

Local Level Brexit Vulnerabilities in Scotland

RESAS (Rural & Environment Science & Analytical Services)

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Executive Summary

Headline findings

This research identifies areas of Scotland that are expected to be most vulnerable to the consequences of Brexit; and what drives those risks to support local authorities and other organisations in understanding local risks around EU exit. It analyses data on eight variables and produces a Brexit Vulnerability Index score for nearly 7,000 different areas (datazones) in Scotland. An accompanying interactive map allows for more granular analysis of each datazone in Scotland. It can be accessed from <https://bit.ly/30W1UVQ>

Key findings are that:

- The risks presented by Brexit are anticipated to have significant social and economic consequences for all areas of Scotland.
- Many of the areas most vulnerable to Brexit are in rural locations, in particular on the Scottish islands. Around half of communities in Shetland Islands, Na h-Eileanan Siar, Argyle & Bute and Dumfries and Galloway are amongst the most vulnerable communities in Scotland (20% most vulnerable datazones).
- On Na h-Eileanan Siar there are nearly 14,000 people in the most vulnerable datazones in Scotland. Likewise, on the Shetland Islands there are more than 11,000 people in the most vulnerable datazones.
- A smaller proportion of areas within cities and large urban areas are found to be in the most vulnerable 20% of datazones in Scotland. However, because the urban population is substantially larger than the rural one, there are still high numbers of people in urban and suburban areas who live in such locations. For example, there are 186,000 people in Glasgow alone and nearly 170,000 people in Fife, North and South Lanarkshire and Edinburgh combined who are living within the most vulnerable datazones in Scotland.

Background

The UK's departure from the European Union (Brexit) poses a complex range of challenges for communities across Scotland. This paper identifies a number of factors which will influence a community's vulnerability. The analysis does not anticipate a specific Brexit scenario. Instead, it starts from the assumption that leaving the EU will create a number of challenges, and that whilst different Brexit outcomes may influence the scale of these challenges, the underlying drivers will be similar. The research takes the following approach: firstly, the factors which make an area vulnerable to Brexit are identified; and secondly, these individual factors are combined into a Brexit Vulnerabilities Index highlighting across Scotland the areas that may be most at risk.

Factors contributing to Brexit vulnerability

Previous Scottish Government analysis has set out the short-term impact that would be caused by a No Deal Brexit and the long-term implications that future trading arrangements post Brexit could have on the Scottish economy.¹ This analysis demonstrates that a No Deal Brexit would risk causing a significant economic shock, whilst any agreement is likely to result in GDP, disposable income and business investment all being lower than if we remained in the EU.

The trends driving these impacts are often operating at a UK or international level. However, they will have local impacts and consequences which will vary significantly across Scotland.

Constructing a Brexit Vulnerability Index

Scotland's communities are not homogeneous, and it is important to understand the different implications and transmission mechanisms via which Brexit will impact on different parts of Scotland. This can be done by assessing the extent to which the characteristics of different communities makes them more or less vulnerable to the implications of Brexit.

The Brexit Vulnerability Index has been constructed for nearly 7,000 different datazones in Scotland.² This index groups together a number of different indicators of exposure to the risks associated with Brexit to provide an overall assessment for each community in Scotland.

Eight variables are used to construct the index, capturing the following factors:

- Access to Services;
- Share of the population of working age;
- Income deprivation;
- Population Change;
- Workers in Brexit sensitive industries;
- EC Payments received (a) CAP,
- EC Payments received (b) ESF/ ERDF; and
- EU Worker Migration.

The variables are then weighted and combined together to form a single indicator for each datazone in Scotland – the Brexit Vulnerability Index.³ The results can then be used to identify the datazones which are believed to be most vulnerable to the challenges which Brexit represents. An interactive map is available at <https://bit.ly/30W1UVQ> which allows the results for individual datazones to be easily identified. The underlying dataset used to produce the analysis is also provided online to allow users to understand how varying underlying assumptions can impact

¹ Previous Scottish Government Brexit analysis is published here: <https://www.gov.scot/publications/deal-brexiteconomic-implications-scotland/>

² Datazones are small area geographical units used for statistical measurement with a population of around 770 people.

³ Further information on how the variables are combined together can be found in [Annex 2](#).

on the overall results⁴. The interactive map is designed to support local authorities' and other organisations in understanding local risks around EU exit and to complement their wider knowledge and analysis. Whilst results are provided for individual datazones, these should not be viewed in isolation. The risks that an individual datazone faces will depend on a range of wider factors such as the vulnerability of the wider region in which it is located, commuter patterns and unique local characteristics.

Results

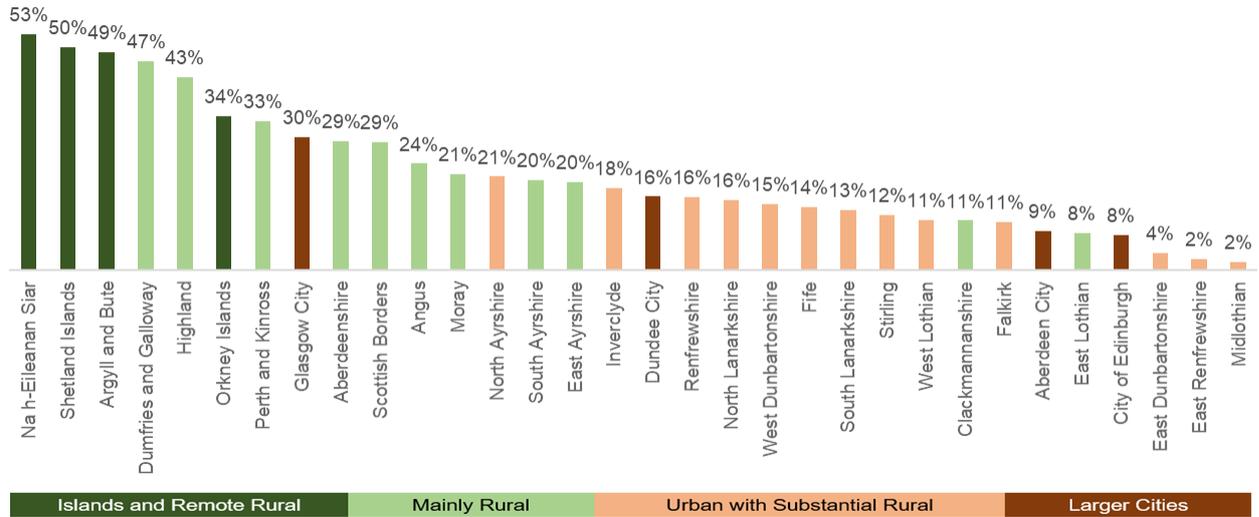
The analysis shows that areas in every local authority in Scotland are exposed to the risk that Brexit represents. However, more rural areas appear to be of proportionately greater risk. For example, in Na h-Eileanan Siar 53% of communities at datazone level are within the 20% most vulnerable communities in Scotland; 50% of those in the Shetland Islands, 49% of those in Argyll & Bute and 34% of those in the Orkney Islands. This equates to around 75,000 people. This generally reflects the high concentration of the workforce in Brexit vulnerable sectors such as fishing and agriculture in these areas; relatively high European funding receipts and rurality, all of which are believed to increase a location's vulnerability to Brexit.

A higher proportion of rural locations are contained within the 20% most vulnerable datazones in Scotland than are more urban locations. This does not mean that urban areas are not vulnerable, but that in aggregate rural communities are typically relatively more exposed to the risks that Brexit represents. Moreover, within Scotland's cities there are a large number of areas which are highly vulnerable to Brexit and have large populations. For example, within Glasgow 186,000 people live within the 20% most vulnerable datazones in Scotland. Likewise, 170,000 people in Fife, North and South Lanarkshire and Edinburgh live in the most 20% most vulnerable datazones. Both in Dundee and in Aberdeen cities around 24,000 people live in the most vulnerable areas. We can see that in Figure 1 below, which shows the distribution of the 20% of datazones identified as being most vulnerable to Brexit by Scottish local authority, split by the RESAS Classification for the rural economy.⁵

⁴ The underlying data are available for download here: <http://www.gov.scot/isbn/9781839601248>

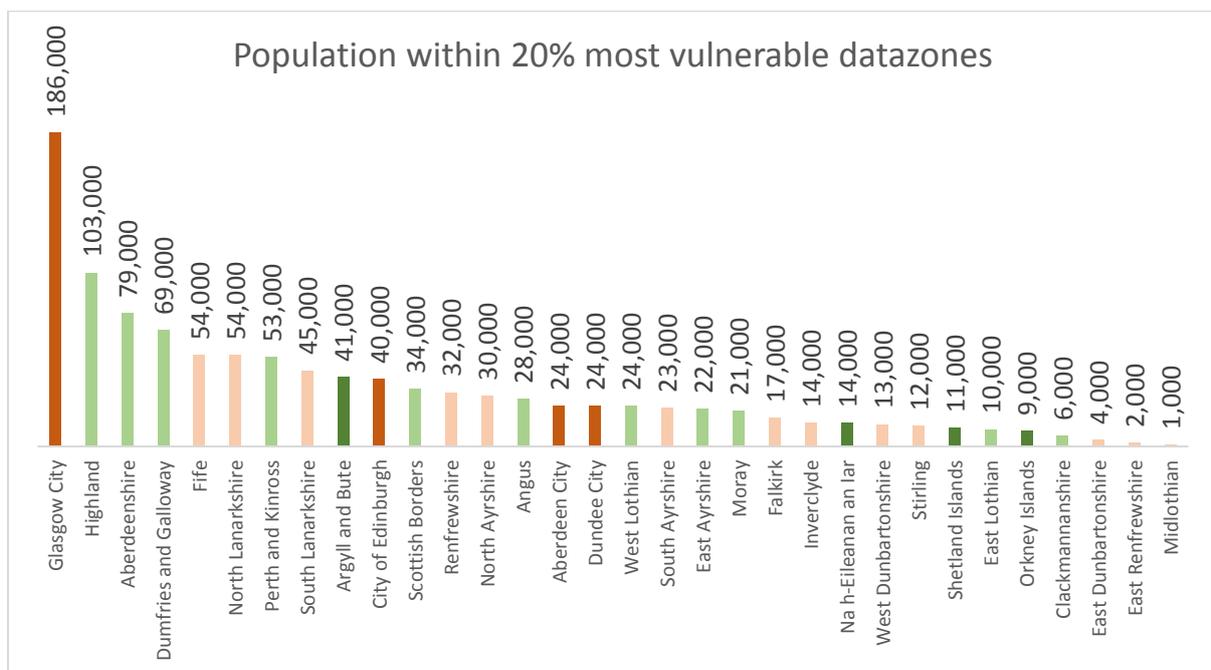
⁵ **Larger Cities:** Glasgow City, City of Edinburgh, Aberdeen City and Dundee City; **Urban with Substantial Rural:** East Dunbartonshire, East Renfrewshire, Falkirk, Fife, Inverclyde, Midlothian, North Ayrshire, North Lanarkshire, Renfrewshire, South Lanarkshire, Stirling, West Dunbartonshire, West Lothian; **Mainly Rural:** Aberdeenshire, Angus, Clackmannanshire, Dumfries and Galloway, East Ayrshire, East Lothian, Highland, Moray, Perth and Kinross, Scottish Borders, South Ayrshire; **Islands and Remote Rural:** Na h-Eileanan Siar, Orkney Islands, Shetland Islands, Argyll and Bute. See: <https://www.gov.scot/publications/understanding-scottish-rural-economy/>

Figure 1 Shares of most Brexit vulnerable datazones by local authority



The areas that have comparatively lower concentrations of Brexit vulnerabilities are Midlothian, East Renfrewshire, East Dunbartonshire, and Edinburgh. Such local authorities share several characteristics: all are located on or near the central belt and have relatively diversified economies. All have had significant population growth over the past decade which helps shelter them against depopulation vulnerabilities and have relatively low levels of deprivation. However, all still contain large populations which will be very vulnerable to Brexit, as shown in Figure 2 below.

Figure 2 Population in 20% most vulnerable datazones in Scotland by local authority



Looking at the same local authority areas as in the paragraph above they have populations of around 1,500 in Midlothian, 2,200 in East Renfrewshire, 4,500 in East Dunbartonshire, 6,000 in Clackmannanshire and 40,000 in Edinburgh within the 20% most vulnerable. Clearly though the largest numbers of the most vulnerable communities are in Glasgow, the Highlands, Aberdeenshire, and Dumfries and Galloway.

1. Introduction

There has been a wide range of analyses of the potential impacts that Brexit may have on Scotland. These have typically assessed the expected impacts on individual sectors and the Scottish economy as a whole. This report complements such analysis by using highly disaggregated local area datasets to assess the vulnerability to Brexit of different communities across Scotland, and the underlying factors which drive this.

The second chapter summarises previous analysis of the economic implications of Brexit at a Scotland level, and identifies the key factors that have been shown in previous research to be most likely to determine an area's vulnerability to Brexit.

Chapter 3 explains the methodology and data used to produce the community level analysis presented in this report. The analysis combines a number of different indicators which measure a community's vulnerability into a single overall indicator. This illustrates how the level of vulnerability to Brexit varies across Scotland. The analysis is undertaken at datazone level.⁶ There are nearly 7,000 datazones covering the whole of Scotland. Datazones are small area geographical units used for statistical measurement with a population of around 770 people. Chapter 3 also summarises the results across Scotland as a whole. This highlights the communities identified as being the most vulnerable and how the results vary by local authority and settlement size.

Chapter 4 summarises the interactive mapping tool, which has been developed as a part of this project, explaining the key features for users. An interactive map is available at <https://bit.ly/30W1UVQ> which allows the results for individual datazones to be easily identified. The underlying dataset used to produce the analysis is also provided online to allow users to understand how varying underlying assumptions can impact on the overall results.⁷

There are three annexes. Annex 1 contains detailed tables from the analysis. Annex 2 contains an explanation of how the Brexit Vulnerability Index was composed. Annex 3 contains a full list of acronyms used in the report.

⁶ The analysis in this paper is based on datazones. The paper also refers to datazones as communities in some places where this aids understanding.

⁷ The underlying data are available here: <http://www.gov.scot/isbn/9781839601248>

2. Implications of Brexit

Scotland has been a member of the EU since 1973. During this time EU membership has been a central element of Scotland's economic and political model. It has been the main destination for Scotland's international exports, has provided significant funding for communities throughout Scotland, has allowed EU citizens to live and work in Scotland and for people in Scotland to easily travel across the continent.

Leaving the EU (Brexit) will therefore have a significant impact on communities across Scotland. There is broad consensus that Brexit will have a negative impact on Scotland's economy.⁸ A No Deal Brexit would impose an immediate economic shock on Scotland. Other forms of Brexit, which provide a transition period followed by a new relationship with the EU, would reduce the risk of a short-term economic shock, but are still expected to reduce Scotland's long run economic performance.

The Scottish Government has published a range of analysis highlighting both the short-term risks that a No Deal Brexit would represent and the long-term economic implications that different trading relationships could have. This section summarises this evidence and presents a methodology for identifying the areas of Scotland which may be most vulnerable to the consequences of such outcomes.

Economic Implications of a No Deal Brexit

Analysis by the Scottish Government's Chief Economist has considered the short-term economic impact that a No Deal Brexit could have on the Scottish economy.⁹ This analysis considered two different scenarios. In the first scenario - a short, sharp, supply disruption - it was assumed that a No Deal Brexit with no transition agreement leads to an immediate economic shock caused by disruption to supply chains, restrictions on trade, delays to investment and recruitment and a depreciation in Sterling leading to higher inflation and reducing household spending power. In the second scenario it is assumed that the supply shock lasts for longer, which in turn leads to a collapse in demand, through a sustained fall in consumer and business confidence.

There are a range of channels through which each scenario could impact on the wider economy. These are summarised in Figure 3. The headings in bold represent the additional transmission channels under the second scenario.

⁸ https://www.strath.ac.uk/media/1newwebsite/departmentsubject/economics/fraser/pdfs/FAI-GMB_Brexit_and_the_sectors_of_the_Scottish_economy_-_2019_update.pdf.pagespeed.ce.bxf3uEicr1.pdf

Fraser of Allander Institute, (2016), Long-term economic implications of Brexit: a report for the Scottish Parliament;

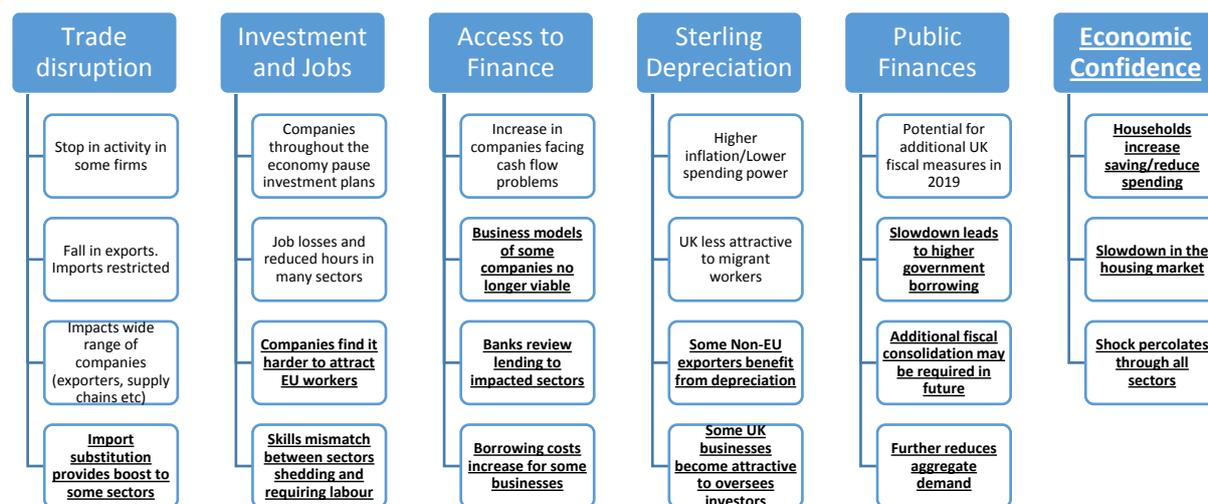
<https://www.researchonline.org.uk/sds/search/go.do?action=document&ref=B46624>

Bank of England, (2018), EU withdrawal scenarios and monetary and financial stability; [https://www.bankofengland.co.uk/-/media/boe/files/report/2018/eu-withdrawal-scenarios-and-monetary-and-financial-](https://www.bankofengland.co.uk/-/media/boe/files/report/2018/eu-withdrawal-scenarios-and-monetary-and-financial-stability.pdf?la=en&hash=B5F6EDCDF90DCC10286FC0BC599D94CAB8735DFB)

[stability.pdf?la=en&hash=B5F6EDCDF90DCC10286FC0BC599D94CAB8735DFB](https://www.bankofengland.co.uk/-/media/boe/files/report/2018/eu-withdrawal-scenarios-and-monetary-and-financial-stability.pdf?la=en&hash=B5F6EDCDF90DCC10286FC0BC599D94CAB8735DFB)

⁹ <https://www.gov.scot/publications/deal-brexit-economic-implications-scotland/pages/2/>

Figure 3 - Transmission Channels for a No Deal Brexit



Source: Scottish Government

The analysis concluded that collectively these pressures have the potential to result in GDP contracting by between 2.5% - 7% over a 12-18 month period depending on the way in which a No Deal Brexit outcome evolves, and for the unemployment rate to increase to up to 8%, equivalent to the number of people unemployed increasing by 100,000.

Similar conclusions have been drawn by other organisations. For example, the Bank of England has estimated that a ‘disorderly’ no deal, no transition scenario could reduce UK GDP by up to 7.5% by the end of 2023 relative to the May 2016 trend.¹⁰

Long Term Economic Implications of Brexit

The Scottish Government paper ‘Scotland’s place in Europe: people, jobs and investment’ highlighted the long-term implications that different trading relationships with the EU post-Brexit would have on Scotland’s economy. This analysis assumed that the UK Government was able to achieve a deal with the EU, and that Brexit was followed by a transition period which reduced the short-term economic shock.

The report concluded that the most likely alternative scenarios to EU membership: a World Trade Organization style relationship, a Free Trade Agreement: outside the Single Market and Customs Union and Membership of the European Economic Area (EEA) would all result in GDP, disposable income and business investment being lower than if we remained in the EU as summarised in Table 1. These results were driven by the fact that leaving the EU is expected to reduce opportunities for trade and increase tariff and non-tariff barriers. This would reduce trade in goods and services, make Scotland a less attractive location for foreign direct investment, reduce net migration, and ultimately lower levels of productivity growth.

¹⁰ Bank of England, (4th September 2019), Letter from Mark Carney, BoE Governor to Treasury Select Committee EU withdrawal scenarios and monetary and financial stability; <https://www.bankofengland.co.uk/-/media/boe/files/letter/2019/governor-letter-to-chair-of-tsc-re-updated-brex-it-scenarios.pdf>

Table 1 Headline Macroeconomic Indicators by 2030 relative to a baseline of Full EU Membership

	GDP (%)	GDP Per Capita in 2016 Cash Prices (£)	Real Disposable Income (%)	Business Investment (%)
European Economic Area	-2.7%	-£688	-1.4%	-2.9%
Free Trade Agreement	-6.1%	-£1,610	-7.4%	-7.7%
World Trade Organization	-8.5%	-£2,263	-9.6%	-10.2%

Source: Scottish Government Global Econometric Model (SGGEM)

Impact of Brexit on different Communities

Many of the trends identified above will operate at a UK or international level, and certainly at a level much higher than that which is easily measurable for local communities. However, they will all have local impacts and consequences.

These local impacts will not be uniform. Some communities will see a greater impact because they have a greater reliance on workers from the EU, or because a high proportion of their companies trade with the EU. For example, there is a relatively high concentration of horticulture farms in parts of Angus, which is both a sector economically exposed to Brexit, and a sector which relies on seasonal migrant workers. Other communities will have less direct exposure to Brexit, but will already suffer from relatively high levels of deprivation which will make them less able to absorb the impact of an economic shock or higher prices.

Likewise, in some communities the economic implications of Brexit will exacerbate underlying challenges. For example, many rural communities already face the challenge of depopulation. Migration, including from the EU, has helped to ameliorate or alleviate this trend over the past decade, but this may not remain the case post Brexit.

Finally, many communities have benefited from EC funding for a number of decades. In rural Scotland, Agri-food businesses have been supported by CAP.¹¹ In urban areas European Social Funds help vulnerable communities, and wider European Structural Funds (of which the social fund is a part) support a range of social and economic programmes across Scotland. There is no guarantee that the UK Government will continue to fund replacement programmes in the same manner or at the same level in the long term. Indeed, if Brexit permanently reduces the UK's economic performance, as most studies expect, this in itself could result in public spending being lower in future years than if we had remained in the EU.

¹¹ https://ec.europa.eu/regional_policy/en/policy/what/glossary/e/european-agricultural-fund-for-rural-development

3. Producing a local Brexit Vulnerability index

As outlined in the previous Chapter, Brexit, and in particular a No Deal Brexit, presents a number of risks to Scotland's communities and businesses. However, Scotland's communities are not homogeneous, and it is important to understand the different implications and transmission mechanisms via which Brexit will impact on different parts of Scotland.

One way in which this can be done is by assessing the extent to which the characteristics of different communities make them more or less vulnerable to the economic implications of Brexit.

The analysis in this paper is derived from a similar methodology used to calculate rankings in the UK indices of multiple deprivation, such as the Scottish Index of Multiple Deprivation (SIMD)¹². The Brexit Vulnerability Index ranks, in order of risk and vulnerability, each datazone according to the data from indicators.

The indicators have been chosen due to the particular exposure to socio-economic conditions that a community may face but does not assume a particular type of Brexit, nor can it estimate the extent of impact that Brexit may have on different communities in Scotland (it is identifying impact likelihood, not extent). Indicators were weighted using a combination of factors, including overall relevance to Brexit, the quality of the data, and significantly also by using outcomes from the work by the UK Government in the "HMG Reasonable Worst-Case Planning Assumption"¹³.

An indexed rank has been produced for each datazone in Scotland. There are nearly 7,000 datazones covering the whole of Scotland and each datazone has a population between 500 to 1,000 people. This allows for a very granular level of analysis.

Eight indicators are used to construct the index, capturing the following factors. Further information on the variables used is summarised in Table 2.

Income Deprivation – Higher levels of deprivation make a community less resilient to large scale socio-economic shocks. Given the likely economic shocks associated with Brexit there is a general risk that these communities will be particularly vulnerable. Additionally, low income households tend to spend the greatest portion of their income on the types of goods that could attract tariffs in some Brexit scenarios (e.g. food).¹⁴ This variable is weighted heavier than other variables. This reflects

¹² For more detail on SIMD including the methodology and weightings applied see

<https://www2.gov.scot/Topics/Statistics/SIMD>.

¹³

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/831199/20190802_Latest_Yellowhammer_Planning_assumptions_CD.L.pdf

¹⁴ E.g. FAPRI, (2017): Impacts of Alternative Post-Brexit Trade Agreements on UK Agriculture: Sector Analyses using the FAPRI-UK Model:

https://www.researchgate.net/publication/320166644_Impacts_of_Alternative_Post-Brexit_Trade_Agreements_on_UK_Agriculture_Sector_Analyses_using_the_FAPRI-UK_Model <https://www.fapri.gov.uk/publications/fapri-report-post-brexit-trade-agreements-uk-agriculture>

outcomes acknowledged in the UK Government's Yellowhammer planning assumptions which note that "low income groups will be disproportionately affected by any price rises in food and fuel"¹⁵.

Workers in Brexit-sensitive sectors – The Scottish Government previously commissioned EY to undertake an analysis of the impact that an orderly Brexit could have on different sectors in the Scottish economy. This found that Life Sciences, High Value Manufacturing, Chemicals; Logistics; Food, Drink, including Agriculture and Aquaculture; Creative Industries, including Digital; and Financial and Business Services would be most at risk.¹⁶ Communities with high levels of employment in Brexit-sensitive sectors may therefore be particularly vulnerable. This variable is weighed more heavily to because of the direct relationship between Brexit and workers jobs and employment risks¹⁷.

Access to Services – This is measured as travel time to core public and private services, such as GP Surgeries, shops, Post Offices and is used as a proxy for geographical remoteness. Communities and businesses that face a long travel time from key services, shops and are at the end of supply chains and are likely to see greater impact from disruption to imports and exports. In addition, longer travel times and smaller labour markets mean individual labour market impacts can have disproportionate effects in such locations. This risk is also reflected in the UK Government's Operation Yellowhammer planning around delivering supplying goods and services.¹⁸ Service providers in some rural parts of Scotland already face challenges in recruiting staff and therefore the assumption is that those areas will be disproportionately affected if service providers go out of business.

Working Age Population (as share of total population) – Brexit poses a challenge for communities with a relatively smaller working age population. These areas are more at risk for three reasons. Firstly, if as a result of Brexit migration slows down, the problem of ageing population will become more severe as migrants tend to be in the working-age. Thus, dependency ratios might increase further. Secondly, an ageing population puts further pressure on the provision of public services and spending. Thirdly, labour markets rely on access to workers, which again becomes increasingly difficult in areas with a relatively smaller population in the working age.

Population Change – Communities which face pre-existing demographic challenges, especially depopulation, are likely to experience a proportionately greater impact from lower levels of migration.

¹⁵

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/831199/20190802_Latest_Yellowhammer_Planning_assumptions_CD.L.pdf

¹⁶ <https://cdn.prgloo.com/media/574fecf008bf482cbb9739166c8815de>

¹⁷ <https://www.gov.scot/news/businesses-concerned-about-brexit/>

¹⁸

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/831199/20190802_Latest_Yellowhammer_Planning_assumptions_CD.L.pdf

European Payments:

a) European Structural Funds and European Social Funds ¹⁹ These are direct monies paid by the European Commission to communities, local authorities and businesses across Scotland to deliver economic development or support vulnerable communities. Communities which receive higher levels of European Funding are at greater risk of negative consequences should that European funding be ended or reduced by the UK Government in the future.

b) Common Agricultural Policy (CAP) payments ²⁰ – In the event of disruption or changes to payments post-Brexit, the communities in highest receipt of these payments are likely to see a greater impact. CAP is recorded separately because of different payment mechanisms.

EU Migration – Companies and communities which are particularly reliant on EU migrants will be more vulnerable to economic disruption and any change in free movement of labour post-Brexit.

¹⁹ <https://www.gov.scot/publications/esif-operations-funding/>. European Social Fund and European Structural Funds support a range of community groups, local authority projects, and wider economic development

²⁰ https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy_en
CAP payments are made up of two Pillars. Pillar One is funded through the European Agricultural Guarantee Fund (EAGF) and primarily finances direct payments to farmers and measures regulating or supporting agricultural. Pillar Two is funded through the European Agricultural Fund for Rural Development (EAFRD) finances rural development. It funds economic, environmental and social measures for the benefit of rural Scotland.

Table 2 – Description of variables used

Theme	How is it being measured	Source	Weight ²¹
Access to Services	Geographic Access to Services (based on a range of drive time data)	Scottish Index of Multiple Deprivation 2016 https://www2.gov.scot/Topics/Statistics/SIMD	20
Working Age Population	Share of the population aged 16 – 64	National Records of Scotland, population statistics https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/population/population-estimates/mid-year-population-estimates	20
Income Deprivation	Share of population who are income deprived	Scottish Index of Multiple Deprivation 2016. https://www2.gov.scot/Topics/Statistics/SIMD	40
Population change	Change in population from 2011-2017	National Records of Scotland, population statistics (2011-2017). https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme	20
Workers in Brexit-sensitive industries	Proportion of the workforce in industries identified as being most exposed to Brexit	These figures are based on an analysis undertaken by the Communities Analysis Division within Scottish Government. Data is taken from NOMIS (BRES), and from the Agricultural Census. Sectors were selected that had been identified as most vulnerable to Brexit and referred to in analysis undertaken by EY for the Scottish Government. EY undertook an analysis of the impact that a disorderly Brexit could have on different sectors in the Scottish economy. This found that Life Sciences, High Value Manufacturing, Chemicals; Logistics; Food, Drink, including Agriculture and Aquaculture; Creative Industries, including Digital; and Financial and Business Services would be most at risk. ²²	30

²¹ Weights sum to 165, this is to ensure all weighting rounds to 5 or 10 to avoid spurious accuracy in percentage weightings.

²² <https://cdn.prgloo.com/media/574fecf008bf482cbb9739166c8815de>

Total vulnerable employment for each datazone (BRES + Agricultural Census) was divided by total employment to calculate percentage employment vulnerable to Brexit. A 30% cut off to define datazones with a higher workforce vulnerability was chosen.

EC Payments	EC CAP payments for 2017 and 2018	The payments data used are for the combined European Commission (EC) financial years of 2017 and 2018. EC financial years run for 16 October to 15 October. The locations assigned to the payments are based on the registered address of the recipients, which in some cases may not be where the money is spent/used. CAP payments data are available to download here: http://cap-payments.defra.gov.uk/Download.aspx	10
	European Structural Funds – European Social Fund (ESF) and European Regional Development Fund (ERDF).	For the period from 2014 to 2020, Scotland received €476 million from the European Regional Development Fund (ERDF) and €465 million from the European Social Fund (ESF). For this paper, only payments to local authorities are included. Payments to Scottish Government or agencies are excluded as they cannot be attributed to specific areas.	5
EU Migration	National Insurance Number registrations by EU nationals	National Insurance Number Adult overseas (NiNo) registrations, Department for Work and Pensions. ²³ https://stat-xplore.dwp.gov.uk/webapi/jsf/login.xhtml	20

For every datazone in Scotland, data on each of these indicators was collected, weighted according to data quality, level of importance and commonality, and combined together to produce an overall Brexit Vulnerability Index Score for each community (Annex 2).

²³ NiNo registration statistics are available at the DWP Stat-Xplore website here: <https://stat-xplore.dwp.gov.uk/webapi/jsf/login.xhtml>

NiNo registrations are made by migrants when moving into employment. This is not a measure of permanent migration and allows the analysis to capture short-time migration that is not covered by population figures. It also is a proxy for the demand for migrant labour, and for those areas with higher migration generally.

The vulnerability ranking is therefore an ordinal measure. This means that the scores represent a ranking of datazones from the least vulnerable to the most vulnerable to Brexit, based on the criteria used. A datazone with a higher score is estimated to have a greater level of vulnerability to Brexit than an area with a lower score. However, the scores do not measure how much more vulnerable an area is. A datazone which has a score of 80, is more vulnerable than one which has a score of 40 but not necessarily twice as vulnerable.

Inevitably, such analysis will never be able to capture the factors unique to any one community in Scotland. Datazones are not standalone areas. They are part of much wider communities where individual risks will interact, overlap and spill over from one datazone to another. For example, if datazone A is found to be comparatively less vulnerable to Brexit on the basis of the above indicators, but the surrounding datazones are all estimated to have a high level of vulnerability this will inevitably have an impact on datazone A. Given the range and subtlety of such interactions, they are impossible to account for in a comprehensive manner in this analysis. As such whilst the broad trends highlighted in the following analysis are clear, care should be taken in seeking to draw specific conclusions about the precise vulnerability of any one datazone.

Further information on the methodology used is provided in Annex 2.

Most Vulnerable Communities in Urban and Rural Scotland

The results show that the areas that are most vulnerable to Brexit (those in the top 20% of vulnerable datazones in Scotland) are distributed throughout the country. However, there is a higher concentration of such datazones in remote and rural locations.

Urban areas have proportionately fewer datazones in the most vulnerable 20% across Scotland, though Glasgow has more vulnerable people than any other local authority in absolute terms. Vulnerabilities in urban areas tend to be caused by low incomes. However, overall urban areas tend to have comparatively stronger demographics, more diversified economies and a better balance of working age population. They also tend to have comparatively low receipts of European CAP funding, but do receive significant amounts of European Social and Structural Funds. Likewise, most local authorities in this classification are located in the central belt, thus have relatively better access to services, higher incomes and positive demographics. Therefore, whilst urban areas are still at risk from the impacts of leaving the EU, these risks are proportionately lower, on average, than those faced by rural areas.

In rural areas there are higher likelihoods of vulnerabilities. Geographical remoteness in itself is likely to increase an area's vulnerability as communities at the end of supply chains are likely to see greater impact from disruption to imports and exports. In addition, longer travel times and smaller labour markets mean individual labour market impacts can have disproportionate effects in such locations. This is compounded by the wider Brexit vulnerabilities that rural locations typically face. For example, CAP funding, tends to be concentrated in rural communities, so future risks to funding are highest in those communities. Depopulation is also more common in rural communities, and as larger urban areas tend to have more diversified economies, and concentrations of workers in Brexit sensitive sectors are less common.

Most Vulnerable Communities within each local authority

The following analysis looks in more detail at the 20% of communities in Scotland identified as being most vulnerable to Brexit.

The chart below summarises the concentration of these datazones across each local authority. It shows 53% of communities in Na h-Eileanan Siar at datazone level are within the 20% most vulnerable communities in Scotland; in the Shetland Islands it is 50%, and 49% of those in Argyll and Bute. This reflects the high concentration of the workforce in Brexit vulnerable sectors such as fishing and agriculture; relatively high European CAP funding receipts and poorer access to services, though there is variation within these areas.

The areas that have the lowest concentrations of Brexit vulnerabilities are Edinburgh, East Dunbartonshire, East Renfrewshire, and Midlothian. These local authorities share several characteristics: all are located on or near the central belt and have relatively diversified economies. All have had significant population growth over the past decade which helps shelter them against depopulation vulnerabilities and have

relatively low levels of deprivation. As noted, such locations are not immune from the risks of Brexit, and they all face clear risks, and have areas which are in the most vulnerable 20%. However, these risks are relatively lower than for more deprived urban or more rural locations.

Figure 4 Shares of most Brexit vulnerable datazones by local authority

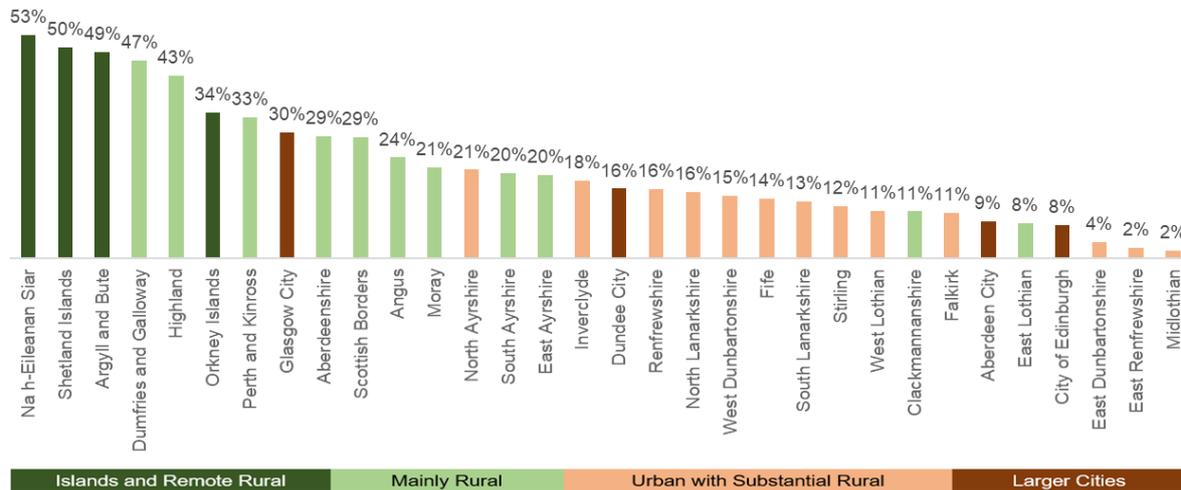


Figure 4 shows the proportion of datazones which are in the nationally most vulnerable 20% for each local authority. The bars are coloured according to the RESAS classification of the rural economy for local authorities. Broad differences between rural and urban areas are clear:

- Rural local authorities tend to have the greatest shares of communities which are included in the 20% most vulnerable
- Urban areas tend to have the smallest shares of communities which are included in the 20% most vulnerable
- Figure 4 shows that the areas that have the lowest concentrations of Brexit vulnerabilities are Midlothian, Edinburgh, East Dunbartonshire and East Renfrewshire. These local authorities share several characteristics: all are located on or near the central belt and have relatively diversified economies. All have had significant population growth over the past decade which helps shelter them against depopulation vulnerabilities and have relatively low levels of deprivation.

Figure 4 however does not reflect the number of people living in most vulnerable areas. Figure 5 below, shows the distribution of the population living in the 20% most vulnerable Scottish datazones by local authority and thus directly links with Figure 4. Figure 5 highlights that whilst urban local authorities have a lower share of the most vulnerable datazones, the population living in these areas is larger. For example, 186,000 people in Glasgow live within the most vulnerable datazones in Scotland, more than any other local authority. Likewise, nearly 170,000 people in Fife, North and South Lanarkshire and Edinburgh combined are living within the most vulnerable datazones in Scotland.

Figure 5 Shares of population in most Brexit vulnerable datazones by local authority

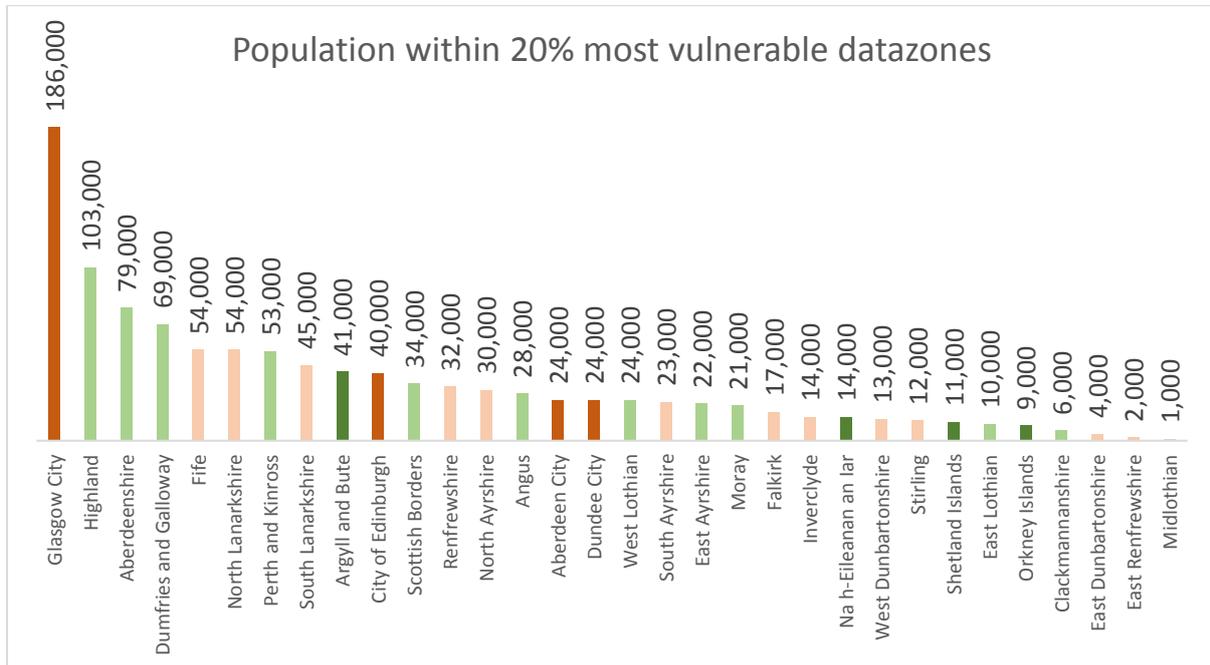
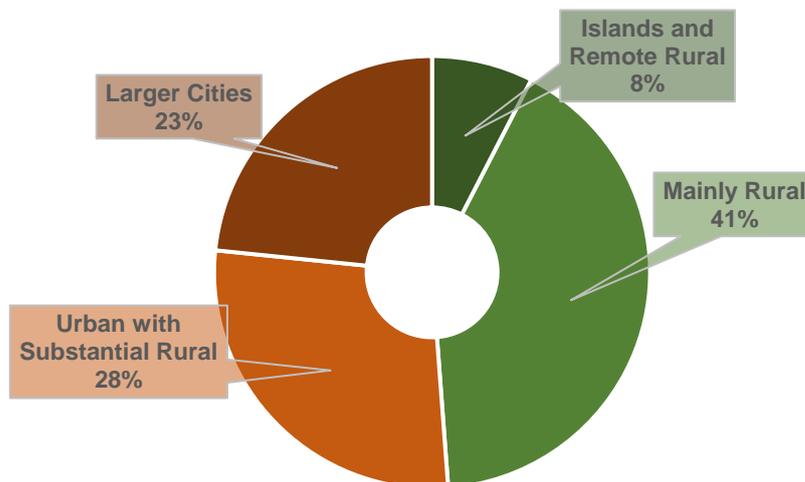


Figure 6 below shows where the 20% most vulnerable communities are located within Scotland, using the LA urban-rural classification. This means we can see the overall share between urban and rural of the most vulnerable communities.

Figure 6 Share of the 20% most vulnerable communities by type of community



This analysis shows that Mainly Rural communities account for two fifths (41%) of the most vulnerable 20% datazones. More than a quarter of the most vulnerable communities are located in Urban with Substantial Rural communities, 23% in Larger Cities and only 8% in Islands and Remote Rural communities. So overall, whilst vulnerability is more common in rural areas, because of the population differences, more datazones (and therefore more people) live in urban or suburban areas at risk

of Brexit. This is explored in Figure 7 below which shows the distribution of people living in the most Brexit-vulnerable communities compared with their overall shares of the population

Figure 7 Distribution of Populations in Most Vulnerable Communities

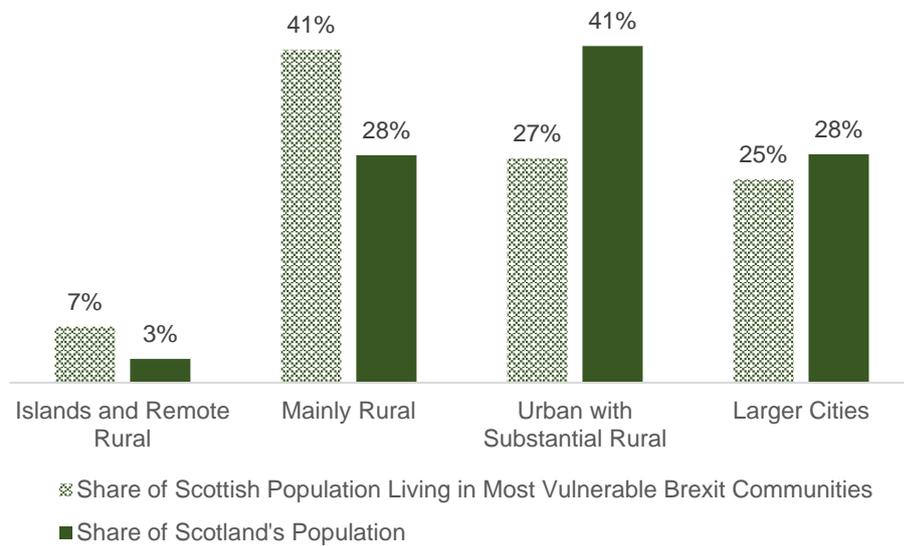


Figure 7 above illustrates the size of the population within each classification overall and the share of those people living in the 20% most vulnerable datazones. The figure shows that whilst the population in Islands and Remote Rural local authorities only accounts for 3%, and in Mainly Rural only for 28% of the Scottish overall population, the share of the population living in vulnerable datazones is substantially higher with 7% in Islands and Remote and 41% in Mainly Rural. In Urban with Substantial Rural local authorities and in Larger Cities, the population is relatively less at risk. Nevertheless, around a quarter in each of the more urban areas live in the most vulnerable datazones.

4. Mapping Vulnerabilities across Scotland

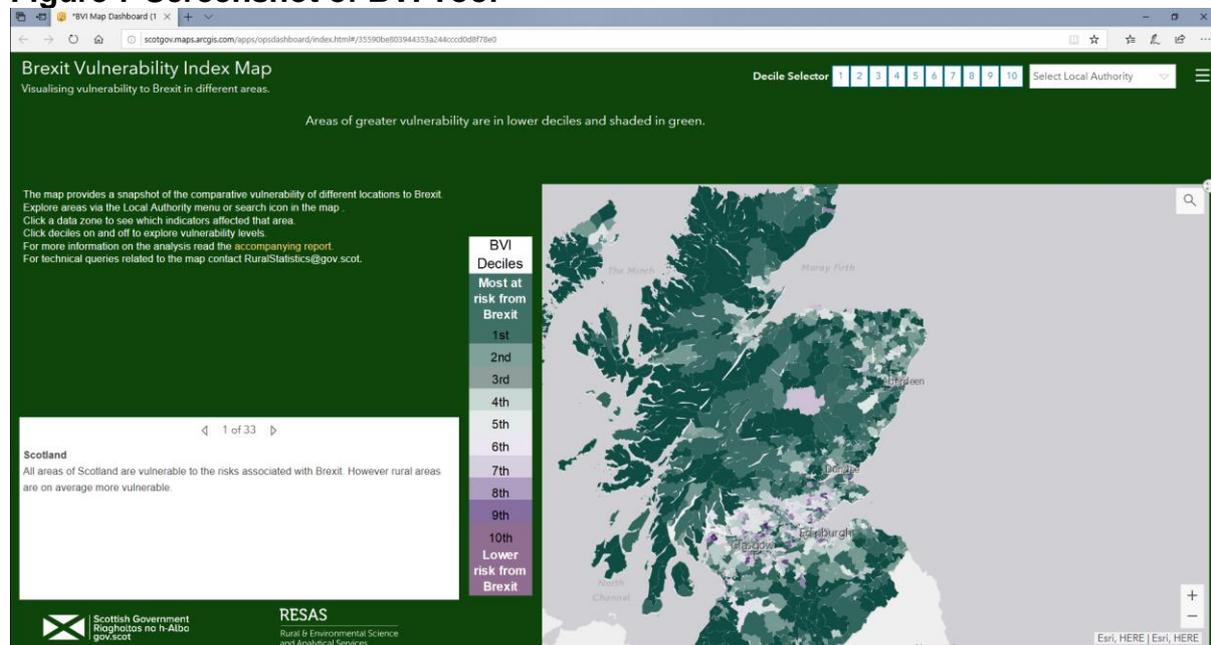
This chapter provides a detailed description of the interactive mapping tool that is available at <https://bit.ly/30W1UVQ>. This tool shows local results for each datazone in Scotland, and for each local authority area.

The interactive map is designed to support local authorities' and other organisations in understanding local risks around EU exit and to complement their wider knowledge and analysis. Whilst results are provided for individual datazones, these should not be viewed in isolation. The risks that an individual datazone faces will depend on a range of wider factors such as the vulnerability of the wider region in which is it located, commuter patterns and unique local characteristics.

The Interactive Brexit Vulnerability Index Map

As described in the previous Chapter, the Brexit Vulnerability Index Score is an additive index combining all eight factors listed in Table 2²⁴. The Brexit Vulnerability Index Map visualises vulnerability to Brexit in different areas. The first map that appears when clicking on the link is the Scotland overall map. Areas most at risk from Brexit appear in darker green and areas that are relatively less vulnerable are shaded in dark purple. The colour shades represent deciles. In other words, the 1st decile illustrates those areas that are amongst the 10% most vulnerable datazones, the 10th decile the 10% least vulnerable ones. Every decile therefore captures around 700 datazones.

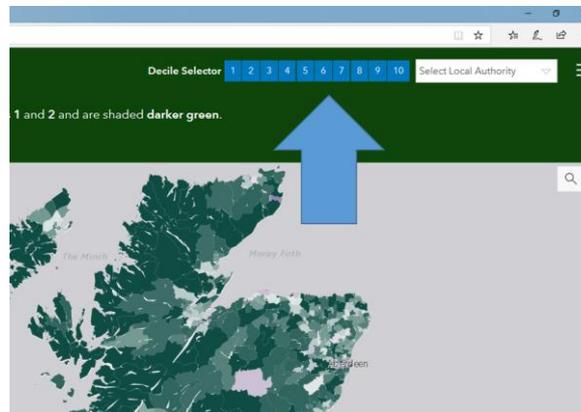
Figure 7 Screenshot of BVI Tool



²⁴ These indicators are: access to services, working age population share, income deprivation, population change, workers in Brexit-sensitive industries, EC payments (a) CAP, and (b) ESF and ESO to the area, and National Insurance Number registrations by EU nationals (see [Table 2](#)).

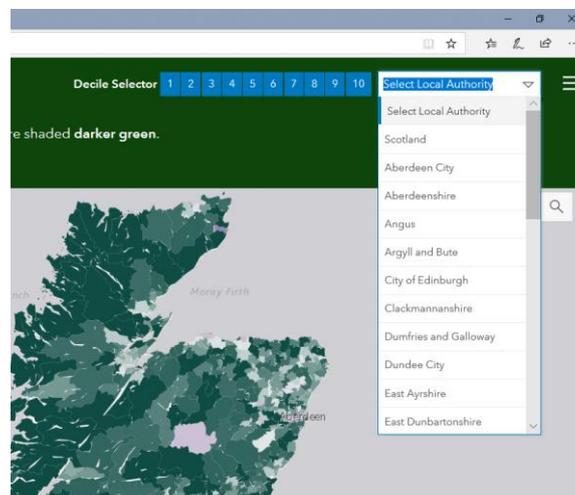
On the top right of the website, deciles can be selected. The user can for example select decile 1 and decile 2 and only datazones within these deciles are highlighted in the map.

Figure 8 BVI decile selector Tool



Right next to the decile selector, the user can select a local authority. The tool then zooms into the selected local authority and all datazones within the local authority become clearer. On the left side of the website a window appears providing explanation for the selected local authority.

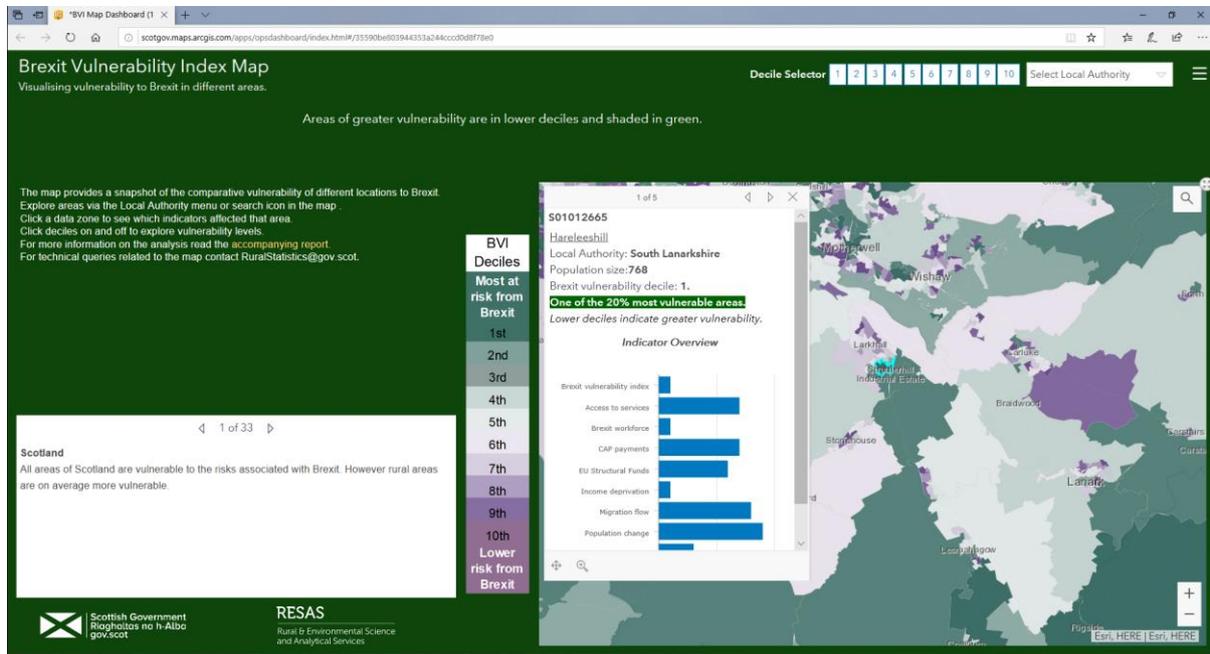
Figure 9 BVI local authority selector Tool



If a user clicks on a specific datazone, a graph appears summarising a simplified version of the data underlining the overall BVI. The top 8 bars show what decile the datazone is located, in terms of each of the variables included in the BVI. If for example a datazone appears in decile 1 for the variable “Income Deprivation” this means that it belongs to the 10% most household income deprived datazones in Scotland. If it appears in decile 10, this means that overall income is highest in this datazone. (Note that for European funding variables, decile 1 will be receiving the highest payments, and decile 10 the lowest payments.) Annex 2 explains how the

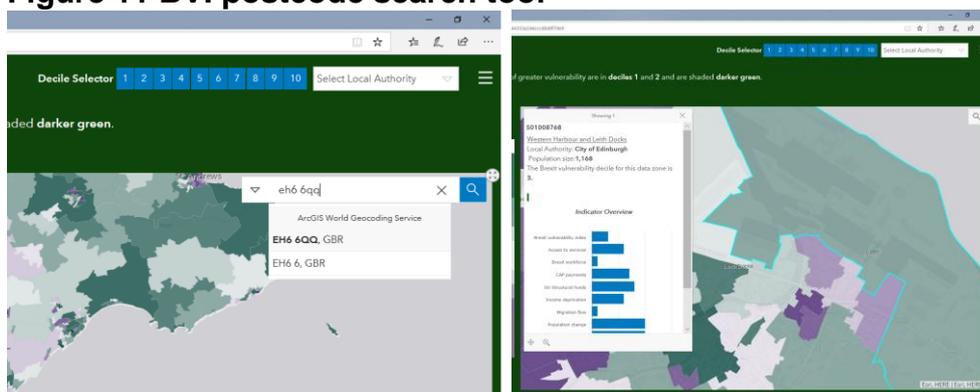
BVI is calculated and it should be noted that the deciles do not simply add up to the overall BVI.

Figure 10 BVI datazone selector Tool



Lastly, the mapping tool has a search function. The user can click on the magnifying glass in the top right corner of the map and type in a postcode or a street address. The map then zooms into the datazone the point of interest is located in and the user can click on the datazone to get additional information.

Figure 11 BVI postcode search tool



A spreadsheet including both the data underlying the mapping tool, but also additional data that can be used to recalculate the BVI score is published alongside this report.²⁵ This allows users to also readjust the weights applied. Annex 2 explains how the BVI was calculated using ranked data.

²⁵ The data are available here: <http://www.gov.scot/isbn/9781839601248>

5. Conclusion

Brexit will affect communities across Scotland in different ways. This research shows at datazone – or community – level where in Scotland is likely to be most vulnerable to Brexit. It does so by identifying the factors which will influence a community's vulnerability, and assesses the extent to which the characteristics of different communities makes them more or less vulnerable to Brexit.

The analysis does not anticipate a specific Brexit scenario. Instead, it starts from the assumption that leaving the EU will create a number of challenges, and that whilst different Brexit outcomes may exacerbate or alleviate the scale of these challenges, the underlying drivers would be the same.

The analysis looks at data on eight variables and produces a Brexit Vulnerability Index score for each datazone area in Scotland. Key findings are that many of the most vulnerable areas to Brexit are rural areas.

Overall the analysis shows that 53% of communities at datazone level in Na h-Eileanan Siar are within the 20% most vulnerable communities in Scotland; 50% of those in the Shetland Islands, 49% of those in Argyll and Bute and 34% in the Orkney Islands. This equates to over 75,000 people in total. This reflects the high concentration of the workforce in Brexit vulnerable sectors such as fishing and agriculture; relatively high European funding receipts and rurality, though there is variation within these areas.

Many of the most vulnerable areas are in Mainly Rural local authorities. This does not mean that urban areas would not see a negative impact from Brexit, but that on average rural communities are typically relatively more exposed to the risks that Brexit represents.

However, Brexit is clearly not a purely rural problem. For example, 186,000 people in Glasgow live within the most vulnerable datazones in Scotland, more than any other local authority. Likewise, nearly 170,000 people in Fife, North and South Lanarkshire and Edinburgh combined are living within the most vulnerable datazones in Scotland.

Annex 1 Data Tables

Table A1.1: Most vulnerable communities

Local Authority	RESAS Classification	Relative share of datazones amongst most vulnerable 20%	Number of datazones amongst most vulnerable 20%	Population in datazones amongst most vulnerable 20%
Aberdeen City	Larger Cities	9%	25	23,630
Aberdeenshire	Mainly Rural	29%	98	78,759
Angus	Mainly Rural	24%	37	28,490
Argyll and Bute	Islands and Remote Rural	49%	61	41,243
City of Edinburgh	Larger Cities	8%	47	40,060
Clackmannanshire	Mainly Rural	11%	8	5,992
Dumfries and Galloway	Mainly Rural	47%	94	68,502
Dundee City	Larger Cities	16%	31	24,355
East Ayrshire	Mainly Rural	20%	32	21,817
East Dunbartonshire	Urban with Substantial Rural	4%	5	4,475
East Lothian	Mainly Rural	8%	11	9,914
East Renfrewshire	Urban with Substantial Rural	2%	3	2,161
Falkirk	Urban with Substantial Rural	11%	23	16,870
Fife	Urban with Substantial Rural	14%	70	54,281
Glasgow City	Larger Cities	30%	223	185,573
Highland	Mainly Rural	43%	135	102,621
Inverclyde	Urban with Substantial Rural	18%	21	13,548
Midlothian	Urban with Substantial Rural	2%	2	1,440
Moray	Mainly Rural	21%	27	21,489
Na h-Eileanan Siar	Islands and Remote Rural	53%	19	13,961
North Ayrshire	Urban with Substantial Rural	21%	39	29,657
North Lanarkshire	Urban with Substantial Rural	16%	70	53,912
Orkney Islands	Islands and Remote Rural	34%	10	8,835
Perth and Kinross	Mainly Rural	33%	62	53,108
Renfrewshire	Urban with Substantial Rural	16%	37	31,995
Scottish Borders	Mainly Rural	29%	41	33,960
Shetland Islands	Islands and Remote Rural	50%	15	11,376
South Ayrshire	Mainly Rural	20%	31	23,381
South Lanarkshire	Urban with Substantial Rural	13%	58	45,299
Stirling	Urban with Substantial Rural	12%	15	11,593
West Dunbartonshire	Urban with Substantial Rural	15%	18	13,011
West Lothian	Urban with Substantial Rural	11%	27	23,607
Scotland²⁶		100%	1,395	1,098,915

²⁶ Scotland total for population does not equal the sum of the constituent parts due to rounding.

Annex 2 Technical Annex

The Brexit Vulnerability Index (BVI)

The Brexit Vulnerability Index is an index which combines data from 8 indicators. Each indicator has been chosen as it provides quantifiable evidence likely to provide either a direct or indirect measure of issues relating the UK leaving the EU. This suite of indicators provides data for each of the 6,976 datazones in Scotland. Datazones are small area geographical units used for statistical measurement with a population of around 770 people.

Eight variables are used to calculate the BVI:

- Access to Services;
- Working age population;
- Income deprivation ranking;
- Population Change;
- Workers in Brexit sensitive industries;
- EC Payments received through
 - CAP and
 - ESF and ERDF; and
- EU Worker Migration.

The rationale for selecting each of the specific variables is discussed in Chapter 3 of the report.

Each variable is first standardised by ranking the values. This is necessary because the variables are measured on different scales and by ranking the variable it is ensured that they have identical distributions with the same range and therefore maximum and minimum values.

However, using the ranks alone would result in distributions which are symmetrical, and one variable indicating vulnerability could be fully 'cancelled out' by lack of vulnerability in another. This does not reflect the prior distribution of the variables and gives undue weight to the least vulnerable scores.

Simply using the symmetrical ranks is inappropriate given that high ranks signify less vulnerability and do not imply a lack of vulnerable to Brexit. A transformation is required to address these issues and the exponential transformation of the ranks was chosen as the most appropriate method. This is in line with the methodology used by the Scottish Index of Multiple Deprivation (SIMD).²⁷

The exponential transformation deals with this question of variables cancelling each other out. It has the advantage that every variable is converted to an identical distribution with the same maximum and minimum values, whilst emphasising the most vulnerable 'tail' of the distribution. The transformation 'draws out' the ranks of

²⁷ <https://www2.gov.scot/Resource/0050/00504822.pdf>

the most vulnerable datazones so that spaces are introduced between datazones that reflect the actual distributions.

The formula for the calculation is:

$$X = -23 \cdot \log\{1 - R \cdot [1 - \exp(-100/23)]\}$$

where R is the rank (for the exponential transformation the least vulnerable datazone is ranked 1 and the most vulnerable datazone is ranked 6,976) transformed to the range [0,1], log is the natural logarithm and exp the exponential transformation.

The constant -23 gives a 10% cancellation property. To illustrate why this property is desirable, suppose two variables were equally weighted and a cancellation factor was not applied. A datazone which was most vulnerable on one of the variables and least vulnerable on the other would be ranked at the 50th percentile. However, it does not seem appropriate to suggest that lack of vulnerability in one variable should exactly cancel out an entirely different dimension of vulnerability in another. Using the 10% cancellation property, the datazone would be ranked within the 10% most vulnerable datazones. This was considered to be more appropriate.

Following the exponential transformation, the datazones have scores ranging between 0 (least vulnerable) and 100 (most vulnerable) on each variable. In addition, the scores increase exponentially so that the most vulnerable datazones have more prominence. The 10% cancellation factor means that the most vulnerable 10% of datazones are emphasised with scores between 50 and 100 whilst the remaining 90% of datazones have scores between 0 and 50. Thus the exponential transformation successfully deals with the issues of cancellation and symmetry.

Weights are applied based on the relative importance of each variable as discussed in Chapter 3 and based on data quality and potential correlations. The standard weight was determined at 20 or 12%, thus around one eights of the overall index.

- Whilst none of the variables are highly correlated, (defined as having a Pearson Correlation Coefficient above 0.69), the variable for **CAP** payments is moderately correlated with the variables measuring the **Brexit Workforce** and **Access to Services**. Thus, despite good data quality, it was decided to weight **CAP** down relative to the remaining variables. The weight was set at 10 or 6%.
- It was further decided to weight down **ESF** and **ERDF** due to poorer data quality. This is because payments are allocated to local authorities. In order to disaggregate data, it was decided to distribute the local authorities' payments to datazones using population weights. Therefore, **ESF/ERDF** payments by datazones are only an estimate and not as accurate as the remaining variables. ESF and ERDF are weighted with factor 5 and account for 3% of the overall BVI.
- **Income deprivation** data is both of high quality and also relatively more important than the remaining variables (see Chapter 3). Thus, the variable counts double with 24% and a weight of 40.
- **Access to Services, Population Decline** and the **Share of the Working Age Population** are given the standard weight of 20 and each account for 12% of the BVI. This is because of high data quality, weak correlation

coefficients and relative importance. However, because **Access to Services** is relatively more relevant to rural areas, it was decided not to weight this variable up. Furthermore, it was decided that because **Population Decline** and the **Share of the Working Age Population** measure similar aspects – despite being only weakly correlated – these should not be weighted up further.

- **EU National Workers**, as measured by National Insurance Registrations, are highly relevant, but because data is only available for intermediate zone and had to be allocated to datazones using population weights, the variable remains at the standard weight of 20 or 12% of the BVI.
- The share of the **Workforce in Brexit-Sensitive Industries** is highly relevant (see Chapter 3) and data quality is high. However, the indicator is weighted up, but not as highly as **Income Deprivation**. Thus, it accounts for 18% of the BVI and was given the factor 30.

The overall BVI score is then constructed by combining the exponentially transformed and weighted variables. The larger the BVI score the more vulnerable the datazone. However, in order to compare datazones it is important to use the relative order of the ranks. It is not correct for example to say that datazone X is twice as deprived as datazone Y because the BVI for X is 50 and that for Y is 25. This is due to the transformation of the data that takes place to enable a variable score to be produced. It is equally not true to say that a datazone of rank 100 is twice as vulnerable as a datazone with rank 50. However, a datazone of rank 75 is more vulnerable than a datazone of rank 125.

Annex 3 List of Acronyms

Acronym	Meaning
BVI	Brexit Vulnerabilities Index
CAP	Common Agricultural Policy
EC	European Commission
EEA	European Economic Area
ESF	European Structural Fund
ESOF	European Social Fund
EU	European Union
ERDF	European Regional Development Fund
EY	Ernst and Young accountants
GDP	Gross Domestic Product
GVA	Gross Value Added
LA	Local Authority
NiNo	National Insurance Number
NOMIS (BRES)	National Labour market statistics information Business Register and Employment Survey
SIMD	Scottish Index of Multiple Deprivation
WTO	World Trade Organisation



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