, wherever social distancing can be achieved in factories. Our approach is more sophisticated than some other early attempts to model the macro effects of the Covid-19 lockdown, but still disregards to a large extent substitution effects by households and producers. As discussed above for labour supply, we motivate this simplifying assumption with the consideration that the shock was large, exogenous, unexpected, and likely of short duration (a few months), hence limiting the opportunities for reorganizing production and consumption plans.

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[7] We assume that in a first period intermediate demand remains unchanged. Relaxing this assumption poses no problems (but also makes very little difference to our empirical results).

[8] So, technically, final demand remains unchanged, and only its composition is affected.

Filling in scenario assumptions on all the three dimensions cited above for the 64 industries used by the IO tables provided by the Office for National Statistics would have required asking for 192 different values. We have therefore opted for selecting key industries only: 23 industries most relevant for household demand, and 11 industries most relevant for exports and intermediate inputs (Appendix 1, Table A1). This brought down the number of industries on which the respondents were asked to focus to 34, and the single values on which they were asked for an opinion to 45. We obtained a 378 valid responses, for a response rate of 14.3%. Removing surveys in which no questions were answered and surveys in which respondents did not consent to the study, we obtain a sample of 257 responses with 81% of complete responses (208 completed surveys and 49 partially completed surveys).[9] The distribution of the responses are reported in Appendix 1, Figures A1-A3.

We then created a mapping between the 192 parameters required, and the 45 obtained (Appendix 1, Table A2). On the basis of this mapping, we identify a baseline scenario with median values of the responses: feeding the IO model with these parameters leads to reduction in GDP of 22.6%, in the lock-down equilibrium. Our baseline is consistent with preliminary estimates showing that the UK economy contracted by 6% in March 2020. Given that lock-down was in place only in the last week of March, this points to a total effect close to one quarter of GDP, in equilibrium, not far away from our 22% figure.

The combination of demand and supply side constraints, as discussed in Section 2, also helps to produce a rapid adjustment. The effects of such a dramatic contraction in production on employment however depend crucially on how firms respond – their specific HR policies at a time of a national emergency. The presence of quite generous government schemes, in this respect, undoubtedly takes some pressure to cushion employment responses away from companies. As a first approximation, we assume a decrease in employment proportional to the decrease in production. This leads to an equivalent of 7.3 million jobs (-22.3%), in the lock-down equilibrium.[10] Our estimated job losses are slightly more conservative than the figure of almost 8 million workers released by HM Treasury on May 20, 2020 – the advantage of the macro model of course being that our estimates are disaggregated by sector.

Figure 1 reports the predicted employment losses by macro-sectors. Sector I - Accommodation & food services is the most badly hit, with an estimated reduction in lock-down of more than 80%, followed by H - Transport & storage with -40% and C - Manufacturing (almost -30%). The least affected sectors are L - Real estate activities, A - Agriculture, forestry & fishing, Q - Human health & social work and K - Finance and insurance, all around -10%.

[ insert Figure 1 here ]

The detailed employment effects predicted by our IO model by industry, which we use to adjust the input data of UKMOD, are reported in Table 1. Note that the estimated effects differ sometimes significantly from the input values obtained from the scenario analysis. For instance, final household demand for industry 39 - Telecommunication services was projected to go up 20% in the consensus analysis, but overall output and employment is estimated to go down 9% from our IO model. This is because of inter-industry linkages in the supply and demand of intermediate inputs.

[9] More information on the study is available at www.euromod.ac.uk/covid-19/consensus.

[10] The results of a low-impact scenario with the p25 values, and a high-impact scenario with the p75 values are available on request, together with their distributional and budgetary consequences. In the aggregate, the employment losses go down to just above 3 million jobs (-9%) in the low-impact scenario, and shoot up to almost 13.5 million jobs (-41%) in the high-impact scenario.

[ insert Table 1 here ]

Interestingly, if we shut down supply constraints we obtain a modified Baseline scenario where the contraction in employment is reduced to 5.5 million jobs, or 16.9% of total employment. Supply side constraints therefore amount to one quarter only of the total macroeconomic effect, in our model.[11]

## 4. The employment transition model

Having obtained from the IO model the expected contraction in employment in each of the 64 industries (as % change from the original level of employment), we need to assign the employment shocks at the individual level. Our assumptions distinguish between self-employment and dependent employment. For the self-employed, we simply assume that income is homogenously reduced proportionally to the industry-level shock. For employees, we assume that some workers remain unscathed, while others go down to 0 hours (whether because they are dismissed or furloughed, see Section 5 below). To identify the employees that make the transition to 0 hours, we model the probability of transitioning from dependent employment to non-employment between two consecutive quarters as a function of a set of individual observable characteristics $X$, the change in the industry-level aggregate employment $\Delta E_j$, and a full set of industry dummies. We use the two-quarter longitudinal version of the Labour Force Survey (LFS). Due to a relatively small number of observations making the transition in any single file, we pool 11 two-quarter longitudinal datasets to cover the period from April 2014 to September 2019.[12] Removing observations with missing values in any of the variables included in $X$ we obtain a sample of 175,475 observations on 128,702 unique individuals, all dependent employees in the first quarter observations, for a total of 4,160 transitions from employment to non-employment. Table 2 reports the estimated coefficients from a logistic regression.

[ insert Table 2 here ]

## 5. Distributional and budgetary consequences

We finally analyse the distributional and budgetary consequences of the employment shocks estimated above, and of the associated policy responses.

We utilise the tax-benefit microsimulation model UKMOD, the UK component of EUROMOD (Sutherland & Figari, 2013; Sutherland 2018). We use UKMOD version A1.5+, released in April 2020 to calculate disposable (net) household incomes, given individual (gross) market incomes and

[11] Pichler et al. (2020) show that the role of supply side vis-a'-vis demand side constraints is sensitive to the assumptions about the production function used. In particular, assuming some degree of substitutability between inputs as we do lowers, *ceteris paribus*, the overall economic effects of the initial shock, and also the role of supply side constraints. As already noted however, the aggregate results we get from our model are quite in line with those of Pichler et al. (and also other independent estimates – see the review in Hughes et al. 2020, already cited).

[12] Descriptive statistics for our sample are reported in Appendix 1, table A2.

personal/household characteristics.[13] UKMOD runs on the Family Resources Survey (FRS), the latest data available being the 2017/18 wave with the different income components uprated to 2020 values.

UKMOD A1.5+ includes the changes announced in the Scottish and UK budgets of this year as well as Covid-19 policy measures, except for the Job Retention Scheme (JRS) and the Self-employment Income Support Scheme (SEISS), which we jointly label Market Income Support Schemes (MISS) and simulate directly.[14] Besides MISS, the main policy changes in response to the Covid-19 crisis are:

- an increase in the yearly basic element of the Working Tax Credit (WTC) of £1,045;
- an increase in the weekly housing benefit disregard of £20;
- an increase in the monthly standard Universal Credit (UC) allowance of £86.67;
- the removal of the minimum income floor for self-employed within the UC calculation;
- an increase in the weekly local housing allowance of £14.86 (on average across regions and accommodation types).

We modify the input data to simulate the effects of the Covid-19 income shock (see Appendix 2). With respect to the *size* of the income shock, we distinguish, as described in Section 4, between self-employed and dependent employees. For self-employed, we consider a homogenous reduction in earnings proportional to the projected reduction in output of their respective industry; for employees, we randomly put workers to 0 hours on the basis of the estimated probabilities coming out of the employment transition model.[15] With respect to the *duration* of the income shock, we assume 2 months of strict lock-down at 100% of the estimated effects, 2 months of partial lock-down at 50% of the estimated effect, and a further 4 months of recovery phase at 25% of the estimated effect. In the recovery phase, self-employed see a reduction in their income loss, while a proportion of the dependent employees that were sent to 0 hours are allowed to get back to their previous employment status.

Our analysis is based on a comparison between three counterfactuals:

1. A "pre-Covid" scenario (referred to as 'Scenario 1'), corresponding to the income distribution and fiscal position that would have occurred in the absence of the Covid-19 crisis and related policy changes;
2. A "post-Covid employment, pre-Covid policies" scenario (referred to as 'Scenario 2'), corresponding to the impact of the Covid-19 crisis in the absence of policy changes, where only the automatic stabilisers already embedded in the tax-benefit system operate. In this scenario, the employed individuals who would stop working in lock-down receive contribution-based Job's Seekers Allowance (Cb-JSA) and other pre-Covid benefits, if they become eligible.[16]
3. A "post-Covid employment, post-Covid policies" scenario (referred to as 'Scenario 3'), corresponding to the combined impact of the Covid-19 crisis and all policy changes.

Comparing Scenario 2 with Scenario 1 gives the un-mitigated socio-economic impact of Covid-19, and the cost that this would have entailed for the public budget due to lower tax revenues and increased

[13] More information can be found in the UKMOD country report available at https://www.iser.essex.ac.uk/files/projects/UKMOD/EUROMOD_country_report.pdf.

[14] The JRS covers employment income, employer National Insurance contributions and employer pension contributions. UKMOD does not simulate the latter, which are therefore excluded from our impact assessment.

[15] Because of the non-linearity of the logistic model, and given that the projected Covid-19 shocks are much larger than the observed quarter-to-quarter employment changes, we further normalise the individual predicted probabilities by the industry shocks, so that the reduction in industry-level employment matches the projected industry-level shocks.

[16] UKMOD checks the eligibility condition for contribution-based JSA by looking at the entire individual work history rather than the last two fiscal years, due to difficulties in approximating the amount of contributions paid. This makes it easier to become eligible for contribution-based JSA in UKMOD. We plan to improve on this approximation in future releases.

benefit payments. Comparing Scenario 3 with Scenario 1 gives the mitigated socio-economic impact of Covid-19, and its overall effect on the public budget. Comparing scenario 3 with scenario 2 gives the additional costs and benefits of the emergency measures.

A crucial assumption in Scenario 3 concerns the take-up rate of MISS. We calibrate this using the latest data released by ONS on the number of people claiming benefits primarily for the reason of being unemployed (19 May 2020). These show an increase from 1.2 million in March 2020 to 2.1 million in April.[17] Considering that the adjustment to the lock-down equilibrium – although fast – could have been still incomplete at the end of April, we assume that 1 million dependent employees become unemployed, rather than being furloughed, and are then checked for eligibility for the less generous contribution-based and income-based JSA and Universal Credit.[18][19] On the other hand, we assume that all self-employed have access to the Self-Employment Income Support Scheme for their lost profits.

Comparing Scenarios 1 and 2, we see that in the absence of any policy change the Covid-19 crisis would have increased the number of claimants of unemployment benefits by 4.8 million, increased the poverty rate – at a constant poverty line – by 1.2 percentage points (pp), and decreased mean equivalised disposable income by 3%, with a more pronounced effect at the top half of the income distribution (Table 3).

[ insert Table 3 here ]

To understand the specific income components driving the changes, we decompose the percentage change in mean equivalised income for each decile looking at the contribution of different income sources (Figure 2). We find that the drop in market incomes (MI) hits proportionally harder at the top half of the income distribution: this is due to (i) many people not having market incomes in the first place, in the lowest deciles, (ii) the distribution of income by industries, and (iii) the distribution of the individual employment transition probabilities within industries.[20] We also confirm that JSA tends to be somewhat progressive due to its flat nature.

[ insert Figure 2 here ]

From the perspective of public finances (Table 4), this counterfactual scenario would have resulted in a drop in government revenues (taxes and social insurance contributions) of more than 28 billion pounds or 7.5% with respect to the baseline, and an increase in government expenditure on social transfers of more than 6 billion pounds. Due to the way eligibility conditions for contribution-based JSA are modelled in UKMOD (see footnote 17), this increase in social transfers is mostly concentrated in

[17] The ONS Claimant Count (series K02000001 UK) is a combination of claimants of Jobseeker's Allowance (JSA) and claimants of Universal Credit (UC) who fall within the UC 'searching for work' conditionality.

[18] This is more conservative than the 2 million unemployment figure considered by the Office for Budget Responsibility, which also considers a bigger contraction in GDP. Robustness analysis to this assumption is available upon request.

[19] Brewer and Handscomb (2020) show that the median effective replacement rate for the Job Retention Scheme is over 90%, compared to 53% for those who do not qualify (the reason why the replacement rate is over the 80% threshold is that many people will pay lower taxes after a 20 per cent fall in earnings, and might also qualify for other benefits – these effects are also included in our simulations).

[20] There is also a fourth, mechanical effect, as any given percentage drop in market income reduces household disposable income differently in different part of the income distribution, due to the rules of the tax-benefit system. The direction of this effect depends on the effective marginal tax rate, with losses for high incomes reducing taxes proportionally more than for low incomes, but triggering lower increases in benefits.

contribution-based JSA – as also visible in Figure 2 – while in reality we would expect more people falling into means-tested benefits such as Universal Credit, income-based Job Seekers Allowance and Income Support.

Overall, the increase in expenditures and the decrease in revenues would have caused a 20% deterioration in the total net revenues, or 35 billion pounds.

[ insert Table 4 here ]

Once we consider the policy changes in Scenario 3, we see that the effects of the Covid-19 crisis become progressive, with positive changes in equivalised household incomes up to the fifth decile, and negative changes in the deciles above (Table 3).[21] The poverty rate consequently goes down from 17.4% in the baseline (Scenario 1) to 16.3%, travelling practically the same distance than in Scenario 2 (a change of 1.1 pp) but in the opposite direction.

The result that the policy response to the crisis reduces poverty is mainly driven by the increase in the means-tested Universal Credit (UC) in the lowest part of the distribution (Figure 3). Note that MISS, with their 80% baseline replacement rate, mirror the distribution of losses in market incomes (which are the same as in Scenario 2), but for the cap at £2,500 per month which introduces some progressivity (this can be seen looking at the ratio between MISS and MI which goes down in absolute terms in the highest deciles). Because (i) MISS only covers 80% of the lost salaries and profits, (ii) some employees go into unemployment rather than being furloughed, and (iii) the rules for Universal Credit have become more generous, more people are now covered by the latter scheme. Moreover, people without labour income already on UC are net gainers from the Covid-19 crisis, as they benefit from the increased generosity of the scheme without suffering from market losses.

[ insert Figure 3 here ]

Finally, Figures 4 and 5 show the socio-economic groups most affected by the Covid-19 crisis in terms of both lost market incomes, and changes to household disposable income (lost market incomes are the same in Scenarios 2 and 3, while the change in equivalised household disposable income showed refer to Scenario 3, which includes the Government rescue package).

The figures show that the most affected groups in terms of lost market income are low-skilled people and people in elementary occupations. In particular, the losses for professionals and clerks are half the size, in percentage terms, than the losses for elementary occupations, craft and trade workers. This is the combined result of (i) the distribution of earnings by industries, and (ii) the distribution of the individual employment transition probabilities within industries. The working of the tax-benefit system reduces the losses, and eliminates most differences between groups. The gender, age, household type and country of origin gradients are less pronounced, while with the exception of Northern Ireland (marginally less affected) there are no regional differences. Changes in after tax and benefits equivalised incomes are positive for inactive people of working age, and for single with children. These groups include many individuals with no market incomes and already on Universal Credit, who as noted above are net beneficiaries from the increased generosity of the system.

[21] While inequality is reduced, changes in the Gini coefficients are too small to be noticeable.

[ insert Figure 4 here ]

[ insert Figure 5 here ]

The lifeline that the Government has given to the economy obviously comes at a high cost for the budget, with the rescue package expected to cause an extra deficit of 26 billion pounds in 2020 with respect to Scenario 2 (Table 4, last column), bringing the overall reduction in total net revenues for the government due to the pandemic to over £60 billion (-35%). This is mostly due to MISS, with an expected direct cost of 36 billion pounds (£33 billion in income support plus £3 billion in employer social insurance contributions paid by the Government), partly offset by an increase in taxes and employee social insurance contributions (+11 billions).

In Scenario 3 fewer people go on unemployment benefits with respect to Scenario 2, with a consequent reduction in expenditure from 6 billion to just over 1 billion. This expenditure however is replaced by an increased expenditure for Universal Credits, which are now more generous (+£5 billion).

To be noted, this relatively minor component of the rescue package (£5 billion out of £25 billion, or 20%) does the bulk of the work in reverting the distributional consequences of the crisis. This is not surprising, as Universal Credits are a highly targeted measure.[22]

## 6. Conclusions

In this paper we have provided an assessment of the distributional and budgetary impact of the Covid-19 crisis and associated policy responses, in the UK. Due to lack of timely data on the employment effects of the crisis, we have nowcasted the market income shocks by means of a dynamic IO model calibrated to the 2016 IO tables and parameterised with the results of a consensus analysis of over 250 UK-based economists to predict macro effects by industry, and a probabilistic model estimated on LFS data to predict employment-to-non-employment transitions within industry. Our macro results point to a reduction in GDP/employment of almost 25% in the lock-down equilibrium, with demand-side constraints accounting for 75% of this effect and supply-side constraints for the remaining 25%. These macro effects are in line with most of the expectations and preliminary estimates available for advanced economies, which roughly point to a 2% yearly GDP loss per month of full lock-down. Having distributed this macro shock between industries, and within industries to each individual worker, we have used the UKMOD tax-benefit model to analyse the distributional and budgetary impact of the crisis, distinguishing between the impact of the shock *per se*, as cushioned by the tax-benefit system in its pre-Covid configuration, and the impact of the emergency measures put in place during the crisis. We have shown that the extra intervention has contained the reduction in the average household disposable income from -3% to -1%. More importantly, we predict that the rescue package has reverted the distributional impact of the pandemic, *reducing* poverty by more than 1 percentage point with respect to the pre-Covid situation. This is mostly due the increased role of Universal Credit, which however accounts only for 20% of the total cost of the emergency rescue package (£26 billion).

A few considerations need to be made here.

First, in this study we examine the income effects of the crisis, and we do not say anything with respect to the increased health inequalities that have been documented elsewhere (e.g. Bibby et al., 2020; Coronini-Cronberg et al., 2020) – nor with respect to how health inequalities interact with income inequality (Baker, 2019).

[22] The positive role of Universal Credit in the crisis is also noted in Brewer and Handscomb (2020).

Second, it is perhaps not surprising that at a time of a national emergency the country comes together and implements steps that reduce inequality, especially given that those more at risk from a health perspective come from more disadvantaged socio-economic group.[23] This is often seen in wars, for instance (Obinger et al., 2018).

Third, 80% of the emergency package goes to policy measures – the Job Retention Scheme and the Self-Employment Income Support Scheme – that are regressive for the lowest deciles and only mildly progressive at the top of the income distribution, while the bulk of the redistribution is operated by the increased generosity of Universal Credit, that accounts only for 20% of the rescue package. This does not mean that these Market Income Support Schemes are a bad use of public money, as they are explicitly motivated by a desire to maintain as much as possible the pre-Covid status quo. Indeed, in their absence the shock to disposable incomes would have caused significant distributional consequences, with workers in some sectors affected much more than in others, and an overall increase in poverty. Moreover, the Market Income Support Schemes might serve other purposes, for instance help the economy bounce back to the previous equilibrium quicker.

Forth, and related, the issue of whether the Job Retention Scheme and the Self-employment Income Support Scheme will be maintained in place throughout the crisis is crucial. This is particularly true for some sectors, (e.g. hospitality and the travel industry) where the shock has been greater.

Finally, the overall cost of the crisis for the public deficit is massive – with a 35% projected decrease in total net revenues for the Government (£61 billion pounds). This raises the issue of how the increased debt will be managed in the years ahead, and in particular if the advances that have been achieved, most notably with an expansion in Universal Credit, will be maintained.

[23] Between March and April 2020, the age-standardised mortality rate of deaths involving COVID-19 in the most deprived areas of England was 55.1 deaths per 100,000 population compared with 25.3 deaths per 100,000 population in the least deprived areas, according to the ONS.

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**Table 1**: Estimated employment effects in the Baseline, High-impact and Low-impact scenarios.

| | | | Change in Employment (%) | | |
|---|---|---|---|---|---|
| | | | Baseline | High-impact | Low-impact |
| | Industry | | median | p25 | p75 |
| 1 | A | Products of agriculture, hunting and related services | -9 | -24 | -2 |
| 2 | A | Products of forestry, logging and related services | -43 | -65 | -19 |
| 3 | A | Fish and other fishing products; aquaculture products; support services to fishing | -13 | -26 | -2 |
| 4 | BDE | Mining and quarrying | -37 | -57 | -19 |
| 5 | C | Food products, beverages and tobacco products | -17 | -30 | -5 |
| 6 | C | Textiles, wearing apparel and leather products | -34 | -50 | -17 |
| 7 | C | Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials | -28 | -46 | -8 |
| 8 | C | Paper and paper products | -23 | -44 | -2 |
| 9 | C | Printing and recording services | -41 | -58 | -25 |
| 10 | C | Coke and refined petroleum products | -27 | -45 | -11 |
| 11 | C | Chemicals and chemical products | -22 | -37 | -4 |
| 12 | C | Basic pharmaceutical products and pharmaceutical preparations | -12 | -30 | -2 |
| 13 | C | Rubber and plastics products | -32 | -51 | -14 |
| 14 | C | Other non-metallic mineral products | -26 | -47 | -3 |
| 15 | C | Basic metals | -41 | -61 | -20 |
| 16 | C | Fabricated metal products, except machinery and equipment | -33 | -52 | -15 |
| 17 | C | Computer, electronic and optical products | -15 | -35 | -1 |
| 18 | C | Electrical equipment | -27 | -45 | -8 |
| 19 | C | Machinery and equipment n.e.c. | -41 | -56 | -28 |
| 20 | C | Motor vehicles, trailers and semi-trailers | -53 | -79 | -31 |
| 21 | C | Other transport equipment | -30 | -48 | -12 |
| 22 | C | Furniture; other manufactured goods | -40 | -65 | -16 |
| 23 | C | Repair and installation services of machinery and equipment | -17 | -37 | 0 |
| 24 | BDE | Electricity, gas, steam and air-conditioning | -18 | -39 | 0 |
| 25 | BDE | Natural water; water treatment and supply services | -16 | -34 | -1 |
| 26 | BDE | Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services | -16 | -35 | -2 |
| 27 | F | Constructions and construction works | -21 | -42 | 0 |
| 28 | G | Wholesale and retail trade and repair services of motor vehicles and motorcycles | -44 | -72 | -23 |
| 29 | G | Wholesale trade services, except of motor vehicles and motorcycles | -13 | -34 | -1 |
| 30 | G | Retail trade services, except of motor vehicles and motorcycles | -22 | -43 | -9 |
| 31 | H | Land transport services and transport services via pipelines | -34 | -59 | -12 |
| 32 | H | Water transport services | -49 | -64 | -30 |
| 33 | H | Air transport services | -89 | -96 | -74 |
| 34 | H | Warehousing and support services for transportation | -39 | -60 | -23 |
| 35 | H | Postal and courier services | -10 | -22 | -4 |
| 36 | I | Accommodation and food services | -82 | -94 | -51 |
| 37 | J | Publishing services | -15 | -41 | 0 |
| 38 | J | Motion picture, video and television programme production services, sound recording and music publishing; programming and broadcasting services | -26 | -40 | -21 |
| 39 | J | Telecommunications services | -9 | -27 | -1 |
| 40 | J | Computer programming, consultancy and related services; information services | -8 | -25 | -1 |
| 41 | K | Financial services, except insurance and pension funding | -11 | -26 | -8 |
| 42 | K | Insurance, reinsurance and pension funding services, except compulsory social security | -12 | -26 | -9 |
| 43 | K | Services auxiliary to financial services and insurance services | -9 | -22 | -4 |
| 44 | L | Real estate services excluding imputed rents | -10 | -27 | 0 |
| 45 | L | Imputed rents of owner-occupied dwellings | -8 | -25 | 0 |
| 46 | M | Legal and accounting services; services of head offices; management consulting services | -13 | -28 | -6 |
| 47 | M | Architectural and engineering services; technical testing and analysis services | -24 | -40 | -18 |
| 48 | M | Scientific research and development services | -3 | -18 | 0 |
| 49 | M | Advertising and market research services | -14 | -30 | -6 |
| 50 | M | Other professional, scientific and technical services; veterinary services | -10 | -27 | -2 |
| 51 | N | Rental and leasing services | -12 | -31 | 0 |
| 52 | N | Employment services | -12 | -31 | -3 |
| 53 | N | Travel agency, tour operator and other reservation services and related services | -92 | -92 | -92 |
| 54 | N | Security and investigation services; services to buildings and landscape; office administrative, office support and other business support services | -12 | -29 | -3 |
| 55 | O | Public administration and defence services; compulsory social security services | -14 | -32 | -2 |
| 56 | P | Education services | -15 | -35 | -7 |
| 57 | Q | Human health services | -11 | -29 | -2 |
| 58 | Q | Social work services | -11 | -32 | -3 |
| 59 | RST | Creative, arts and entertainment services; library, archive, museum and other cultural services; gambling and betting services | -23 | -54 | -2 |
| 60 | RST | Sporting services and amusement and recreation services | -63 | -86 | -34 |
| 61 | RST | Services furnished by membership organisations | -10 | -33 | -4 |
| 62 | RST | Repair services of computers and personal and household goods | -20 | -42 | -16 |
| 63 | RST | Other personal services | -11 | -34 | -6 |
| 64 | RST | Services of households as employers; undifferentiated goods and services produced by households for own use | -20 | -50 | 0 |
| | | Total | **-22.3** | **-41.0** | **-9.2** |

**Table 2**: Employment transition model: Estimated coefficient (logistic regression)

| | Coef. | St.Err. | |
|---|---|---|---|
| Sex of respondent (1= male) | 0.011 | 0.039 | |
| Age in years | -0.205 | 0.008 | *** |
| Age in years squared | 0.003 | 0.000 | *** |
| % change in employment in sector | -0.096 | 0.008 | *** |
| 2014 (omitted) | 0.000 | . | |
| 2015.year | -0.010 | 0.060 | |
| 2016.year | -0.045 | 0.062 | |
| 2017.year | -0.142 | 0.063 | ** |
| 2018.year | -0.131 | 0.063 | ** |
| 2019.year | -0.135 | 0.065 | ** |
| Hours worked weekly | -0.028 | 0.002 | *** |
| Occupation: | | | |
| Managers (omitted) | 0.000 | . | |
| Professionals | 0.000 | 0.070 | |
| Technicians | -0.059 | 0.069 | |
| Clerks | 0.133 | 0.068 | * |
| Sales | -0.003 | 0.068 | |
| Trade and crafts | -0.169 | 0.092 | * |
| Plant operators | 0.189 | 0.088 | ** |
| Elementary | 0.139 | 0.072 | * |
| Public sector | -0.087 | 0.055 | |
| Marital status: | | | |
| Single (omitted) | 0.000 | . | |
| Married | -0.317 | 0.048 | *** |
| Separated | -0.481 | 0.128 | *** |
| Divorced | -0.250 | 0.073 | *** |
| Widowed | -0.308 | 0.123 | ** |
| Education level: | | | |
| Low (omitted) | 0.000 | . | |
| Medium | -0.011 | 0.049 | |
| High | 0.089 | 0.062 | |
| Tenure in months | -0.002 | 0.000 | *** |
| Industry dummies | Yes | | |
| Constant | 1.558 | 0.248 | *** |

| | | | |
|---|---|---|---|
| Mean dependent var | 0.024 | SD dependent var | 0.152 |
| Pseudo r-squared | 0.082 | Number of obs | 175,475 |
| Chi-square | 3644.319 | Prob > chi2 | 0.000 |
| Akaike crit. (AIC) | 36261.174 | Bayesian crit. (BIC) | 37137.721 |

Note: *** p<0.01, ** p<0.05, * p<0.1. Standard errors reported are clustered at individual level.
Source: Our computation on LFS two-quarter longitudinal data, April 2014 to September 2019.

**Table 3**: Distributional consequences of Covid-19

| | Scenario 1 | Scenario 2 | Δ[2-1] | Scenario 3 | Δ[3-1] |
|---|---|---|---|---|---|
| Poverty | | | | | |
| Rate | 17.4% | 18.6% | 1.2pp | 16.3% | -1.1pp |
| Fixed Poverty Line | £ 982.10 | | | | |
| Mean equivalised income | | | | | |
| Decile 1 | £ 613.02 | £ 603.33 | -2% | £ 630.20 | 3% |
| Decile 2 | £ 935.34 | £ 913.46 | -2% | £ 955.82 | 2% |
| Decile 3 | £ 1,129.70 | £ 1,106.59 | -2% | £ 1,146.46 | 1% |
| Decile 4 | £ 1,322.55 | £ 1,288.74 | -3% | £ 1,328.06 | 0% |
| Decile 5 | £ 1,529.15 | £ 1,486.79 | -3% | £ 1,524.97 | 0% |
| Decile 6 | £ 1,757.29 | £ 1,694.99 | -4% | £ 1,739.52 | -1% |
| Decile 7 | £ 2,025.91 | £ 1,955.69 | -3% | £ 2,000.07 | -1% |
| Decile 8 | £ 2,359.14 | £ 2,273.16 | -4% | £ 2,327.18 | -1% |
| Decile 9 | £ 2,859.04 | £ 2,752.04 | -4% | £ 2,807.83 | -2% |
| Decile 10 | £ 4,554.44 | £ 4,394.29 | -4% | £ 4,451.20 | -2% |
| All | £ 1,908.28 | £ 1,846.64 | -3% | £ 1,890.86 | -1% |

Notes: Income figures are monthly averages over the year. Scenario 1 is our baseline and considers "pre-Covid" employment and policies. Scenario 2 is a counterfactual exercise that considers "post-Covid employment, pre-Covid policies". Scenario 3 is our estimate of the real effect of the Covid-19 crisis, with "post-Covid employment, post-Covid policies".
Source: Our computation based on UKMOD A1.5+.

**Table 4**: Budgetary consequences of Covid-19 (yearly, million £)

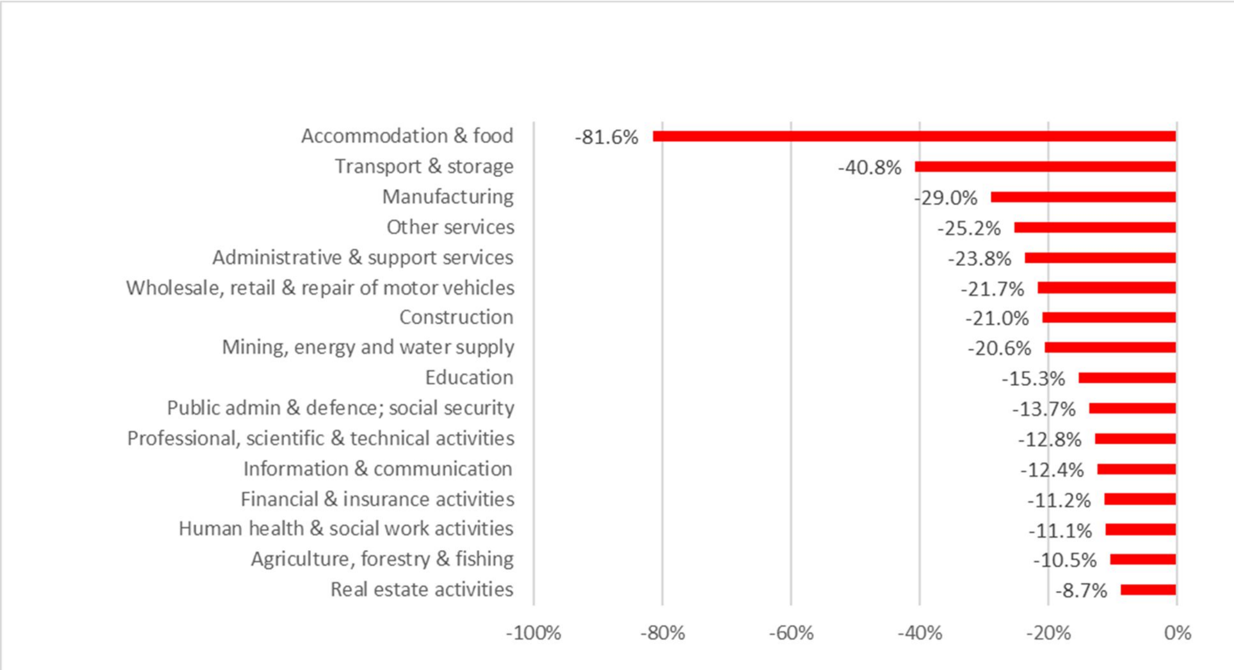
| | Scenario 1 | Scenario 2 | Δ[2-1] | Scenario 3 | Δ[3-1] | Δ[3-2] |
|---|---|---|---|---|---|---|
| Total market incomes | £ 1,104,502 | £ 1,044,386 | -£ 60,116 | £ 1,044,386 | -£ 60,116 | £ - |
| ... income from (self) employment | £ 954,334 | £ 894,218 | -£ 60,116 | £ 894,218 | -£ 60,116 | £ - |
| ... other sources | £ 150,168 | £ 150,168 | £ 0 | £ 150,168 | £ 0 | £ - |
| | | | | | | |
| Government expenditure supporting market incomes | £ - | £ - | £ - | £ 32,939 | £ 32,939 | £ 32,939 |
| Government expenditure on social transfers | £ 205,315 | £ 211,747 | £ 6,433 | £ 212,964 | £ 7,649 | £ 1,216 |
| ... contribution-based Job Seekers Allowance | £ 164 | £ 6,188 | £ 6,024 | £ 1,265 | £ 1,101 | -£ 4,923 |
| ... WorkingTax Credit | £ 1,101 | £ 861 | -£ 240 | £ 1,469 | £ 367 | £ 608 |
| ... Family Tax Credit | £ 4,511 | £ 4,184 | -£ 327 | £ 4,674 | £ 163 | £ 489 |
| ... Universal Credit | £ 32,362 | £ 32,958 | £ 596 | £ 38,123 | £ 5,762 | £ 5,165 |
| ... other benefits | £ 75,807 | £ 76,293 | £ 486 | £ 76,424 | £ 617 | £ 131 |
| Government revenue through taxes and social insurance contributions | £ 381,473 | £ 352,832 | -£ 28,641 | £ 360,960 | -£ 20,513 | £ 8,128 |
| ... Direct taxes and (self) employee social insurance contributions | £ 301,749 | £ 279,721 | -£ 22,027 | £ 291,198 | -£ 10,551 | £ 11,477 |
| ... employer social insurance contributions (not part of disposable income) | £ 79,725 | £ 73,111 | -£ 6,614 | £ 73,111 | -£ 6,614 | £ - |
| ... employer social insurance contributions paid by Job Retention Scheme | £ - | £ - | £ - | -£ 3,349 | -£ 3,349 | -£ 3,349 |
| | | | | | | |
| Total net revenue (revenue - expenditure) | £ 176,158 | £ 141,085 | -£ 35,074 | £ 115,057 | -£ 61,102 | -£ 26,028 |

Notes: Scenario 1 is our baseline and considers "pre-Covid" employment and policies. Scenario 2 is a counterfactual exercise that considers "post-Covid employment, pre-Covid policies". Scenario 3 is our estimate of the real effect of the Covid-19 crisis, with "post-Covid employment, post-Covid policies".

Contribution-based Job Seekers Allowance is over-simulated due to lack of data in UKMOD. Claimants must have paid a minimum amount of National Insurance contributions in the two previous tax years. UKMOD does not have this information and approximates it using the number of years in work. Improving on this approximation would result in fewer unemployed individuals being entitled to this benefit and more households receiving other means-tested benefits such as Universal Credit, income-based Job Seekers Allowance and Income Support.

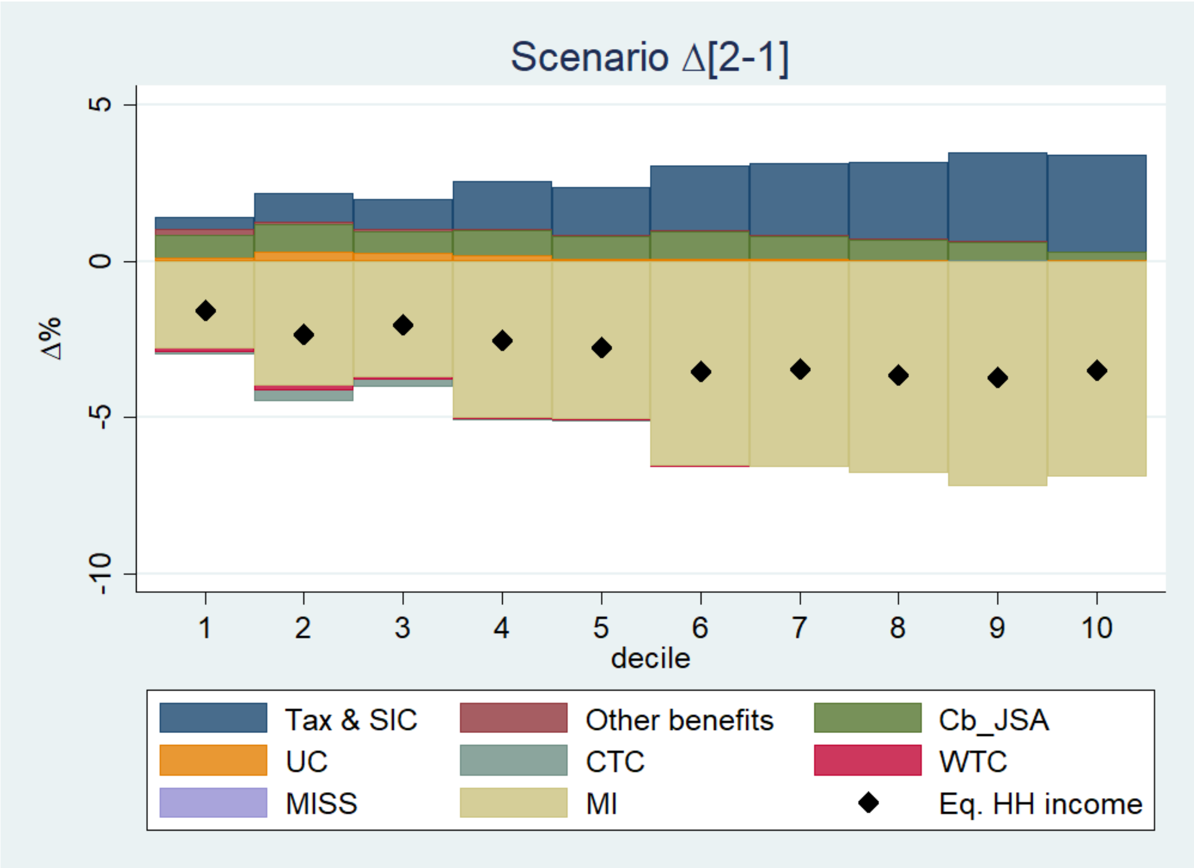
Source: Our computation based on UKMOD A1.5+.

**Figure 1**: Employment effects by macro-sectors, baseline scenario.




Source: Our computation

**Figure 2**: Decomposition of percentage change in mean equivalised income by income component, effects of income shock only (difference between Scenario 2 and Scenario 1).

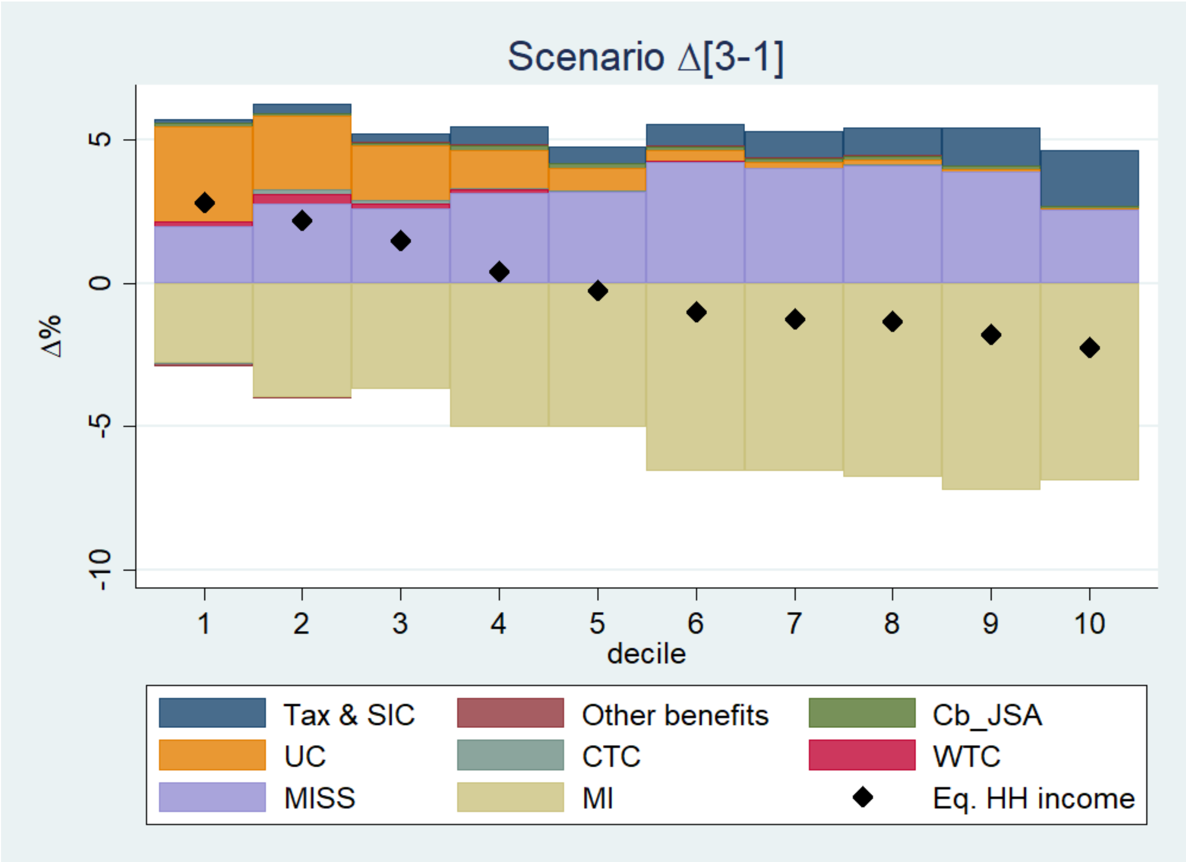



Notes: Cb_JSA = contribution-based Job Seekers Allowance, UC = Universal Credit, CTC = Child Tax Credit, WTC = Working Tax Credit, MI = Market Income, MISS = MI Support Schemes.

Scenario 1 is our baseline and considers "pre-Covid" employment and policies. Scenario 2 is a counterfactual exercise that considers "post-Covid employment, pre-Covid policies". The figure reports a decomposition of the percentage change between Scenario 2 and Scenario 1.

Source: Our computation based on UKMOD A1.5+.

**Figure 3**: Decomposition of percentage change in mean equivalised income by income component, effects of income shock and policy responses (difference between Scenario 3 and Scenario 1).



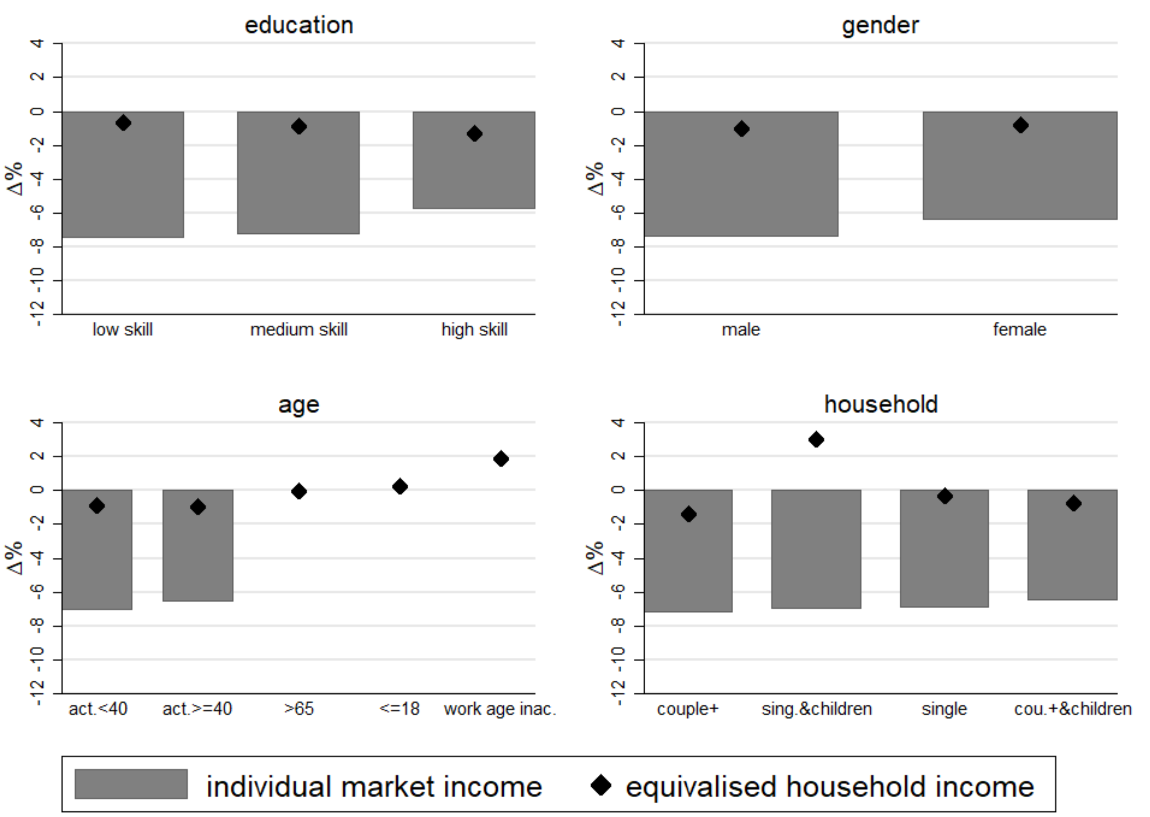

Notes: Cb_JSA = contribution-based Job Seekers Allowance, UC = Universal Credit, CTC = Child Tax Credit, WTC = Working Tax Credit, MI = Market Income, MISS = MI Support Schemes.

Employer National Insurance contributions paid by the government under the JRS are included as negative contributions (or credits) in the employer social insurance contributions category.

Scenario 1 is our baseline and considers "pre-Covid" employment and policies. Scenario 3 is our estimate of the real effect of the Covid-19 crisis, with "post-Covid employment, post-Covid policies". The figure reports a decomposition of the percentage change between Scenario 3 and Scenario 1.

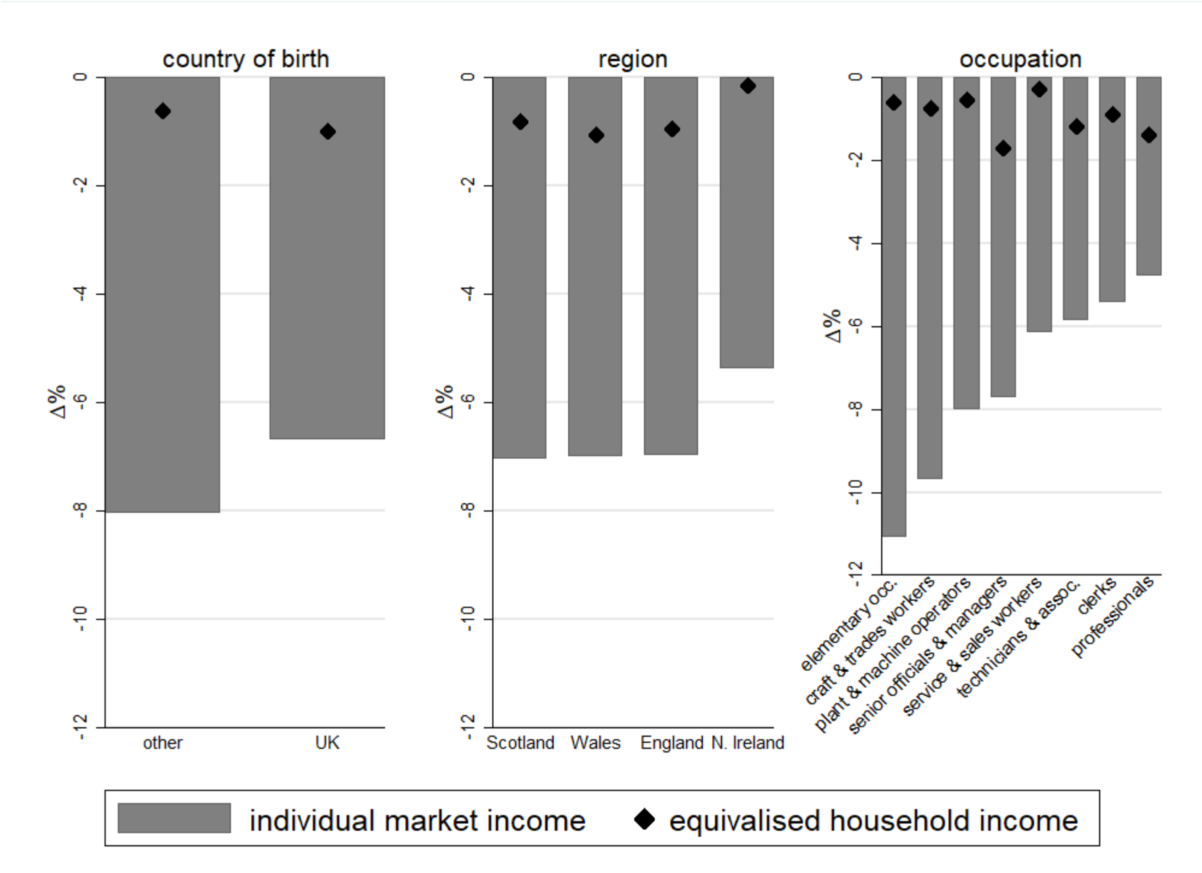
Source: Our computation based on UKMOD A1.5+.

**Figure 4**: Mean income lost by education, gender, age and household composition.




Note: To make market and household incomes more comparable, the means only include people with positive market incomes, except for inactive people in the chart by age (there are few under-18 and elderly people with market incomes, and they are excluded from the graph).
. low skill = not completed primary, primary & lower secondary education, medium skill= upper secondary & post-secondary, high skill = tertiary. act. = working age with positive market income. couple+ = couple or more adults.
Source: Our computation based on UKMOD A1.5+.

**Figure 5**: Mean income lost by country of origin, region and occupation.




Note: To make market and household incomes more comparable, the means only include people with positive market incomes. The regions of England are put together.
Source: Our computation based on UKMOD A1.5+.

## Appendix 1: Additional tables and figures

**Table A1**: Industries included in the questionnaire

| Industry | Ref | Industry | Ref |
|---|---|---|---|
| Food and beverages | F1 | Coke and refined petroleum products | X1 / Z1 |
| Electricity, water, sewage | F2 | Chemicals and chemical products | X2 / Z2 |
| Textiles, wearing apparel and leather products | F3 | Basic pharmaceutical products and pharmaceutical preparations | X3 / Z3 |
| Furniture | F4 | Other manufacturing | X4 / Z4 |
| Motor vehicles | F5 | Constructions and construction works | X5 /Z5 |
| Computer, electronic and optical products | F6 | Mining and quarrying | X6 / Z6 |
| Wholesale and retailing | F7 | Land and water transport | X7 / Z7 |
| Hotels, restaurants, pubs, etc. | F8 | Advertising | X8 / Z8 |
| Air transport | F9 | Other professional, scientific and technical services | X9 / Z9 |
| Public transport | F10 | Scientific research and development | X10 / Z10 |
| Telecommunication services | F11 | Public administration | X11 / Z11 |
| Postal and courier services | F12 | | |
| Financial, insurance and legal services | F13 | | |
| Rents | F14 | | |
| Other real estate services | F15 | | |
| Compulsory education | F16 | | |
| Non-compulsory education | F17 | | |
| Public health services | F18 | | |
| Private health services | F19 | | |
| Services of households as employers | F20 | | |
| Arts and culture (both live and digital) | F21 | | |
| Sports | F22 | | |
| Other services | F23 | | |

Note: Industries in the left column were considered for final household demand, with values of the responses being referred to as F1-F23; industries in the right column were considered for exports and supply of intermediate goods and services, with values of the responses being referred to as X1-X11 and Z1-Z11 respectively.

**Table A2**: Mapping from results of the consensus analysis to parameters used for the macro model.

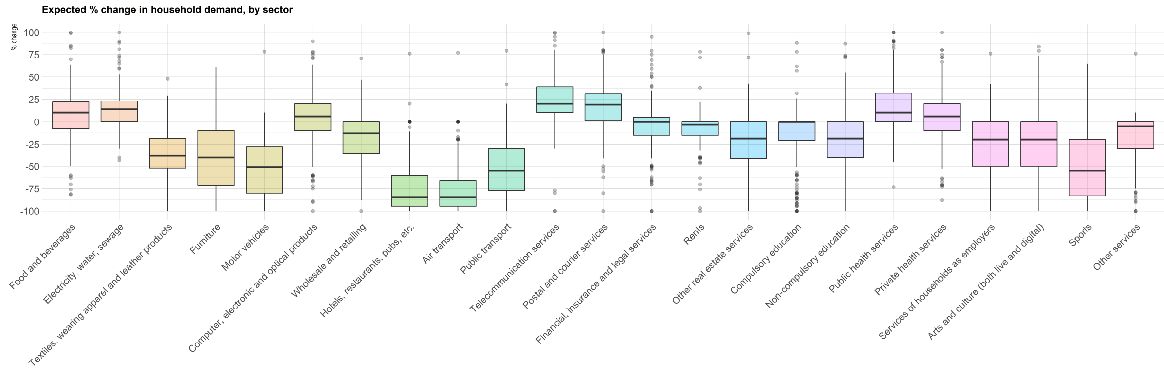
| | Industry | | Direct Multiplier of Lockdown on Final Consumption (Exports ecluded) | Direct Multiplier of Lockdown on Exports | Direct Multiplier of Lockdown on Supply of Intermediate Inputs |
|---|---|---|---|---|---|
| 1 | A | Products of agriculture, hunting and related services | F1 | F1 | F1 |
| 2 | A | Products of forestry, logging and related services | Z4 | X4 | Z4 |
| 3 | A | Fish and other fishing products; aquaculture products; support services to fishing | F1 | F1 | F1 |
| 4 | BDE | Mining and quarrying | Z6 | X6 | Z6 |
| 5 | C | Food products, beverages and tobacco products | F1 | F1 | F1 |
| 6 | C | Textiles, wearing apparel and leather products | F3 | X4 | Z4 |
| 7 | C | Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials | Z4 | X4 | Z4 |
| 8 | C | Paper and paper products | Z4 | X4 | Z4 |
| 9 | C | Printing and recording services | Z4 | X4 | Z4 |
| 10 | C | Coke and refined petroleum products | Z1 | X1 | Z1 |
| 11 | C | Chemicals and chemical products | Z2 | X2 | Z2 |
| 12 | C | Basic pharmaceutical products and pharmaceutical preparations | Z3 | X3 | Z3 |
| 13 | C | Rubber and plastics products | Z4 | X4 | Z4 |
| 14 | C | Other non-metallic mineral products | Z4 | X4 | Z4 |
| 15 | C | Basic metals | Z4 | X4 | Z4 |
| 16 | C | Fabricated metal products, except machinery and equipment | Z4 | X4 | Z4 |
| 17 | C | Computer, electronic and optical products | F6 | F6 | Z4 |
| 18 | C | Electrical equipment | Z4 | X4 | Z4 |
| 19 | C | Machinery and equipment n.e.c. | Z4 | X4 | Z4 |
| 20 | C | Motor vehicles, trailers and semi-trailers | F5 | F5 | Z4 |
| 21 | C | Other transport equipment | Z4 | Z4 | Z4 |
| 22 | C | Furniture; other manufactured goods | F4 | F4 | Z4 |
| 23 | C | Repair and installation services of machinery and equipment | Z4 | X4 | Z4 |
| 24 | BDE | Electricity, gas, steam and air-conditioning | F2 | X6 | Z6 |
| 25 | BDE | Natural water; water treatment and supply services | F2 | X6 | Z6 |
| 26 | BDE | Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services | F2 | Z4 | Z4 |
| 27 | F | Constructions and construction works | Z5 | X5 | Z5 |
| 28 | G | Wholesale and retail trade and repair services of motor vehicles and motorcycles | F5 | F7 | F7 |
| 29 | G | Wholesale trade services, except of motor vehicles and motorcycles | F7 | F7 | F7 |
| 30 | G | Retail trade services, except of motor vehicles and motorcycles | F7 | F7 | F7 |
| 31 | H | Land transport services and transport services via pipelines | F10 | X7 | Z7 |
| 32 | H | Water transport services | F9 | X7 | Z7 |
| 33 | H | Air transport services | F9 | F9 | F9 |
| 34 | H | Warehousing and support services for transportation | Z7 | X7 | Z7 |
| 35 | H | Postal and courier services | F12 | F12 | F12 |
| 36 | I | Accommodation and food services | F8 | F8 | F8 |
| 37 | J | Publishing services | F21 | X9 | Z9 |
| 38 | J | Motion picture, video and television programme production services, sound recording and music publishing; programming and broadcasting services | Z9 | X9 | Z9 |
| 39 | J | Telecommunications services | F11 | F11 | F11 |
| 40 | J | Computer programming, consultancy and related services; information services | Z9 | X9 | Z9 |
| 41 | K | Financial services, except insurance and pension funding | F13 | F13 | F13 |
| 42 | K | Insurance, reinsurance and pension funding services, except compulsory social | F13 | F13 | F13 |
| 43 | K | Services auxiliary to financial services and insurance services | F13 | F13 | F13 |
| 44 | L | Real estate services excluding imputed rents | (F14+F15/2) | (F14+F15/2) | (F14+F15/2) |
| 45 | L | Imputed rents of owner-occupied dwellings | | | |
| 46 | M | Legal and accounting services; services of head offices; management consulting | F13 | F13 | F13 |
| 47 | M | Architectural and engineering services; technical testing and analysis services | F23 | X9 | Z9 |
| 48 | M | Scientific research and development services | Z10 | X10 | Z10 |
| 49 | M | Advertising and market research services | Z8 | X8 | Z8 |
| 50 | M | Other professional, scientific and technical services; veterinary services | Z9 | X9 | Z9 |
| 51 | N | Rental and leasing services | Z9 | X9 | Z9 |
| 52 | N | Employment services | Z9 | X9 | Z9 |
| 53 | N | Travel agency, tour operator and other reservation services and related services | | | |
| 54 | N | Security and investigation services; services to buildings and landscape; office administrative, office support and other business support services | Z9 | X9 | Z9 |
| 55 | O | Public administration and defence services; compulsory social security services | Z11 | X11 | Z11 |
| 56 | P | Education services | (F16+F17)/2 | (F16+F17)/2 | (F16+F17)/2 |
| 57 | Q | Human health services | (F18+F19)/2 | (F18+F19)/2 | (F18+F19)/2 |
| 58 | Q | Social work services | F23 | F23 | F23 |
| 59 | RST | Creative, arts and entertainment services; library, archive, museum and other cultural services; gambling and betting services | F21 | F21 | F21 |
| 60 | RST | Sporting services and amusement and recreation services | F22 | F22 | F22 |
| 61 | RST | Services furnished by membership organisations | F23 | F23 | F23 |
| 62 | RST | Repair services of computers and personal and household goods | F23 | F23 | F23 |
| 63 | RST | Other personal services | F23 | F23 | F23 |
| 64 | RST | Services of households as employers; undifferentiated goods and services produced by households for own use | F20 | F20 | F20 |

Note: Values referred to as per Table A1.

**Table A3**: Employment transition model: Descriptive statistics

| Variable | mean | sd | min | max |
|---|---|---|---|---|
| Employment to Non-employment transition = 1 | 0.0237 | | 0 | 1 |
| Age | 43.19 | 12.77 | 16 | 69 |
| Sex (1 = Male) | 0.482 | | 0 | 1 |
| Single | 0.324 | | 0 | 1 |
| Married | 0.555 | | 0 | 1 |
| Separated | 0.025 | | 0 | 1 |
| Divorced | 0.082 | | 0 | 1 |
| Widowed | 0.014 | | 0 | 1 |
| Total usual hours worked in main job (incl. overtime) | 36.00 | 12.73 | 0 | 97 |
| Months continuously employed | 109.4 | 110.2 | 0 | 696 |
| Public sector = 1 | 0.290 | | 0 | 1 |
| % change in employment in industry | 0.469 | 2.372 | -16.67 | 36.36 |

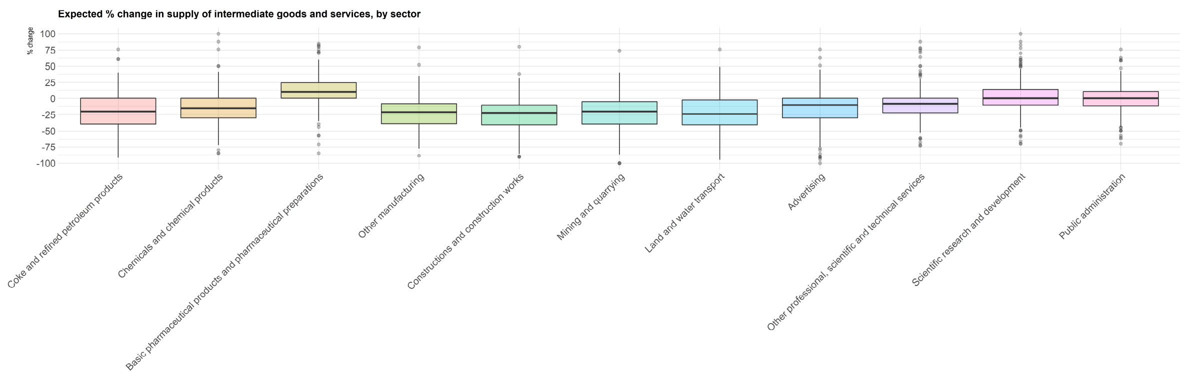
**Figure A1**: Box-plot for the expected change in household demand, by sector




Responses to the question: Please provide your estimates of the effects on final household demand for goods and services of the Covid-19 related lock-down measures implemented by the UK Government on March 23: these are due to constraints preventing consumers from physically visiting sellers.

Note: Statistics based on 257 valid responses to this question.

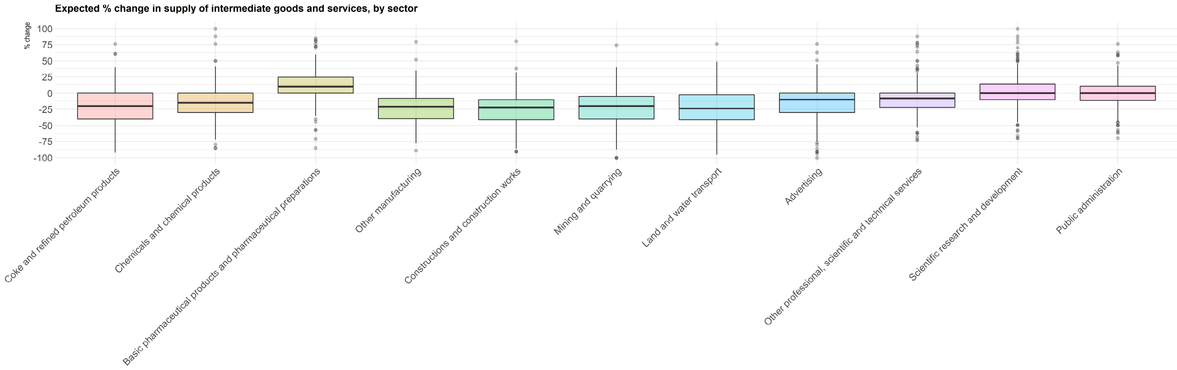
**Figure A2**: Box-plot for the expected change in supply of intermediate goods and services, by sector




Responses to the question: Please provide your estimates of the effects on the supply of intermediate goods and services to businesses of the Covid-19 related lock-down measures implemented by the UK Government on March 23: these are due to social distancing and smart working measures reducing the output of intermediate goods and services, which producers sell to other producers.

Note: Statistics based on 223 valid responses to this question.

**Figure A3**: Box-plot for the expected change in export of intermediate and final goods and services, by sector




Responses to the question: Please provide your estimates of the effects on the supply of intermediate and final goods and services of the Covid-19 related lock-down measures implemented by the UK Government on March 23: these are due to due to reduction in the demand from importers, or to difficulties to get the goods and services through the border.

Note: Statistics based on 208 valid responses to this question.

## Appendix 2: Modifications to UKMOD input data and modelling assumptions

UKMOD runs on the Family Resources Survey (FRS). This survey contains weekly information on incomes. For most analyses, incomes are simply extrapolated to months in UKMOD (and to years in our fiscal overview). Since we are simulating that the COVID-19 crisis lasts for part of the year, we modify incomes from employment (yem), self-employment (yse) and contributory-based Job Seekers Allowance (bunct_s) to obtain weighted average amounts that reflects the months during and after the crisis (while we do not modify hours of work), as detailed in Table A4.

We consider as employed (self-employed) individuals, people with positive employment (self-employment) income and whose incomes from this source are higher than those from self-employment (employment).

**Table A4**: Changes to UKMOD variables.

| Var | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|
| yem | yem | yem*(8/12) | MISS=1 → as in Scenario 2 + min(0.8*yem,2500)*(4/12) |
| | | | MISS=0 → as in Scenario 2 |
| yse | yse | yse*(8/12) + new_emp*yse*(4/12) | as in Scenario 2 + min(0.8*(yse-new_emp*yse), 2500) *(4/12) |
| bunct_s | 0 | bunct_s *(4/12) [this & yem removed from disregard] | MISS=1 → 0 |
| | | | MISS=0 → bunct_s *(4/12) [as in Scenario 2] |
| lhw | lhw | (not modified) | (not modified) |

*Job Retention Scheme (JRS)*

JRS is a grant that covers 80% of usual monthly wage costs, up to £2,500 a month, plus the associated Employer National Insurance contributions and pension contributions (up to the level of the minimum automatic enrolment employer pension contribution). UKMOD does not simulate employer pension contributions; therefore, we do not assess their impact of revenue changes. Employees pay the taxes they normally pay, which includes automatic pension contributions, unless the employee has opted out or stopped saving into their pension. We do not have information on the latter, and therefore assume they continue to pay pension contributions. Employer National Insurance contributions are paid by the government instead of the employers under the JRS. Accordingly, for the fiscal overview we made those contributions negative.

| | |
|---|---|
| yem = yem*(8/12) + min(0.8*yem,2500)*(4/12) | (A1) |

*Self-Employment Income Support Scheme (SEISS)*

SEISS is taxable grant of 80% of average monthly trading profits, paid out in a single instalment covering 3 months, and capped at £7,500 altogether. UKMOD uses the FRS variable on gross earnings from self-employed Opt 2 (yse). SEISS is subject to Income Tax and self-employed National Insurance. The pseudo-code for the implementation of this policy is:

| | |
|---|---|
| yse = yse*(8/12) + income_reduction_coeff*yse*(4/12) + min(0.8*(yse - income_reduction_coeff *yse),2500)*(4/12) | (A2) |

*Contribution-based Job Seekers Allowance (Cb-JSA)*

UKMOD includes a Labour Market Adjustment (LMA) add-on to transition people across employment statuses. When transitioning people to unemployment during the crisis, we modify income from employment (in the LMA add-on) and contribution-based Job Seekers Allowance (in UKMOD) as in Table A4. In addition, for those transitioning we remove income from employment from the base for disregards in UKMOD (otherwise the income earned after the crisis would be part of this base). Furthermore, for the (very few) people considered as employed that also have some self-employment incomes, the latter incomes are maintained (and not put to 0 as by the default in the LMA add-on).