# Understanding regional economic performance and resilience in the UK: trends since the Global Financial Crisis

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**Abstract**

We investigate economic resilience of UK regions before, during and after the 2007/08 global financial crisis. We date business cycle turning points in GVA, employment and productivity to assess the resilience dimensions of resistance, recovery and renewal and rank the economic resilience of regions with a scorecard. Our empirical work reveals that the business cycle in productivity has returned to its pre-recession peak level for all but one UK region (Yorkshire and Humberside) and for 27/40 sub-regions. We find that sub-regions with greater specialisation, higher rates of investment and skills suffered less loss during the recession and subsequently recovered quicker.

Keywords: economic resilience, regional disparities, productivity, business cycles.

JEL classification: C22, E32

## Introduction

The headline figures for the UK national economy mask huge regional disparities and the gap is growing between London and other UK regions and countries. The UK has the greatest spatial disparity among European countries in terms of GDP per head (see Wong et al, 2019). The Industrial Strategy Commission (2017) stated that this extraordinary regional imbalance is "now a major drag on the performance of the whole UK economy, with deleterious effects on productivity and fiscal balance", (p.87). These disparities have widened since the global financial crisis, with some regions demonstrating greater economic resilience while others have been slow to recover. The UK economy has also suffered from a "productivity puzzle" of very low growth in national productivity since before the financial crisis, see McCann (2018). Many explanations have been put forward for the low growth in productivity including the stalling of investment and innovation (Sichel, 2019), digital and communication technologies being undercounted in the UK accounts (Coyle, 2018) and the rise in low paid and insecure work (Forth and Aznar, 2018). Our contribution to the literature is to analyse the economic resilience of UK regions over the course of the financial crisis in terms of their output, employment and labour productivity. We apply a business cycle dating algorithm to retrieve individual turning points for the regional series between 1998-2017. Based on our set of resilience measures for resistance, recovery and renewal we create a resilience scorecard to rank the UK region's resilience at the NUTS 1 and 2 levels.

To preview our results, our empirical work reveals that real productivity has returned to its pre-recession peak level for all but one NUTS 1 region (Yorkshire and Humberside) and for 27 out of 40 NUTS 2 regions (up to 2017). Most UK region's real GVA series have returned to their pre-recession levels but rapid job growth in many regions (apart from the North East and Scotland) has reduced productivity growth rates. The South East and the sub-regions within this are the most resilient regions according to our resilience scorecard, with the North East and Yorkshire and Humber regions being the least resilient. Finally we present the results of our cross-section regression analysis and find that sub-regions with greater specialisation (particularly in the higher-tech knowledge economy), higher rates of investment and higher skill levels suffered less loss during the recession and subsequently recovered quicker. Our resilience scorecard could be useful for local policy makers and the Industrial Strategy Council to help identify regional disparities. The structure of the paper is as follows: in the next section we review the literature on economic resilience; in section 3 we describe our business cycle dating methodology along with the data and statistical measures we calculate to measure regional resilience; in section 4 we present the empirical results for the business cycle turning points and resilience scorecard; in section 5 we discuss the factors of resilience and the results from the cross-section regressions and conclude in section 6.

**Understanding Economic Resilience**

Regional economic resilience is defined as the capacity of a regional economy to withstand, recover from and reorganise in the face of market, competitive and environmental shocks to its developmental growth path (Bristow and Healy, 2014; Martin and Sunley, 2014). The root cause of these shocks could be global (the 2008 financial crisis), national (1990s house price crash) or local (closing of a factory) in nature. Martin (2012) analysed the resilience of UK regions and defines four dimensions of economic resilience to describe how a regional economy responds to a recessionary shock. The first is resistance which is the sensitivity of a region compared to the nation during the recession. The second is the speed and extent of the recovery from the recession. The third is assessing if the region had undergone structural re-orientation and what implications this has for the region's jobs, output and income. The fourth is the degree of renewal a region will undergo following the shock and the extent to which it renews its growth path.

A number of empirical studies have examined UK regional resilience. Martin and Gardiner (2019) chart 85 UK cities economic resilience over three recessions and four decades and they forecast how city regions could respond to a Brexit shock. They discover that northern cities have lower recoverability rates from recession than southern cities and that generally city recoverability has declined with distance from London. Kitsos and Bishop (2018), study local authorities employment rates in Great Britain and estimate cross-section regressions where the dependent variable is the impact of the recession on the employment rate. They find that areas with higher initial employment rates experienced greater falls in employment over the downturn and that this impact was greater for the North of England and West Midlands. They also found that those areas with a greater share of higher level skills and younger populations had less employment declines. Lee (2014) found that UK cities with higher skill levels had the smallest increase in unemployment over the 2008-09 recession. Martin et al (2016) state that economic structure of places varies across the UK and the degree of foreign ownership, the geographical distribution of supply chains, export orientation and legacy of the inherited labour market (see also Gherhes, et al 2018) all play a part in why some regions are more resilient than others. Bailey and Berkeley (2014) discuss the operation of the West Midland's Regional Taskforce that was set up to deal with business and employment issues during the downturn to ensure resilience over the short and longer term. They document a number of central and local government funds that were set up to help firms access credit and advice during the downturn. The retention of institutional memory and lessons from dealing with the 2005 closure of the Rover plant were vital in helping deal with 2008 recession. They suggest the resilience dimensions of resistance and recovery were important in the short-term but then the renewal and reorientation of the local automotive sector to diversify into low carbon and higher value activities were important for long-term planning.

A European Commission project, Resil.net, has produced a dashboard of indicators for European countries and regions resilience. Manca et al (2017) propose a framework for societal resilience and suggest a society can resist shocks (absorptive capacity); adopt a degree of flexibility in making changes (adaptive capacity) and may need larger system change (transformative capacity). Benzcur et al (2018) analyse stages of resilience through an economic cycle and compare the characteristics of the resilience phases with factors that affect resilience for countries. Pontarollo and Serpieri (2018) analyse the life cycle of resilience for European NUTS 2 level regions utilising stages of the cycle to create a regional economic resilience indicator. Both this study and the Benzcur et al (2018) paper use fixed turning points. Studies that have examined the resilience of US counties include Han and Goetz (2015) who find that counties employment level that entered recession earlier had longer downturns and that those adjacent to metro areas experienced more serious shocks. Ringwood et al (2019) measure resilience of US counties over the 2007-09 shock and find that farming dependent counties in rural locations were the most resilient compared to those reliant on manufacturing. Lewin et al (2017) analyse US counties personal income and find that counties with increased income inequality entered recession earlier, they suggest this could be due to falling personal savings and increased credit in the run up to the financial crisis.

In contrast to previous studies that largely rely on the onset of the recession to be the same time period for each region within a country our research individually dates business cycle turning points for regions. In Sensier et al (2016) we analyse the effect of the global financial crisis on regions across Europe. We compare GDP and employment as the reference state for European NUTS 2 regions and apply a business cycle dating algorithm to individual regions to allow flexibility so regions can have different turning points (peaks and troughs) in their economic cycle. This allows for some regions to lead and some to lag the movements in their national business cycle. This approach enabled us to assess if each region's GDP and employment were resistant to the crisis or if they experienced recession, we were then able to quantify the duration and depth of the downturn in economic variables to map the progress and the impact of the crisis across Europe. An additional contribution of our study is the introduction of an economic resilience scorecard which allows us to rank places based on their resilience measures of resistance, recovery and renewal compared to the national average before, during and after the financial crisis. This gives a fuller picture of the evolution of regional growth paths before and after the crisis. Our cross-section regressions then allow us to test a range of explanatory factors to investigate if a range of variables affect regional economic resilience.

**Business Cycle and Resilience Methodology**

Our approach builds on Sensier and Artis (2016) which dates countries within the UK employment cycles, and adds flexibility to the approach of Martin (2012). The economy can

be in either of two mutually exclusive phases: expansion phase ($E_t$) or recession phase ($R_t$). The convention is that a peak terminates an expansion and a trough terminates a recession. To enforce the alternation of peaks and troughs it is useful to distinguish turning points within these two phases:

$$E_t \equiv \begin{cases} CE_t \\ P_t \end{cases}$$
$$R_t \equiv \begin{cases} CR_t \\ T_t \end{cases} \quad (1)$$

From the continuation of expansion ($CE_t$) we can make a transition to the peak ($P_t$) or continue the expansion, but not vice versa as only $P_t \rightarrow CR_{t+1}$ is admissible. Analogously, from continuation of recession ($CR_t$) we can make a transition to the trough ($T_t$) and $T_t \rightarrow CE_{t+1}$ with the probability of 1. The dating rules impose a minimum duration of a phase of 1 year as we are analysing annual data. We also impose the minimum length of the entire business cycle (from peak to peak) to be 3 years. The maximum length of cycle is unlimited and if two business cycle phases occur in quick succession then the maximum (highest peak) is dated as the start of the cycle and the minimum (lowest trough) is the end of the cycle, this could then take in two cycles (a 'double dip' recession). In the Empirical Results section we utilise the business cycle turning points dating algorithm in Stata 14 program adapted from Harding and Pagan (2002).

We assess how UK regions fared in the run up to the financial crisis, then during the recession and how they subsequently recovered. We compare two regional levels of data (NUTS 1 and 2) and assess economic performance with the Office for National Statistics (ONS) time series of regional real balanced Gross Value Added (GVA) produced in 2016 pounds which takes account of regional price differences (see ONS, 2018b). UK national GVA is the sum of the regions and countries and excludes Extra-Regio which is the activity that cannot be assigned to regions (this is to match the number of productivity jobs as the UK total is less Extra-Regio). The employment series is the amount of productivity jobs from the latest sub-regional productivity release ONS (2019). We calculate real productivity as:

Real Productivity = Real GVA/Productivity Jobs (2)

When we have established the turning points of the business cycle we can calculate a range of indicators that will be utilised in the resilience scorecard and in the cross-section regressions. We calculate the LOSS over the recession where we take the difference in the level of employment in a region ($Emp_r$) between the peak and trough dates and divide this by the level at the peak, multiplying by 100 to show a percentage loss:

$LOSS$=100.($Emp_{peak\_r}$ - $Emp_{trough\_r}$)/ $Emp_{peak\_r}$] (3)

The duration of the recession is the difference in years between the trough and peak dates.

To compare the resistance of regions to the nation we compute a sensitivity index ($\beta_r$) from Martin (2012) which is the percentage change in the variable, here for employment lost in a region ($Emp_r$) compared to that lost at the national level ($Emp_n$), between peaks and trough turning points as follows:

$$\beta_r=[100.(Emp_{peak\_r} - Emp_{trough\_r})/ Emp_{peak\_r}]/[100.(Emp_{peak\_n} - Emp_{trough\_n})/ Emp_{peak\_n}] \quad (4)$$

If the value of $\beta_r > 1$ then the region has lost a greater percentage of employment than the nation and is less resistant to the recession but if the $\beta_r < 1$ then the region has lost a smaller share of employment than the nation and is more resistant to the recession than the nation.

We calculate the expansion average growth rate (EAGR) to measure the 5 year average of the growth rate (first difference of the natural log) before the recession including the date of the peak year. Following the recession we calculate the rate of growth for the series after the trough by taking the second expansion average of the growth rate (E2AGR) for 5 years. To rank UK region's economic resilience we present a resilience scorecard that compares regional statistics before, during and after the recession to assess a region's growth path. The resistance of regions are compared to the nation as the benchmark along with how quickly they recovered from the crisis. The renewal measure compares the growth rates 5 years before the recession and then 5 years after the recession. A greater rate of increase after the recession indicates that the region is accelerating to a higher growth path. The date of recovery is noted when the region has regained its pre-recession peak level or if by 2017 (last year available) it has not recovered (NR). The economic resilience scorecard ranks the resilience measures for all UK regions. We will compare 4 statistics for each region over the recession and up to 2017, including:

1. **RESISTANCE**: Has the fall in GVA/jobs/productivity been less than the national decrease (so is the sensitivity index $\beta_r < 1$)?
2. **DURATION**: Has the duration of the recession been shorter or the same as the national recession?
3. **RECOVERY**: Has the region recovered faster or at the same time as the nation?
4. **RENEWAL**: Was the rate of growth after recession greater than before (E2AGR> EAGR)?

If the answer to the above question is yes then the region is classified as being more resilient than the national data series and is coded 1, if no it is less resilient and coded 0. Based on the binary response to these questions we sum up all regions over 4 statistics for 3 variables, so the highest score for a region if it has been very resilient is 12.

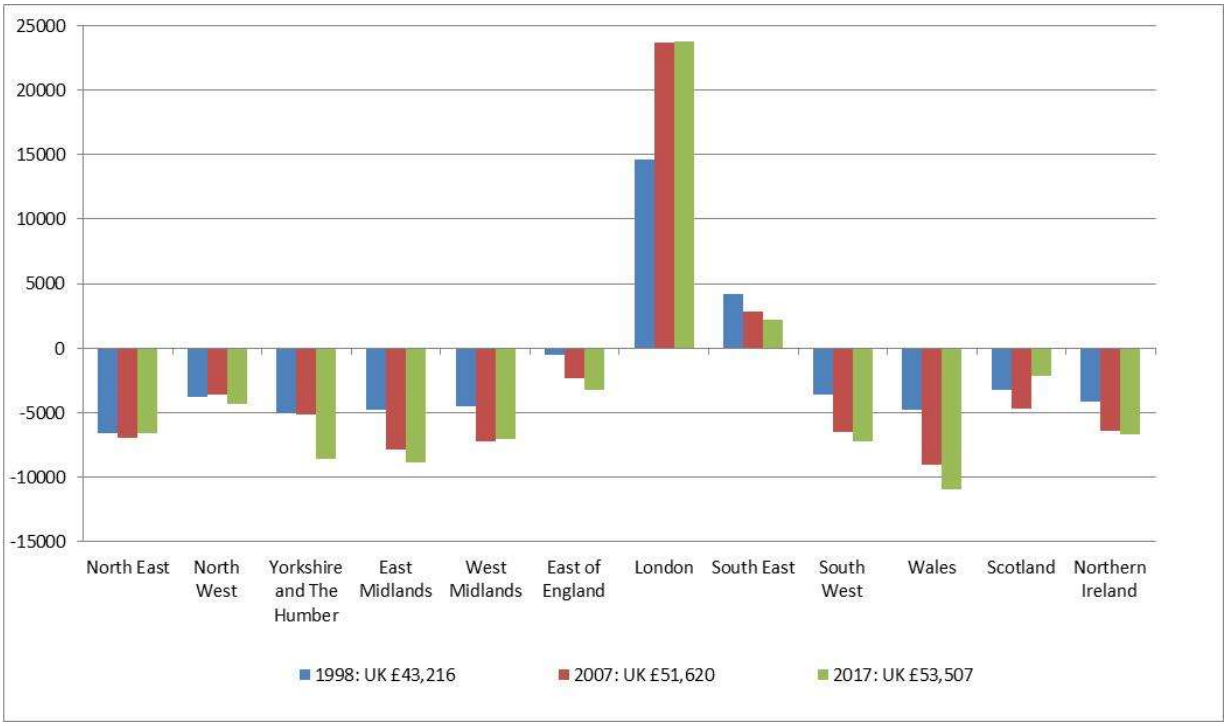
**Regional Business Cycles**

Initially we will compare the regional shares of national GVA and jobs for regions and countries of the UK at the NUTS 1 level. In Table 1 the regional shares of real GVA are shown for three years: 1998, 2007 & 2017, and then for productivity jobs for 1998, 2008 and 2017 (2007 is the most frequent peak date for GVA and 2008 the most frequent peak date for jobs). The regional share of GVA for most regions has fallen between 1998 and 2017 with the exception of London which has grown from almost 20% share of real GVA in 1998 to 24% in 2017. The productivity jobs series have followed a similar pattern but London and the South East have slightly increased their share of total employment along with the East of England and Wales. In terms of real productivity we compare the productivity gap between each region with UK national productivity level in Figure 1. The ONS estimates of real productivity per job filled in 2017 for the UK was £53,507, with the highest region being London (£76,238), middle of the range are the North West (£48,683) and the West Midlands (£47,077) and the lowest is Wales (£44,037). From Figure 1 we can see that as the London share of output and employment is increasing the productivity gap with the UK is widening over time and the negative gap is growing for Yorkshire and Humberside, East Midlands, East of England, the South West, Wales and Northern Ireland.

**Table 1: Regional Shares of National Real GVA and Jobs (percentages of UK total)**

| | Real GVA | | | Productivity Jobs | | |
|---|---|---|---|---|---|---|
| **Region** | **1998** | **2007** | **2017** | **1998** | **2008** | **2017** |
| North East | 3.23 | 3.23 | 2.95 | 3.82 | 3.72 | 3.37 |
| North West | 9.89 | 10.01 | 9.62 | 10.85 | 10.72 | 10.47 |
| Yorkshire and The Humber | 7.18 | 7.24 | 6.46 | 8.13 | 7.97 | 7.69 |
| East Midlands | 6.17 | 5.89 | 5.76 | 6.94 | 6.84 | 6.9 |
| West Midlands | 8.02 | 7.30 | 7.36 | 8.96 | 8.45 | 8.48 |
| East of England | 8.74 | 8.59 | 8.48 | 8.84 | 8.96 | 9.02 |
| London | 19.86 | 21.9 | 24.01 | 14.84 | 15.35 | 16.63 |
| South East | 15.24 | 14.7 | 14.81 | 13.89 | 13.92 | 14.23 |
| South West | 7.7 | 7.41 | 7.25 | 8.40 | 8.47 | 8.38 |
| Wales | 3.72 | 3.59 | 3.44 | 4.19 | 4.33 | 4.33 |
| Scotland | 7.91 | 7.79 | 7.67 | 8.56 | 8.59 | 7.99 |
| Northern Ireland | 2.33 | 2.34 | 2.19 | 2.58 | 2.68 | 2.5 |

**Figure 1: Difference between National and Regional Productivity over time**




The dates of the turning points for each region are shown in Table 2. Here we can see that UK GVA peaks in 2007 with the majority of NUTS 1 areas, the North East (NE) leads the national recession and starts one year earlier. Scotland (SC) and southern and the East of England (ET) region lag the national turning point by one year and start the recession in 2008, exiting recession after the trough turning point in 2009. The last two areas to come out of recession are Northern Ireland (NI) and Yorkshire and Humberside (YH). The employment series generally peaks a year later than GVA in 2008 for most areas apart from the East Midlands (EM) which reaches its peak turning point in 2007. The North East and Northern Ireland experience the longest downturn in jobs of 4 years exiting recession after the trough in 2012. Most regions reach peak productivity turning points in 2007 with the South West (SW) reaching it one year earlier in 2006. Scotland, the East Midlands and the South East (SE) only experience one year of decline in productivity and the longest recessions of 3 years are experienced in the South West, Northern Ireland and Yorkshire and Humberside.

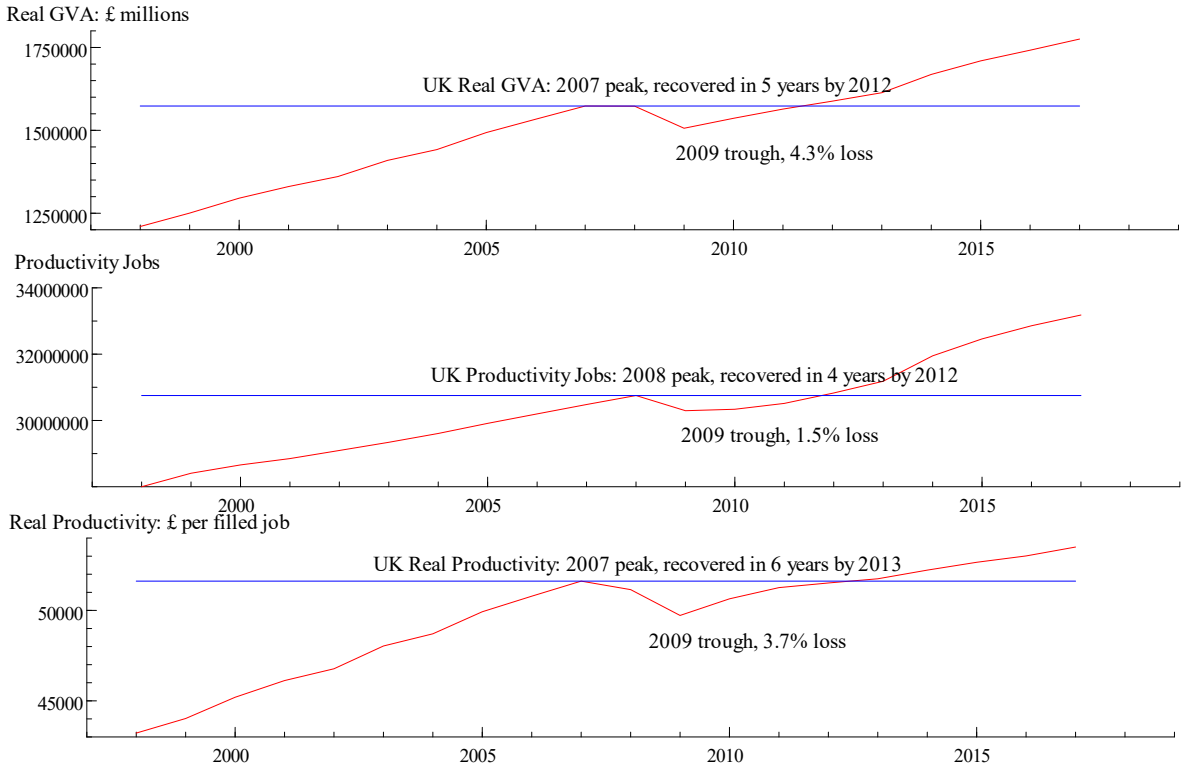
**Table 2: Timeline of Turning Points in the Recession for Real GVA, Jobs and Productivity**

| Measure | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| Peak GVA | NE | UK, NW, YH, EM, WM, WL, NI | ET, LN, SE, SW, SC | | | | |
| Trough GVA | | | | UK, NE, NW, EM, WM, ET, LN, SE, SW, WL, SC | YH, NI | | |
| Peak Jobs | | EM | UK, NE, NW, YH, WM, ET, LN, SE, SW, WL, SC, NI | | | | |
| Trough Jobs | | | | UK, EM, SE, SW, WL, | YH, WM, ET, LN, SC | NW, WL | NE, NI |
| Peak Productivity | SW | UK, NW, YH, WM ET, LN, WL, SC, NI | EM, SE | | | | |
| Trough Productivity | | | SC | UK, NE, NW, EM, WM, ET, LN, SE, SW, WL | YH, NI | | |

Charts of the UK national series are shown in Figure 2 against which we benchmark the regions. Here we can see that GVA sustained a deeper recession (-4.3%) than jobs (-1.5%, also found by Gregg and Wadsworth, 2010, who suggested that employers held onto workers and cut hours and pay rather than make them redundant) and took longer to recover its peak level after 5 compared to 4 years. Real productivity suffered a -3.7% fall but was slower again to recover its peak level after 6 years. We present the turning points and resilience measures for real GVA in Table 3 which shows that the largest GVA loss over the recession was for Yorkshire and Humberside at -7.5%, then Northern Ireland with a loss of -6.5%, both these areas had the longest recession duration of 3 years, along with the North East. The West Midland's (WM) GVA loss of -6.4% was over 2 years and Bailey and Berkeley (2014) also document the large rise in unemployment during the recession for the West Midlands and the strong recovery in 2010. They suggest the West Midlands was particularly at risk during the recession due to "long-term underinvestment in infrastructure; an ongoing process of deindustrialization and a wider economic structure reliant on low volume, low growth sectors; a relatively poor business and employment performance in the private sector; a relatively poor education and skills record; relatively poor performance in

developing 'knowledge economy' sectors and in R&D spend; and pockets of high levels of unemployment and worklessness" (p.1802).

**Figure 2: UK Real GVA, Jobs and Productivity Business Cycle Measures**




In Table 3 the sensitivity index in the fourth column is the regional loss over the recession divided by the UK aggregate GVA loss. We find that the North East, North West (NW), South East, South West and Scotland had lower GVA percentage loss than the national series so were more resistant. The first regions to recover their pre-recession peak level in 2011 were London (LN), the South East and Scotland and the longest recovery duration for GVA of 9 years was for the North East and Yorkshire and Humberside. The average rate of GVA growth after the recession was higher than before the recession (E2AGR>EAGR) for the West Midlands, East of England, South East and South West so for 5 years following the recession these regions moved to a higher growth path. Some regions experienced further falls in the GVA growth rate after the financial crisis, in particular the North East GVA declined over 2012-13 and in 2016 as also found by Koop, et al (2018). The North West GVA growth rate fell in 2011 as did the South West, with Yorkshire and Humberside experiencing a small decline in 2012. In Figure A.3 we show the deep recession in Yorkshire and Humberside's GVA (-7.5%) but there is a shallow loss of employment (-0.5%), meaning that productivity is reduced markedly when the jobs recovery starts after 2013 as they grow faster than GVA keeping productivity growth flat, which does not recover its peak level.

**Table 3: Real GVA Real BC Turning Points and Resilience Measures NUTS 1 regions**

| Region | Peak year | Trough year | Loss Peak to Trough | Beta - Resist | Year Recover | EAGR | E2AGR |
|---|---|---|---|---|---|---|---|
| UK | 2007 | 2009 | -4.26 | 1 | 2012 | 2.9 | 2.05 |
| NE | 2006 | 2009 | -4.22 | **0.99** | 2015 | 3.79 | 0.79 |
| NW | 2007 | 2009 | -3.64 | **0.85** | 2014 | 2.98 | 1.07 |
| YH | 2007 | 2010 | -7.46 | 1.75 | 2016 | 2.97 | 1.42 |
| EM | 2007 | 2009 | -5.58 | 1.31 | 2012 | 2.88 | 2.29 |
| WM | 2007 | 2009 | -6.37 | 1.5 | 2012 | 1.76 | **2.47** |
| ET | 2008 | 2009 | -4.49 | 1.05 | 2014 | 1.64 | **1.67** |
| LN | 2008 | 2009 | -5.66 | 1.33 | 2011 | 3.73 | 3.33 |
| SE | 2008 | 2009 | -3.77 | **0.89** | 2011 | 1.86 | **1.94** |
| SW | 2008 | 2009 | -3.34 | **0.79** | 2012 | 1.66 | **1.83** |
| WL | 2007 | 2009 | -5.73 | 1.34 | 2012 | 2.56 | 1.65 |
| SC | 2008 | 2009 | -3.08 | **0.72** | 2011 | 2.6 | 1.93 |
| NI | 2007 | 2010 | -6.45 | 1.51 | 2015 | 3 | 1.69 |

Note: bold font in Beta – Resistance column signifies the region is more resistant than the nation. Bold font in the second expansion average growth rate (E2AGR) column means that this is greater than the expansion average growth rate (EAGR) before the recession.

**Table 4: Productivity Jobs Business Cycle Turning Points and Resilience Measures**

| Region | Peak year | Trough year | Loss Peak to Trough | Beta - Resist | Year Recover | EAGR | E2AGR |
|---|---|---|---|---|---|---|---|
| UK | 2008 | 2009 | -1.49 | 1 | 2012 | 0.94 | **1.06** |
| NE | 2008 | 2012 | -3.52 | 2.37 | NR | 1.06 | 0.48 |
| NW | 2008 | 2011 | -0.76 | **0.51** | 2013 | 0.63 | **1.12** |
| YH | 2008 | 2010 | -0.48 | **0.32** | 2014 | 0.79 | **0.94** |
| EM | 2007 | 2009 | -2.9 | 1.95 | 2011 | 1.71 | 0.92 |
| WM | 2008 | 2010 | -3.24 | 2.18 | 2013 | 0.54 | **1.42** |
| ET | 2008 | 2010 | -1.61 | 1.08 | 2012 | 0.98 | **1.63** |
| LN | 2008 | 2010 | -1.62 | 1.09 | 2011 | 1.27 | **2.85** |
| SE | 2008 | 2009 | -1.67 | 1.12 | 2011 | 0.65 | **1.29** |
| SW | 2008 | 2009 | -0.13 | **0.09** | 2010 | 1.09 | 1.03 |
| WL | 2008 | 2011 | -1.24 | **0.84** | 2014 | 0.99 | **1.19** |
| SC | 2008 | 2010 | -5.14 | 3.46 | NR | 1.07 | 0.76 |
| NI | 2008 | 2012 | -5.94 | 4 | 2017 | 1.32 | **1.45** |

In Table 4 the employment turning points and resilience statistics are shown. Northern Ireland suffered the greatest share of jobs lost at -5.9% and suffered the longest recession

duration of 4 years (along with the North East). Dawley et al. (2014) discuss North East employment in relation to the rise and fall of the Northern Rock bank, in particular they suggest historical occupational disadvantage limited the adaptive capacity and ability of the region to diversify into new growth paths or upgrade economic activities and employment after the crisis. Northern Ireland, the North West and Wales all experienced a "double dip" recession where jobs grew slightly after the first year but fell to a lower level until the trough turning points. The first region to recover its jobs pre-recession peak level in 2010 was the South West and the longest was Northern Ireland which took 9 years to recover. Scotland had a larger loss of jobs than fall in GVA so this means that productivity dropped only marginally and then increased quickly, see Figure A.10. Both Scottish and North East jobs (Figure A.1) have not recovered their peak levels by 2017. Jobs growth was greater after the recession than before for the UK, and for most regions apart from the North East, East Midlands, South West and Scotland where jobs growth slowed. Figure A.6 shows the time series for London which had the highest rate of growth of jobs after the recession as also reported by Beatty and Fothergill (2018). The rapid job growth in London appeared to dampen the recovery in productivity as real GVA did not rise as quickly, so for the five years after the recession the average productivity growth rate was 0.9% compared to the average of 3.6% for the five years before (see Table 4). In Table 5 we see that Yorkshire and Humberside experienced the greatest decline in productivity (-7%) over the downturn and has not recovered its pre-recession peak level. Figure A.4 presents the business cycle turning points for the West Midlands and from Tables 4-5 we can see that the rate of growth for all variables were higher after the recession meaning that the series are on a higher growth path.

**Table 5: Real Productivity Business Cycle Turning Points and Resilience Measures**

| Region | Peak year | Trough year | Loss Peak to Trough | Beta - Resist | Year Recover | EAGR | E2AGR |
|---|---|---|---|---|---|---|---|
| UK | 2007 | 2009 | -3.67 | 1 | 2013 | 1.97 | 0.98 |
| NE | 2007 | 2009 | -4.13 | 1.13 | 2011 | 1.36 | 1.24 |
| NW | 2007 | 2009 | -3.33 | **0.91** | 2015 | 2.23 | 0.3 |
| YH | 2007 | 2010 | -7.04 | 1.92 | NR | 1.83 | 0.48 |
| EM | 2008 | 2009 | -3.06 | **0.83** | 2012 | 0.87 | **1.37** |
| WM | 2007 | 2009 | -4.06 | 1.10 | 2011 | 1.12 | **1.59** |
| ET | 2007 | 2009 | -3.39 | **0.92** | 2016 | 1.39 | 0.44 |
| LN | 2007 | 2009 | -6.19 | 1.68 | 2016 | 3.64 | 0.91 |
| SE | 2008 | 2009 | -2.13 | **0.58** | 2013 | 1.21 | 0.65 |
| SW | 2006 | 2009 | -3.66 | 1 | 2014 | 1.02 | 0.79 |
| WL | 2007 | 2009 | -5.55 | 1.51 | 2011 | 1.27 | 0.91 |
| SC | 2007 | 2008 | -0.02 | **0.01** | 2009 | 2.02 | 1.4 |
| NI | 2007 | 2010 | -6.24 | 1.7 | 2012 | 1.7 | **1.74** |

We also date turning points for NUTS 2 level regions for Great Britain (shown in the Appendix Tables A.1-A.3). Table A.1 presents the business cycle turning point dates for real GVA in NUTS 2 regions. We find that East Yorkshire and North Lincolnshire (UKE1) had the longest recession with a duration of 6 years, the greatest loss of -13% GVA and this region and Outer London – South (UKI6) had not recovered their pre-recession peak levels by 2017. Few regions experienced greater average growth rates following the recession compared to the years leading up to the recession, exceptions include Merseyside which although it experienced a long recession of 4 years, it recovered its peak level 2 years after the trough turning point and grew at a rate of 1.96% on average after the recession, compared to 1.39% before. The highest growth rate after the recession was for North East Scotland (UKM5 including Aberdeen) which grew at 5% (though lower than the average growth rate of 6.3% before recession), then Outer London – West and North West (UKI7) which grew at a faster 4% after the recession than 3.25% before. Lincolnshire (UKF3) and the regions within the West Midlands (UKG1-3) all suffered greater losses than the UK, so were less resistant, but rebounded relatively quickly and experienced higher average growth rates after the recession, possibly helped by the West Midlands Regional Taskforce, see Bailey and Berkeley (2014).

In Table A.2 the turning points for productivity jobs are shown and from here we can see that employment in Inner London – West (UKI3 with boroughs Camden, City of London, Westminster, Kensington and Chelsea, Hammersmith and Fulham and Wandsworth) actually resisted recession and continued to growth throughout the financial crisis. Overman (2011) suggested the larger proportion of middle income earners and jobs in the professional services helped London recover quicker, along with the Government's bank bailouts protecting jobs in the finance sector. Infrastructure investment in the construction of Olympics venues and Crossrail also helped. Coyle and Sensier (2019) highlight how London had the highest concentration of transport infrastructure spending (£3,200 per head between 2013-2017) compared to the next highest region the North West (£1,300 p.h.). Some regions are yet to recover their pre-recession peak in employment including Tees Valley and Durham (UKC1), Lancashire (UKD4), and three of the five Scottish regions (Highlands and Islands, UKM6; West Central Scotland, UKM8 and Southern Scotland, UKM9). O'Brien et al (2017) describe how the Tees Valley's labour market shows the continued impact of de-industrialisation with high joblessness, low skills and an ageing workforce. The Redcar steelworks closed in 2015 with the loss of 2,200 jobs[1]. Similar de-industrialisation has occurred in Lancashire and around Glasgow (UKM8). Preston, Lancashire has aimed to rebuild itself post financial crisis after the loss of inward investment from a shopping centre development in 2011. McInroy (2018) describes how Preston city council has been working on local wealth building initiatives with anchor institutions to pay the living wage and procure more goods and services locally. Turning points for NUTS 2 regions productivity are shown in Table A.3. Here we can see that a number of regions have yet to recover their pre-

[1] See BBC story: https://www.bbc.co.uk/news/uk-england-34509329

recession peaks, including: Greater Manchester (UKD3), Cheshire (UKD6), Merseyside (UKD7), East Yorkshire and North Lincolnshire (UKE1), North Yorkshire (UKE2), West Yorkshire (UKE4), Bedfordshire and Hertfordshire (UKH2), Essex (UKH3), Outer London – East and North East (UKI5), Outer London – South (UKI6), Dorset and Somerset (UKK2), Cornwall and Isles of Scilly (UKK3) and Devon (UKK4). So contrary to Martin and Gardiner (2019) we find lack of recovery across the country and not just in northern regions.

**Table 6: Resilience Scorecard for NUTS 1 regions**

| | NE | NW | YH | EM | WM | ET | LN | SE | SW | WL | SC | NI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GVA | | | | | | | | | | | | |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| 2 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 3 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 |
| 4 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| Jobs | | | | | | | | | | | | |
| 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 4 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| Prod | | | | | | | | | | | | |
| 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 2 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| 3 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| 4 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Total | 3 | 6 | 2 | 7 | 7 | 6 | 5 | 10 | 9 | 6 | 6 | 3 |
| Rank | 6 | 4 | 7 | 3 | 3 | 4 | 5 | 1 | 2 | 4 | 4 | 6 |

Key: 1 – RESISTANCE; 2 – DURATION; 3 – RECOVERY and 4 – RENEWAL.

The summary of the resilience scorecard for NUTS 1 regions is in Table 6 (for NUTS 2 regions in the appendix in Table A.4). The NUTS 1 ranking of resilience in Table 5 shows that the most resilient region was the South East and the least resilient region was Yorkshire and The Humber. When we analyse the sub-regions at the NUTS 2 level in Table A.4 what emerges is still South Eastern regions (UKJ1, UKJ2 and UKJ3) are the most resilient but the final South East region, (Kent, UKJ4) scores 6/12 points as GVA and employment experienced a deeper loss than the nation and GVA and productivity took longer to recover and were slower to grow after the recession than before. The Bristol region (UKK1) was the most resilient within the South West helping make this region more resilient but the sub-regions (UKK2, UKK3 and UKK4) perform poorly on GVA and productivity indicators so are lower down in the scorecard. When the components of the Midlands are scored by sub-regions Lincolnshire scores 8/12 points, Derbyshire and Nottingham (UKF1) 7/12 points and the Birmingham city

region (UKG3) 6/12. Other regions within the Midlands do not do as well with Leicestershire, Rutland and Northamptonshire (UKF2) scoring the least with 3/12. So looking beyond the headline figures for the nation and the main regions we find quite different levels of resilience at sub-regional levels, in the next section we explore a number of factors affecting resilience.

**Factors Affecting Resilience**

There are a number factors affecting resilience that have been discussed in the literature and we estimate cross-section regressions for these at each stage of the business cycle (expansion, recession and subsequent expansion). Martin and Sunley (2015) note the debate of diversity vs. specialisation for regional resilience. Regions that specialise in their most competitive sectors are more inclined to increase gains in productivity, but a downturn in that sector could impact the region adversely. Diversifying activity across a number of sectors could help resilience by spreading the risk in a downturn. To gauge how important the concentration of industrial activity is for regions we will consider a specialisation measure and location quotients. The ONS (2018a) have calculated the Krugman specialisation index (KSI) which quantifies the differences between the distribution of GVA economic activity across NUTS 2 regions and a reference distribution (national GVA). They compute the KSI using an aggregation of the 2-digit level industries breakdown of the 2007 Standard Industrial Classification into 11 groups according to their technological or knowledge intensity (see the Appendix in ONS, 2018a). The KSI is calculated by the ONS as:

$$KSI_j = \sum ABS \left[\frac{x_{ji}}{x_j} - \frac{(x_i - x_{ji})}{(x - x_j)}\right] \quad (5)$$

where $X_{ji}$ is the output of region (j) in industry (i), $X_j$ is the total output of region (j), $X_i$ is the total output of industry (i) and X is the national output. The KSI indicates the relative specialisation of the region compared to the nation and takes the value zero if region (j) has an industrial structure identical to the rest of the UK, indicating that region (j) is not specialised. Higher KSI values indicate increased specialisation and the maximum value of 2 indicates the region has no sectors in common with the rest of the UK. In the dataset for the last available year, 2016, the region closest to the UK average is Gloucestershire, Wiltshire and Bristol/Bath area (KSI=0.12) and the most specialised region is Inner London – West which includes the City of London and has a high concentration of financial services industry (KSI=0.64). We also included ONS (2018a) location quotients which are used to assess the relative specialisation of regions in groupings of industries. The location quotient for region (j) industry (i) measures the level of relative specialisation of region (j) in industry (i), and it is given by the expression:

$$LQ_{ji} = \frac{x_{ji}/x_j}{x_i/x} \quad (6)$$

With *x* representing output as in equation (5). A location quotient of 1 indicates that the share of industry (i) in the regional output is comparable with the contribution of that industry to the national output.

Kitsos and Bishop (2018) include as an explanatory variable the high level skills in an area and suggest they operate through 2 channels: (i) embedded knowledge and experience. Places and firms with more skilled workers may hoard them (reduce hours) rather than make redundancies, these may exhibit lower crisis impact. (ii) human and firm-specific capital created through on the job training, these have less lay-offs and lower staff turnover. We assess the share of people in a region with NVQ4+ qualifications (a University Degree or equivalent and above), from NOMIS along with the share of the population classified as managers and professional occupations. Lee (2014) finds the unemployment rate is related to how British cities recovered their employment rates after the financial crisis so we include this rate from NOMIS. We also include the local rates of company start-ups. Work by Gherhes, et al (2018) studies a peripheral post-industrial place (Doncaster) and finds high rates of start-up but mainly for self-employed and small businesses.

In terms of investigating how important investment is for sub-regions we include the series for gross fixed capital formation (GFCF), which is the largest share of investment, accessed from Eurostat (2019). GFCF is the acquisition (less disposal) of fixed assets and the improvement of land. It is calculated gross of any deduction for depreciation or consumption of fixed capital. GFCF reflects investment in tangible assets that contribute to the productive process for more than a year and are not used up in the process of production, such as buildings, plant and machinery, and vehicles. It also includes investment in intangibles (for example, intellectual property and brand names), costs of transfer of ownership (for example, estate agency fees) and valuables (for example, precious stones and metals), see ONS (2018a). We include the level and growth rate of investment. The explanatory variables we include in our regressions are three year averages of the series over the three phases of the business cycle as follows: (1) pre-recession expansion phase we average over 2004-06; (2) the recession phase the average is over 2007-09 and (3) the expansion phase after the recession we average 2010-12. Initially we check the cross-correlations of all explanatory variables and find relatively high correlation between skills and the specialisation variables, suggesting that places with the highest skills are those that generally contain the highest amounts of specialisation. This suggests potential multi-collinearity within our cross-section regressions if all variables are included so each variable is tested individually along with the control variables of regional dummies for NUTS 1 regions – to take account of potential regional differences (1 when the NUTS 2 region is within the NUTS 1 region).

**Table 7: Cross-section Regressions for Average Growth Rate before the Recession**

| | GVA | Jobs | Productivity |
|---|---|---|---|
| Constant | 7.79 (1.94)* | 1.03 (0.44)* | 0.44 (0.50) |
| Less KIS&Other | -0.50 (0.19)* | | |
| Krugman | | 0.30 (0.12)* | 0.26 (0.14)* |
| Dummies | YES | YES | YES |
| London | 0.70 (0.50) | -1.02 (0.47)* | 1.75 (0.54)* |
| North East | 0.93 (0.64) | -0.49 (0.56) | 0.56 (0.65) |
| North West | -0.13 (0.49) | -1.14 (0.44)* | 1.09 (0.51)* |
| South East | -1.11 (0.49)* | -0.77 (0.42)* | 0.52 (0.49) |
| West Midlands | -0.85 (0.52) | -0.81 (0.46)* | 0.40 (0.53) |
| R^2 | 0.45 | 0.17 | 0.38 |
| N | 41 | 41 | 41 |
| Hetero. test | 0.54 | 0.04 | 0.01 |
| RESET test | 0.52 | 0.72 | 0.11 |

Note: regressions are weighted by population, * coefficient significant at 10% level. The dependent variable is the average rate of growth calculated as 5 years before the recession including the peak turning point, the explanatory variables are the average over 2004-2006.

The results from Table 7 show statistical significance for specialisation variables for each regression. In the first regression for GVA, we find a negative relationship with Less Knowledge Intensive Service sectors (LKIS) so areas including a larger share of these sectors have had less growth before the recession. We see from the regional dummies that the South East is negative and significant as these NUTS 2 regions had lower rates of growth before the recession. The Krugman specialisation index is positive and significant for the employment and productivity regressions, suggesting that relatively more specialised areas have had greater jobs and productivity growth before the recession. For the employment equation the lower rates of growth are significant for regional indicators for London, North West, South East and West Midlands. In the productivity regression the rates of productivity growth before the recession were positive and significant for London and the North West. We find the explanatory variables of skills, unemployment rate and investment are not significant for the pre-recession growth rates when tested individually (not shown).

The results from Table 8 for the loss over the recession with GVA show a positive relationship with the lead/lag variable so regions that were earlier into recession had greater loss (as also found for the US by Han and Goetz, 2015). The positive relationship with investment (GFCF) suggests those areas with greater levels of investment had less loss, whereas the negative relationship with specialisation in the Medium-High Tech Manufacturing sectors suggests a greater concentration of these sectors was associated with greater loss - as Lee (2014) found with cities with higher shares of manufacturing employment had deeper recessions. The negative coefficients on the London and Yorkshire

dummies signify those areas experienced the deepest recessions. In terms of the employment regression the longer the duration of the recession the greater the loss, and the relatively most specialised areas have had lower jobs losses. For the productivity equation the greatest loss is associated with earlier entry into recession and in the London and Yorkshire regions this is the case. Productivity loss is positively related to unemployment rates, so places with higher rates of unemployment have less people in employment which in turn will increases productivity. Less loss is related to areas with higher shares of the Knowledge Intensive and High-Tech Services, making areas with concentrations of these services more resilient (with London and South East sub-regions having higher concentrations of these). We find the explanatory variables of skills are important and they are positively related so areas with greater skills suffer less loss (as found by Kitsos and Bishop, 2018), but as these are highly correlated with the specialisation measures they are not shown.

**Table 8: Cross-section Regressions for Loss during the Recession**

| | GVA | Jobs | Productivity |
|---|---|---|---|
| Constant | -21.0 (5.21)* | -3.36 (1.21)* | -8.03 (1.97)* |
| Peak_LeadLag | 0.92 (0.42)* | | 0.69 (0.36)* |
| LossDuration | | -0.89 (0.27)* | |
| Unemployment | | | 0.53 (0.27)* |
| GFCF | 1.89 (0.57)* | | |
| Med-HighTechMan. | -1.22 (0.47)* | | |
| KIS+HighTech | | | 2.07 (1.12)* |
| Krugman | | 0.95 (0.30)* | |
| Dummies | YES | YES | YES |
| London | -3.62 (1.14)* | -1.83 (1.22) | -6.05 (1.66)* |
| North East | 3.00 (1.43)* | 1.05 (1.61) | -1.72 (1.82) |
| Scotland | 1.24 (1.16) | -2.95 (1.25)* | -0.94 (1.47) |
| Yorkshire & Humber. | -2.10 (1.14)* | 1.92 (1.23)* | -4.86 (1.47)* |
| R^2 | 0.60 | 0.55 | 0.50 |
| N | 41 | 41 | 40 |
| Hetero. test | 0.27 | 0.00 | 0.13 |
| RESET test | 0.76 | 0.15 | 0.49 |

Note: regressions are weighted by population, * coefficient significant at 10% level. The dependent variable is the rate of loss over the recession between peak and trough, the explanatory variables are the average over 2007-2009.

The results from Table 9 are for the expansion phase following the recession. In the GVA equation the longer the recovery lasts is related to lower growth, the greater share of managers and professionals in an area is positively related to growth along with an increase

in the rate of investment. Subdued GVA growth for the North West, South East and South West can be seen with the negative coefficients on the regional dummies. The employment equation suggests that sub-regions with longer recoveries have lower jobs growth and there is a negative effect from areas with high concentrations of real estate services. Jobs growth was buoyant after the recession in London, East of England and the West Midlands as shown by the positive regional dummies. In the productivity equation the negative relationship with unemployment indicates that higher unemployment is related to lower productivity growth and an increase in the rate of investment is positively related to productivity growth following the recession. We find that skills are significant and they are positively related for each regression so areas with greater skills have had stronger recovery since the recession (again these are not shown due to highly correlation with other variables). So to sum up, growth in investment and higher skills levels are related to areas with greater output and productivity growth and these factors helped regional resilience during the recession.

**Table 9: Cross-section Regressions for Expansion after the Recession**

| | GVA | Jobs | Productivity |
|---|---|---|---|
| Constant | 1.52 (1.10) | 2.49 (0.54) | 2.42 (0.62)* |
| RecoverDuration | -0.15 (0.06)* | -0.15 (0.05)* | |
| ManagersProfess. | 0.06 (0.03)* | | |
| Unemployment | | | -0.13 (0.07)* |
| Change Investment | 0.04 (0.02)* | | 0.03 (0.02) |
| RealEstateLQ | | -1.13 (0.49)* | |
| Dummies | YES | YES | YES |
| R^2 | 0.62 | 0.58 | 0.44 |
| East of England | -0.26 (0.42) | 1.05 (0.40)* | -0.80 (0.42)* |
| London | 0.14 (0.48) | 2.37 (0.41)* | -0.59 (0.41) |
| North West | -0.70 (0.40)* | 0.66 (0.38)* | -0.65 (0.40) |
| Scotland | -0.31 (0.42) | 1.01 (0.46)* | 0.74 (0.43)* |
| South East | -1.01 (0.41)* | 0.64 (0.39) | -1.06 (0.41)* |
| South West | -1.08 (0.44)* | 0.46 (0.42) | -1.01 (0.46)* |
| West Midlands | 0.17 (0.42) | 1.04 (0.42)* | 0.23 (0.44) |
| Yorkshire & Humber. | -0.46 (0.47) | 0.51 (0.41) | -0.91 (0.44)* |
| N | 40 | 41 | 40 |
| Hetero. test | 0.74 | 0.44 | 0.38 |
| RESET test | 0.10 | 0.49 | 0.50 |

Note: regressions are weighted by population, * coefficient significant at 10% level. The dependent variable is the average rate of growth calculated as 5 years after the recession trough, the explanatory variables are the average over 2010-2012.

## Conclusions

To understand a region's economic resilience we first dated the business cycle turning points so we could determine when the region was experiencing recession, how it recovered and then compared the recovery growth rate to the rate of growth before the onset of the global financial crisis. By quantifying expansion gains and recessions losses for the economic resilience dimensions of resistance, recovery and renewal between the peak and trough turning points of the cycle we created a resilience scorecard to rank the effect of the crisis on UK NUTS 1 regions and NUTS 2 sub-regions. Most UK region's real productivity series have returned to their pre-recession levels but rapid job growth in most regions (apart from the North East and Scotland) has reduced productivity growth rates, possibly due to the growth of low paid employment and the "hollowing out" of middle earning jobs which are easier to automate (Goos and Manning, 2007). Our findings show that the English regions of the South East, South West and the Midlands rank highest in the resilience scorecard but when looking at sub-regions within these we find some regions are not doing as well. At the sub-regional level we estimated cross-section regressions for a range of factors that could explain resilience and our results indicate that areas with greater specialisation (particularly in the higher-tech knowledge economy), higher skills and those that have experienced greater rates of investment have been more resilient and have emerged with stronger growth rates since the crisis. Our resilience scorecard could be useful for local policy makers and the Industrial Strategy Council to help identify the UK regions that have lacked economic resilience during and since the downturn. The factors we have identified as affecting resilience could be explored further and could help direct future funding streams (like the Shared Prosperity Fund) towards the regions lacking economic resilience to help reduce regional disparities.

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**Appendix: UK NUTS 2 Business Cycle Turning points in Real GVA, Jobs and Real Productivity and Economic Resilience Scorecard**

**Table A.1: NUTS 2 Real GVA BC Turning Points and Resilience Measures**

| Region | Peak year | Trough year | Loss Peak to Trough | Beta - Resist | Year Recover | EAGR | E2AGR |
|---|---|---|---|---|---|---|---|
| UK | 2007 | 2009 | -4.26 | 1 | 2012 | 2.9 | 2.05 |
| UKC1 | 2007 | 2009 | -1.91 | **0.45** | 2015 | 3.06 | 0.38 |
| UKC2 | 2006 | 2009 | -6.73 | 1.58 | 2015 | 3.88 | 1.11 |
| UKD1 | 2008 | 2009 | -3.12 | **0.73** | 2010 | 2.16 | 1.39 |
| UKD3 | 2007 | 2009 | -3.31 | **0.78** | 2013 | 2.92 | 0.94 |
| UKD4 | 2007 | 2009 | -7.86 | 1.85 | 2015 | 3.10 | 1.56 |
| UKD6 | 2007 | 2009 | -6.64 | 1.56 | 2013 | 3.11 | 2.17 |
| UKD7 | 2009 | 2013 | -4.57 | 1.07 | 2015 | 1.39 | **1.96** |
| UKE1 | 2007 | 2013 | -13.00 | 3.05 | NR | 3.10 | 0.59 |
| UKE2 | 2007 | 2010 | -7.51 | 1.76 | 2017 | 2.00 | 0.91 |
| UKE3 | 2007 | 2009 | -8.40 | 1.97 | 2015 | 3.31 | 1.45 |
| UKE4 | 2007 | 2010 | -6.70 | 1.57 | 2015 | 3.12 | 1.77 |
| UKF1 | 2007 | 2009 | -5.29 | 1.24 | 2011 | 2.79 | 2.43 |
| UKF2 | 2007 | 2009 | -6.47 | 1.52 | 2014 | 3.42 | 2.08 |
| UKF3 | 2008 | 2009 | -5.19 | 1.22 | 2012 | 1.13 | **2.46** |
| UKG1 | 2006 | 2009 | -6.02 | 1.41 | 2011 | 2.81 | **3.58** |
| UKG2 | 2008 | 2009 | -6.73 | 1.58 | 2014 | 1.65 | **1.87** |
| UKG3 | 2007 | 2009 | -7.60 | 1.78 | 2014 | 1.48 | **2.21** |
| UKH1 | 2007 | 2009 | -4.07 | **0.96** | 2012 | 2.59 | 1.97 |
| UKH2 | 2008 | 2011 | -7.21 | 1.69 | 2014 | 1.89 | **3.14** |
| UKH3 | 2007 | 2009 | -5.29 | 1.24 | 2014 | 2.19 | 1.44 |
| UKI3 | 2008 | 2009 | -4.86 | 1.14 | 2011 | 4.54 | 3.58 |
| UKI4 | 2008 | 2009 | -4.03 | **0.95** | 2011 | 4.88 | 3.44 |
| UKI5 | 2007 | 2009 | -10.33 | 2.42 | 2014 | 3.22 | 2.43 |
| UKI6 | 2007 | 2009 | -9.85 | 2.31 | NR | 3.17 | 1.24 |
| UKI7 | 2007 | 2009 | -9.36 | 2.20 | 2012 | 3.25 | **4.02** |
| UKJ1 | 2008 | 2009 | -3.63 | **0.85** | 2011 | 1.63 | **2.57** |
| UKJ2 | 2008 | 2009 | -3.76 | **0.88** | 2012 | 1.95 | 1.57 |
| UKJ3 | 2008 | 2009 | -2.84 | **0.67** | 2010 | 2.06 | 1.82 |
| UKJ4 | 2008 | 2009 | -5.32 | 1.25 | 2014 | 1.92 | 1.48 |
| UKK1 | 2008 | 2009 | -3.12 | **0.73** | 2010 | 1.73 | **2.34** |
| UKK2 | 2008 | 2009 | -3.16 | **0.74** | 2014 | 1.71 | 1.19 |
| UKK3 | 2008 | 2009 | -4.85 | 1.14 | 2013 | 1.61 | 1.34 |
| UKK4 | 2006 | 2009 | -6.07 | 1.43 | 2014 | 3.24 | 1.30 |
| UKL1 | 2006 | 2009 | -5.42 | 1.27 | 2013 | 3.14 | 1.68 |
| UKL2 | 2007 | 2009 | -6.38 | 1.50 | 2012 | 2.79 | 1.62 |
| UKM5 | 2008 | 2009 | -4.10 | **0.96** | 2010 | 6.33 | 5.00 |
| UKM6 | 2008 | 2009 | -1.88 | **0.44** | 2010 | 2.28 | 1.78 |
| UKM7 | 2007 | 2010 | -3.23 | **0.76** | 2013 | 2.90 | 1.85 |
| UKM8 | 2008 | 2010 | -4.29 | 1.01 | 2014 | 2.16 | 1.85 |
| UKM9 | 2008 | 2009 | -4.39 | 1.03 | 2014 | 1.96 | 1.53 |

**Table A.2: NUTS 2 Productivity Jobs BC Turning Points and Resilience Measures**

| Region | Peak year | Trough year | Loss Peak to Trough | Beta - Resist | Year Recover | EAGR | E2AGR |
|---|---|---|---|---|---|---|---|
| UK | 2008 | 2009 | -1.49 | 1 | 2012 | 0.94 | **1.06** |
| UKC1 | 2007 | 2012 | -5.67 | 3.82 | NR | 1.45 | 0.31 |
| UKC2 | 2009 | 2013 | -2.89 | 1.95 | 2017 | 0.92 | 0.80 |
| UKD1 | 2009 | 2011 | -1.02 | **0.69** | 2012 | 0.20 | **1.12** |
| UKD3 | 2010 | 2011 | -1.80 | 1.21 | 2013 | 0.16 | **1.60** |
| UKD4 | 2008 | 2012 | -2.59 | 1.74 | NR | 1.07 | 0.33 |
| UKD6 | 2010 | 2011 | -0.29 | **0.19** | 2013 | 0.57 | **1.96** |
| UKD7 | 2008 | 2012 | -1.61 | 1.08 | 2014 | 0.40 | **1.39** |
| UKE1 | 2007 | 2013 | -2.41 | 1.62 | 2014 | 0.98 | **1.84** |
| UKE2 | 2009 | 2011 | -0.66 | **0.44** | 2012 | 1.65 | 1.62 |
| UKE3 | 2006 | 2010 | -2.91 | 1.96 | 2014 | 2.00 | 1.00 |
| UKE4 | 2008 | 2009 | -1.45 | **0.98** | 2013 | 0.90 | 0.68 |
| UKF1 | 2007 | 2009 | -3.07 | 2.07 | 2011 | 1.42 | 1.06 |
| UKF2 | 2007 | 2009 | -2.48 | 1.67 | 2011 | 1.80 | 0.95 |
| UKF3 | 2007 | 2009 | -3.49 | 2.35 | 2011 | 2.35 | 0.44 |
| UKG1 | 2008 | 2010 | -3.87 | 2.61 | 2014 | 1.66 | 1.47 |
| UKG2 | 2008 | 2011 | -3.00 | 2.02 | 2013 | 0.65 | **1.53** |
| UKG3 | 2006 | 2009 | -6.16 | 4.14 | 2015 | 0.35 | **1.26** |
| UKH1 | 2006 | 2009 | -3.21 | 2.16 | 2013 | 1.96 | 1.27 |
| UKH2 | 2008 | 2010 | -2.61 | 1.76 | 2013 | 1.02 | **2.10** |
| UKH3 | 2008 | 2010 | -2.40 | 1.61 | 2012 | 0.66 | **1.45** |
| UKI3 | | | | | RS | 1.14 | **2.73** |
| UKI4 | 2008 | 2010 | -2.40 | 1.61 | 2011 | 2.99 | **3.99** |
| UKI5 | 2008 | 2011 | -4.79 | 3.22 | 2012 | -0.10 | **2.94** |
| UKI6 | 2008 | 2011 | -8.90 | 5.99 | 2017 | 0.92 | **1.44** |
| UKI7 | 2008 | 2010 | -2.25 | 1.51 | 2011 | 0.53 | **2.35** |
| UKJ1 | 2008 | 2009 | -2.28 | 1.53 | 2012 | 0.80 | **1.55** |
| UKJ2 | 2010 | 2011 | -0.21 | **0.14** | 2012 | 0.85 | **1.74** |
| UKJ3 | 2008 | 2009 | -2.34 | 1.58 | 2011 | 0.86 | **1.10** |
| UKJ4 | 2008 | 2009 | -2.31 | 1.55 | 2011 | 0.72 | **1.10** |
| UKK1 | 2011 | 2012 | -2.10 | 1.41 | 2014 | 1.06 | **1.51** |
| UKK2 | 2008 | 2009 | -1.10 | **0.74** | 2013 | 1.65 | 0.96 |
| UKK3 | 2008 | 2009 | -4.00 | 2.69 | 2014 | 2.35 | 1.04 |
| UKK4 | 2006 | 2008 | -0.74 | **0.50** | 2009 | 1.50 | 0.44 |
| UKL1 | 2009 | 2011 | -2.08 | 1.40 | 2013 | 0.98 | **1.34** |
| UKL2 | 2008 | 2009 | -1.58 | 1.06 | 2014 | 0.83 | **0.84** |
| UKM5 | 2008 | 2010 | -1.17 | **0.78** | 2011 | 1.50 | 1.32 |
| UKM6 | 2008 | 2009 | -5.61 | 3.77 | NR | 1.36 | 0.47 |
| UKM7 | 2007 | 2010 | -3.95 | 2.66 | 2017 | 0.62 | **0.73** |
| UKM8 | 2008 | 2013 | -11.30 | 7.61 | NR | 1.57 | **2.62** |
| UKM9 | 2008 | 2010 | -7.77 | 5.23 | NR | 1.43 | 0.39 |

Note: NR is not recovered; RS is resistant to recession.

**Table A.3: NUTS 2 Productivity BC Turning Points and Resilience Measures**

| Region | Peak year | Trough year | Loss Peak to Trough | Beta - Resist | Year Recover | EAGR | E2AGR |
|---|---|---|---|---|---|---|---|
| UK | 2007 | 2009 | -3.67 | 1 | 2013 | 1.97 | 0.98 |
| UKC1 | 2008 | 2009 | -0.60 | **0.16** | 2010 | 1.49 | 0.76 |
| UKC2 | 2006 | 2009 | -7.52 | 2.05 | 2014 | 1.59 | **1.60** |
| UKD1 | 2008 | 2009 | -3.30 | **0.90** | 2010 | 1.73 | 0.65 |
| UKD3 | 2007 | 2010 | -2.84 | **0.77** | NR | 2.17 | 0.49 |
| UKD4 | 2007 | 2009 | -7.66 | 2.09 | 2015 | 2.35 | 1.33 |
| UKD6 | 2007 | 2009 | -6.94 | 1.89 | NR | 2.47 | 0.87 |
| UKD7 | 2009 | 2013 | -4.18 | 1.14 | NR | 1.30 | 0.24 |
| UKE1 | 2007 | 2014 | -11.11 | 3.02 | NR | 2.12 | -1.57 |
| UKE2 | 2007 | 2009 | -10.02 | 2.73 | NR | 1.22 | 0.85 |
| UKE3 | 2007 | 2009 | -6.97 | 1.90 | 2017 | 1.72 | 0.97 |
| UKE4 | 2007 | 2010 | -6.40 | 1.74 | NR | 2.02 | 0.60 |
| UKF1 | 2008 | 2009 | -2.34 | **0.64** | 2011 | 1.02 | **1.37** |
| UKF2 | 2007 | 2009 | -4.09 | 1.11 | 2014 | 1.63 | 1.14 |
| UKF3 | 2008 | 2009 | -3.56 | **0.97** | 2012 | -0.35 | **2.02** |
| UKG1 | 2006 | 2009 | -6.99 | 1.90 | 2011 | 0.72 | **2.83** |
| UKG2 | 2007 | 2009 | -7.00 | 1.91 | 2011 | 1.71 | 1.53 |
| UKG3 | 2007 | 2009 | -2.24 | **0.61** | 2011 | 1.34 | 0.95 |
| UKH1 | 2008 | 2009 | -1.97 | **0.54** | 2011 | 0.88 | 0.70 |
| UKH2 | 2007 | 2012 | -6.89 | 1.88 | NR | 1.54 | 0.90 |
| UKH3 | 2006 | 2009 | -5.65 | 1.54 | NR | 2.26 | 0.77 |
| UKI3 | 2007 | 2009 | -6.19 | 1.69 | 2016 | 4.77 | 0.85 |
| UKI4 | 2007 | 2009 | -4.66 | 1.27 | 2010 | 2.62 | 0.37 |
| UKI5 | 2007 | 2009 | -10.19 | 2.77 | NR | 3.86 | 0.24 |
| UKI6 | 2007 | 2010 | -4.91 | 1.34 | NR | 2.46 | 0.07 |
| UKI7 | 2007 | 2009 | -8.70 | 2.37 | 2014 | 2.76 | 1.88 |
| UKJ1 | 2007 | 2009 | -2.52 | **0.69** | 2011 | 1.63 | 1.01 |
| UKJ2 | 2008 | 2009 | -3.52 | **0.96** | 2015 | 1.63 | 0.31 |
| UKJ3 | 2008 | 2009 | -0.51 | **0.14** | 2010 | 1.20 | 0.72 |
| UKJ4 | 2008 | 2009 | -3.09 | **0.84** | 2017 | 1.20 | 0.37 |
| UKK1 | 2008 | 2009 | -3.81 | 1.04 | 2012 | 1.16 | 1.08 |
| UKK2 | 2006 | 2010 | -4.18 | 1.14 | NR | 0.71 | 0.42 |
| UKK3 | 2005 | 2010 | -9.69 | 2.64 | NR | 3.57 | 1.11 |
| UKK4 | 2006 | 2009 | -6.17 | 1.68 | NR | 1.95 | 0.70 |
| UKL1 | 2006 | 2009 | -5.91 | 1.61 | 2011 | 1.28 | 1.01 |
| UKL2 | 2007 | 2009 | -5.47 | 1.49 | 2012 | 1.69 | 0.77 |
| UKM5 | 2008 | 2009 | -2.97 | **0.81** | 2010 | 4.82 | 3.36 |
| UKM6 | 2005 | 2007 | -4.92 | 1.34 | 2010 | 3.44 | 2.32 |
| UKM7 | 2010 | 2012 | -1.54 | **0.42** | 2013 | 1.09 | **2.21** |
| UKM8 | 2006 | 2008 | -2.56 | **0.70** | 2010 | 2.34 | **2.34** |
| UKM9 | 2005 | 2007 | -2.26 | **0.61** | 2009 | 1.58 | 1.13 |

**Table A.4: NUTS 2 Resilience Scorecard**

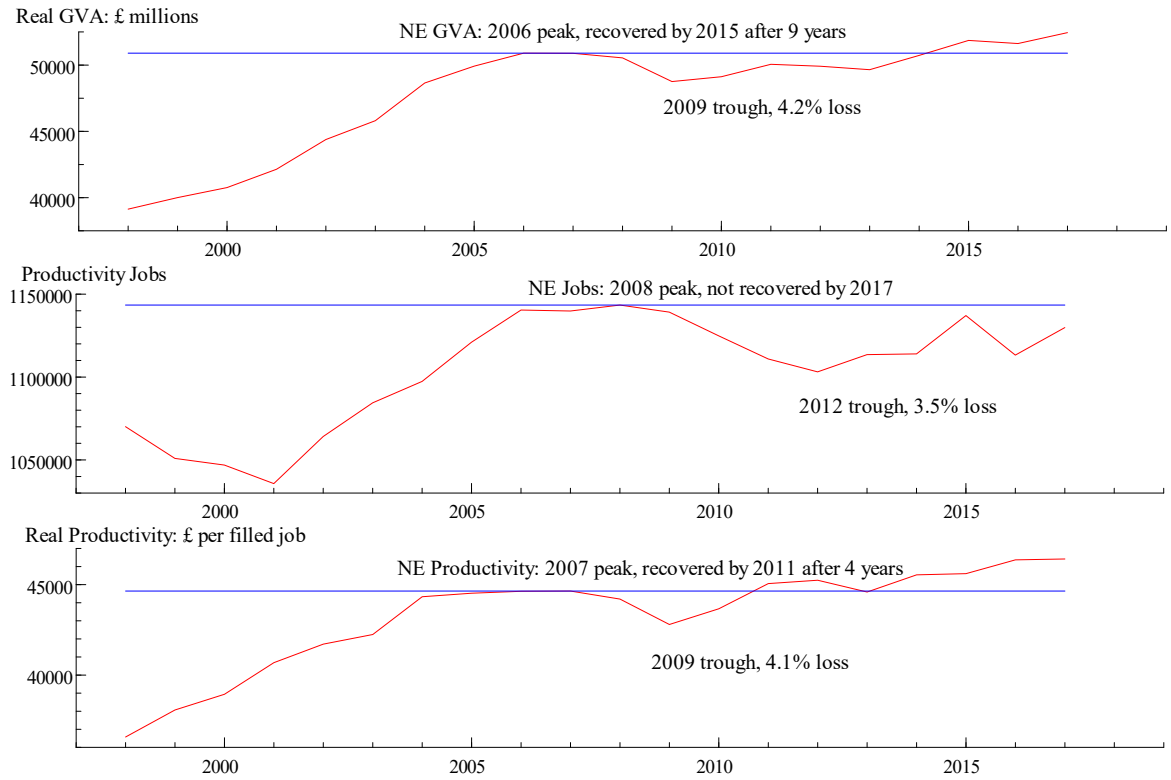
| | Real GVA | | | | Productivity Jobs | | | | Real Productivity | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **Sum** |
| UKC1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 5 |
| UKC2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| UKD1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 9 |
| UKD3 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 6 |
| UKD4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| UKD6 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 6 |
| UKD7 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| UKE1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| UKE2 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 3 |
| UKE3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| UKE4 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| UKF1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 7 |
| UKF2 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 3 |
| UKF3 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 8 |
| UKG1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 4 |
| UKG2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 5 |
| UKG3 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 6 |
| UKH1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 6 |
| UKH2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| UKH3 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 3 |
| UKI3 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 7 |
| UKI4 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 7 |
| UKI5 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 4 |
| UKI6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| UKI7 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 6 |
| UKJ1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 10 |
| UKJ2 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 9 |
| UKJ3 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 9 |
| UKJ4 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 6 |
| UKK1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 9 |
| UKK2 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| UKK3 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| UKK4 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| UKL1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 3 |
| UKL2 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 6 |
| UKM5 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 8 |
| UKM6 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 6 |
| UKM7 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 6 |
| UKM8 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 6 |
| UKM9 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 4 |

Note: The economic resilience scorecard ranks the resilience measures for each measures as follows: (1) Has the fall in GVA/jobs/productivity been less than the national decrease (so for the sensitivity index $\beta_r$ <1)? (2) Has the duration of the recession been shorter or the same as the national recession? (3) Has the region recovered faster at the same time as the nation? (4) Was the rate of growth after recession greater than before (E2AGR> EAGR)?

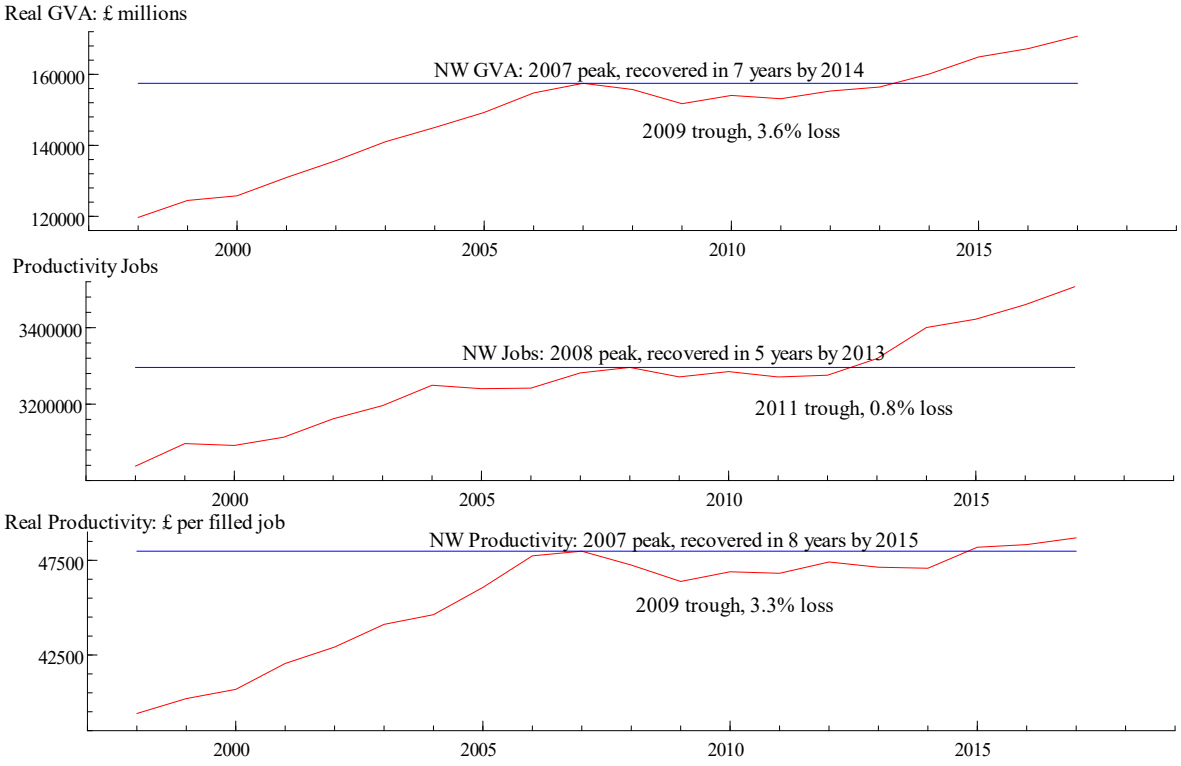
**Table A.5: NUTS 2 Resilience Scorecard Ranking**

| Rank | Region | Score |
|---|---|---|
| 1 | Berkshire, Buckinghamshire and Oxfordshire (UKJ1) | 10/12 |
| 2 | Cumbria (UKD1); Surrey, East & West Sussex (UKJ2); Hampshire & The Isle of Wight (UKJ3); Gloucestershire, Wiltshire and Bath/Bristol area (UKK1) | 9/12 |
| 3 | Lincolnshire (UKF3); NE Scotland (UKM5) | 8/12 |
| 4 | Derbyshire and Nottinghamshire (UKF1); Inner London – West (UKI3); Inner London – East (UKI4) | 7/12 |
| 5 | Greater Manchester (UKD3); Cheshire (UKD6); West Midlands (UKG3); East Anglia (UKH1); Outer London - West and North West (UKI7); Kent (UKJ4); East Wales (UKL2); Highlands & Islands (UKM6); Eastern Central Scotland (UKM7); West Central Scotland (UKM8) | 6/12 |
| 6 | Tees Valley and Durham (UKC1); Shropshire and Staffordshire (UKG2) | 5/12 |
| 7 | Herefordshire, Worcestershire and Warwickshire (UKG1); Outer London - East and North East (UKI5); Dorset and Somerset (UKK2); Southern Scotland (UKM9) | 4/12 |
| 8 | North Yorkshire (UKE2); Leicestershire, Rutland and Northamptonshire (UKF2); Essex (UKH3); Cornwall and Isles of Scilly (UKK3); West Wales and The Valleys (UKL1) | 3/12 |
| 9 | Lancashire (UKD4); Merseyside (UKD7); South Yorkshire (UKE3); West Yorkshire (UKE4); Bedfordshire and Hertfordshire (UKH2); Outer London – South (UKI6); Devon (UKK4); | 2/12 |
| 10 | Northumberland and Tyne and Wear (UKC2); East Yorkshire and Northern Lincolnshire (UKE1) | 1/12 |

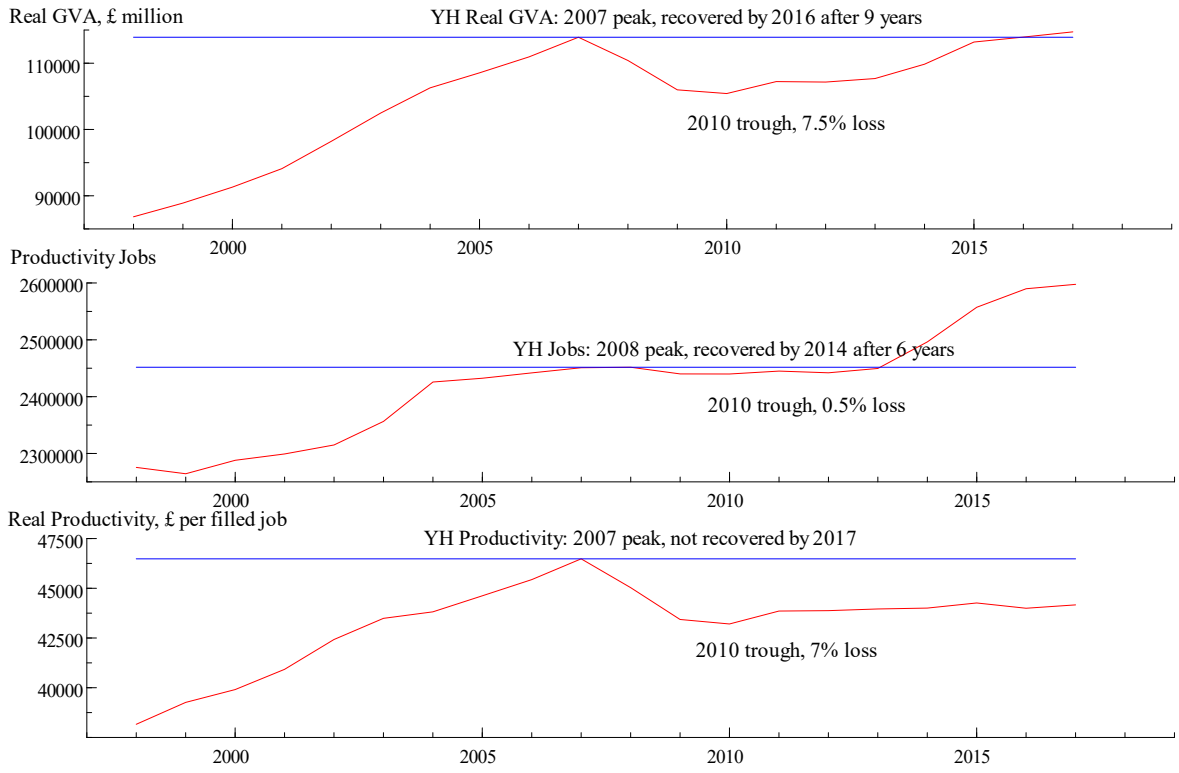
## Figure A.1: North East Real GVA, Jobs and Productivity Business Cycle Measures



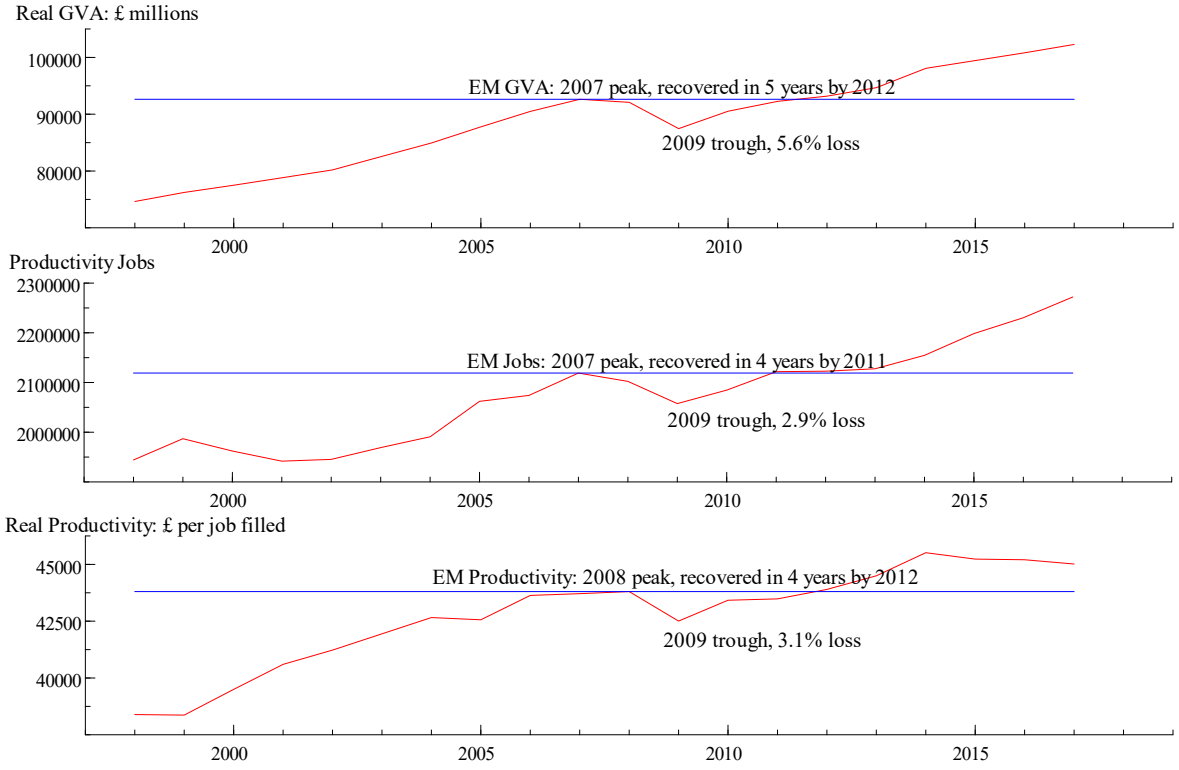

## Figure A.2: North West Real GVA, Jobs and Productivity Business Cycle Measures



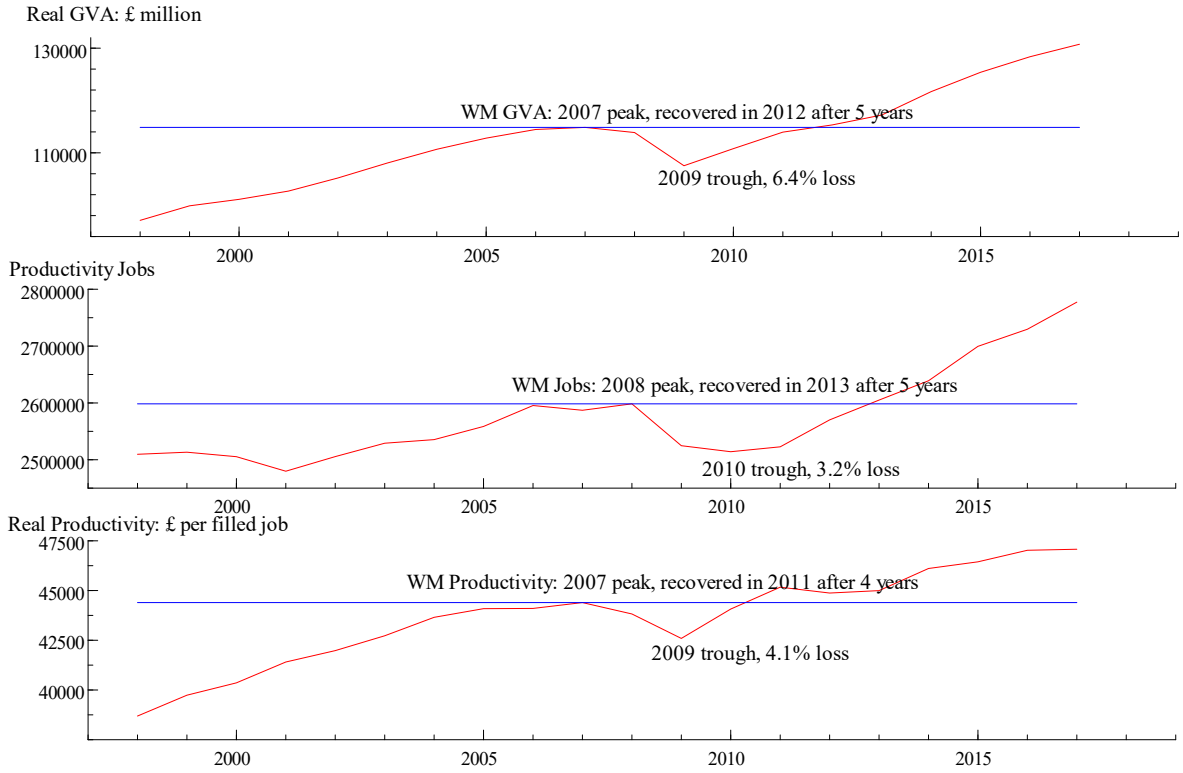
## Figure A.3: Yorkshire & Humber Real GVA, Jobs and Productivity Business Cycle Measures



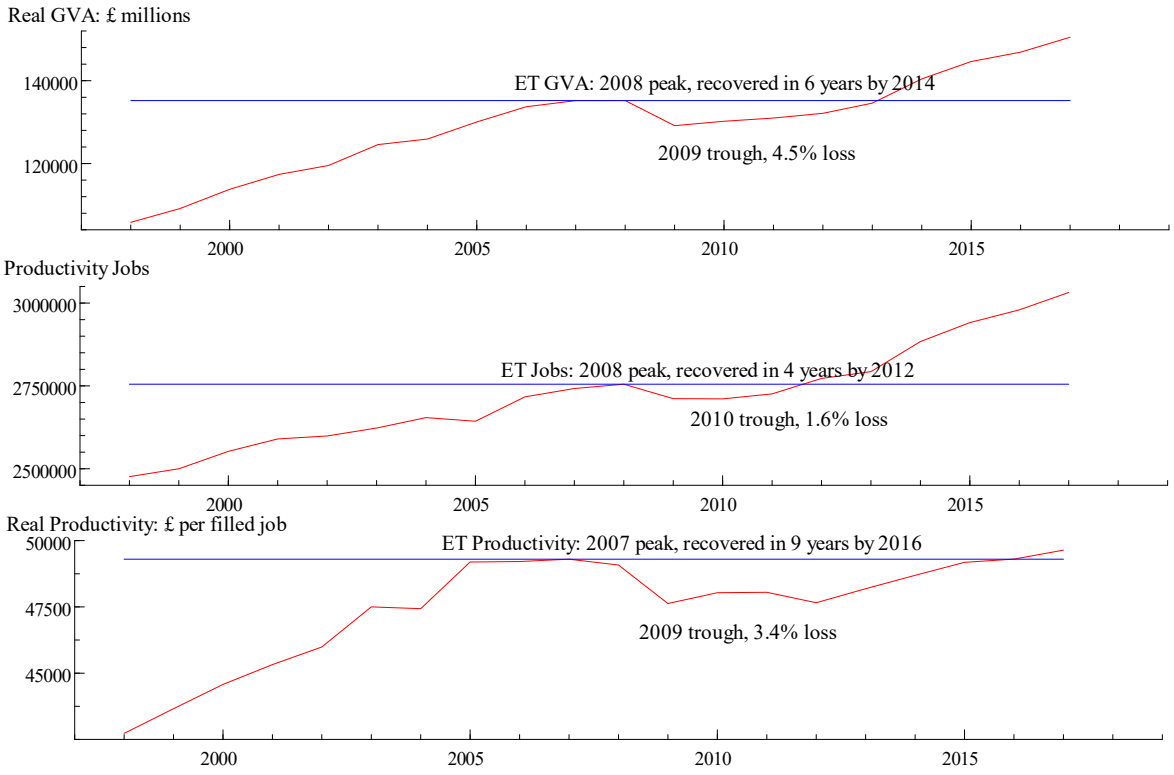

## Figure A.4: East Midlands Real GVA, Jobs and Productivity Business Cycle Measures



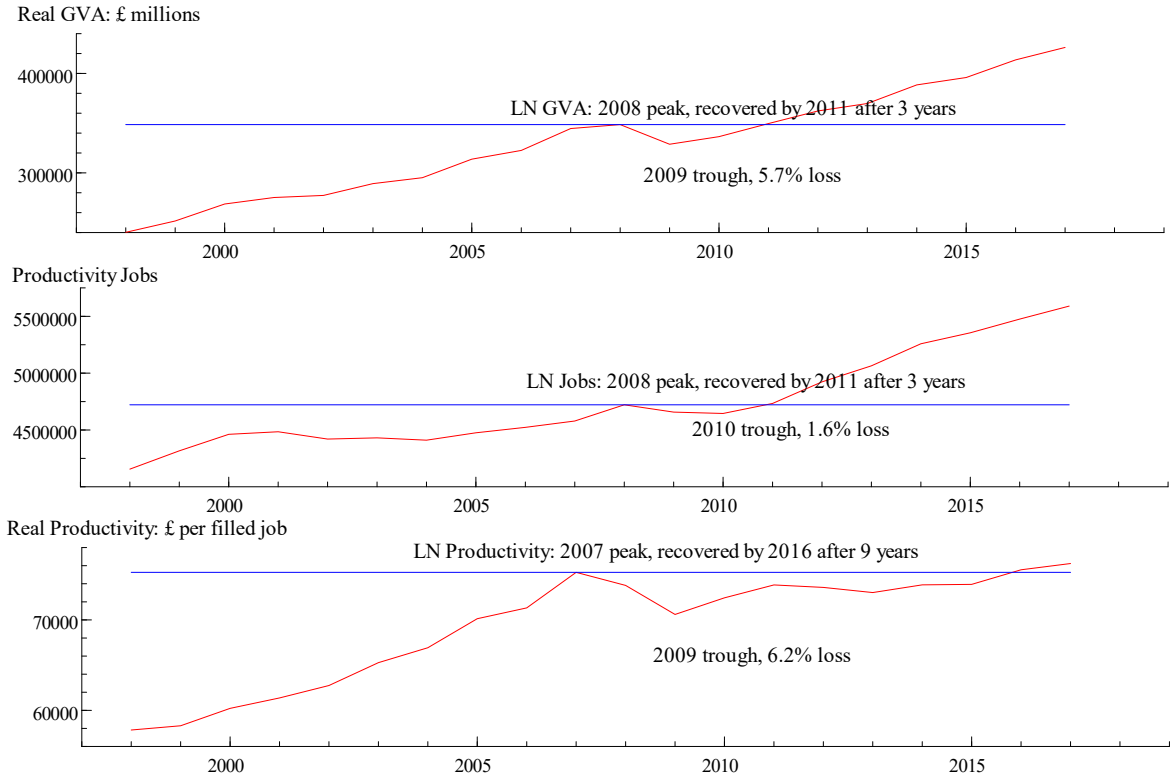
## Figure A.5: West Midlands Real GVA, Jobs and Productivity Business Cycle Measures



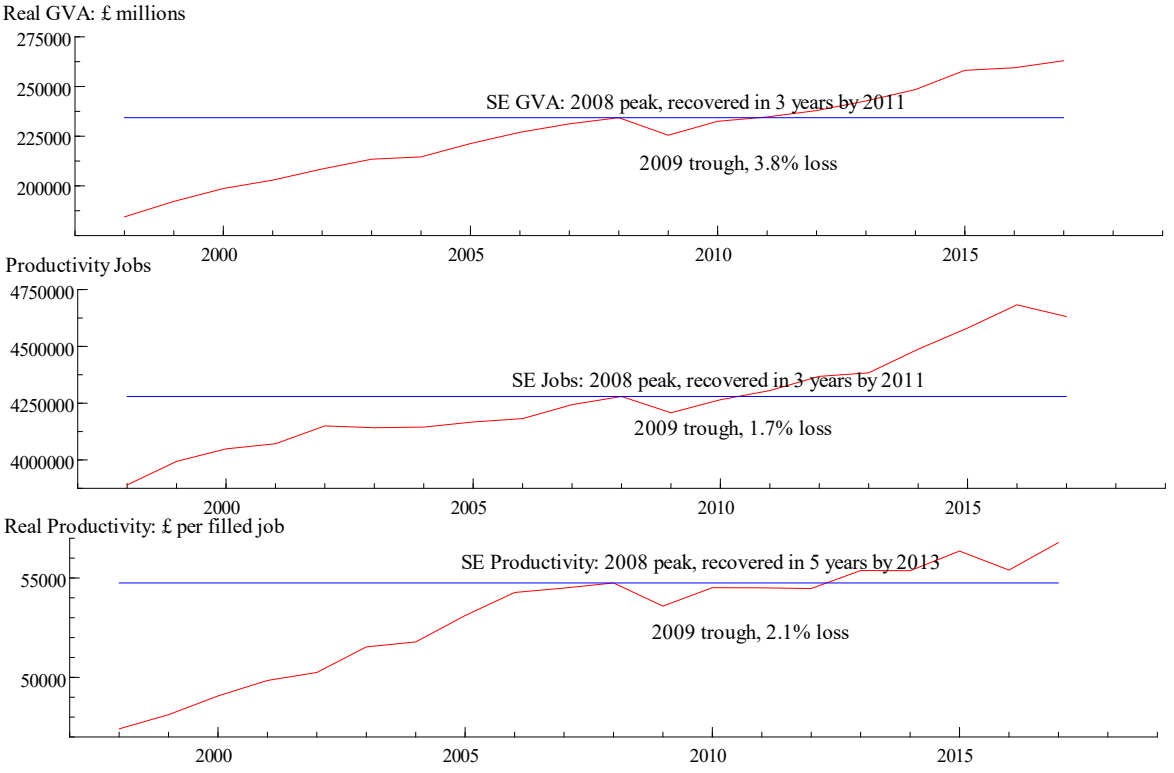

## Figure A.6: East of England Real GVA, Jobs and Productivity Business Cycle Measures



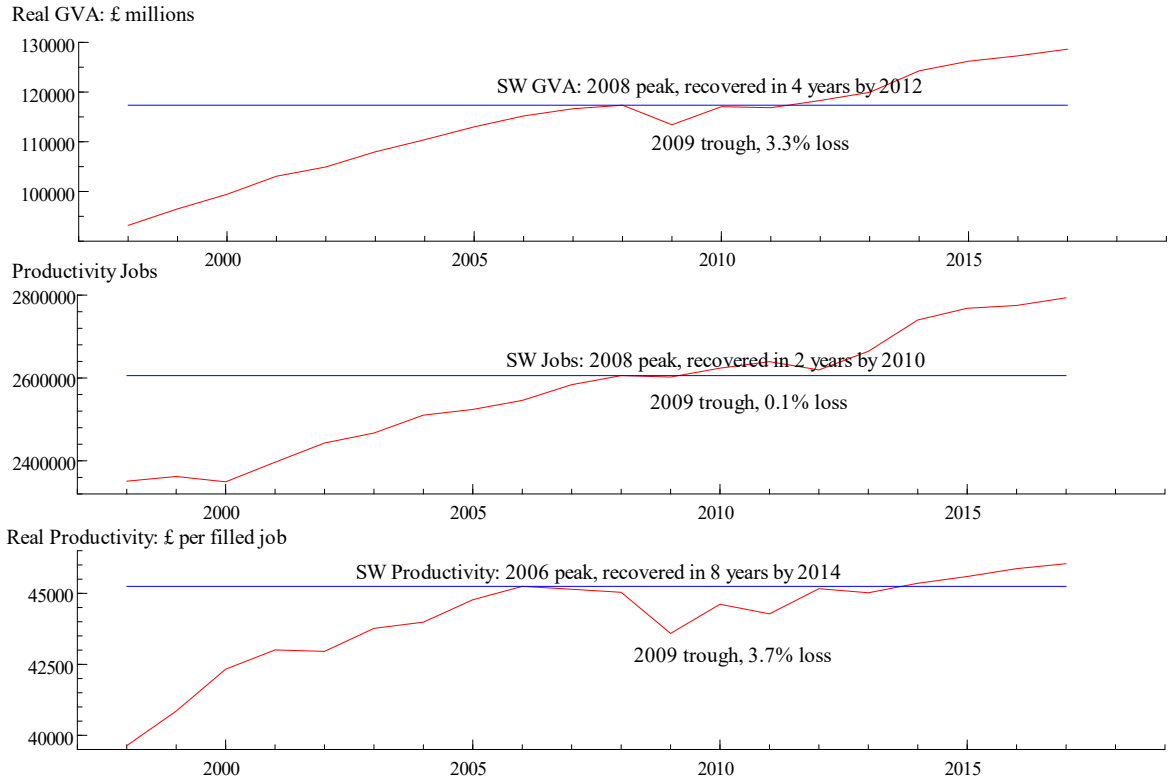
## Figure A.7: London Real GVA, Jobs and Productivity Business Cycle Measures



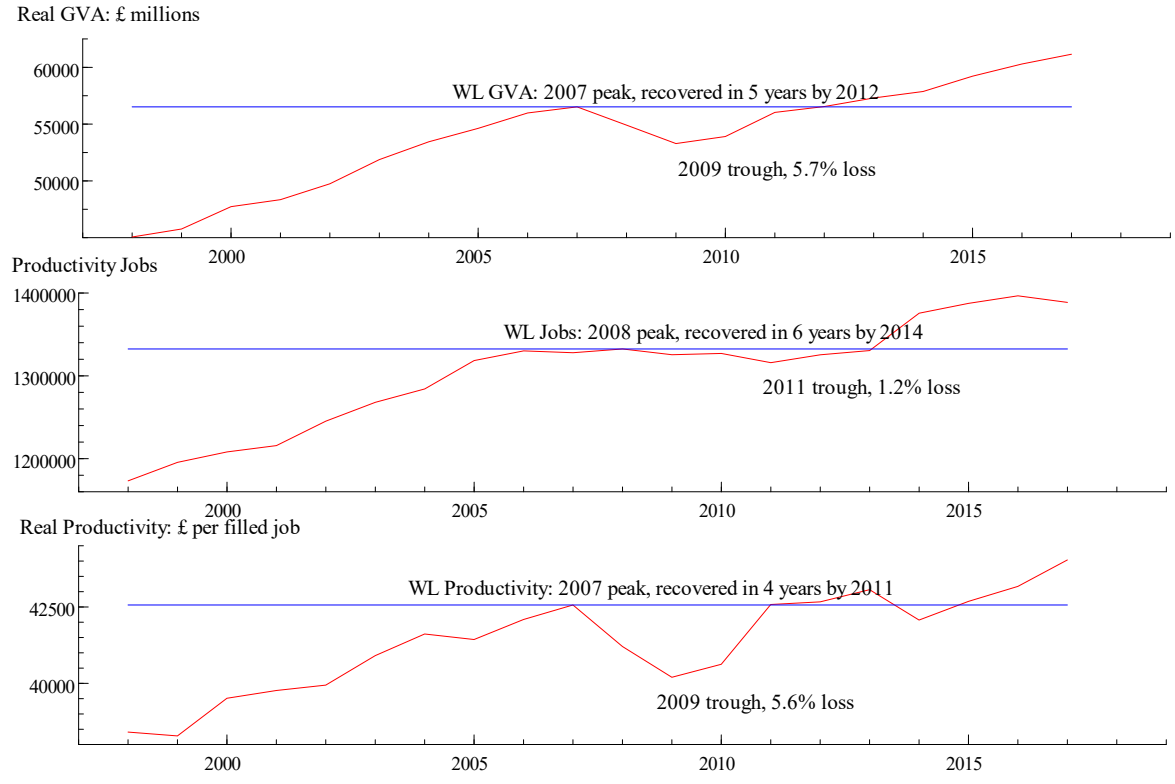

## Figure A.8: South East Real GVA, Jobs and Productivity Business Cycle Measures



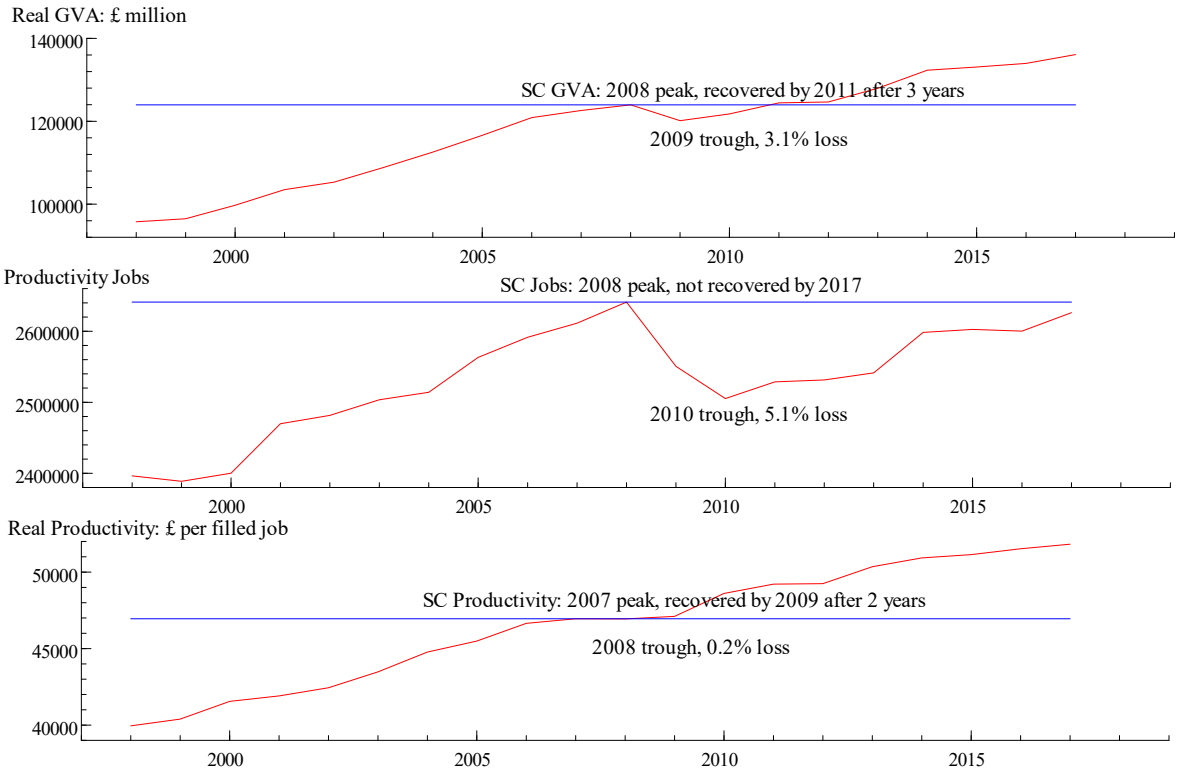
## Figure A.9: South West Real GVA, Jobs and Productivity Business Cycle Measures




## Figure A.10: Wales Real GVA, Jobs and Productivity Business Cycle Measures



## Figure A.11: Scotland Real GVA, Jobs and Productivity Business Cycle Measures




## Figure A.12: Northern Ireland Real GVA, Jobs and Productivity Business Cycle Measures