UNIVERSITY of STRATHCLYDE
FRASER OF ALLANDER INSTITUTE

The sectoral economic impacts of COVID-19 on the tourism economy: a regional analysis focused on Scotland

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Authors: *Grant Allan, Kevin Connolly, Gioele Figus, Aditya Maurya and Jack Williamson*

Executive summary

- This report summarises the project “The sectoral economic impacts of COVID-19 on the tourism economy: a regional analysis focused on Scotland”, funded by the Economic and Social Research Council.
- The project was undertaken by a research team comprising of researchers from the Fraser of Allander Institute and Department of Economics at the University of Strathclyde.
- The project adopted an economic modelling approach which used a (pre-pandemic) baseline of spending by different categories of tourists in Scotland and measures of changes in tourism demand in Scotland in 2021 and 2022. These were then used as inputs to an economic model which was used to estimate the consequences of COVID-19 for the tourism industry, as well as the propagation of impacts across the wider Scottish economy.
- Results were presented to key stakeholder groups during the duration of the project and sought to contribute the evidence base for decisions around policy choices during COVID-19 and in the recovery of the tourism sector post-COVID-19.
- Main findings from the project are discussed in an academic paper and six blog posts summarised at the end of this report.
- In this final report we summarise the projects activities, including:
    - The construction of a baseline of pre-pandemic tourism spending identifying categories of tourism spending, months of the year and at a sub-national level for Scotland;
    - The development of a computable general equilibrium (CGE) model of Scotland which we were able to use to explore the impacts of COVID-related changes in tourism activities;
    - Our simulation approach to modelling the impacts of COVID-19;
    - Results from our analysis across different scenarios for 2021 and 2022.
- Through the project we have identified some areas where it could be possible to significantly improve our understanding of the economic contribution of tourism in Scotland in particular and to regional economies in general. We summarise these in this report under two headings: first, our reflections on the value of economic modelling for tourism analysis and, second, some areas where the data that is used to understand the tourism industry and its wider impacts on the economy could be improved.

Acknowledgements

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Contents

1. Introduction

The COVID-19 pandemic led to an immediate and major disruption for the tourism industry globally. Immediately from early 2020 onwards, sudden rapid non-pharmaceutical interventions (NPIs) were introduced to restrict person-to-person interaction and lower transmission of the highly contagious virus. The impacts of COVID-19-related interventions across multiple areas of public policy including education, healthcare, public finances, mental health and technology are going to be widely studied for years to come. These presented fundamental challenges for the normal way of life for billions, with a range of policies including stay-at-home orders, closure of travel options, restrictions on movement introduced over a matter of months. Such policies directly impacted on the tourism industry, which was "stopped overnight" in Spring of 2020, and have led to economic disruption of the industry on a scale not seen previously. Over the course of the last two and a half years, the changes in the tourism industry have had a significant economic impact, affecting regions and nations across the world.

This project report contains the summary of a project titled, "The sectoral economic impacts of COVID-19 on the tourism economy: a regional analysis focused on Scotland", funded by the Economic and Social Research Council (ESRC). The work, which ran from March 2021 until August 2022, was undertaken by a research team from the Fraser of Allander Institute and Department of Economics of the University of Strathclyde.

The objectives of the project were to provide economic analysis of the impact of the changes during COVID-19 on the tourism industry in Scotland. The project made use of a computable general equilibrium economic (CGE) modelling framework to consider the potential impact of changes in tourism activity for the industry and for the whole Scottish economy, as well as the sub-regions of Scotland.

The rationale for using a CGE framework was two-fold. First, these frameworks are widely adopted to explore the impact of demand and supply disturbances and isolate the impact on the whole economy of changes in tourism industry. Second, these models naturally consider many sectors, and so can explore the factors which affect the propagation of a shock to one industry or sector to the rest of the economy. Third, the FAI had developed CGE models for Scotland, so that with some appropriate updates, a model would be available for rapid use to meet the initial activities of the project and so contribute immediately to the need for economic analysis of the impacts of changes on the tourism industry and wider economy through COVID-19.

The project developed quantitative scenarios for tourism through COVID and worked with project partners in VisitScotland to produce and deliver research to stakeholder audiences. The activities of the project have been reported on and published through a number of channels, including series of blogs – published through the project website[1] – in addition to presentations to industry and stakeholder organisations, plus presentations to academic audiences and preparation of academic papers.

The rest of the report is structured as follows. Section 2 sets out the economic details of tourism in Scotland, taking data up until the end of 2019 to explore the role that the tourism industry played in the wider economy before COVID-19. We set these out across multiple dimensions, including the level and pattern of tourism spending in Scotland across tourism types, and details on the economic size and performance of the tourism sector prior to 2019, including its contribution to economic metrics such as Gross Value Added (GVA) and employment and the geographical characteristics of tourism activities in Scotland.

Section 3 sets out the features of the modelling approach which was used in the project. This includes the construction of the necessary economic datasets which drew on publicly available data and the design of simulations. We illustrate the modelling approach through the evaluation – undertaken during 2021 – of the anticipated changes in demand that year, to estimate the economic impacts of these changes. We show how our modelling approach produces impacts both at high-level scale (on aggregate figures of employment and value added) as well as sectoral results and at more local geographies.

Section 4 sets out the results of analysis looking at 2022, while Section 5 discusses some concluding points from the project and avenues for future research, which includes the usefulness of economic modelling for tourism, and the data challenges which were found during the project: both areas suggest important areas for future research to meet the needs of stakeholders across Scottish tourism.

2. Tourism in the Scottish economy pre-COVID

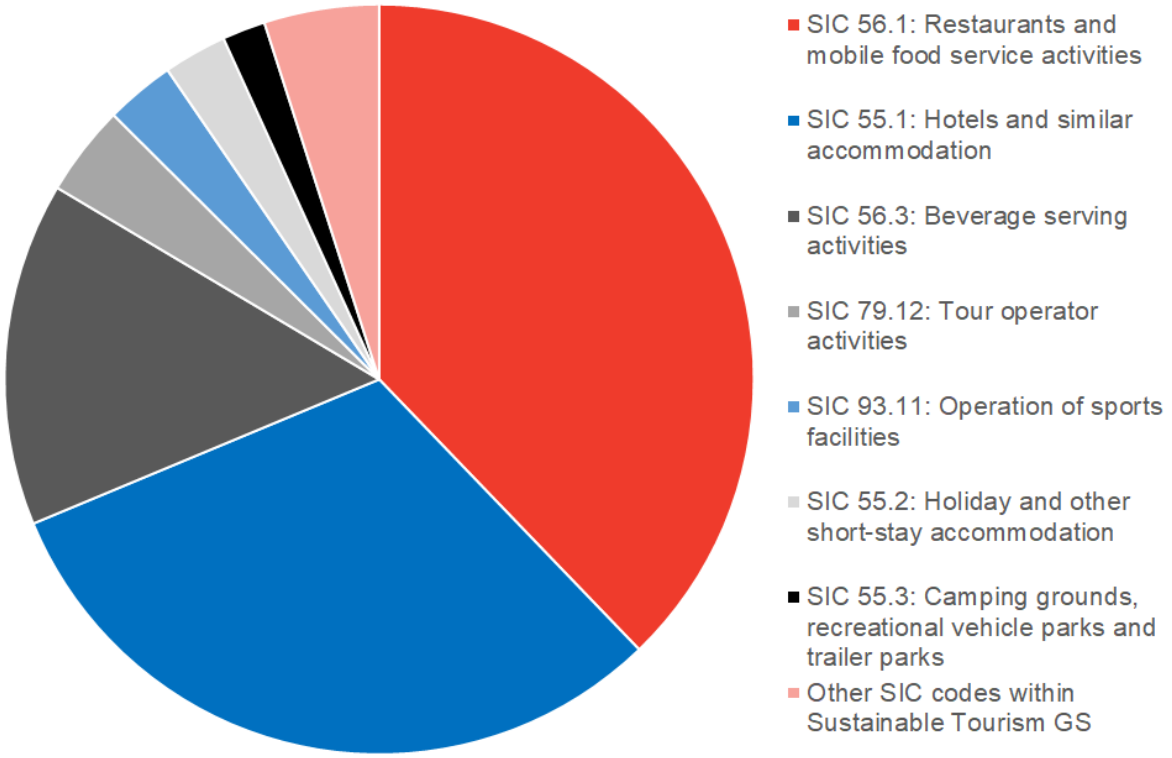
Tourism is an important economic industry for Scotland: indeed, the Scottish Governments' Economic Strategy (Scottish Government, 2015) identified tourism as a "growth sector" where Scotland has a distinct comparative advantage[2]. The statistics bear out this sector's

[1] The project website is at https://fraserofallander.org/research/economic-impacts-of-covid-on-the-tourism-economy/.
[2] "Scotland's National Strategy for Economic Transformation" was published in March 2022. We understand that the growth sector statistics will be reviewed in 2022.

economic importance. In 2019, 229,000 or around 8.8% of total Scottish employment, was in the "Sustainable Tourism" sector[3]. Between 2015 and 2019, employment in this sector grew by around 7,000.

The business base in the tourism sector in 2019 was very heterogenous, with almost 15,000 registered businesses in Scotland. The majority (50.3%) of these having fewer than 50 employees, a much larger share than for the Scottish economy as a whole (32.4%). The sector contributed around £4.5 billion to Scottish Gross Value Added in 2019, with the majority of this in three specific activities: "Hotels and similar accommodation", "Restaurants and mobile food service activities" and "Beverage serving activities" (Figure 1).

Figure 1: Contribution to Gross Value Added in Sustainable Tourism sector, 2019, £millions



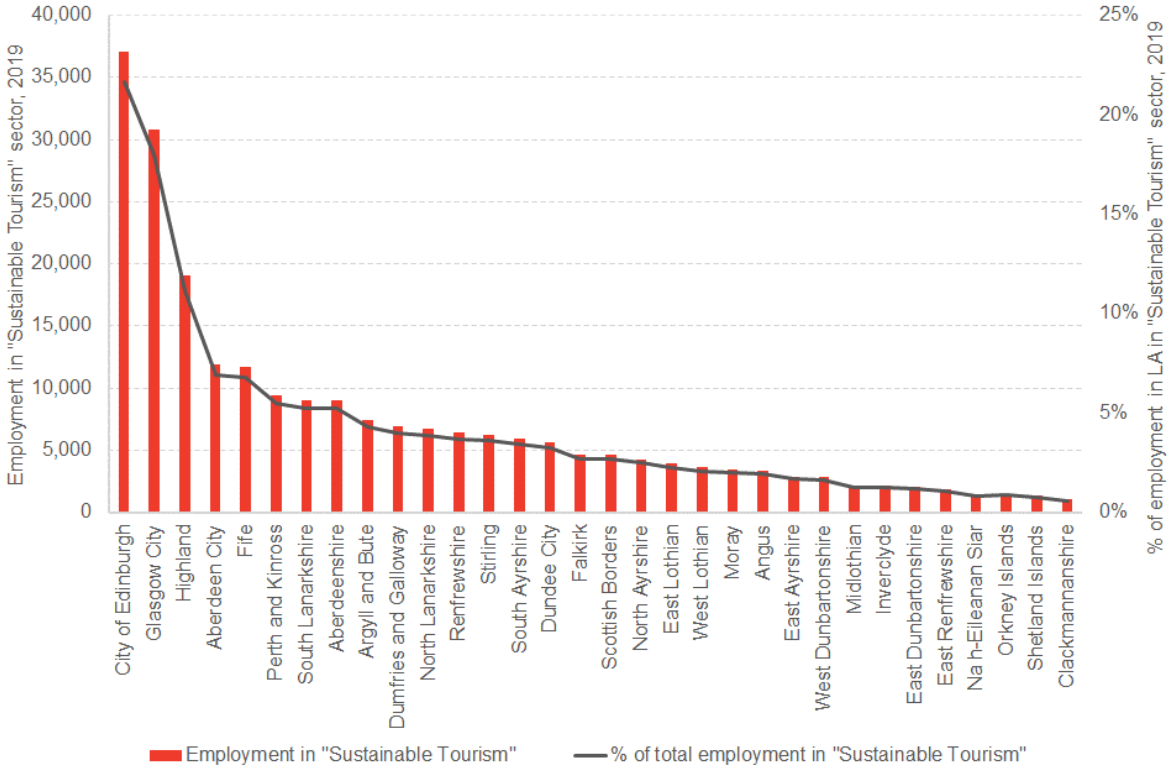
Source: *Growth Sector Statistics, Scottish Government (Table 2.2)*

While the tourism industry makes a significant portion to national economic activity, for some parts of the Scotland tourism is a critical industry. Perhaps unsurprisingly given their tourism markets, Edinburgh and Glasgow were the local authorities with the largest employment in

[3] The "Sustainable Tourism Growth Sector" includes businesses registered in the specific SIC codes 55.1, 55.2, 55.3, 56.1, 56.3, 79.12, 79.9, 91.02, 91.03, 91.04, 93.11, 93.199, 93.21 and 93.29.

Sustainable Tourism in absolute numbers in 2019 (37,040 and 30,785 respectively) (Figure 2). These were also the areas of Scotland where the tourism industry made the largest proportion of employment (21.6% and 18.0% respectively). The area with the third largest number of jobs and contribution to total employment was “Highland” with 19,060 and 11.1%, highlighting that it is not only the urban areas of Scotland where tourism activity supports employment.

Figure 2: Contribution of Sustainable Tourism to employment by Scottish local authority, 2019



Source: *Business Register and Employment Survey*

Another perspective on tourism in Scotland comes from an analysis of the spending behaviour of tourists in Scotland. Spending data comes from surveys of tourists, including the GB Day Visitors Survey, GB Tourism Survey and the International Passenger Survey (ONS). These provide information on the number of trips and spending both by place of residence and by location of spending in GB, in including in Scotland.

At the headline level, and adding together the different surveys, Table 1 breaks tourism spending in Scotland in 2019 by tourists’ place of residence and whether these were for

overnight or day trips. We see that a total of £11.64 billion was spent by tourists in Scotland in that year. Comparing the totals of the first and second columns we can see that day trip expenditure is only around £90 million lower than spending by tourists who stayed overnight. Spending during day trips is dominated by Scottish residents (77% of total spending on day trips in that year), while we can see how for overnight trips, tourists outside of the UK provided 43% of the total spending in Scotland.

Table 1: Tourist spending in Scotland by place of residence, 2019, £millions

		Spending in Scotland		
		Day trip	Overnight trip	Total
Place of residence	Scotland	4,455	1,422	5,877
	Rest of the UK	1,322	1,905	3,227
	Rest of the world	-	2,538	2,538
	Total	5,777	5,865	11,642

Sources: Visit Britain (2020a, 2020b) and ONS (2019) Notes: "Day trips" relate to all tourism day trips, (e.g., non-regular activities, outside the place of residence) and so differ from leisure trips. Some totals may not match those in other UK sources due to inclusion of spending which cannot be matched to place of residence in the latter publications. Any errors and omissions are the responsibility of the authors.

These spending figures identify five categories (based on the combination of either "day" or "overnight" trip spending, and by place of residence) and the levels of tourism spending in Scotland in the whole year preceding COVID-19. One of the first actions in the project was to decompose these spending levels by month of the year and by location in Scotland, so these totals are of critical importance to our understanding of the economic drivers of tourism activity in Scotland. We return to this point when we discuss "Data Issues" later in this report when we consider the timeliness and level of geography in the data.

Tourism activities have been viewed so far in this report from one of two perspectives: first, the production-, or supply-, side, i.e., what businesses by their industrial classification undertake tourism-related activities, or second, from the consumption-side, i.e. how much is spent by tourists in Scotland.

For our purposes, we wish to link these two perspectives into a coherent picture of what activities (from different industries) are sold to tourists (and different categories of tourism). This alternative perspective can be viewed using a set of Input Output (IO) accounts, which we are fortunate in having produced on an annual basis by the Scottish Government[4]. These

[4] These are published here: https://www.gov.scot/publications/about-supply-use-input-output-tables/

provide a snapshot of the Scottish economy for a specific period, and the interconnectedness between production (identified by different industries) and consumption (where goods produced by specific industries are consumed either as inputs to production, or in final consumption).

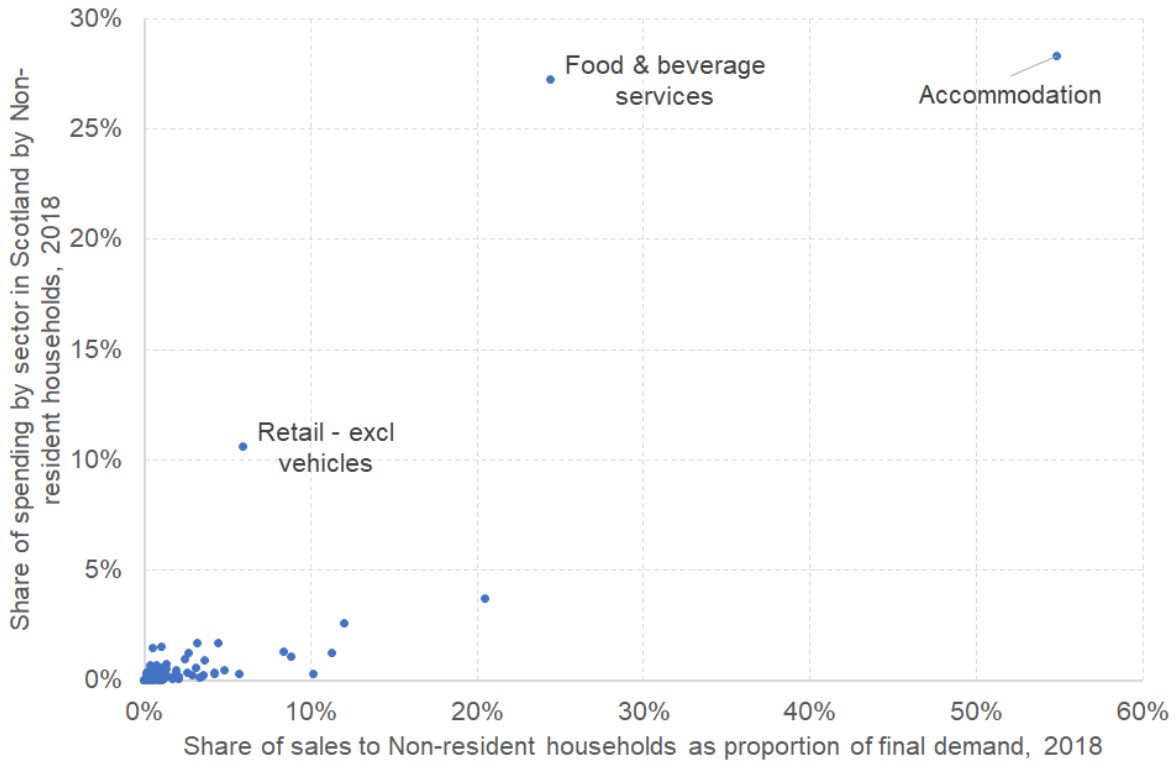
From the perspective of IO accounts, we can identify some overlaps between the two alternatives described earlier. We can for instance see how much of the output of specific industries in the IO tables are sold to non-Scottish residents, while we can also identify those sectors where non-Scottish residents spend (and which might not be in sectors included in a supply-side definition).

For the most recent IO tables for Scotland (2018) we can identify these points in

Figure 3. Along the horizontal axis, we plot what portion of the final demand of each sector goes to non-resident households. We can see that this is a significant portion of the sales for a small number of sectors, for “Accommodation” (54.8%) but also is important for “Food and Beverage Services” (24.4%). The vertical axis in this chart shows the proportion of non-resident households spending in Scotland which is made to each sector. We can see for instance that both these sectors are also important recipients of spending by non-resident households (with 28.3% and 27.2% of the money spent by non-resident households is in these sectors respectively). However, the retail sector is also important, receiving more than 10% of non-resident households spending, despite it not being included within a definition of a tourism industry[5].

[5] A sector’s total sales to tourists will not include sales to Scottish residents consuming as tourists, which are not separately included in the IO table. The share for non-residents will therefore understate the true importance of tourism demand for a sectors output.

Figure 3: Non-resident spending by sector and importance of non-resident spending for each sector, 2018



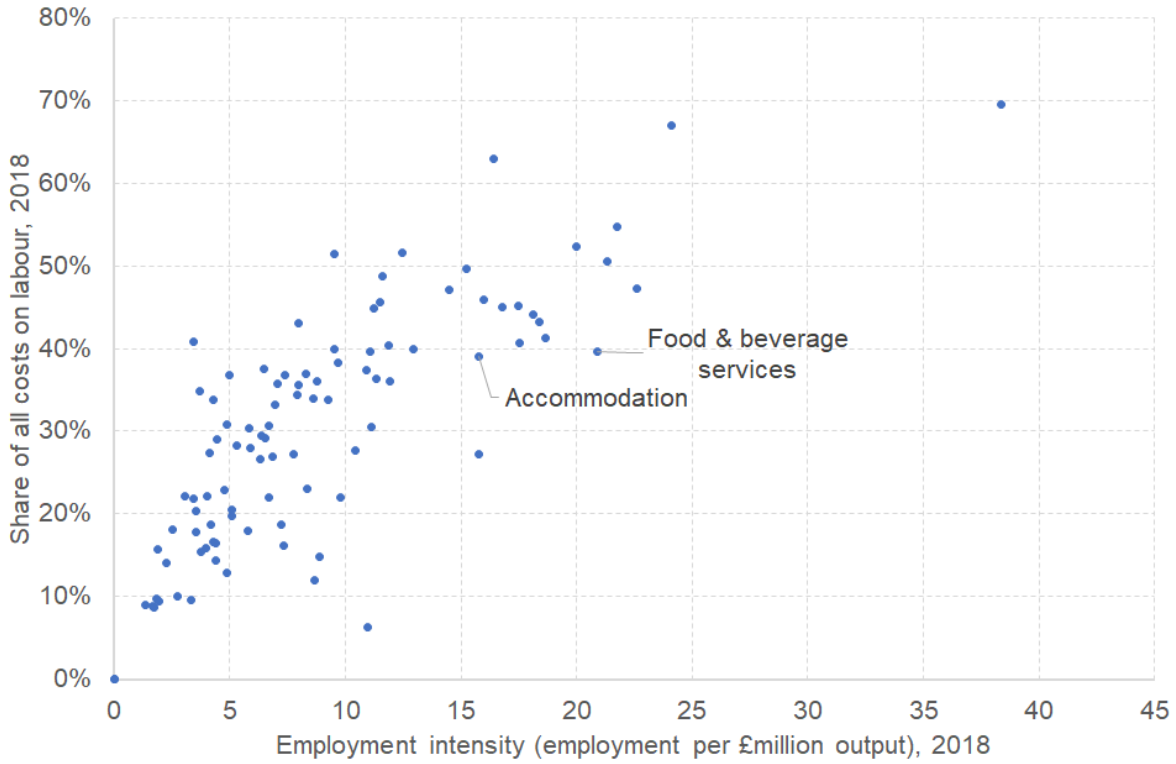
Source: Input Output Tables and Multipliers for Scotland, 2018, Industry-by-Industry table

From the IO accounts we can also note not only the level of employment by industry but also the employment intensity of sectors (i.e., the number of jobs per £millions of output) and also the proportion of total sectoral costs which are for cost of labour inputs (i.e., wages and other labour costs).

Both measures are shown in

Figure 4 below on the horizontal and vertical axis respectively. We can see that the important industrial sectors for tourism, “Accommodation” and “Food and beverage services”, have among the highest values on both counts, being labour intensive (15.8 and 20.9 jobs per £million respectively) and also amongst the sectors where labour costs make around 40% of all input costs for the sector.

Figure 4: Employment intensity and labour intensity of industrial sectors, 2018



Source: *Input Output Tables and Multipliers for Scotland, 2018, Industry by Industry table and own calculations*

We will describe later how we use the IO accounts for Scotland for the modelling work of this project. In simple terms, the IO accounts provide us with lots of detail on the interconnectedness within sectors of the economy and the relationship between production and consumption. The data contained within them is perfect for using as a major input to a Computable General Equilibrium (CGE) model of Scotland. Through simulation of economic disturbances, the propagation of these through the rest of the economy requires information on how sectors are interconnected, and this information largely comes from the IO accounts.

3. Modelling the impacts economics of changes in tourism during COVID

3.1 Our approach

The project uses quantitative changes in tourism in Scotland and an economic modelling framework to analyse the effects of these on the whole Scottish economy. Here we introduce the modelling approach – specifically, Computable General Equilibrium (CGE) modelling.

Economic models are used to help us better understand how the world works. They simplify the myriad of complex economic interactions in the real world down into their key elements which are crucial to understand a particular issue.

A CGE model is a large-scale economic framework that captures interactions between industries and consumers in an economy. It represents the production structure of industries, including the supply chain of produced inputs (both domestic and imported), the use of labour (i.e., staff) and capital inputs (i.e., machines, computers etc). It details how outputs produced by industries are sold to other industries, households, government, non-residents and exports.

The CGE model for Scotland that we will use in this project is calibrated using the Input-Output accounts published by the Scottish Government. These two points – detail on the connectedness between specific activities of the economy – including tourism – and details on the sectors that sell to non-residents, give a perfect framework in which to examine the economic role of tourism from both a production and consumption perspectives.

The model allows us to perform “what if” scenarios, and to compare the state of the economy with and without a shock, or a set of shocks. Following a disturbance, the model will capture the reaction of economic agents to changes in prices and income. As it encompasses the entire economic system – production, consumption, and prices, as well as product(s) and the labour market, the model will “translate” shocks, which might be targeted on one individual element, to the whole economy to show the total consequences of the disturbance.

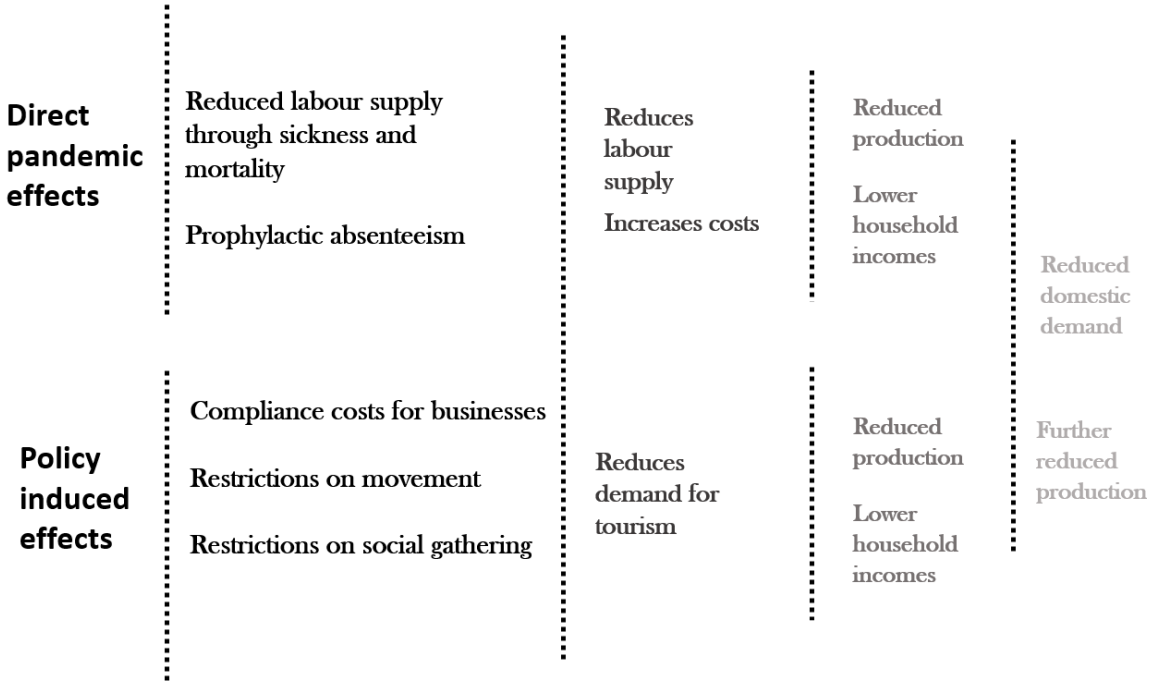
3.2 The mechanisms between COVID-19, and macroeconomic, and sectoral impacts

In principle, CGE models can capture the impact of any demand and supply side shocks and the propagation of these on different industries. The propagation of the impact of the COVID-19 pandemic through the economy is complex as it affects different parts of the economy directly and indirectly.

CGE models capture direct impacts, for instance a reduction in restaurant meals purchased, as well as indirect impacts, such as reduction in purchases of agricultural products by restaurants caused by a fall in demand for meals. Furthermore, it captures induced (general equilibrium) impacts, such as reduced consumption due to lower wage income in the food and drinks and agricultural industries. In the case of COVID-19, supply and demand shocks are either a direct result of the pandemic, or caused by public health policies aimed at restricting the spread of the virus.

Figure 5 attempts to summarise the main impact channels for the tourism economy. At different times during the pandemic, these channels will be varying in their impact on the economy, for instance with the varying of restrictions on travel in response to changes in the number of cases.

Figure 5: Propagation mechanisms of COVID-19 in the economic system



Direct impacts are reported in the third column, while indirect and induced impacts are reported in the fourth and fifth columns. For instance, sickness and mortality linked to COVID-19 would be expected to lower labour supply and adds costs for firms. Similarly,

limitations of social interactions or of travel from home would reduce consumption of tourism activities. These in turn reduce production and income in the economy, particularly in tourist-facing sectors, and causing further reductions in demand.

Of course, there will be other impacts on the economy that are not considered in our analysis – such as disturbances in overseas supply chains, inflation, Brexit and other changes which impact on the macroeconomic outcomes, and will impact on the tourism industry – but by focusing on those disturbances which directly affect Scottish tourism we can isolate the critical effects for this sector and the wider Scottish economy.

3.3 A baseline model of tourism spending in Scotland

One of the first activities of the project was to construct a counterfactual baseline for the level of spending by each tourism category by month and by local authority for 2019. This was important to provide the counterfactual for the case of the no-COVID, against which "with COVID" cases could be developed. As the year immediately preceding the pandemic, this gives us the detail of the counterfactual tourism behaviour in the absence of COVID-19.

The baseline was constructed using publicly available information and consists of monthly spending in Scotland for five tourism categories: domestic (i.e., tourism spending by Scottish residents) day trips, domestic overnight, and "Inbound", specifically rest of UK day trips and rest of the UK overnight and (non-UK) international overnight, as spending by non-Scottish residents.

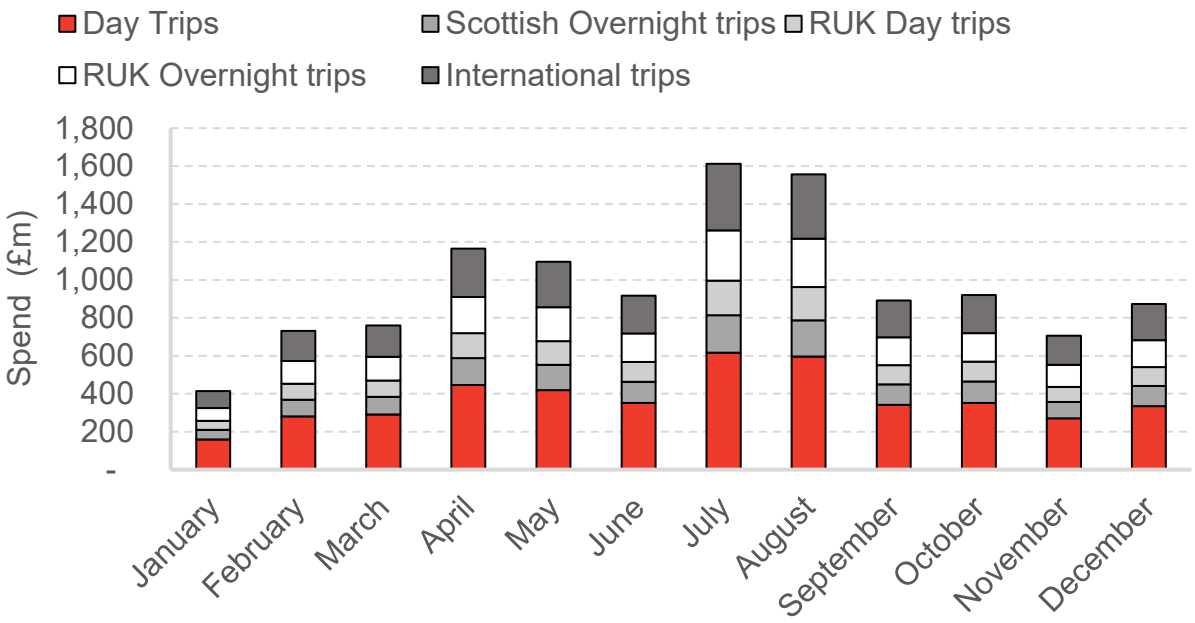
To derive the baseline counterfactual tourism expenditure in 2019 for day trips, overnight trips and international spending we use information from the Great Britain Day Visitor survey (GBDVS), Great Britain Tourism Survey (GBTS) (VisitBritain, 2020a, 2020b) and International Passenger Survey (ONS, 2020) (see Table 1). The GBDVS contains information on the geographic pattern of day trip spending across Scotland's 32 local authorities averaged over the period from 2017 to 2019.

We aggregate these to estimate total day trip spending in 2019 in Scotland by Scottish and rest of the UK residents. For the domestic and RUK baseline we use information from Table 1 and VisitBritain (2020a, 2020b). International tourism spending estimates come from the International Passenger Survey ONS (2021).

To disaggregate tourism spending categories by month, we use information contained in the GBTS (Visit Britain, 2020a). This reports monthly spending for overnight tourism but not for day and international tourism. Thus, we assume that the spending patterns for overnight also

apply to day and international.[6] Applying these adjustments, we can show our resulting pattern of spending by tourism category across the months of the year (Figure 6), from which we can see the important peaks of tourism spending in July and August, coinciding with the northern hemisphere summer.

Figure 6: Monthly breakdown of tourism spending in Scotland in 2019, £million



Source: *Author's calculations based on VisitScotland (2021) and VisitBritain (2021b)*

3.4 Our economic model

Our CGE model is based on the AMOS framework which has previously been used in a number of applications, including tourism (see for instance Allan et al., 2017). Our model considers the impact that changes in tourism demand have on economic transaction of 30 aggregated industries, households, Government and the state of the economy following a disturbance with a counterfactual baseline which in our case is a situation where COVID-19 has no impact on the economy.

The core dataset for the model is a 30-industry Social Accounting Matrix (SAM) purposely built for this project (Allan et al., 2021, 2022). The dataset is based on the most recent annual Scottish Input-Output (IO) tables available at the time of the research (2017 and

[6] This is done in absence of better information. However, should better data become available, we are able to update our estimates.

2018) which was aggregated to 30 industries. The specific 30 sectors identified in our work are given in Appendix 1.

Our aggregation retains details of different categories of tourism demand, and of those sectors supplying products to tourism consumption, at the highest level of detail possible. It identifies five tourist-facing industries, namely “Accommodation”, “Food and beverages services”, “Creative services”, “Cultural services”, and “Sports and recreation”. On the demand side, final demand in Scotland of non-residents (inbound) from the rest of the UK and rest of the World is separately identified from exports in the Scottish IO table.

Similar to previous studies (for instance Pham et al., 2021, and UNCDT, 2020), we identify two labour markets from which firms can hire employees: one for high-skilled and one for low-skilled workers, each with a pool of unemployed workers. To identify skilled and unskilled workers we follow the methodology outlined in Ross (2017) to split the Scottish IO accounts. This uses the UK Labour Force Survey[7] (ONS, 2021b) to estimate the skill level for each industry based on the highest qualifications of employees. For simplicity, any employee with a qualification at UK National Framework of Qualifications (NQF) level 3[8] or higher is classified as skilled, whereas employees with qualifications below NQF level 3 are classified as unskilled. There is labour mobility between industries for workers within the same skill level. In practical terms, this reflects that workers may find employment in roles that require similar skills level in the short term, , but they are less likely to find employment in a role requiring a higher skill level without appropriate training. Firms employ a combination of both skilled and unskilled labour but the two are considered imperfect substitutes.

Whilst typically CGE models are used for long term analysis, here we make a series of adjustments to our model, following for example Pham et al. (2021), to reflect economic conditions typical of short run shock. First, we assume that sectoral capital stocks are fixed as there is not enough time for capital stocks to accumulate or decumulate via investment (or disinvestment). However, investment responds to changes in the value of capital, and this will have an impact on capital stocks in the following years if the shock persists.

Second, we assume that nominal wages are fixed. This is because wages do not adjust rapidly enough to have a significant impact in the short term. Third, we assume that exports are initially price insensitive. Typically, a negative demand shock would put downward pressure on the demand for factors of production which would lower their price. This would

[7] We use data from 2017-2019 to increase the sample size for Scotland.
[8] National Qualifications Framework (NQF) Levels 3 and above correspond to qualifications achieved after the UK minimum mandatory education period (11 years).

in turn reduce the costs of producing goods in Scotland relative to the rest of the world. Whilst these competitiveness effects may take place, we believe that one year is too short a period for exports to respond as a result to changes in relative prices (in addition, the COVID-related fall in economic activity is not only hitting Scotland, so that prices could also be falling in other countries from the pure effects of the fall in demand). Fourth, we keep government expenditure fixed, and assume that governments do not adjust current spending instantaneously following a change (reduction) in their revenue. Scotland is a devolved UK nation with a complex fiscal system and tax/spending rebalancing mechanism (see Lisenkova et al. 2021 for details). This allows us to separate out the impact of the reduction in tourism demand and their propagation through the economy from any government stimulus programme.

4. Modelling the impact of COVID on tourism industry and wider economy in 2021 and 2022

With our baseline counterfactual for spending by tourists in Scotland established, we could now proceed to estimating the impact of the changes in tourism activity, and then using these as the input to our CGE model to calculate the impacts of the on the tourism activities and the wider economy.

We used two different approaches to estimating changes in tourism activity relative to pre-pandemic baseline. First, we developed quantitative projections for each category of tourism demand using proxies for each category, drawn from more frequently available data. These included metrics which would be associated with the level of spending by each category, which were not available on a useful timescale. We illustrate the use of this approach for the simulation of 2021[9]. The second approach, applied to 2022, used a survey to gather individual's projections for these same categories.

[9] Throughout 2021, we regularly updated the proxies with more recent information and projecting figures for the rest of that year, running the analysis and providing updated results of modelling to project partners and stakeholders. The writeup here consists of the latest data for 2021, last updated in May 2022.

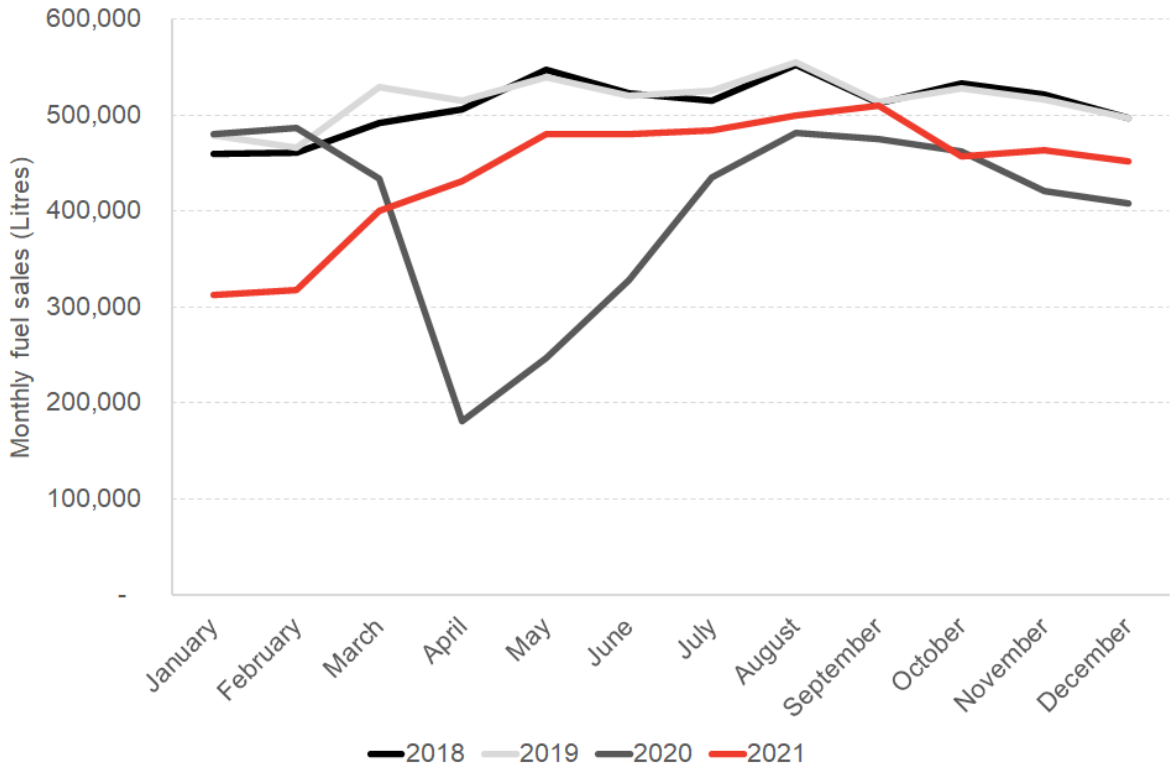
4.1 The example of 2021: Using proxies to calculate changes in tourism[10]

To model the whole-economy impact of changes in tourism through COVID in 2021, we required an estimate of how domestic and inbound tourism demand changes in 2021 relative to the pre-pandemic level. In the absence of real-time monthly tourism spending, we calculate monthly changes for tourism spending in 2021 relative to our pre-pandemic counterfactual by looking at three indexes[11], which we match to different categories of tourism spending: day trips, overnight and international. Here we set out how we calculated the changes in these indexes during 2021 relative to their pre-pandemic levels.[12]

Changes in spending in Scotland by (Scottish and Rest of the UK) day trip tourists in 2021 are estimated using monthly fuel sales in Scotland data from the UK Department for Business, Energy and Industrial Strategy (BEIS, 2021) (see Figure 7).[13] To isolate fuel used for day trip purposes, we calculate an "essential fuel use" baseline from the observed data during the lockdown period between January and March 2021. This is then subtracted from total fuel used over the rest of the year, under the assumption that the fuel used during the full lockdown represents the level of fuel consumption that persists in the absence of any other movements.[14]

[10] Sections 4.1 and 4.2 draws on material subsequently published in Allan *et al* (2022).
[11] We spent time identifying the usefulness of potential proxies for each category, settling on choosing the three reported here on the basis of the fit between the measure we were seeking to capture and the variable of interest, and the data being available on a minimum of a monthly series.
[12] This section draws upon material from an academic paper produced during the project, which is currently under review (as of 4th August 2022).
[13] As the series is published in litres we do not need to adjust for inflation, however over a longer period we would expect that changes in the efficiency of the vehicle fleet would make it necessary to adjust this metric to take account of the distance equivalent of the fuel consumption. As we are comparing the relatively short period from 2019 to 2021 we assume an unchanged vehicle fleet, so that we can use the series on fuel sales as a proxy for movement.
[14] Recall that during these months the Scottish Government issued a 'Stay at home' order, limiting all but essential travel.

Figure 7: Scottish monthly fuel sales, litres, January 2018 to December 2021



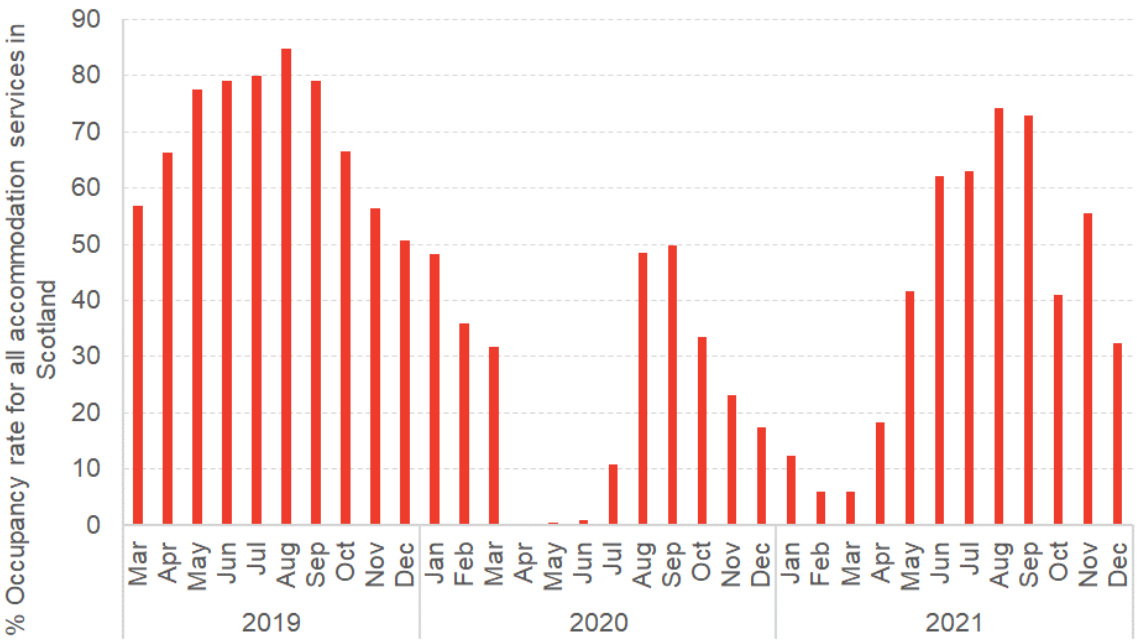
Source: *BEIS (2021)*

For changes in spending in Scotland by (Scottish and Rest of the UK) overnight tourists in 2021, we set the overnight spending between January and April to zero (i.e., a 100% reduction from 2019). From May 2021 onward, we use data from the monthly series on room occupancy in Scotland (VisitScotland, 2021) (see Figure 8).[15]

We calculate the bed occupancy ratio between comparable months in 2019 and 2021 to see changes in the level of hotel use during 2021 relative to the pre-pandemic levels by month. As we did not have data for the month of December, we take the average occupancy ratio between August and November, with an adjustment to reflect the growing incidence of the Omicron variant in the UK through this month. We adjust for the changes in pricing by multiplying the room occupancy rate by the average room rate, to get the change in spending relative to 2019.

[15] Although this is a very good proxy for spending by overnight tourists, one limitation is that it is published with a lag of approximately four months.

Figure 8: Scottish monthly room occupancy rate for all accommodation services, March 2019 to December 2021

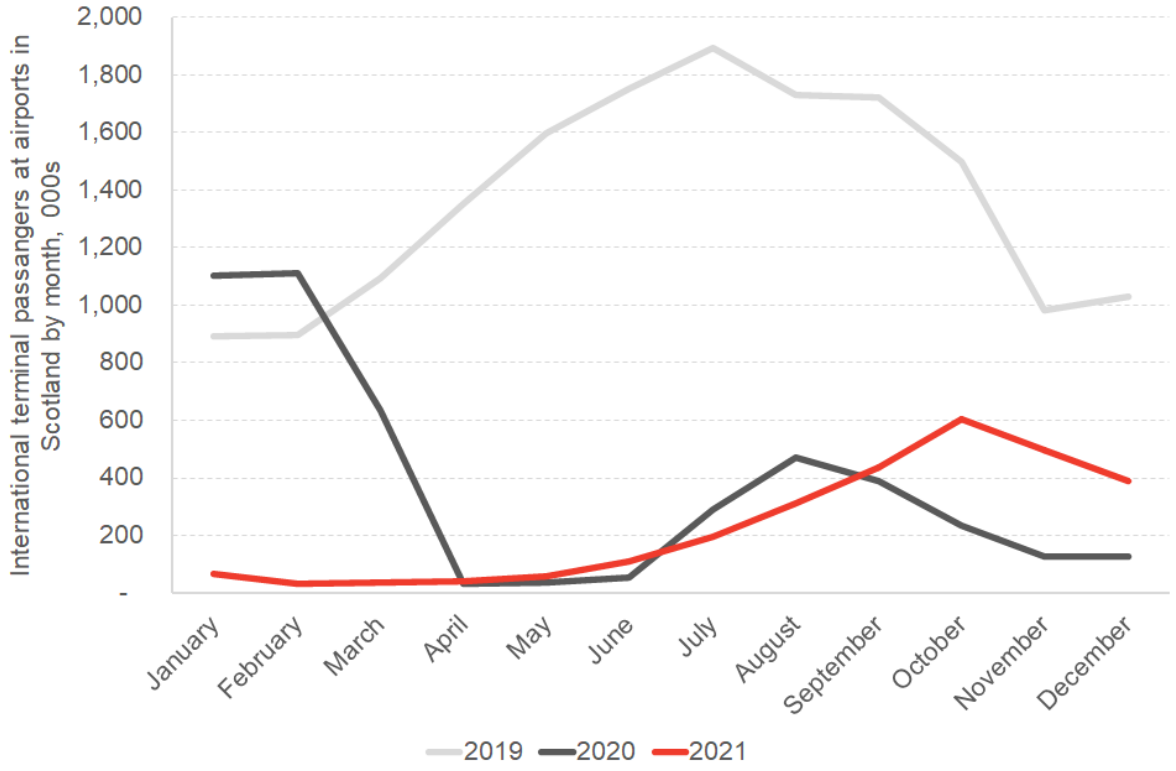


Source: *VisitScotland (2021)*

To calculate the change in spending in Scotland from international tourists in 2021, we use monthly data on international passenger numbers at Scottish airports (see Figure 9). Similar to the other two variables, we calculate an "essential travel" baseline from the data between January and April (the lockdown period) and subtract this from each monthly value for 2019 and 2021, before calculating the change in the monthly values between these two years from May 2021 onwards (when non-essential international travel could return). For instance, in August 2021 (adjusted) passenger numbers were 16% of their value in August of 2019 (an 84% reduction).

Finally, we note that our use of passenger data as a proxy for spending assumes the reduction in international spending is proportional to the reduction in passenger numbers however in the absence of information on the changing characteristics of international visitors seems appropriate. We return to the appropriateness of the indicators and the timeliness of indicators on tourism spending later in this report.

Figure 9: International terminal passengers at airports in Scotland by month, 2019 to 2021



Source: *UK Civil Aviation Authority (2022)*

Using each of these monthly series, the calculated reductions of tourism spending in Scotland by category in 2021 relative to the pre-pandemic levels for 2019 was calculated, and then summed to provide an annual change in tourism spending. The resulting changes in spending (in 2017 prices) were calculated and are reported in Table 2. This is introduced to the model through a direct shock to final demand[16] in our CGE model, which subsequently captures how this shock propagates across the Scottish economy.

[16] The total shock is distributed across sectors of the Scottish economy in proportion to the spending by each category (Scottish Government, 2021b). Spending patterns by sector (what each category of tourist purchases from Scottish industries) depend on the type of tourist category, for example day trip tourists will not spend money on "Accommodation". The simultaneous reduction in domestic and inbound tourism demand constitutes our central case scenario. To demonstrate the different impacts that reduction in domestic and inbound tourism demands have, and facilitate the interpretation of results, we present economy-wide results for the two shocks separately and together. Domestic changes (both day trips and overnight) are introduced as a reduction in household consumption. This occurs as within the standard Scotland IO table, tourism spending by Scottish residents is included in the household column. However, domestic demand is endogenously linked to income and is price responsive. Thus, we introduce a wedge between disposable income and final demand by calculating a price increase that would deliver the desired reduction in household demand.[16] The difference between disposable income and final demand is then considered as savings and these are exogenous in the model, as (following Lecca et al., 2013) we do not assume that savings equal to

Table 2: Summary of simulations input, % changes relative to baseline unless otherwise stated

Category	*Type*	*Reduction, %*
Domestic	Scotland Day	-47.4
	Scotland Overnight	-41.9
	Total domestic	*-46.0*
Inbound	RUK Overnight	-41.9
	RUK Day	-47.4
	International Overnight	-86.0
	Total inbound	*-63.0*
Domestic + Inbound	*All*	*-54.2*
	All – absolute change in demand	£6.3 billion

Source: *Authors' calculation.*

4.2 Results from a focus on 2021

Table 4 presents the results of reduced tourism demand on key macroeconomic indicators. These are short-run results that represent the first year of the shock, which is assumed here to be 2021. It is important to recall that the final demand shock is a combination of two different shocks, one to inbound tourism spending and one to domestic tourism spending. These shocks are aggregated in the "All" simulation in Table 2, with the results presented in the final column of Table 3.

Table 3: The economic impact of tourism demand reduction in 2021 on key macroeconomic indicators, % changes from base unless otherwise specified

	Inbound	Domestic	All
Gross Domestic Product (GDP)	-1.13	-0.55	-1.76
GDP (£M)	-1,600	-800	-2,400
Consumer Price Index	-0.97	-0.55	-1.49
Unemployment Rate (%)	-2.38	-1.18	-3.63

investment in the short run. Inbound tourists' income is exogenous to our single region model and so it is possible shock international tourism demand directly.

Employment (FTE)	-65,000	-32,000	-100,000
Employment	-2.51	-1.25	-3.83
Nominal Gross Wage	0.00	0.00	0.00
Real Gross Wage	0.98	0.55	1.51
Labour supply	0.00	0.00	0.00
Replacement cost of capital	-0.63	-0.38	-1.01
Investment	-4.46	-2.39	-6.84
Household Disposable income	-0.97	-0.49	-1.50
Households Consumption	-0.96	-3.37	-4.36
Households Savings	-1.83	64.78	62.54
Gov expenditure	0.00	0.00	0.00
Gov revenue	-1.72	-0.92	-2.62
Export Tot	0.00	0.00	0.00
Employment Unskilled	-3.39	-1.61	-5.10
Employment Skilled	-1.79	-0.94	-2.78

Source: *Authors' calculations. Notes: absolute numbers for GDP and employment changes are rounded to the nearest £million and 100 respectively.*

The fall in domestic and inbound tourism demand due to COVID-19 restrictions leads to an overall reduction in economic activity, indicated by a 1.76% fall in GDP. Firms adjust their output to accommodate lower demand. The lower output leads to a reduction in the requirement for capital and labour. Whilst capital stocks are fixed in the short run, their value falls, causing a sharp reduction in investment. However, labour demand falls by 3.83% and the unemployment rates increase by 3.62 percentage points.[17] Unsurprisingly, there is a larger impact on unskilled employment (which falls by 5.10%) over their skilled counterparts which reduces by only 2.78%, due to the nature of industries that are directly adversely affected by the shock employing a greater proportion of unskilled labour.

The loss of labour and of value of capital results in lower income within the economy. This affects households' disposable income, which falls by 1.50%. However, the overall reduction in demand, puts downward pressure on domestic prices, resulting in a decrease in Consumer Price Index (CPI) by 1.49% which in turn leads to an increase in the real wage by

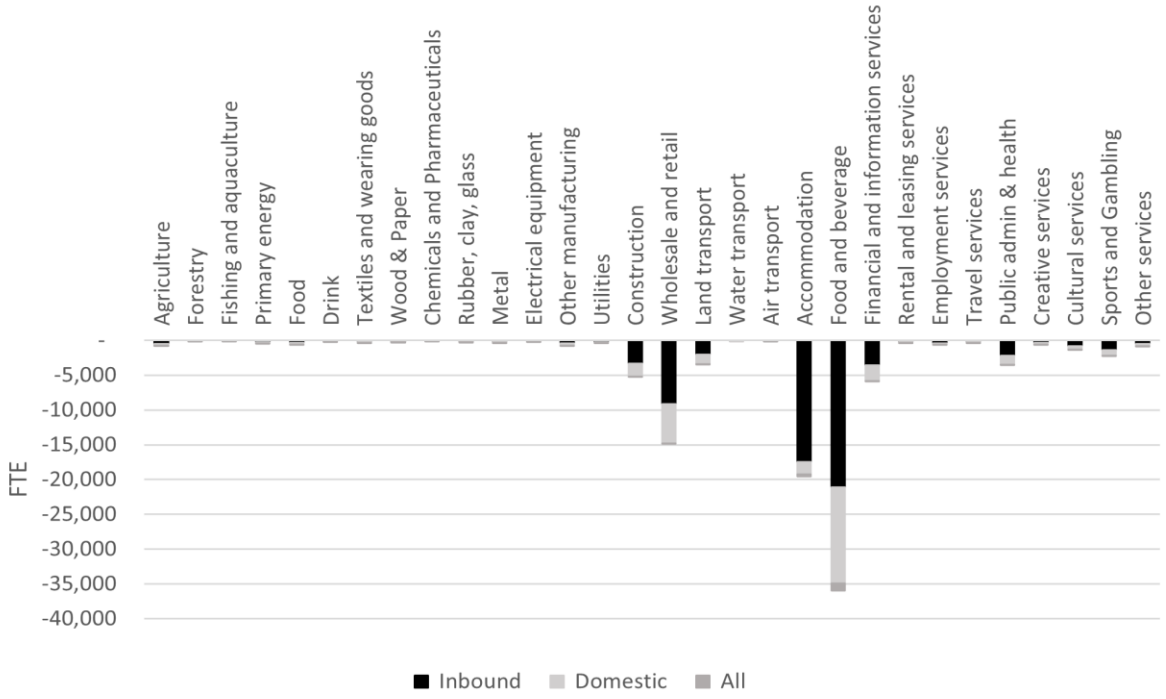
[17] Note that this implies that if foreign workers become unemployed, they stay in the country. However, it may be the case that they decide to return to their home country thus leaving the Scottish labour force.

1.51%. Recall that in this scenario we are keeping the nominal wage fixed. This partly dampens the erosion in household nominal income, but it is not sufficient to completely offset it. However, due to restrictions in activities liked to COVID-19, households' consumption falls by 4.36%, whilst households' savings increase by a staggering 62.54%. Since the model assumes that exports are initially price irresponsive, the fall in prices – which would otherwise improve the competitiveness of Scottish products - has no impact on exports. Government expenditure is held fixed. However, government revenues (from taxes) fall by 2.62%.

The first and second columns of Table 3 present results from simulations where domestic and inbound tourism demands are shocked individually. The qualitative impact of results is comparatively similar to when these shocks are aggregated. However, it is interesting to notice that the reduction in inbound tourism has a larger overall impact. Moreover, the overall impacts (in the "All" simulation) are slightly larger than the summation of the two individual shocks, due to the ripple effect that one has on the other.

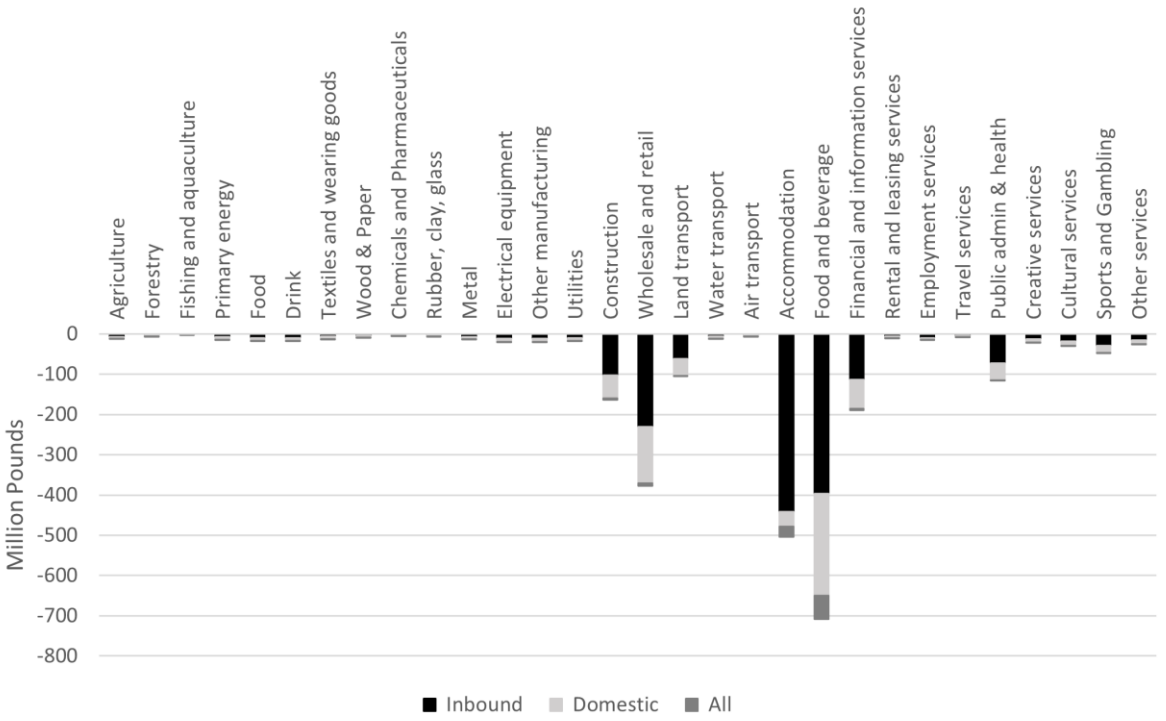
The macroeconomic results can be decomposed at the sectoral level, to see what industries are expected to be more impacted to the fall in tourism demand. Figure 10 reports the absolute change in employment expressed in full time equivalent jobs (FTE). The combined reduction in domestic and inbound tourism demand leads to a potential loss of 100,000 jobs (Table 3). These are primarily concentrated in the "Food and Beverage Services" and "Accommodation services" sectors, which together account for approximately 56% of the aggregate jobs at risk. The decomposition of the shock between domestic and inbound demonstrates that the Accommodation services sector is particularly impacted by the reduction in inbound tourism, as domestic tourism is mainly based on daytrips, while the "Food and Beverage Services" sector is impacted roughly equally by the change in inbound and domestic tourism demand respectively. The "Wholesale and Retail" sector is the third most impacted sector while the other 27 sectors account for approximately 29% of the jobs at risk.

Figure 10: Absolute change in employment by industry, FTE



Source: *Authors' calculations*

Figure 11: Absolute change in value added by industry, £millions



Source: *Authors' calculations.*

Figure 11 reports the change in value added by industries. Value added is defined as the contribution of labour and capital (factors of production) to the value of a product and is directly dependent on the total production in the economy. As demand falls, output decreases and so does sectoral value added. The resultant shock leads to a reduction in value added of about £2,500 million, of which 48.3% is concentrated in the Food and Beverage Services and Accommodation sectors (approximately £1.2 billion). Wholesale and Retail contributes an additional £378 million loss and these three industries together account for a total of 63% of the aggregate loss in value added across the Scottish economy. Land transport services, Public Admin and Health and Construction services account for a further 15% of the total loss.

We know that the model outputs will be sensitive to a range of factors, including our assumptions about the best way to model the determination of wages in the labour market, and specific choice of parameter values. We undertook sensitivity analysis on this point to illustrate the impact that these choices had on model results and report these in the academic writeup of these results. The results of the sensitivity analysis can be found in Appendix 2.

4.3 The example of 2022: Using expert surveys as inputs to the modelling framework

Recall that our approach requires the estimation of the first order changes in tourism spending by category to use as the inputs to our economic modelling framework. In the first approach, we used changes in proxy indicators to identify changes in demand by our different categories of tourists in Scotland. Our second approach was to use a survey to get their projections for tourism spending in each category. Unlike the approach for 2021, based on trends in proxy indicators for tourism spending, we approached this by soliciting expert input opinions on what the level of demand would be for each category in 2022, relative to pre-pandemic baselines (i.e., 2019).

The attraction of the survey approach is that it can be forward looking – drawing on projections of experts in the field – and can also be regularly updated, reflecting changes in the environment for travel and tourism in Scotland.

I At the beginning of 2022, we invited stakeholders involved in STERG[18] to complete the survey, and the analysis presented here is based on the fully complete responses. The responses provide quantitative demand scenarios for 2022 that compare tourism spending from five different categories of tourists: Scottish residents day and overnight visitors; rest of UKs day and Overnight visitors and International Tourists (i.e., from outside of the UK) relative to the 2019 pre-pandemic level.

We took the mean of the responses to each tourism category for 2022 to construct our "Central scenario" and take an average of the two responses with the smallest and largest change relative to the pre-pandemic levels to construct a "High" and "Low" scenario respectively. Results of the survey are presented in

Table *4*.

Table 4: Tourism demand in 2022 as a percentage of pre Covid-19 demand levels (2019)

	Central scenario	High	Low
Scottish residents - Day tourism	61.5%	75.0%	50.0%
Scottish residents - Overnight tourism	56.3%	77.5%	33.0%
Rest of the UK residents - Day tourism	68.7%	75.0%	62.0%
Rest of the UK residents - Overnight tourism	67.0%	76.5%	55.0%
International tourism	46.8%	57.0%	35.0%

Source: *Author's calculation based on survey responses.*

4.4 Results from a focus on 2022

The impact on macroeconomic variables is shown in Table 5. In the Central scenario (the first column) we find that the reduction in demand leads to a reduction in GDP of 1.23% and

[18] During 2022, the project engaged with partners from the Scottish Tourism Emergency Recovery Group. During May 2022, the research team shared a survey with stakeholders involved in STERG to gather quantitative information on what members expect tourism demand in Scotland to be in 2022, relative to pre-pandemic levels. Note that the responses to the survey were done on an (anonymous) individual basis and the scenarios do not represent the views of STERG or its individual partner organisations.

impacts around 75,000 jobs relative to the baseline case. The fall in demand for inbound tourism (both international and from the rest of the UK) contributes to a reduction of GDP by 0.73% while fall in demand for domestic (Scottish) tourism contributes to a loss of 0.47%.

In the High scenario, GDP reduces by 0.86%. In the Low scenario, GDP falls by1.64%. The impact on jobs in these two cases are 53,000 and 98,000 respectively.

In the Central scenario household consumption falls by 3.34%. Consumption falls both because of the reduction in income and from avoidance behaviour. This leads to an increase in saving by 50%. In reality, it is likely that at least part of these savings will be spent on other non-tourism goods and services. However, this is not considered in this analysis. In the High (Low) scenario, we see a smaller (larger) increase in household savings due to higher (lower) consumption than the Central scenario.

Table 5: Macroeconomic impacts of the scenarios, % differences to baseline unless otherwise stated

	Central scenario	High	Low
GDP	-1.23	-0.86	-1.64
GDP (£M)	-1,700	-1,200	-2,300
Consumer Price Index	-1.06	-0.76	-1.36
Unemployment Rate	2.83	2.00	3.71
Employment (FTE)	-75,000	-53,000	-98,200
Employment	-2.99	-2.12	-3.92
Real Gross Wage	1.07	0.77	1.38
Investment	-4.99	-3.56	-6.48
Households Consumption	-3.34	-2.15	-4.50
Households Savings	50.15	30.64	68.25
Gov Savings	-123.15	-88.16	-159.73

Source: *Authors calculation based on simulation results.*

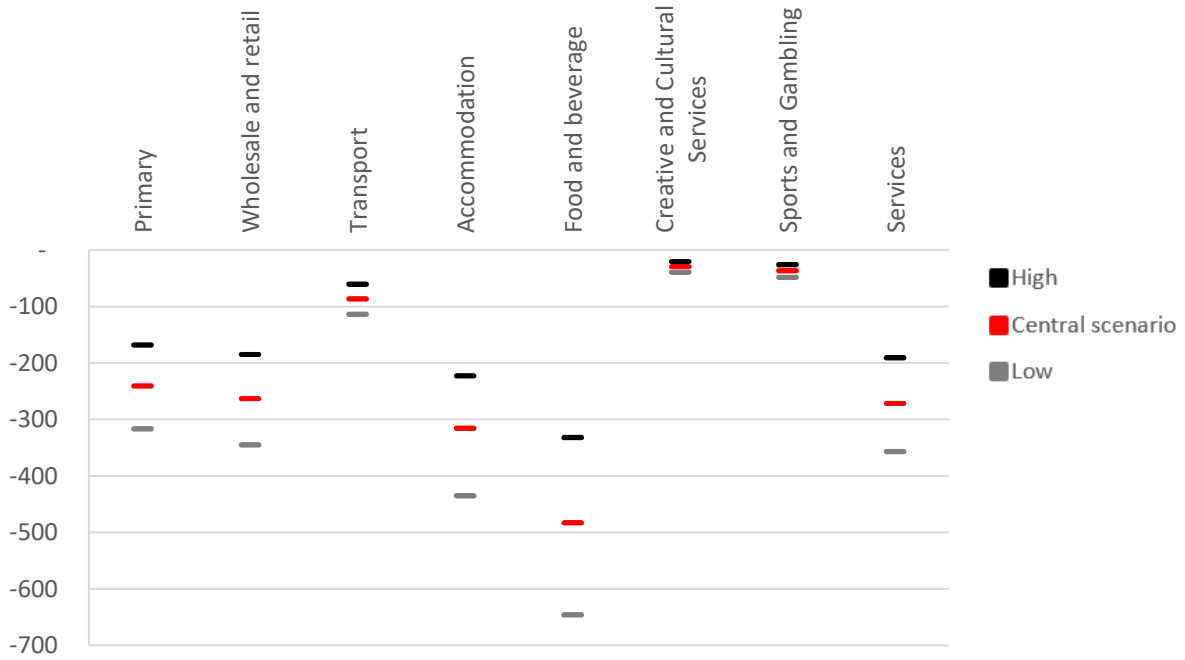
Figure 12 shows the impact on GVA across sectors of the economy. GVA in the “Food and Beverage Services” sector falls by £480 million in the Central scenario (and £650 million and £330 million in the Low and High scenarios). Similarly, the “Accommodation” sector is the

second most impacted sector with a reduction in GVA of £320 million in the Central scenario (and £440 million and £220 million in the Low and High scenarios). If we account for the "Wholesale and Retail" sector, the three sectors together contribute 61% of the GVA reduction in the Central scenario.

Figure *13* shows the Employment impacts across sectors. The impact on sectoral employment mirrors that in GVA with “Food and Beverage Services”, “Accommodation” and “Wholesale and Retail” the highest impacted sectors. Together these sectors account for 72% of the overall reduction in Employment in the Central scenario.

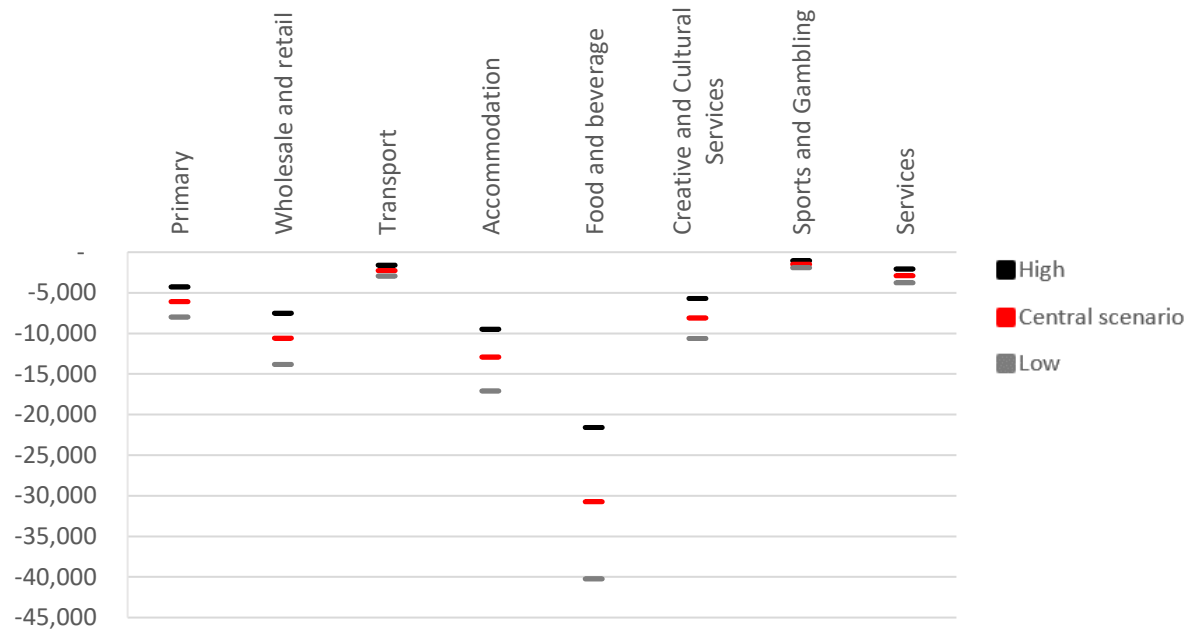
Particular care should be exercised when we interpret the employment results, as our scenarios do not consider changes in the supply of labour that have occurred as a result of changes in Visa requirements for workers from the EU. Whilst our model results suggest that spare capacity in the labour market may exist as a result of the reduced demand, it may be the case that a portion of EU nationals have left the labour market and have not been replaced with other workers.

Figure 12: Change in sectoral Value Added under the three scenarios, absolute changes from baseline (£million)



Source: *Authors calculation based on simulation results.*

Figure 13: Change in sectoral employment under the three scenarios, absolute changes from baseline (FTEs)

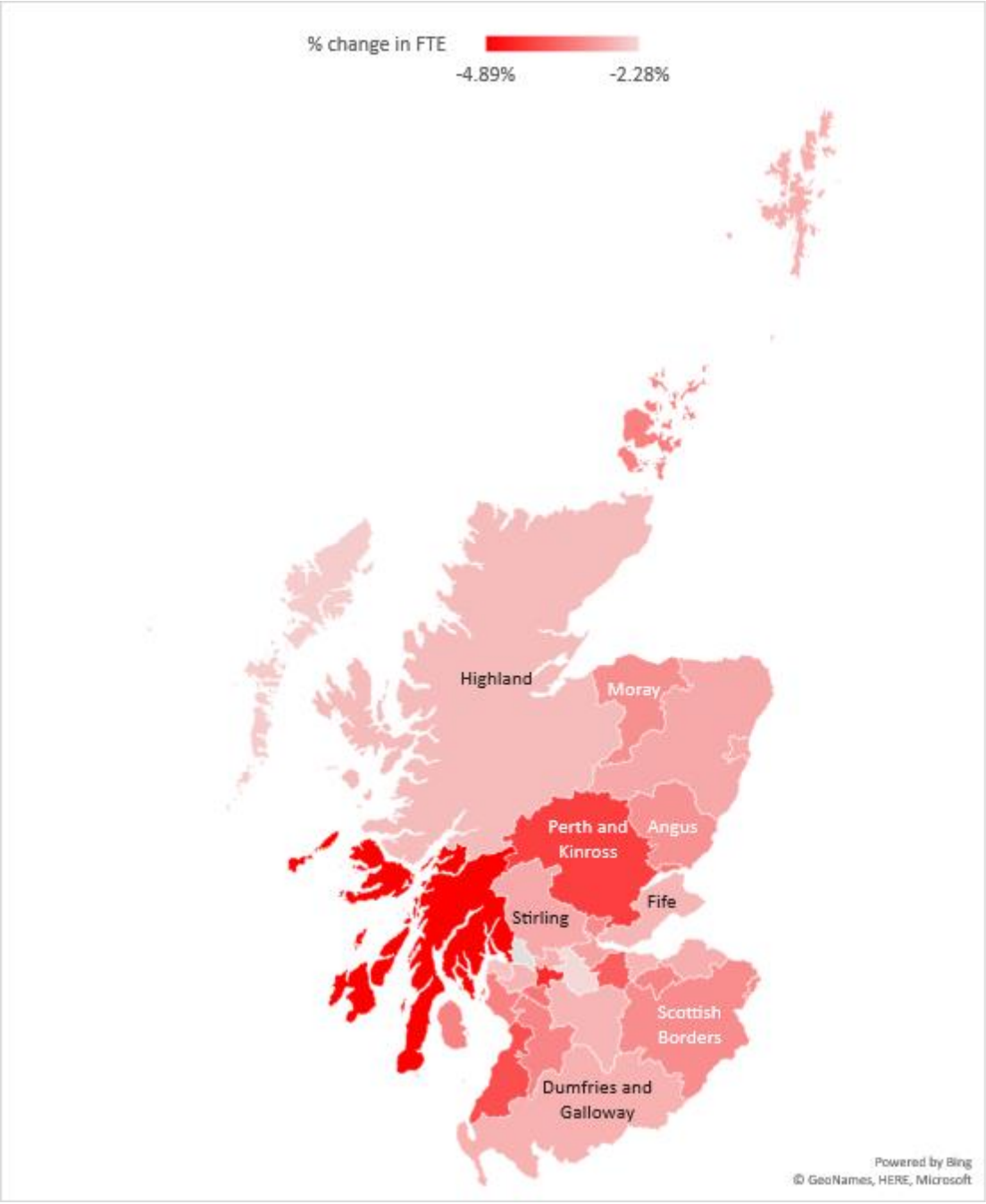


Source: Authors calculation based on simulation results.

We can regionalise our national-level results using 2019 employment data by industry and local authority. Our regionalised results (

Figure *14*) suggest that “Argyle and Bute”, “Glasgow City” and “Perth and Kinross” are likely to be the most impacted areas.

Figure 14: Impact on employment (FTE) by local authority, % changes from baseline



Source: Authors calculation based on simulation results.

5. Issues with interpretation of model results

Results are presented as a counterfactual simulation rather than a forecast and expressed as a percentage (or absolute) change from the baseline scenario that is a situation where

tourism demand is at pre-pandemic levels (i.e., 2019). No probabilities are attached to any of the simulations considered.

The results tell us what the impact of the reduction in tourism demand could be if tourism demand falls compared to a counterfactual of pre-pandemic tourism demand, all other things being equal.

This “all other things being equal” has a specific meaning here. This means for example that we do not capture the impact of changes in demand for non-tourism goods and services (and there is evidence of households increasing their spending outside of tourism), the impact of increased import prices or other direct changes in costs of other inputs, and the impact of labour shortages due to changes in Visa requirements to work in the UK and fluctuations in exchange rates. Similarly, we do not consider potential mitigating policies or behavioural responses such as re-spending of savings from reduced spending on tourism activities. Essentially, we focus on the pure effect of the change in demand by different tourists’ categories.

Finally, while modelling expected policy changes is always difficult, the rapid changing of the pandemic and of the macroeconomic outlook in the UK, has made it more challenging to interpret the results.

6. The usefulness of CGE modelling for tourism in COVID

Over the last twenty years, the tourism literature has recognised the usefulness of computable general equilibrium models in understanding the economic impacts of changes in tourism behaviour, or the consequences of policies target at tourism (Dwyer et al, 2000; Dwyer et al, 2004, Wickramasinghe and Naranpanawa, 2021). The CGE framework is – as discussed above – ideally suited for the simulation of shocks which impact on a particular sector (or sectors) of an economy and demonstrating quantitively the economic consequences of these for the whole economy.

There are three properties that make CGE models particularly useful for looking at tourism. First, they are multisectoral – i.e., being built using a set of IO accounts they can explicitly distinguish between different industries within an economy, and also summing to the whole economy. This makes them perfect for the simulation of disturbances that initially affect only a category of activities or sectors, such as such as tourist-facing activities - but where there is interest in the scale of the whole-economy effects.

Second, they can reflect real-world constraints in the economic system which could affect the ability of firms/industries in the economy to adapt to a shock in the short term. This would include the level of capital in specific sectors, or the substitutability of inputs from different sectors. These constraints will be important aspects of the ability of firms to respond when unexpected shocks impact on level of demand/output, and so would be important for the "resilience" of the sector and wider economy.

Third, as a simulation tool, they can simulate *ex ante* the impacts of disturbances against a counterfactual scenario, typically that of "no change". The consequences of specific shocks can be isolated from other disturbances which might be impacting an economy, so that the pure impact of a specific disturbance can be analysed. This use as a simulation tool can be valuable in the case of an economy being impacted by several disturbances at the same time, or in the case where unprecedented, rapid and multiple policy interventions are also taking place.

It is unsurprising therefore that the last two years has seen a wide adoption of CGE models to understand the propagation of shocks from COVID-19 to the whole economy (Keogh-Brown et al, 2020; Walmsley et al, 2020) as well as studies examining the system-wide impacts of changes in tourism (Allan et al, 2022; Deriu et al, 2021; Henseler et al, 2022; Malahayati et al, 2021; Pham et al, 2021; UNCDAT, 2020; Wang et al, 2022).

Future extensions of economic modelling

Through our project we have identified some areas which could be productive for improving the usefulness of CGE models for tourism policy analysis. We summarise these under two points, first, the sectoral detail in Input Output accounts, and second, the detail on tourism consumption by category.

The IO tables offer lots of sectoral detail to help analysts to understand the shape of the economy. As noted earlier, the Scottish IO tables are published with 98 distinct industrial activities. However, the level of detail does not map onto the Sustainable Tourism growth sector: IO tables identify individual sectors for all activities within SIC 55, 56, 79, 91 and 93, while only some elements in these are included in the "Sustainable Tourism" growth sector definition (see footnote 3).

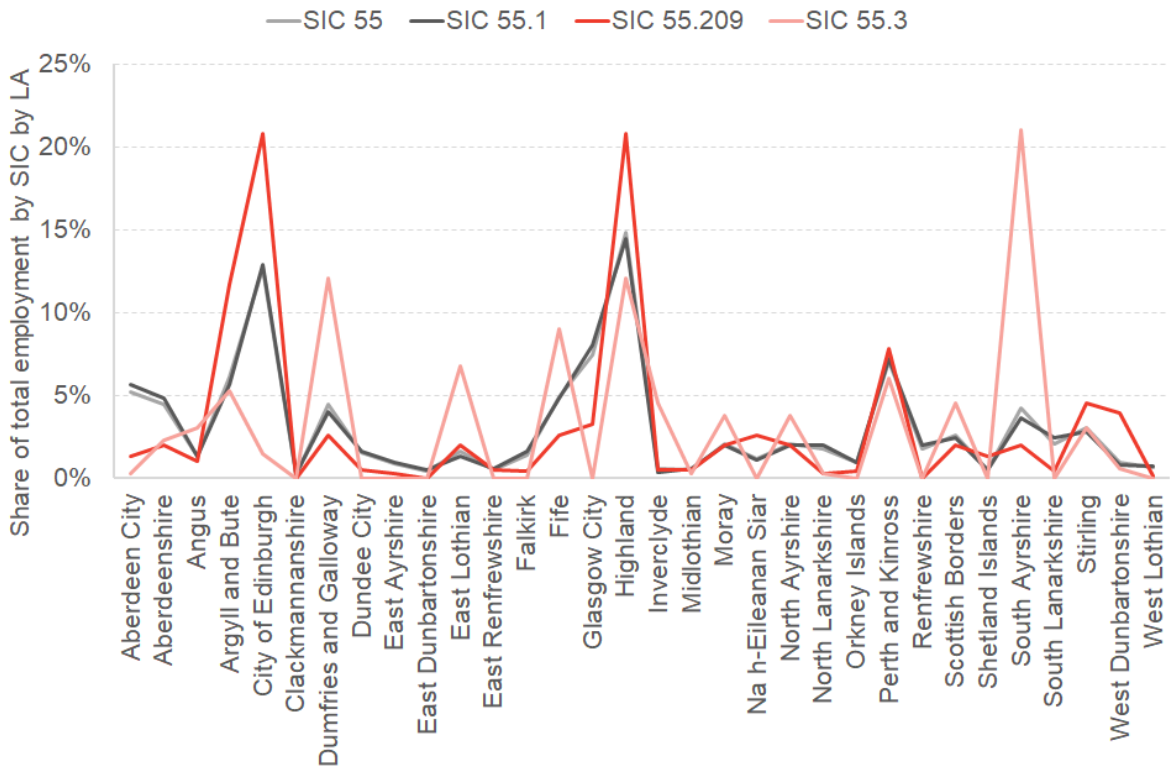
Why would this matter? The economic characteristics within these activities could be very different, for instance in the labour intensity of output in those activities, and also in the linkages between these activities and other sectors in the Scottish economy. Currently, for

instance, we are assuming that within the “Accommodation” sector there is one type of industry represented by the average for the sector as given in the IO tables, while this sector covers a wide range of activities, from Caravan Parks, to Bed and Breakfasts and Hotels. Given the heterogeneity of business size and ownership within the Sustainable Tourism growth sector, we might expect to have considerable difference in the embeddedness of these activities within the wider Scottish economy.

As we are working with the higher level of sectoral aggregation as given in the IO accounts, this has implications for the regionalisation of our modelling results. We base the regionalisation on the employment shares by IO (CGE) modelling sectors, so that we cannot reflect the regional differences in each sub-activity within Sustainable Tourism.

Figure 15 below for instance, shows the share of employment in “Accommodation” sector across the 32 local authorities of Scotland alongside the share of employment in different sub-sectors.

Figure 15: Share of employment within Accommodation SIC codes by local authority, 2019



Source: *BRES and authors calculations.*

On the consumption side, the IO accounts do record spending in Scotland by “non-residents” however this is not broken down into the component elements (i.e., by place of origin/residence) or by the category of spending (as either overnight or day trips). In addition, spending by Scottish residents on tourism activities are included within the household consumption category and spending on day and overnight trips are not separately reported in the full set of IO accounts. There are important differences in the level of spending by each of these tourism categories (see Table 1).

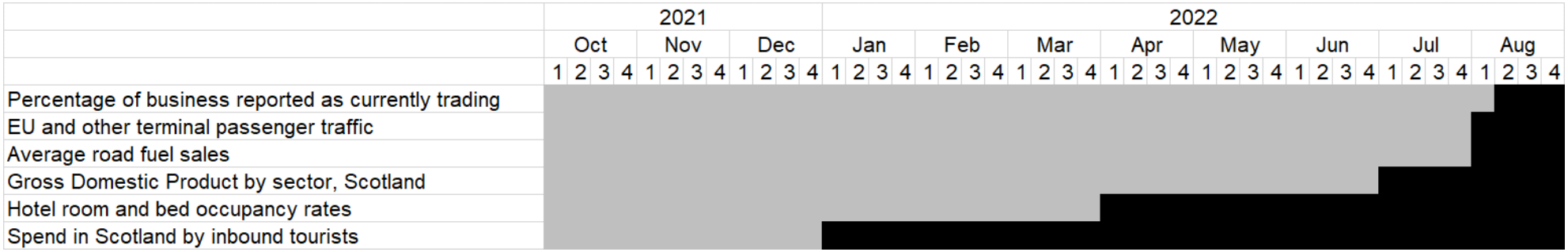
In addition, each type of spending is likely to have quite different demand profile over the months of the year and by geography as well. In addition, there is only limited information on the spending pattern across industries by tourists in Scotland. Better knowledge on these – and consistency between the surveys which pull this information together – would aid a more complete understanding of the impact of specific disturbances affecting each category differently.

7. Data issues in understanding tourism changes in Scotland

Throughout the project, we sought to identify and report timely changes in tourism in Scotland. We published several blogs reporting on trends in indicators related to tourism (see section on “Project outputs” at the end of this report).

The publicly available data available to provide such a commentary was however quite limited. We highlight this for a small range of relevant indicators, shown in Figure 16, taking the extent to which data was available on these at the end of August 2022. Areas shown in Grey represent time periods on which data is available on this indicator, with Black areas representing where data does not cover the time period. The longer black sections indicate where the lags between the end of the period covered by the data and the current date (as of end of august) is the larger.

Figure 16: Different timeliness of indicators relevant for Scottish tourism



Sources: *(in order) Scottish Government, "Business Insight and Conditions Survey"; Civil Aviation Authority, "Airport data"; Department for Business Energy and Industrial Strategy; Scottish Government, "GDP monthly estimate"; Moffatt Centre, "Scottish Accommodation Occupancy Survey Report"; VisitBritain, based on International Passenger Survey by ONS.*

From this (albeit small) sample of indicators, we can highlight the varying lags between the period covered by the data and its public availability. For instance, at the end of August 2022, information on the amount spent in Scotland by inbound (i.e., non-UK) tourists is only information to the end of the fourth quarter in 2021, and for the year of 2021 as a whole. For hotel occupancy, at the end of August, we have information for March 2022. This predates the critical summer season, for example, and so illustrates the extent to which policy is operating on less robust (but timelier) indicators.

We have seen significant discovery and use of new indicators for understanding short-term change across the economy. During the COVID-19 response, such data as case numbers, severity of cases and hospital admissions data, took centre stage in daily statistics and supported public health policy actions, as well as helping to communicate the need for and direction of current and future policy actions in transparent ways.

One critical challenge for policy is the publication and availability of good quality statistics to help guide policy decisions. We recommend that a review on the availability and timeliness of tourism statistics be undertaken to understand the extent to which the current production of statistics on tourism visits and expenditure continues to meet the needs of all stakeholders to understand the evolution of changes in tourism activity. Such an evaluation should also consider the timeliness of data (i.e., the lags between the period to which data relates and its availability), the detail across different categories of tourism (including by place of residence and day or overnight tourism) and the geographic level of analysis, including local authority, regional and national levels. Across other fields, we have seen the development of new datasets making use of advances in satellite, GPS and other technologies to capture data which can provide useful insights, and this could be an important direction for the tourism industry to be understood in more detail, and provide useful insights quicker to help firms, the industry and policy respond to future challenges.

Project outputs

Blogs

Blog 1 –"New project examines the effect of COVID-19 on the tourism industry in Scotland" https://fraserofallander.org/new-project-examines-the-effect-of-covid-19-on-the-tourism-industry-in-scotland/, 1st April 2021

Blog 2 –"CGE modelling to capture the consequences of COVID-19 on tourism", (13/5/21) – https://fraserofallander.org/cge-modelling-to-capture-the-consequences-of-covid-19-on-tourism/, 13th May 2021

Blog 3 –"COVID-19 and Scottish tourism in 2021", https://fraserofallander.org/covid-19-and-scottish-tourism-in-2021/, 4th August 2021

Blog 4- "Trends in Scottish tourism activity", https://fraserofallander.org/trends-in-scottish-tourism-activity-through-2021/, 3rd February 2022

Blog 5 – "An updated 2018 SAM for Scotland", (17/6/22) – https://fraserofallander.org/an-updated-2018-sam-for-scotland/, 17th June 2022

Blog 6 – After Omicron: Tourism trends through 2022 – https://fraserofallander.org/after-omicron-tourism-trends-through-2022/, 11th July 2022

Presentations to academic audiences (chronological by month)

27th May 2021 - "The sectoral economic impacts of COVID-19 on the tourism economy: a regional analysis focused on Scotland", Engage with Strathclyde Event, online.

27th August 2021 – "Impact and recovery from the COVID-19 pandemic on the Scottish tourism industry: a computable general equilibrium analysis", 60th European Regional Science Association congress, online.

9th May 2022 – "The sectoral economic impacts of COVID-19 on the tourism economy: a regional analysis focused on Scotland", Strathclyde and the Pandemic event, University of Strathclyde, Glasgow, United Kingdom.

1st July 2022 – "System-wide impacts of COVID-19 related changes in tourism in Scotland", International Association of Tourism Economics, Perpignan, France.

7th July 2022 – "Resilience of the Scottish economy to COVID-19 related changes in tourism demand", Regional Science Association International: British and Irish Section conference, Stirling, United Kingdom.

22nd August 2022 – "Resilience of the Scottish economy to COVID-19 related changes in tourism demand", 61st European Regional Science Association congress, online.

Academic articles published

Allan, G.J., Connolly, K., Figus, G. and Maurya, A. (2022), “Economic impacts of COVID-19 on inbound and domestic tourism”, *Annals of Tourism Research Empirical Insights*, available online 11th October 2022

Academic articles in progress

Allan, G.J., Figus, G., “Economic resilience to changes in tourism demand: an ex-post modelling contribution”, paper in progress, journal submission expected by the end of 2023.

References

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Appendices

Appendix 1: List of sectors used in the Model

Number	Abbreviation	Sector Name
1	ARG	Agriculture
2	FOR	Forestry
3	FISH	Fishing and aquaculture
4	PRY	Primary energy
5	FOOD	Food
6	DRK	Drink
7	TXT	Textiles and wearing goods
8	WOP	Wood & Paper
9	CHEM	Chemicals and Pharmaceuticals
10	RUB	Rubber, clay, glass
11	MET	Metal
12	ELE	Electrical equipment
13	OTHM	Other manufacturing
14	UTL	Utilities
15	CON	Construction
16	WHR	Wholesale and retail
17	LND	Land transport
18	WTR	Water transport
19	AIR	Air transport
20	ACC	Accommodation
21	FBS	Food and beverage
22	FINS	Financial and information services
23	RETL	Rental and leasing services
24	EMPY	Employment services
25	TRL	Travel services
26	PUB	Public admin & health
27	CREA	Creative services
28	CULT	Cultural services
29	SPRT	Sports and Gambling
30	OTHS	Other services

Appendix 2: 2021 case: results of sensitivity analysis

	Central case	Endogenous exports	Endogenous wage	Endogenous export & wage
Gross domestic product	-1.76	-1.50	-0.62	-0.41
Gross domestic product (£M)	-2400	-2100	-800	-600
Consumer price Index	-1.49	-1.20	-2.54	-1.81
Unemployment rate	3.63	3.21	1.77	1.43
Employment (full time equivalent)	-100,000	-88,000	-48,000	-39,000
Employment	-3.83	-3.39	-1.87	-1.50
Nominal gross wage	0.00	0.00	-5.43	-4.23
Real gross wage	1.51	1.22	-2.97	-2.46
Labour supply	0.00	0.00	0.00	0.00
Replacement cost of capital	-1.01	-0.72	-1.76	-1.09
Investment	-6.84	-5.32	-4.96	-2.77
Households disposable income	-1.50	-1.23	-2.73	-1.96
Households Consumption	-4.36	-4.10	-5.55	-4.81
Households savings	62.54	63.20	59.49	61.35
Gov revenue	-2.62	-2.13	-3.54	-2.48
Export rest of UK	0.00	1.22	0.00	2.09
Export rest of World	0.00	1.15	0.00	2.10
Export total	0.00	1.19	0.00	2.09
Employment low skill	-5.10	-4.60	-2.31	-1.90
Employment high skill	-2.78	-2.39	-1.50	-1.17

Fraser of Allander Institute
University of Strathclyde
199 Cathedral Street
Glasgow G4 0QU
Scotland, UK

Telephone: 0141 548 3958
Email: fraser@strath.ac.uk
Website: fraserofallander.org
Follow us on Twitter: @Strath_FAI
Follow us on LinkedIn: FAI LinkedIn
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