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Tackling the UK's regional economic inequality: binding constraints and avenues for policy intervention

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ABSTRACT

We analyse binding constraints to productivity growth in the UK's regions outside London and the greater South East. These analyses challenge a number of common arguments about the UK's regional economic inequality problem. We find little evidence consistent with the hypotheses (i) that low shares of university graduates remain the primary constraint on growth for the UK's regions; (ii) that there is a generalised issue with access to finance for firms outside the South East; or (iii) that low or falling regional migration rates are to blame for the persistence of the UK's regional economic inequalities. Instead, we find evidence consistent with (i) a specific relative shortage of STEM degrees; (ii) binding transport infrastructure constraints within major non-London conurbations; (iii) a failure of public innovation policy to support clusters beyond the South East, in particular through the regional distribution of public support for Research and Development (R&D); and (iv) missed opportunities for higher internal mobility due to London's overheating housing market. We also find some suggestive evidence consistent with constraints on access to early-stage equity financing for high-growth-potential SMEs in certain regions.

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1. Introduction

For most of the twentieth century, inequality in GDP per capita between UK regions was relatively low by European standards (Rosés & Wolf, 2018). Over recent decades regional inequality has increased in many countries, particularly the UK – now the most regionally unequal industrialised economy in terms of GDP per capita, productivity, and disposable income (McCann, 2020). These economic inequalities come alongside regional disparities in important outcomes like life expectancy, educational attainment, and social mobility (Carneiro et al., 2022; Farquharson et al., 2022; Marmot, 2020), and have been linked to a 'geography of discontent' which may feed political instability (McCann, 2020). Moreover,

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given the UK's national productivity problem (Office for National Statistics, 2022), boosting productivity in lagging regions opens the possibility for gains in equity as well as efficiency.

What are the defining features of the UK's regional economic inequality problem? In Section 2, we present five stylised facts, arguing that the problem is best characterised by productivity differentials between London and the greater South East of England versus the rest, largely driven by the underperformance of non-London cities. Earlier differences in employment rates and in industrial structure across regions have narrowed, leaving within-industry productivity differentials the prime driver of divergent regional economic performance. And, while different education mixes across regions mechanically drive a large portion of average productivity and earnings differentials, there is still a large regional productivity gap even controlling for education.

These stylised facts inform the animating question for the rest of our analysis: **how can policy most effectively boost productivity in the UK's lagging regions?** For this analysis, we focus on four key inputs to growth – education, infrastructure, support for Research and Development ('R&D'), and access to finance – analysing each in turn in sections 3 through 6.[1] For each of these policy areas, we attempt to identify not just whether and to what degree each input for productivity growth is *present*, but also to identify whether or not that input is in shortage in each region relative to its demand: whether it is a particularly *binding constraint* on growth. In doing so, we follow the growth diagnostic approach developed by Hausmann, Rodrik, et al. (2008) and Hausmann, Klinger, et al. (2008), which illustrates how market signals like prices and quantities can be used to infer the relative scarcity of different inputs to growth, in order to identify binding constraints.

Identification of which constraints are more or less binding is crucial for effective prioritisation of avenues for policy intervention. A region which is lagging economically may lack many of the important inputs for growth: it may have a poorly educated workforce, poor physical infrastructure, little innovative activity going on, and little financial capital flowing into the region. With scope for policy intervention in any of these areas, identification of which avenues will be most effective therefore requires identifying not just a laundry list of all the factors that are lacking, but also a diagnosis of which of these constraints are the most binding: which constraints, when alleviated, will be more likely to generate growth (Rodrik, 2010)? And a policy intervention to increase a region's supply of an input which is not a binding constraint will fail to generate productivity growth in that region unless the other binding constraints are also alleviated at the same time. Ideally, this process is iterative: policy should first identify and target the most binding constraints, then identify and address any new bottlenecks that may emerge as a result.

To identify whether an input is a more or less binding constraint, we build a collage of evidence from a range of indicators, comparing within the UK across regions and over time, and with elsewhere in Western Europe where possible. We then determine whether this collage of evidence is consistent with the input being a binding constraint on growth. The factors we consider include whether the input is in particularly scarce supply; whether there is evidence of economic actors being willing to pay a high price (in terms of money or time) to access this input; and whether there is reason to believe that increasing the provision of this input would boost productivity – or whether some other factor would still prevent growth from occurring. This collage approach to identify binding constraints on growth can necessarily only be indicative: it must be done at a high level, across regions and indicators, and requires judgment to identify the key messages from the evidence. But we

believe even an imprecise evaluation of the available evidence is important to inform – as best as possible – the prioritisation of scarce policy time and resources.[2]

We start with education in section 3. Education levels are strongly correlated with regional productivity, and there is an important mechanical role for increased educational attainment in boosting productivity. But which skills should be prioritised? A growth diagnostic approach would suggest that the relative scarcity of different skills across regions and over time can be inferred from their prices. As such, we use university wage premia to estimate the degree to which graduate skills are in scarce supply relative to demand in each region over time. A rising university wage premium would suggest increasing shortage of university graduates relative to demand, and vice versa. We find that in the 1990s, university wage premia outside London were high and university graduate shares were low. But over the last three decades, the massive increase in university attainment has come alongside a substantial decline in the university wage premium in almost all regions outside London, suggesting the expansion of higher education has helped alleviate the prior scarcity of graduate skills relative to demand.

On the other hand, we find that the wage premium for university-level STEM skills has hardly fallen – and even, in some regions, has risen – even as STEM attainment has risen rapidly. This is in stark contrast to the wage premium for other degrees: the STEM wage premium has remained high even as the wage premium for formerly highly rewarded degrees in law, finance, and management has fallen substantially. Thus while the expansion of university education may have reduced the scarcity of graduate skills in general (reflected in declining university wage premia), this was not the case for STEM graduate skills: demand for STEM skills appears to have risen as fast as supply. This suggests that prioritising STEM degrees is likely to have higher returns – as compared to a generic focus on increasing the number of university graduates.

In the context of free labour mobility, however, we also caution that increasing enrolment alone cannot be the solution. Net graduate outmigration from even low-enrolment regions suggests that the dominant problem for most regions is a lack of demand for graduates, more than a lack of supply of graduates.

We examine infrastructure in section 4. We show that UK cities' transport infrastructure stands out in international context: the UK's cities have more congested roads and smaller road networks than peer US cities and are less accessible by public transport than peer Western European cities, limiting their 'effective size' and their ability to benefit from agglomeration economies. Using the growth diagnostic approach, a high degree of congestion at rush hour would suggest a high economic value of commuter travel (since people are willing to pay a high cost in terms of time), and therefore that poor transport infrastructure may be a binding constraint on further growth. Indeed, while London's transport congestion is well known we also see high congestion on roads and a combination of high crowding and poor reliability on trains in several non-London cities, suggesting that improving road and rail infrastructure in congested cities would likely bring significant economic returns. UK infrastructure spending has been disproportionately directed toward London given London's high congestion: by this logic, more could be done in other cities as well (and there is scope to do so, since UK infrastructure spending is low relative to other OECD countries).

We turn to innovation in section 5. Public and higher education R&D policy can be important for generating local knowledge spillovers and stimulating coordination

externalities around high-productivity industries. Discerning directly whether or not a lack of public support for R&D is a binding constraint on growth is difficult using existing data, since one cannot easily measure the degree to which firms are constrained by their lack of access to these knowledge spillovers. We do show, however, that public and higher education R&D expenditure has been heavily biased toward richer regions – more so even than business R&D spend. If business R&D spend is seen as an indicator of a region's absorptive capacity for innovative activity, then this may suggest that in regions with high business R&D but low public R&D, a lack of support for R&D from the public sector may be impeding growth. In Germany, by contrast, public sector and higher education R&D spend – while still directed towards richer regions on average – are substantially less spatially biased than business R&D spend, thus helping regional convergence.

In section 6, we analyse access to finance. The prior three inputs – education, infrastructure, and R&D – may be binding constraints on growth if their absence means that there are fewer high-return economic opportunities in a given region. In contrast, access to finance may be a binding constraint on growth if high-return economic opportunities exist but firms cannot get financing to pursue them. The growth diagnostic approach would suggest that, if access to finance is a binding constraint on growth, we should see evidence in prices and quantities: we may expect to see higher interest rates, margins, or collateral requirements; higher rejection rates or appeals rates; or we may expect to see only the best prospects getting funded (and therefore higher returns or lower default rates). We find little evidence on any of these metrics that a lack of access to finance disproportionately affects investment in non-London regions. Across a wide range of indicators, we find no evidence of differential regional access to bank lending – the main source of SME financing. And while there is a large equity funding gap between London and non-London based SMEs, this gap can be largely explained by differential business characteristics across regions. There is some indication of constraints on access to equity financing for high growth SMEs in certain regions – SMEs in Yorkshire and the Midlands are substantially less likely to receive equity financing than observably equivalent firms in London. For most regions, though, data on non-London equity investors, and on follow-on funding rounds is more consistent with the hypothesis that these gaps are being driven by differential growth prospects, rather than by investor bias or missed opportunities. More research on this question is warranted.

Finally, in section 7, we consider the role of migration. Our growth diagnostic approach above focuses on avenues for policy intervention to increase productivity growth in lower-productivity regions of the UK. But in a single economy, labour mobility can also play a role in equalising incomes: spatial equilibrium suggests that productivity and incomes would be expected to converge on the margin as people leave lower-earning regions for higher-earning regions. This is not happening in the UK: in fact, interregional mobility in the UK goes in the 'wrong' direction for spatial convergence: people on net move away from high-productivity London to other regions. Why might this be? We find no evidence to suggest that the persistent income differentials between the UK's regions are a result of a low propensity for UK residents to move. In fact, UK interregional migration is relatively high in international context and has not declined over time (unlike in the US). Instead, people move out of London as high housing costs erode London's wage premium for much of the income distribution, making the net return to migration to London small or negative.

In our analyses we draw on a range of data sources: cross-national data from EU's ARDECO database, the OECD regional and national statistics databases, and the University of Gothenburg Quality of Government EU regional dataset; UK government statistics from the Office for National Statistics, the Department for Transport, the Office of Rail and Road, the Department for Education, the British Business Bank, and OFCOM; individual-level survey data from the UK's Labour Force Survey; data from private sector sources including UK Finance, BVA BDRC, TomTom, and INRIX; and data compiled by other researchers (Britton et al., 2021; Conwell et al., 2022; Ekpu et al., 2020; György, 2018; Rodrigues & Breach, 2021a; Wilson et al., 2019; Xu et al., 2021). Where possible, we always conduct our analyses for the entire UK. However, some data sources are available for England only, or for England and Wales only.

We conclude by reviewing the contemporary UK policy debate in light of our findings. Together, our analyses challenge some common arguments about the UK's regional economic inequality. We find little evidence consistent with the hypotheses (i) that the low share of university graduates is a primary binding constraint on growth for the UK's regions; (ii) that a generalised lack of access to finance is a binding constraint on growth for firms outside the South East; or (iii) that low or falling regional migration rates are to blame for the lack of income convergence between the UK's regions. Instead, we find evidence consistent with (i) a specific relative shortage of STEM degrees; (ii) binding transport infrastructure constraints within major non-London conurbations; (iii) a failure of public innovation policy to support clusters beyond the South East, in particular through the regional distribution of public support for R&D; and (iv) missed opportunities for higher internal mobility due to London's overheating housing market. We also find some suggestive evidence consistent with constraints on access to early-stage equity financing for high-growth-potential SMEs in some of the UK's regions. Notably, outside education policy, the type of large-scale, systematic, and consistent policy action needed to address any of these binding constraints has not taken place in the UK in recent decades. Policymakers seeking to tackle regional economic inequality would therefore do well to make progress on each of the constraints we have identified.

2. Where are we, and how did we get here? Five stylised facts

In this section, we document five important stylised facts about regional economic inequality in the UK. We see these five facts as jointly characterising the most striking and persistent features of the UK's regional economic divides, as compared to other countries. This characterisation of the problem informs our approach in the rest of the paper: an analysis of avenues for policy intervention with the most potential to boost productivity in regions outside London and the South East.

Stylised Fact 1: The UK's regional economic inequality is primarily a productivity problem. In the 1980s, the defining regional economic disparity in the UK was in employment (Balls et al., 1991; Evans & McCormick, 1994). Today, while there is still evidence of employment scarring from the 1970s/80s (Beatty & Fothergill, 2017; Rice & Venables, 2021), UK regional inequality in employment rates is relatively low in international context and has been falling. In contrast, regional inequality in productivity, measured by GVA per worker, is high by international standards and has been rising (Appendix Figure 1).

Stylised Fact 2: The UK's regional economic inequality is best characterised as London and the South East vs. the rest of the country (Carrascal-Incera et al., 2020; Harris & Moffat, 2022; McCann, 2020). Since 1980 the rise in regional inequality as measured either by GDP per capita or GVA per worker has been driven by London and the South East, which started off substantially richer and grew faster than almost any other region. Today, the gap between London and the South East, vs. the rest of the UK, is larger than the gaps between East and West Germany or North and South Italy. Specifically, in 2019, GVA per worker in East Germany was 80% of that of West Germany, GVA per worker in South Italy was 78% of that of North Italy, and GVA per worker in the rest of the UK was 71% of that of London and the South East (see Appendix note A1).

Stylised Fact 3: The underperformance of regions outside London and the South East is largely driven by underperforming cities. The UK's cities – outside of a few Southern exceptions, notably London – do not appear to benefit from the agglomeration economies seen in other countries**,** where scale and population density are strongly associated with higher productivity (Forth, 2017; McCann & Yuan, 2022; OECD, 2015; Özgüzel, 2020a). Figure 1 shows that Manchester and Birmingham have particularly low productivity for their population size. The underperformance of large cities outside London and the South East means that the growing urban/non-urban divides seen in other countries are less stark in the UK (Martin et al., 2021; McCann, 2020). Despite this central role of underperforming cities, for maximum comparability across datasets and countries in our analysis we primarily focus on regions (defined at the NUTS1/TL2 level). Large metropolitan clusters or 'city-regions' make up a majority of the population in many of the UK's regions (see Appendix Note A2).

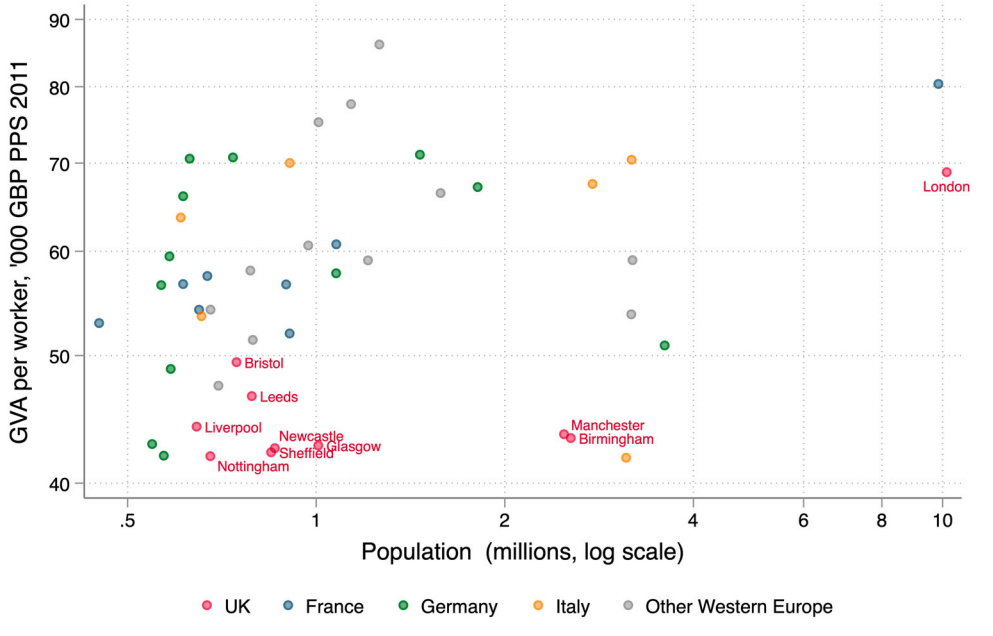

Figure 1. Productivity and city populations, Western Europe. Source: Recreated from Rodrigues and Breach (2021). Original data source: OECD.

Stylised Fact 4: Education mix is important – but it's not all about education. Different education and skill mixes play a central role in productivity differentials across regions. Since more highly educated residents earn more, different education levels across regions mechanically explain a large share of the regional inequality in incomes and productivity in the UK.[3] Boosting both tertiary and secondary education in non-London regions would therefore almost certainly boost productivity (see e.g. Machin & Vignoles, 2018). But wage differentials suggest that regional productivity disparities are not solely explained by education mix. To illustrate this, we estimate region wage premia, relative to the North East, for private sector workers aged 25–59 over 2010–19 using the Labour Force Survey. We regress the log of hourly wages on indicators for each region of workplace, and fixed effects for age, sex, and year in our baseline specification (blue), and run a further regression with fixed effects for highest educational qualification (red). As Figure 2 illustrates, even conditional on education, wages in the 2010s were somewhat higher in the East and the South East, and substantially higher in London, with workers in London earning approximately 29% more than workers of the same age, sex, and education level in the North East.[4] As the right panel of Figure 2 shows, wage differentials across regions have been relatively consistent since the late 1990s.

Stylised Fact 5: Industry is important and was a major driver of the UK's regional economic inequalities – but industry mix is less important now. Regional inequalities were widened by particularly extreme exposure to two global trends: deindustrialisation, and the rise of the knowledge economy. In 1980, the UK had five of the sixteen most

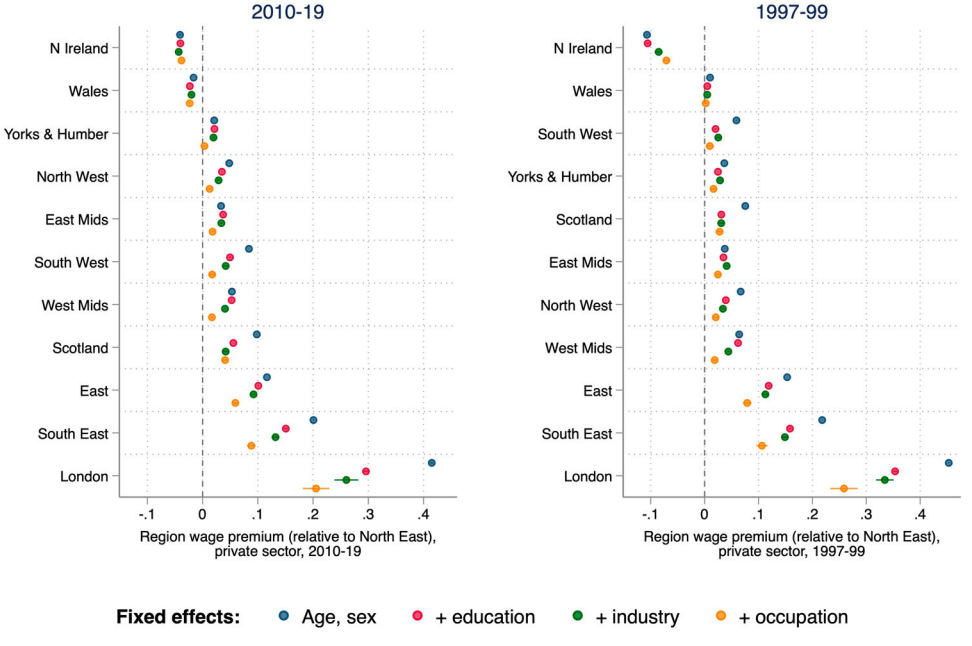

Figure 2. Region wage premia, relative to the North East. Source: Labour Force Survey.

Note: Dots represent coefficient estimates (and bars 95% confidence intervals) in a regression of log hourly wage on region dummies. All specifications have sex, age, and year fixed effects. Sample: 25–59 year olds, private sector. Blue shows coefficient estimates for a specification with age, sex, and year fixed effects, red adds fixed effects for highest level of education, green adds 2-digit industry fixed effects, and orange adds 4-digit occupation fixed effects. Robust standard errors clustered at region level.

industrialised regions in Western Europe: the East and West Midlands, Yorkshire and the Humber, Wales, and Northern Ireland (as measured by employment share in manufacturing and mining). At the same time, London, the South East, and the East of England were all in the top six in terms of their employment shares in finance and business services. As finance and business services became the engine of productivity growth across the industrialised world (Ehrlich & Overman, 2020),[5] London and the greater South East were uniquely poised to benefit; meanwhile, as automation and globalisation led to deindustrialisation, much of the rest of the UK was distinctively exposed.

Moreover, deindustrialisation in UK regions was particularly rapid compared to similarly industrialised regions in Western Europe (Figure 3). Between 1980 and 2018, the West Midlands saw its employment share in manufacturing and mining fall by 30 percentage points, and the East Midlands and Yorkshire and the Humber saw falls of around 25 percentage points. The five other Western European regions with comparably high manufacturing and mining employment shares in 1980 – North-Rhine Westphalia, Baden-Wuerttemberg, and the Saarland in Germany, North-Western Italy, and North-Eastern Spain – saw much smaller falls of 14–20 percentage points. When we examine the most acute instances of regional deindustrialisation within this period, as measured by the sharpest falls in manufacturing and mining employment share within a ten-year timeframe, the only other EU regions to have seen comparably rapid deindustrialisation were regions in formerly Communist countries in the decade following the transition to capitalism.[6] These large, regionally-concentrated collapses in employment led to long-lasting economic scarring (Martin et al., 2021; Rice & Venables, 2021, 2022).

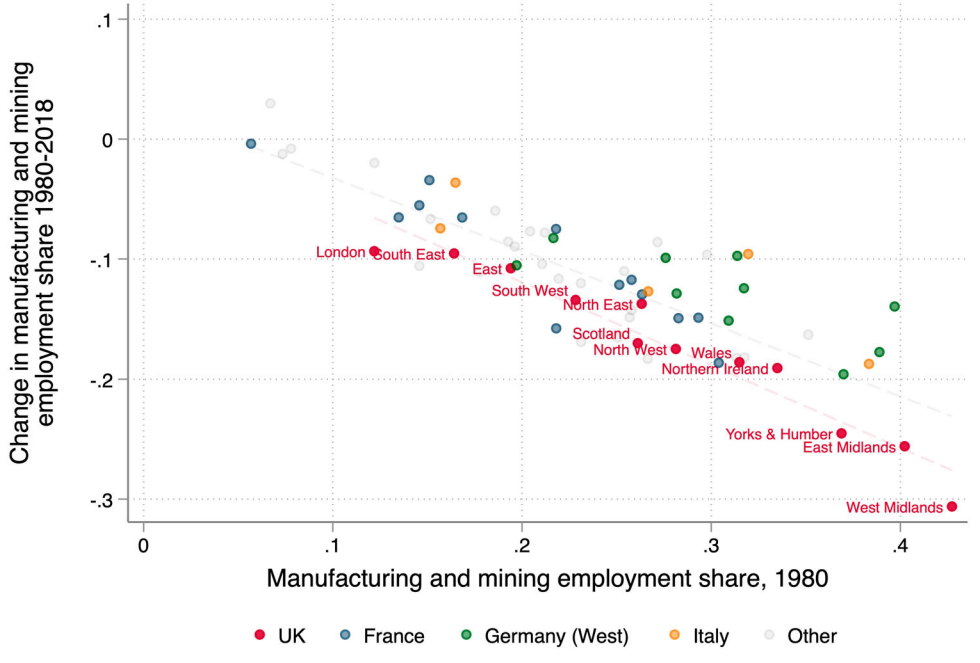

Figure 3. Deindustrialisation in Western European regions, 1980–2018. Source: ARDECO.

Note: Grey denotes line of best fit across all regions; red line denotes line of best fit for UK only. 'Other' includes regions in Austria, Belgium, Denmark, Finland, Greece, Ireland, Luxembourg, Netherlands, Norway, Portugal, Spain.

While these sectoral shifts aggravated regional inequality, they have led to substantial convergence in regional sectoral composition over time. As a result, today the within-sector productivity differential is a bigger contributor to the productivity gap between London and non-London regions than sectoral composition. Two exercises support this conclusion. First, when estimating region wage premia in the Labour Force Survey, the addition of industry fixed effects has almost no effect on the coefficient estimates (Figure 2), suggesting that industry composition only explains a small fraction of region wage differentials. Second, a simple counterfactual exercise where each region is given London's 2018 sectoral composition, but keeps its own region's sector-by-sector productivity, does almost nothing to close the regional productivity gap (Figure 4).[7] This is because, while the remaining manufacturing in formerly industrialised regions is highly productive, finance and business services in these regions are not – perhaps because the type of finance and business services activity carried out differs between London and elsewhere.

Motivated by these five stylised facts, in the remainder of the paper we ask **how policy can most effectively boost productivity in the UK's lagging regions**. We focus on four inputs to growth – education, infrastructure, R&D, and access to finance – for each input seeking to identify whether a lack of this input represents a binding constraint to growth and, if so, whether alleviating this constraint is a promising avenue for policy intervention. We begin with education.

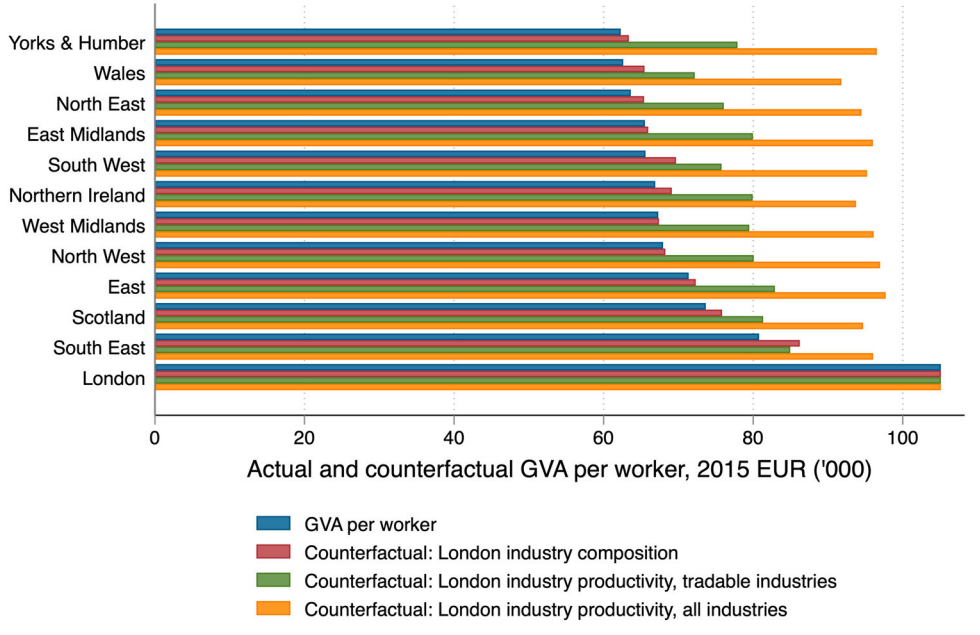

Figure 4. Regional GVA per worker, 2018 – actual and counterfactuals. Source: ARDECO; Authors' calculations.

Note: (1) Red bars: each region is assigned London's employment shares for each sector but retains its sector productivity. (2) Green bars: each region is assigned London's productivity for each tradable sector – manufacturing and mining, and finance and business services – but retains its employment shares. (3) Orange bars: each region is assigned London's productivity for all sectors but retains its employment shares.

3. Education

Education is the first of the four inputs to growth we analyse in this paper. Educational attainment is extremely strongly correlated with regional productivity, and different levels of education can explain mechanically much of the average income differences between regions (see e.g. Overman & Xu, 2022). While workforce education levels have risen rapidly in all UK regions over recent decades, the gap between regions remains large. Together, these facts have led to calls for upskilling, or reducing the 'graduate drain' (the outflow of graduates from non-South East regions).

To what extent is a lack of education a key binding constraint on growth for the UK's lower productivity regions? It is important to emphasise that increasing education will surely boost productivity. However, its effects may be weaker than anticipated if a lack of education is not the most binding constraint on firms' growth. Low education levels may be an *outcome* of low regional productivity – a lack of well-paid graduate jobs reducing the incentive to go to university or encouraging outmigration – rather than a cause. If so, increasing education in lower-productivity regions without other reforms alongside may simply lead either to underemployment or outmigration of the highly-educated.

Under the growth diagnostic framework, a high market price can be an indicator that a factor of production is a binding constraint (Hausmann, Klinger, et al., 2008): a high price suggests high demand relative to supply. Similarly, a rising price suggests increasing relative scarcity. The relevant market price, in the case of education, is the private sector wage premium for people with a given type or level of education. For example, by comparing the private sector university wage premium across regions, we can infer the relative scarcity of university graduates in some regions relative to others. All else equal, a higher university wage premium in one region than in another would indicate that the demand for university graduates from employers in that region is particularly high relative to their supply. Similarly, by studying the evolution of the university wage premium over time, we can infer how this relative scarcity has changed over time. (See Appendix B for more details on identification assumptions, such as there being no regionally differential change in graduate quality over time).

We use the Labour Force Survey to estimate the university wage premium within each region for 25–59 year old employees, relative to someone with A-levels only.[8] We limit our analysis to the private sector where wages likely reflect firms' willingness to pay for skills. In Figure 5, we plot these estimated university wage premia for each region against the share of private sector employees who are university graduates in that region (on a log scale). All regions substantially increased their graduate share from 1997 to 2019, and – in all regions except London – this came alongside a large decline in the university wage premium. Most regions see a pronounced downward-sloping line suggestive of a demand curve: as the relative supply of graduates increases in a region, the relative price of a graduate (versus a non-graduate) falls. London is an exception: it saw a large increase in its graduate share, but no decline at all in its university wage premium over the period.[9] In most UK regions in 1997, the university wage premium was higher than it was in London; in contrast, by 2019 the university wage premium was much higher in London than in any other UK region, at about 40% in London compared to 30% in most other regions.[10] Interpreted through the lens of the growth diagnostic approach, this pattern of private sector university wage premia (holding all else constant) would

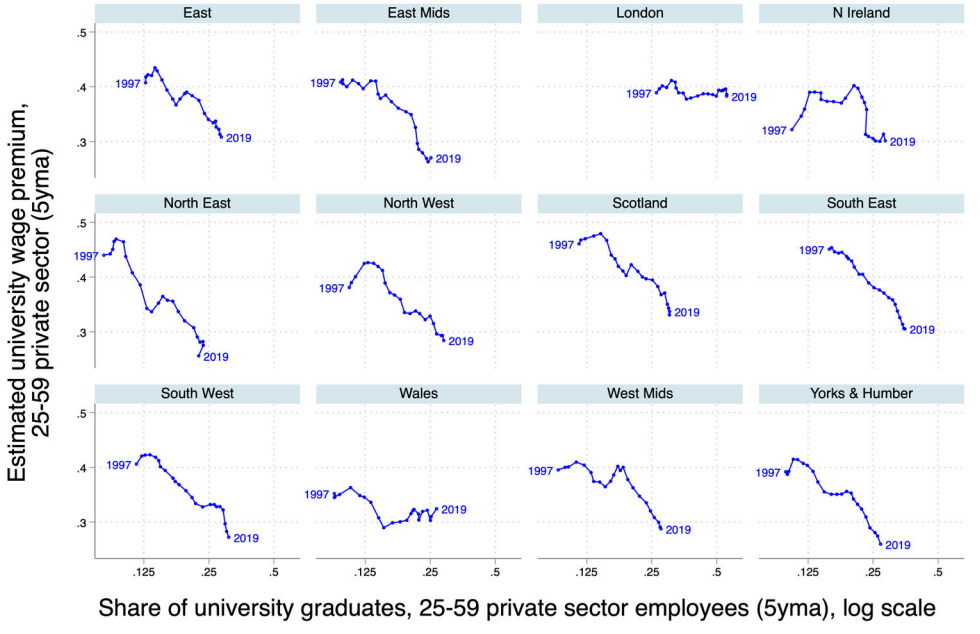

Figure 5. Private sector university wage premia across regions, 1997–2019. Source: Analysis of UK Labour Force Survey.

Note: '5yma' refers to five year moving average. Sample restricted to private sector only, 25–59 year olds. Each point represents a five year centred moving average of the estimated wage premium for university graduates relative to A-level recipients, and the share of university graduates among employees in each region in each year 1997–2019.

suggest that (i) in the 1990s university graduates were relatively scarce across the UK, and (ii) that the mass expansion of university education in the last two decades alleviated this scarcity relative to demand for graduates for most regions outside of London.[11] This suggests in turn that a lack of university graduates in general is unlikely to be a highly binding constraint on growth in most regions outside London.

Next, we use the same data and methodology to estimate the private sector university wage premium separately for three groups of degrees – STEM (science, technology, engineering, and mathematics), LFM (law, finance, and management), and all other degree subjects.[12] We do this for two reasons. First, the skillsets conferred by STEM and LFM degrees may be differently demanded by employers. Second, we may be concerned that the average quality of graduate skills may have fallen as university education expanded. The average quality of a STEM or LFM degree may be expected to have remained more constant over the period.[13] Figure 6 illustrates the results, plotting the estimated university wage premium for each year 1997–2019 for each of STEM, LFM, and other degrees, against the share of 25–59 year old private sector employees in each region who have those degrees. For non-STEM non-LFM degrees (shown in blue), we see the same kind of pattern across regions and over time as we saw for all degrees in Figure 5: almost all regions outside London saw a large increase in university attainment and a large decline in university wage premia, while London saw a large increase in university attainment but no decline in the university wage premium. Indeed, the university wage premium outside London for these non-STEM, non-LFM

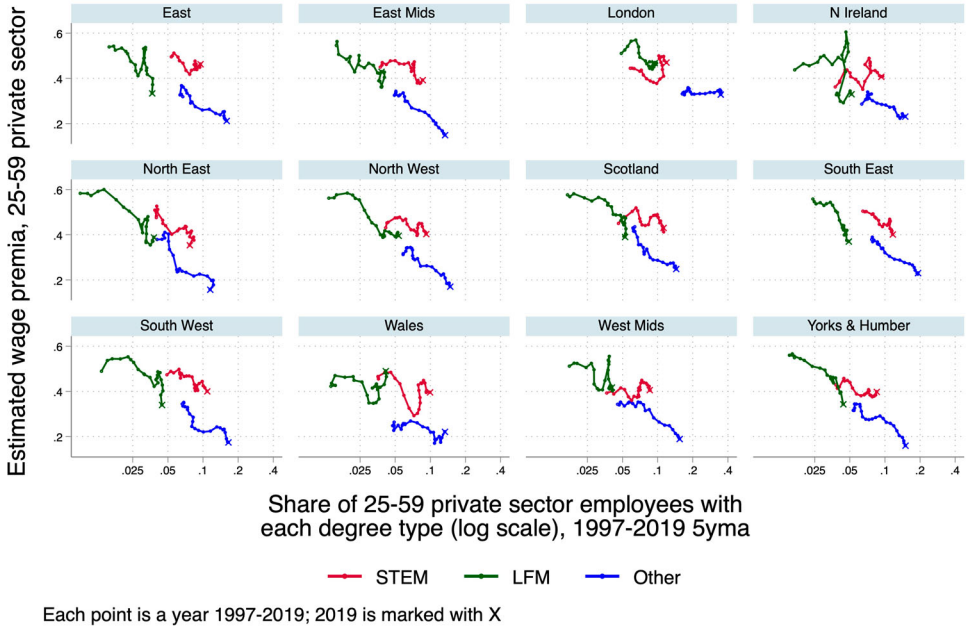

Figure 6. Private sector university wage premia for STEM, LFM and other degrees. Source: Analysis of UK Labour Force Survey.

Note: '5yma' refers to five year moving average. STEM: Science, Technology, Engineering, and Mathematics. LFM: Law, Finance, and Management. Sample restricted to 25–59 year old private sector employees. Each point represents a 5-year centred moving average of the estimated university wage premium for STEM/LFM/other degrees relative to A-levels, and the share of employees who have that type of degree in each region in each year 1997–2019. 2019 is marked with an X.

degrees is now quite low at around 20%. For LFM degrees, the pattern over time is similar: while the estimates are noisier as these represented only 15% of degrees in 2019, most regions saw an increase in LFM degree attainment and a decline in the LFM wage premium, again seeming to trace out demand curves (in green). LFM degree wage premia in regions outside London fell from around 50–60% in the late 1990s to between 35% and 45% by the late 2010s.

For STEM the pattern looks different. First, the STEM wage premium is higher than the LFM wage premium in most regions, and much higher than the wage premium for other degrees. Moreover, as STEM degree attainment has increased the STEM wage premium has fallen much more slowly than it has for LFM degrees – in fact, it rose in London and hardly fell at all in the East or West Midlands, the North West, or Yorkshire and the Humber. Again using the logic of the growth diagnostic approach, this suggests that STEM degrees are scarcer relative to their supply than other degrees, and that – unlike for LFM degrees – the increase in supply over the last twenty years has *not* alleviated this shortage, suggesting that demand for STEM degrees has been increasing just as fast as (if not faster than) supply in most regions.[14]

Overall, therefore, the facts that (i) university wage premia are so much lower outside than in London on average and (ii) university wage premia outside London have fallen so much since the 1990s as the supply of university graduates rose, together suggest that the massive expansion of university education in the UK helped alleviate the degree to which a lack of university graduates *in general* was a binding constraint on growth in

most UK regions outside London. However, the facts that (iii) STEM-specific wage premia are consistently much higher than an average degree subject and (iv) STEM wage premia have fallen much less over time (even compared to other high-wage degrees) suggest that a shortage of STEM-specific degree-level skills may still be a binding constraint on growth across most regions.

An important caveat to our analysis: it could be that the observed university wage premium fell due to lower quality training – or students – as university access expanded (see e.g. O'Leary & Sloane, 2005 and our Appendix B). We think it unlikely that this is driving our results, for three reasons. First, one might expect the marginal student induced to get a degree to be of lower ability than the average university graduate, but of higher ability than the average A-level recipient, meaning that university expansion would cause the average quality of both university graduates and A-level recipients to decline. It is not clear which way this would net out, and indeed Blundell et al. (2022) in a bounding exercise conclude that changes in selection on unobserved ability would predict at most a small decline in the UK's overall university wage premium.[15] Second, since the expansion of university attainment was similarly large across regions, our results would require the relative quality of university graduates to have decreased outside London but not in London. Third, our estimate of university wage premia for LFM degrees – where one might expect the quality to have remained more constant over time – also finds large decreases in the wage premium as the share of the workforce with these degrees rose, with the slope of the relationship strikingly similar to that of the other non-STEM non-LFM degrees. Nonetheless, to be sure of estimating the pure effect of changes in relative supply and demand holding unobserved ability and education quality constant would require an analysis of returns to individual university courses across regions and over time, with controls for prior academic preparation and ability. We leave this for future research.

We can repeat the analysis for advanced further education (defined as any non-university tertiary qualifications), again estimating the private sector wage premium relative to someone with an A level or equivalent.[16] Our estimates are shown in Figure 7. In every region the wage premium for advanced further education has declined substantially, by around 10 percentage points, even though in most regions there has been very little increase in the share of the workforce with these qualifications. Through the lens of the growth diagnostic approach, this pattern suggests a decrease in private sector relative demand for these qualifications since the late 1990s. This could be a result of a decline in the relative usefulness of the skills provided by advanced further education, or a decline of the relative quality of the education provided. Alternatively, it could be that as university education expanded, the signalling value of an advanced further education qualification fell. In any case, it suggests that the average value private sector firms attach to advanced further education qualifications has fallen substantially in recent years, suggesting that a shortage of these skills *as they are currently taught* is unlikely to be an important constraint. It is still possible that other non-university tertiary skills may be important; we are unable to examine whether there is a relative shortage for certain specific advanced further education skills within this broad category. We leave this for future research.

Market prices – education wage premia – are not the only tool we can use to understand whether or not a lack of education is a highly binding constraint on firms' ability

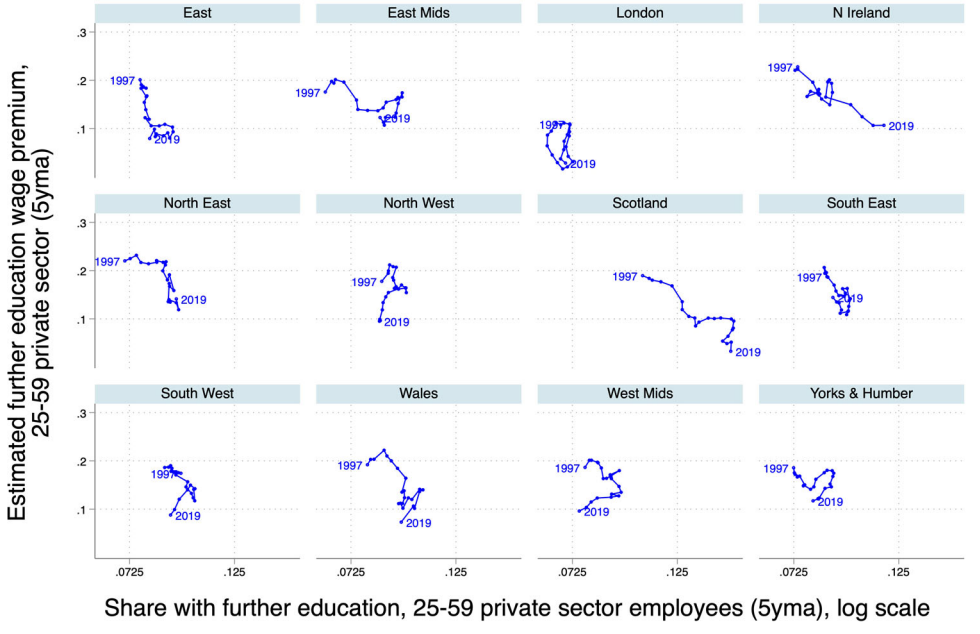

Figure 7. Private sector wage premia for advanced further education, by region. Source: Analysis of UK Labour Force Survey.

Note: '5yma' refers to five year moving average. Sample restricted to 25–59 year old private sector employees. Each point is a five-year centred moving average of the estimated wage premium for advanced further education recipients relative to A-levels, and the share of advanced further education recipients among employees 1997–2019.

to grow. Graduates' geographic mobility can also shed light on possible binding constraints. If a region has a low graduate share because local residents are not going to university – but when they do, they find productive local jobs – this might illustrate that the region has a shortage of graduates caused by some bottleneck in the education system. On the other hand, if a region has a low graduate share because local graduates leave to work elsewhere, this suggests that the supply of local graduates is not the most binding constraint on growth – rather, local demand for graduates (availability of productive graduate jobs) is relatively low even as compared to supply.

Recently, Britton et al. (2021) combined administrative educational records from the Longitudinal Educational Outcomes (LEO) database with geographic information after students leave education, to analyse the geographic mobility of university graduates. We use these data, provided to us at an aggregate level by Britton et al. (2021), to analyse a snapshot of English regions' 'graduate gain' vs 'graduate drain': the difference between the graduate share among 27-year olds who grew up in the region, vs. the graduate share among 27-year olds currently living in the region (Figure 8).[17] (This data only includes people who went to school in England). While regions outside London and the South East do produce fewer graduates, there is still substantial net 'graduate drain' to London: the share of 27-year olds living in each non-London region who have degrees is lower than the share of 27-year olds from each of those regions who have degrees. The combination of low shares of students going to university, *and* net outmigration of those who do get university degrees, is consistent with the hypothesis that the low graduate shares in the North of England and the Midlands are the result of a

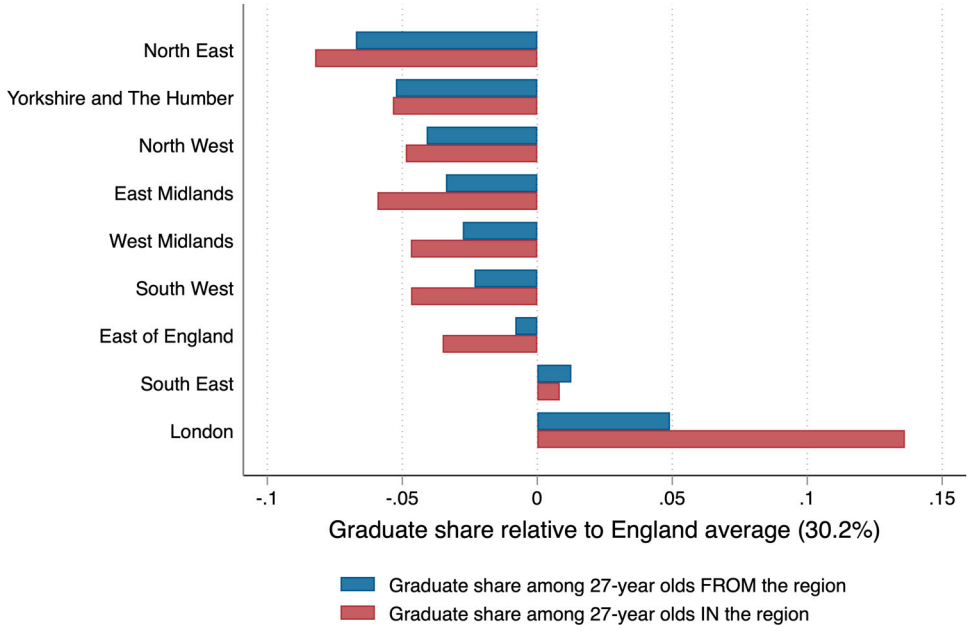

Figure 8. Graduate shares in and from English regions (27-year olds). Source: Authors' analysis of data provided by Britton et al. (2021), which was drawn from the Department for Education Longitudinal Educational Outcomes dataset.

lack of high-paying jobs for graduates – and not a result of a bottleneck on the supply of graduates (see also McCann, 2016). This suggests in turn that increasing university education for students from these regions without simultaneously increasing the availability of graduate jobs may do little to boost regional productivity, and may simply lead to underemployment or further outmigration of graduates.[18]

We note three caveats to our education analyses. First, we focus on formal qualifications, which may not always measure business-relevant skills. Second, even if graduate skills are not *currently* a key binding constraint on growth in lagging regions, this may change – in fact, the substantial university expansion of recent decades seems to have worked to alleviate the bindingness of the education constraint. Finally, improved education and skills are a good in and of themselves, both from the perspective of individuals' welfare and to improve national productivity.

Overall, our education analyses have suggested that a lack of general university graduates and or of people with advanced further education qualifications is not likely to be the primary binding constraint on growth for the UK's non-London regions. In contrast, there is evidence that STEM degrees in particular are in relatively scarce supply as compared to private sector demand, suggesting that alleviating this shortage by boosting STEM skills could have a particularly large impact on growth. In the next section, we turn to infrastructure.

4. Infrastructure

The second input to growth we analyse is infrastructure, with a focus on transportation. Evidence on agglomeration effects finds that areas with larger or denser populations have

higher productivity even controlling for population composition (Graham & Gibbons, 2019; Özgüzel, 2020b; Rice et al., 2006), suggesting that improved transportation infrastructure – by creating a larger effective population – can boost productivity. While isolating plausibly exogenous transportation investments is difficult, there is evidence to suggest beneficial local economic effects of improvements to both road and rail accessibility (Bernard et al., 2019; Gibbons et al., 2018; Gibbons et al., 2019; Heuermann & Schmieder, 2019; Özgüzel, 2020b).

The UK's transport infrastructure investment, as a share of GDP, has been relatively low by international standards. Road investment, in particular, has been among the lowest of any industrialised economy over the last three decades according to OECD data: the UK spent an average of 0.3% of GDP per year over 1995–2020, compared to 0.4% in Italy, 0.5% in Germany and the United States, and 0.65% in France.[19] By contrast, in recent years the UK has spent one of the highest shares of GDP on rail investment of any large industrialised economy (Appendix Figure 13). Within the UK, transport spending has been skewed toward London and the South East, with per capita spending nearly twice as high as in other English regions over 1999–2019 (Appendix Figure 14).

Yet, as the growth diagnostic framework emphasises, the fact that infrastructure investment is low does not tell us whether more or better infrastructure would boost growth. To what extent is a lack of investment in transport infrastructure a binding constraint on growth for non-London regions? To answer this question – and therefore understand whether policy aimed at increasing connectivity would boost productivity growth – we need indicators of whether private sector demand for transport infrastructure outstrips the supply. Unlike with education, there are few market prices which can help us infer relative private sector demand for transportation infrastructure. But an analogous indicator of whether existing infrastructure meets the needs of the regional economy is congestion. Road congestion is particularly analogous to a price: it imposes a direct cost on commuters' time. For rail traffic, crowded trains impose a smaller cost (discomfort, but not lost time); nonetheless, the degree of crowding on trains can indicate the degree to which there is latent demand for trains which is not met by the existing supply. Due to data availability, and because transport infrastructure is typically oriented around cities, we focus here on cities/metropolitan areas, not regions.

We start with roads. Most UK commuters travel by road. Even in large non-London cities like Manchester, Birmingham, or Liverpool, more than 75% of commutes are by road (mostly by car).[20] To investigate road congestion, we use two indicators for 2019, each measuring a different aspect of congestion. TomTom uses real-time traffic data to calculate the average percentage increase in travel time for a thirty-minute trip in a given city over the year, as compared to free-flow conditions, weighted across roads by their total traffic (TomTom, 2022). INRIX estimates the total hours lost per driver per year driving at peak times relative to a free traffic flow scenario (INRIX, 2022). While these measures are calculated for individual drivers, congestion will typically impact bus travel as well (except in cases where there are special car-free bus lanes). Using these measures, we compare road congestion in UK cities to peer cities in the US and Western Europe (see Appendix Note A4).

We find that on average, UK cities have much higher road congestion levels than similarly-sized US cities: specifically, 48% higher on the TomTom measure, and 101% on the INRIX measure. We also find that UK cities have on average higher road congestion levels

than similarly-sized Western European cities: 15% higher per TomTom, 31% per INRIX.[21] We visualise congestion in UK, US, and Western European cities on the TomTom measure in Figure 9, and on the INRIX measure in Appendix Figure 17.

Thus, while roads in the UK's non-London cities are no more congested than they are in London,[22] the UK as a whole performs very poorly on road congestion in international context – suggesting that commuters in several non-London cities and in London are willing to pay a high cost to access the city centres at peak times, and therefore that alleviating congestion by improving infrastructure might alleviate a binding constraint on growth for several of the UK's cities (including London).

Next, we look at rail congestion. We create a composite congestion index for the morning and evening peaks from four measures in the Department for Transport's Rail Passenger Use Statistics for 2018–19: passengers in excess of capacity, as a share of load and as a share of services, at the 1-hour and 3-hour peaks. These statistics only cover England and Wales. (See Appendix Note A5 for details.) To create our generalised congestion measures, we estimate the first principal component across these four measures (capturing 95% and 83% of variance for the morning and evening peaks respectively, and illustrated in Appendix Figure 16). While it is well known that London has substantial rail congestion, our analysis finds that Birmingham, Cardiff, Leeds, Manchester, Bristol, and Cambridge also have high rail congestion – with Birmingham's actually more severe than London's.

The presence of congestion might indicate demand for transport, but an absence of congestion does not indicate an absence of demand. If trains are unreliable, commuters

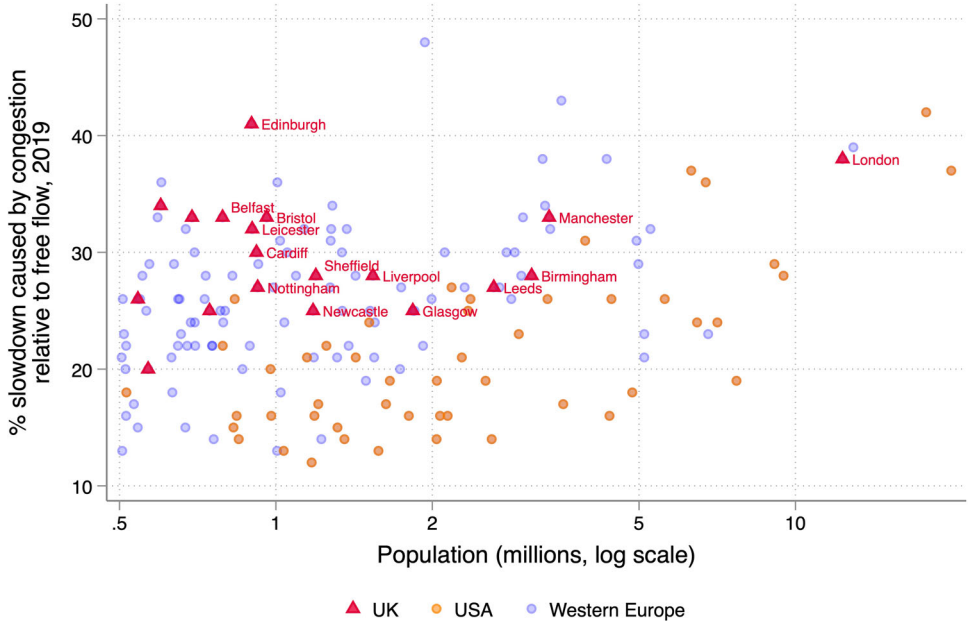

Figure 9. Road congestion in UK, US and Western European cities. Source: TomTom (2022) Congestion Index, OECD.

Note: TomTom uses its own city definition that may not overlap directly with OECD metropolitan areas. UK metropolitan areas with 2018 population >750,000 are labelled.

may not use them – making measured congestion low even if there is latent demand. Office of Rail and Road data on punctuality of trains by operator over 2014–19 suggests that trains outside London and the South of England are, on average, substantially more likely to be late.[23] Since UK rail reliability overall is substantially below the EU27 average (EU, 2021), this makes rail reliability outside the South of England particularly poor in international context. Moreover: the degree to which congestion reflects true latent demand will be affected by the frequency of rail services, the price of rail commuting, and the structure of the rail network, which we are unable to analyse here.

Another way to look at whether a lack of transport infrastructure affects growth is to look at the 'effective size' of a city, which is determined jointly by the scope of the public transport and road networks, speed and congestion of travel, and the location and density of housing. Relative to looking only at congestion, this has the advantage of being more holistic in capturing many different aspects of infrastructure which might constrain economic activity. On the other hand, it is less directly interpretable through the lens of the growth diagnostic approach, since finding that a city's effective size is small does not necessarily tell us that boosting its size would boost its productivity.

To analyse the effective size of UK cities in international context, we use data collected by Conwell et al. (2022) on the area accessible from the city centre within 30 min at rush hour for 103 US and European cities, by car and public transport. On average US cities are better served by car and European cities are better served by public transport. UK cities look poor on both counts: the area accessible by car is much smaller than for almost any US city analysed, and the area accessible by public transport is much smaller than for most other European cities analysed, as illustrated in Figure 10. Similarly, using data provided to us by Rodrigues and Breach (2021a), we show in Figure 11 the number of people who can reach the city centre within 30 min by public transport across 48 Western European cities (using data from TravelTime). UK cities have systematically less extensive public transport networks than other Western European cities: conditional on population, the share of the total city population that can reach the city centre within 30 min by public transport is 23 percentage points lower in UK cities than in Western Europe.[24]

These data illustrate that UK cities have much smaller effective sizes than their population would suggest. As Forth (2017, 2019) and Rodrigues and Breach (2021a) argue, this disparity between actual and effective city population sizes may go some way to resolving the puzzle of the UK's apparent lack of agglomeration economies. And as Blagden and Tanner (2021) emphasise, poor transport infrastructure is likely holding back economic activity most acutely in towns which are close to large cities but poorly connected to them. Yet while this is likely important, we emphasise that it is unlikely to explain the entirety of the UK's regional productivity gap: empirical estimates of agglomeration economies from other countries suggest that a doubling of population is only associated with around 4–5% higher productivity (Graham & Gibbons, 2019).

We have focused here on intra-city, and not inter-city, transport links. Arguments about the effective size of UK cities could also apply to inter-city transport links between geographically proximate cities, such as the cities in the North and Midlands of England, which are not far apart but are very limited in their effective size.[25] This would suggest a different prioritisation of high speed rail links than that adopted under the HS2 plan, where benefits likely disproportionately accrue to London relative to its share of the UK population (New Economics Foundation, 2019).

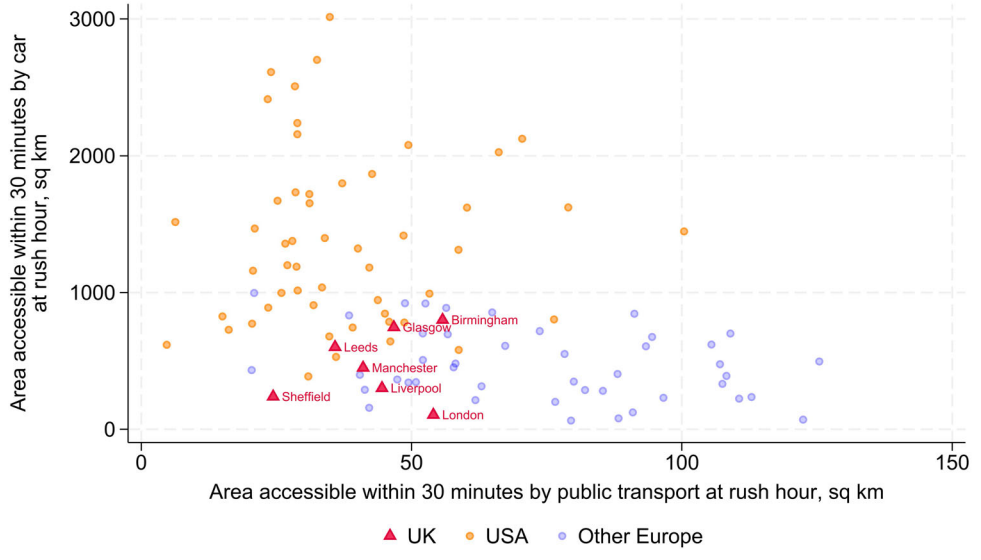

Figure 10. Area accessible by road and public transport, UK, US and Western Europe. Source: Conwell et al. (2022), calculated from Google Maps, Wednesday 8:30am.

Two other aspects of infrastructure are important. First, housing. The limited effective size of UK cities is only partly a result of limited transport networks – it is also partly driven by low housing density (Rodrigues & Breach, 2021a). Limited housebuilding near city

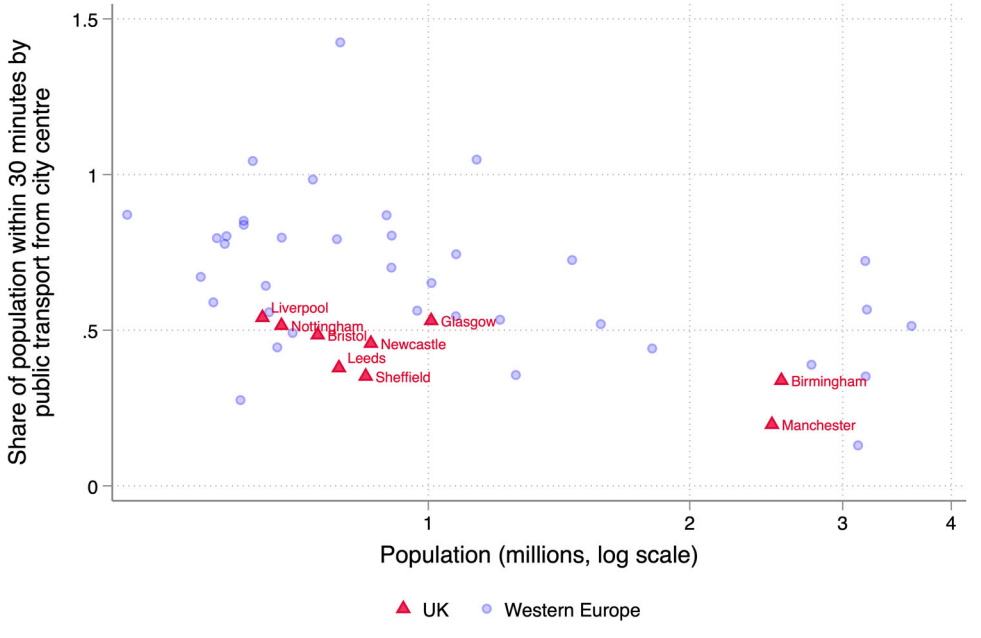

Figure 11. Public transport accessibility in UK and Western European cities. Source: Rodrigues and Breach (2021a), based on data from TravelTime, ONS, and Eurostat. London and Paris are not shown.

centres also increases the strain on transport infrastructure because it increases need for commuting longer distances. As such, increased housing density (particularly near city centres or major transport hubs) may be needed to fully reap the benefits of agglomeration.

Second, internet connectivity. While there are no meaningful differences in broadband speeds between London and the UK's other major cities (per OFCOM's fixed broadband coverage data), the UK as a whole lags well behind peer countries in its access to ultrafast internet. According to the OECD in 2021 the UK had fewer than 10 ultrafast fixed broadband subscriptions per 100 inhabitants, a figure among the lowest in the OECD and substantially lower than Germany (14), France (20), the USA (25), or Korea (40). The UK also ranks in the bottom tercile of OECD countries on three different measures of average broadband download speed (Ookla, M-Lab, and Steam). Thus, while the regional disparity in access to high speed internet within the UK is minimal, the UK's regions may well be held back by slow internet when compared to peer countries.

Overall, our infrastructure analyses have suggested that poor transportation infrastructure is likely a constraint on growth in some of the UK's non-London large cities. This is a function both of roads which are highly congested and relatively limited in scope compared to peer cities in the US or Western Europe, and of a public transport network which is more limited and less reliable than peers in Western Europe. This suggests improvements to transport, with the goal of expanding the effective size of the UK's large non-London cities, may be an impactful avenue for policy intervention. In the next section, we turn to innovation.

5. Research and development

The third input to growth we analyse is innovation, focusing specifically on government support for research and development ('R&D'). R&D is central to productivity-enhancing innovation (see e.g. Crepon et al., 1998; Griffith et al., 2006). Empirical evidence suggests that knowledge spillovers from public R&D spend tend to 'crowd in' private sector R&D, particularly for smaller firms (Aitken et al., 2021; Azoulay et al., 2019; Becker, 2015; Moretti et al., 2019). These spillovers are largely local, meaning the regional distribution of public R&D matters (e.g. Andrews, Forthcoming; Hausman, 2022; Jaffe, 1989; Kantor & Whalley, 2014). Public support for R&D in the UK is heavily skewed towards richer regions. First, much public support for R&D is in the form of public support for business R&D (through tax relief), as opposed to direct expenditure by the public sector. This has regional implications: subsidising business R&D amplifies existing regional disparities since business R&D is concentrated in richer places. Second, the discretionary components of government R&D funding in the UK – direct public R&D expenditure, and higher education R&D (66% of which is government funded) – are also skewed to richer regions (Forth & Jones, 2020). Per capita direct government R&D expenditure in 2016 was £60 in London and the South East, versus £21 in the North of England, £14 in the Midlands, £7 in Northern Ireland and £5 in Wales. For higher education R&D, the pattern was similar, with per capita figures in London (and Scotland) more than twice those for the North of England, Midlands, Wales, or Northern Ireland.

To what extent is limited access to the knowledge spillovers generated by R&D a binding constraint on growth? By the logic of the growth diagnostic approach, to

understand how much increased public R&D outside London and the South East would help boost growth, we would need to evaluate firms' absorptive capacity for knowledge spillovers. But this is very difficult to measure. As a basic proxy for private sector absorptive capacity for knowledge spillovers, we therefore use the regional pattern of business R&D. Specifically, we calculate each region's share in national government R&D *minus* that region's share in business R&D (on average 2000–2018). A positive share means the region receives a larger share of government R&D than it does of business R&D. Business R&D is (presumably) undertaken in places with productive research environments, where the expected return on R&D is high. If a low-income region receives a larger share of business R&D than it does of government R&D, this might indicate that the region has the absorptive capacity to benefit from increased government R&D.

Our analysis shows that government-funded R&D is even more skewed toward rich regions than business R&D (Figure 12). The regions that stand out the most are the North West, the East and West Midlands, and the East of England, which receive far smaller shares of government R&D than they do of business R&D. We see a similar pattern for higher education R&D relative to business R&D. This is not inevitable, as Figure 13 illustrates: in Germany, poorer regions (particularly those in the former GDR) receive substantially larger shares of public and higher education R&D than they do of business R&D.[26] German public sector and higher education R&D partially counterbalance regional economic inequality in business R&D spending, while UK public sector and higher education R&D spending amplify it. Forth (n.d.) and Forth and Jones (2020) find similarly.[27]

The UK's limited public R&D spend outside the 'Golden Triangle' area around London, Oxford, and Cambridge is particularly striking when considering that fact that many other

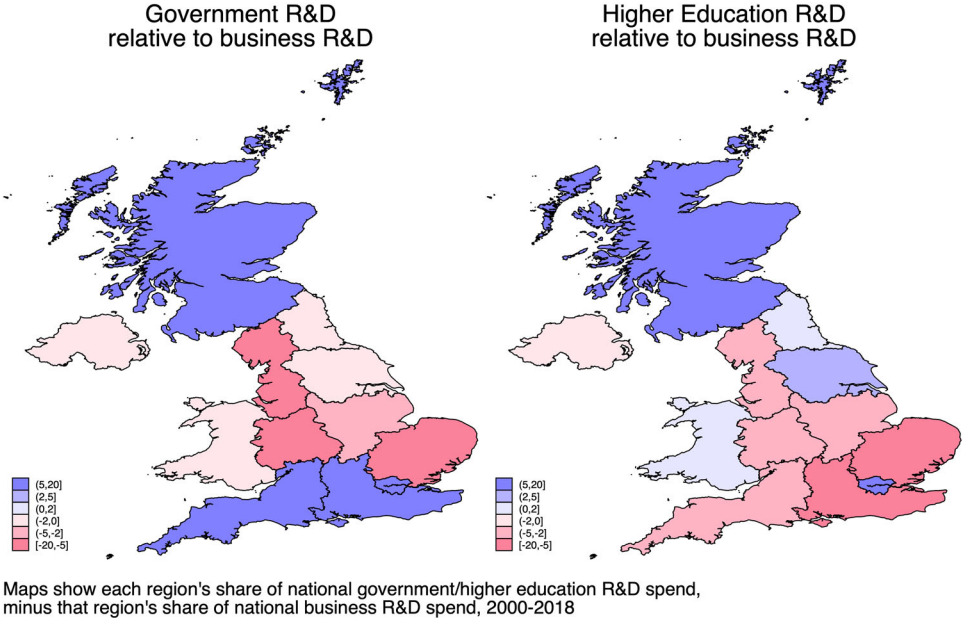

Figure 12. Government/higher education R&D spending share relative to business R&D spending share, by region (2001–2018 average). Source: OECD Regional Statistics.

UK cities perform very highly in international measures of academic research. For example, ranking cities by the number of highly-cited academic articles they produced between 2014 and 2016 using Web of Science data, we find 9 UK cities in the global top 100 (including Birmingham, Manchester, Edinburgh, and Glasgow); this compares to only 4 French cities, 5 German cities, 3 Italian cities, and 2 Spanish cities (György, 2018).[28] This evidence suggests substantial capacity in several other UK cities for increased higher education R&D expenditure.

This analysis, while more speculative than that in the previous sections, suggests that increasing public support for R&D in some of the UK's poorer regions – particularly the North West and the Midlands – may be a promising avenue for policy intervention, since these regions have demonstrated innovative capacity (both in terms of business

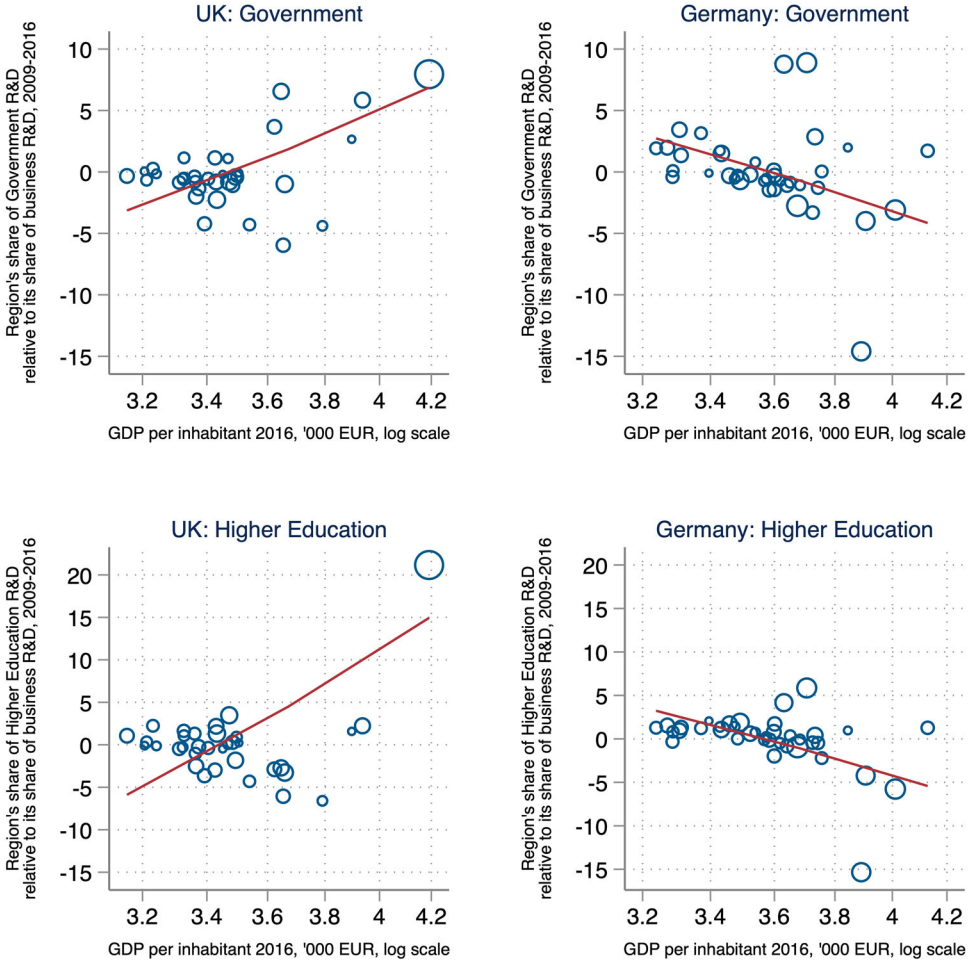

Figure 13. Government and higher education R&D spend relative to business R&D spend: UK and Germany, 2009–2016. Source: Quality of Government EU Regional dataset.

Note: Each bubble is a small (OECD TL3) region, with bubble size weighted for each region's population. Inner and Outer London are combined.

R&D activity and top universities) as well as demonstrated absorptive capacity from firms. In the next section, we turn to finance.

6. Access to finance

In Sections 3, 4, and 5, we explored the potential for education, infrastructure, and innovation policy to boost productivity in poorer regions of the UK. A poorly educated workforce, poor infrastructure, or limited access to knowledge and innovative ideas, can reduce the potential return on private sector investment and in doing so, limit growth.

It is possible, however, that the growth of lagging regions in the UK is held back not by an absence of high-return economic opportunities, but by an absence of financing for those opportunities – if access to finance is limited or expensive in these regions. And indeed London receives a disproportionate share of lending and equity investment relative to its share of the population of Small and Medium Sized Enterprises ('SMEs'). London-based SMEs are more likely to use external finance, and have higher credit balances as a % of turnover, than SMEs in most other regions (BVA BDRC, 2020). But from these facts alone it is not possible to conclude that access to finance is a binding constraint on economic development for regions outside London. Total financing is an outcome of both supply and demand conditions: financial investment in a region may be low because the returns to this investment are low, and not because of supply constraints.

To what extent is limited access to financing a binding constraint on growth for the UK's non-London regions? If it is disproportionately difficult for firms outside London with high-return economic opportunities to access funding, the growth diagnostic framework suggests that we should expect to see evidence in market financing indicators. For example, we may see evidence that banks make it more expensive for equivalent firms outside London vs. in London to access financing (higher interest rates, margins, or collateral requirements), or that they deny funding more often (higher rejection rates or appeals rates). Below, we analyse a number of these kinds of indicators which can help us distinguish whether limited external financing for non-London SMEs is a binding constraint on growth, rather than just a symptom of poor investment opportunities.

First, SMEs outside London do not report feeling more constrained by access to finance than those in London (Figure 15).[29] If anything, the opposite holds. SMEs in London are more likely than average to report that it 'feels quite difficult to get external finance', and more likely than SMEs in any other region to report that cashflow, late payment, or access to external finance would be an obstacle in the next 12 months, that they do not have confidence a bank would say yes if they requested a loan, and that they injected personal funds into their business because they had no other choice.

Second, SME bank lending appeals rates are similar across regions. If SMEs outside London are more likely to be unfairly denied finance or are more likely to be constrained in their growth plans by lack of access to finance, one would expect to see a higher appeals rate in non-London regions. This is not the case: most regions make up the same share of appeals as their share of total SME lending, as illustrated in Figure 14.

Third, SME bank rejection rates, margins, and collateral requirements are similar for SMEs in London and outside London. Armstrong et al. (2013) find that over 2001–2012 there was no statistically significant difference in bank loan rejection rates, margins, or collateral requirements across regions when controlling for business characteristics and owner

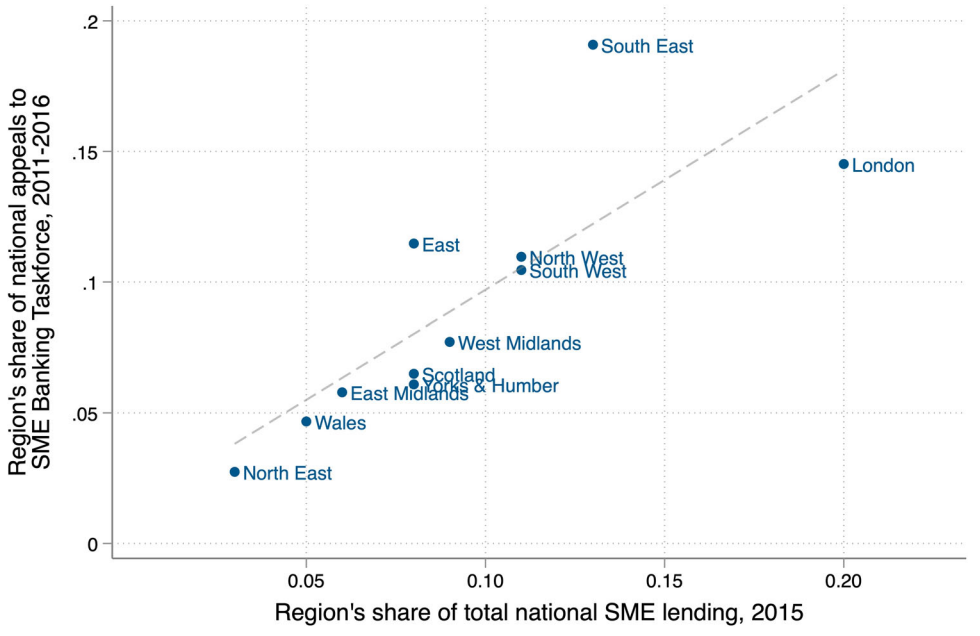

Figure 14. SME appeals 2011–2016 against total lending 2015. Source: Banking Taskforce Appeals Process Independent Reviewer Annual Report 2016, UK Finance Postcode Lending data.
Note: Excludes Northern Ireland.

qualifications. Cowling et al. (2020) similarly find no differences in credit application outcomes between observably equivalent firms across UK regions. While they find evidence of a higher price of credit for firms in the North West, Scotland, and Wales as compared to London, they find no differences between London and the other regions. Zhao and Jones-Evans (2017) find evidence for differences in credit rationing across UK regions, but with London one of the more financially constrained regions.[30] However, even if collateral requirements don't differ by region, London-based SMEs on average have more access to collateral for bank loans due to higher home prices (e.g. Bahaj et al., 2020).

Finally, we find no evidence of regional disparities in peer-to-peer lending. Analysis of FundingCircle data over 2010–17 shows that the median interest rate on peer-to-peer loans is lower for most non-London regions than for London (Ekpu et al., 2020, Table 4), and that the default rate on peer-to-peer loans across all UK regions is lower in London (Xu et al., 2021), neither of which is consistent with greater funding constraints for non-London SMEs.

Our discussion so far focuses on lending: the primary source of finance for most SMEs. Next, we investigate equity investments. Only 4% of SMEs report *either* using or planning to use equity finance (BVA BDRC, 2020). But equity disparities may matter since early stage equity investments in high growth potential companies are disproportionately important for stimulating growth (see e.g. Lerner & Nanda, 2020; Müller & Zimmermann, 2009).

London is both the recipient and the source of most UK equity financing: 75% of all equity investment in UK SMEs over 2011–17 went to London, the South East, and the East of England, and nearly half of all equity investment in UK SMEs over 2011–2017 was from London-based investors (Wilson et al., 2019). Most of this disparity across regions,

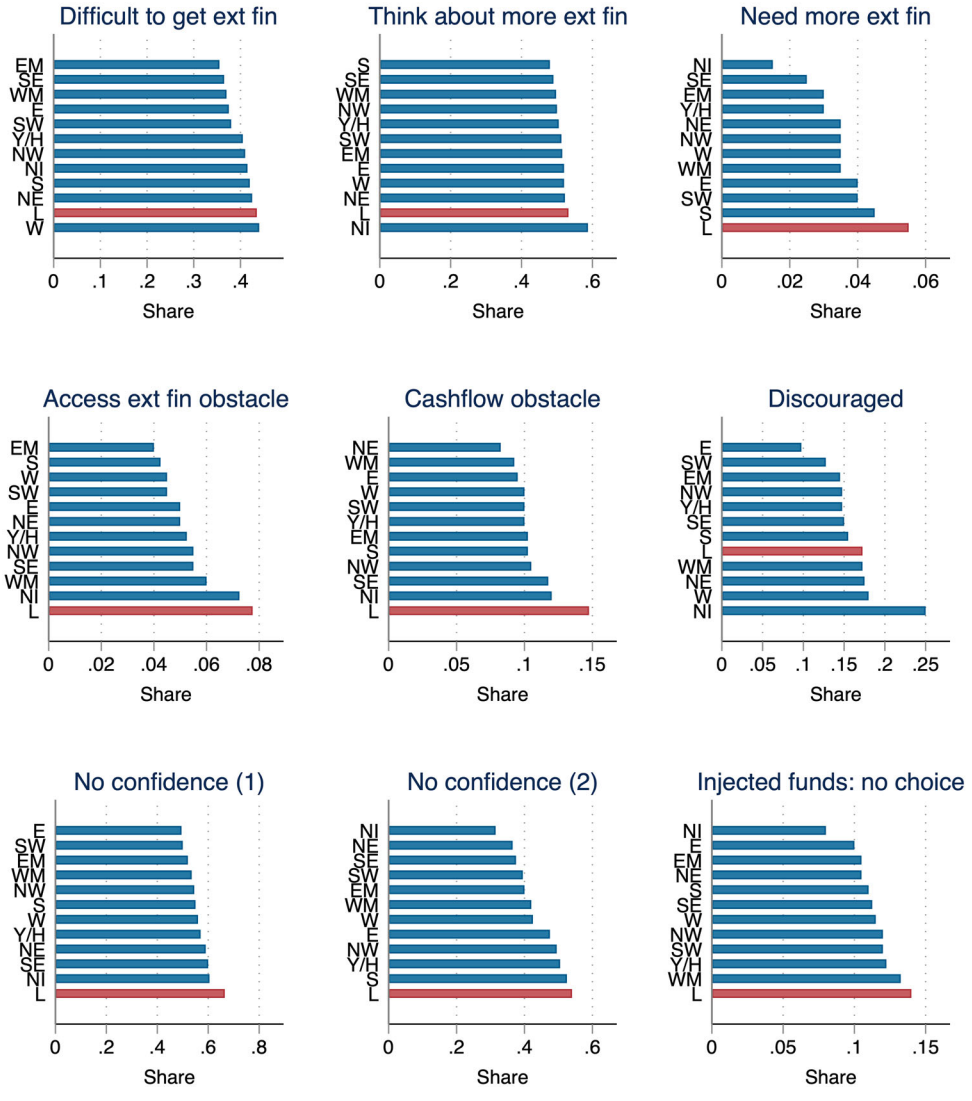

Figure 15. Self-reported access to finance, SMEs 2016–19. Source: SME Finance Monitor, BVA BDRC.

Note: All variables are averaged over 2016–2019 unless otherwise noted. 'Difficult to get ext fin': share of SMEs agreeing or strongly agreeing with the statement 'My impression is that it is quite difficult for businesses like ours to get external finance' (2018 & 2019 only). 'Think about more ext fin': 1 minus the share of SMEs agreeing or strongly agreeing with the statement that they 'Never think about using (more) external finance'. 'Need more ext fin': share of SMEs reporting that they had a need for more external funding in the past 12 months (2018 & 2019 only). 'Access ext fin obstacle' and 'Cashflow obstacle': respectively, the share of SMEs identifying 'Access to external finance' or 'Cash flow/late payment' as an obstacle to them running the business in the next 12 months. 'Discouraged': number of SMEs reporting being discouraged from pursuing bank lending, as a share of the SMEs who do not plan to apply for/renew external finance because there are barriers that stop them from applying. 'No confidence (1)': share of SMEs who do not plan to apply for finance in the next 12 months, but would have liked to, who report not having confidence that the bank would say yes (2018 & 2019 only). 'No confidence (2)': share of SMEs who plan to apply for finance in the next 12 months who report not having confidence that the bank would say yes (2018 & 2019 only). 'Injected funds: no choice': share of SMEs reporting having injected personal funds into the business in the last 12 months because they felt they had no other choice.

however, is explained by differences in the investment opportunities available to equity investors: Wilson et al. (2019) analyse all equity investments in SMEs in the UK 2011–17, using Beauhurst data, and find that 90% of variation in deal flow can be explained by three differences in regions' economic structure: number of SMEs, share of 'high-growth firms', and share of firms in high-tech manufacturing or knowledge-intensive services.[31]

The remaining regional disparity in equity investment, however, may still reflect differential access to financing. When controlling for a large range of firm-level characteristics, Wilson et. al find a statistically significant difference in the likelihood of receiving equity funding for SMEs in some regions: the East and West Midlands, and Yorkshire and the Humber were only 50% as likely to receive equity funding as observably equivalent firms in London, and, conditional on receiving funding, received 27–35% less.[32] We illustrate this in Figure 16, with blue dots showing the relative likelihood of any SME in a given region receiving an equity deal, as compared to London-based SMEs, red triangles showing the relative likelihood of a high-growth SME receiving an equity deal, and green squares showing the estimated regression coefficients: the relative likelihood that an SME in a given region receives an equity deal, compared to an observably equivalent SME in London.

This disparity in equity funding even conditional on firm observables could indicate that access to equity financing is more constrained outside of London, perhaps because London-based investors' distance from potential targets means less capacity for pre-investment screening (see e.g. Howell, 2020) or post-investment support (Bernstein et al., 2016). On the other hand, it could also simply reflect lower growth prospects outside London for a firm of a given size and industry. We bring two pieces of evidence to bear on this question. First, among all UK firms who received equity investments during 2011–13, firms inside and outside London had similar initial investment sizes and a similar chance of follow-on funding rounds, but firms in London had much larger follow-on funding rounds (Appendix Figure 20) (British Business Bank, 2022). This would be less consistent with the story that low equity deal volume outside London reflects London-based investors' lack of awareness of opportunities, and more consistent with the story that investors see more promise in the growth prospects of their London-based than those of their non-London-based investments over time. Second, data provided to us by Wilson et al. (2019) allows us to examine the share of investment funding devoted to each region by private sector equity investors headquartered in each region. If low equity funding in a region is not due to lack of capacity for investment, but rather to London-based investors overlooking opportunities outside of the capital, we should see non-London-based investors devoting a significant share of their investments towards projects in their home regions. While patterns in some regions are consistent with this story (see Appendix Figure 21 for a breakdown by region), overall we find that non-London investors devote on average less than a third of their investments to their home regions and a third of their investments to London and the South East, which would be most consistent with limited investment opportunities in the non-London regions.

It is possible that firms' access to finance is limited not because they lack profitable opportunities, but because they lack the entrepreneurial or management capacity to capitalise on them. Research documents the importance of certain high-productivity management practices (Bloom et al., 2016; Bloom & Van Reenen, 2007). But regional variation in

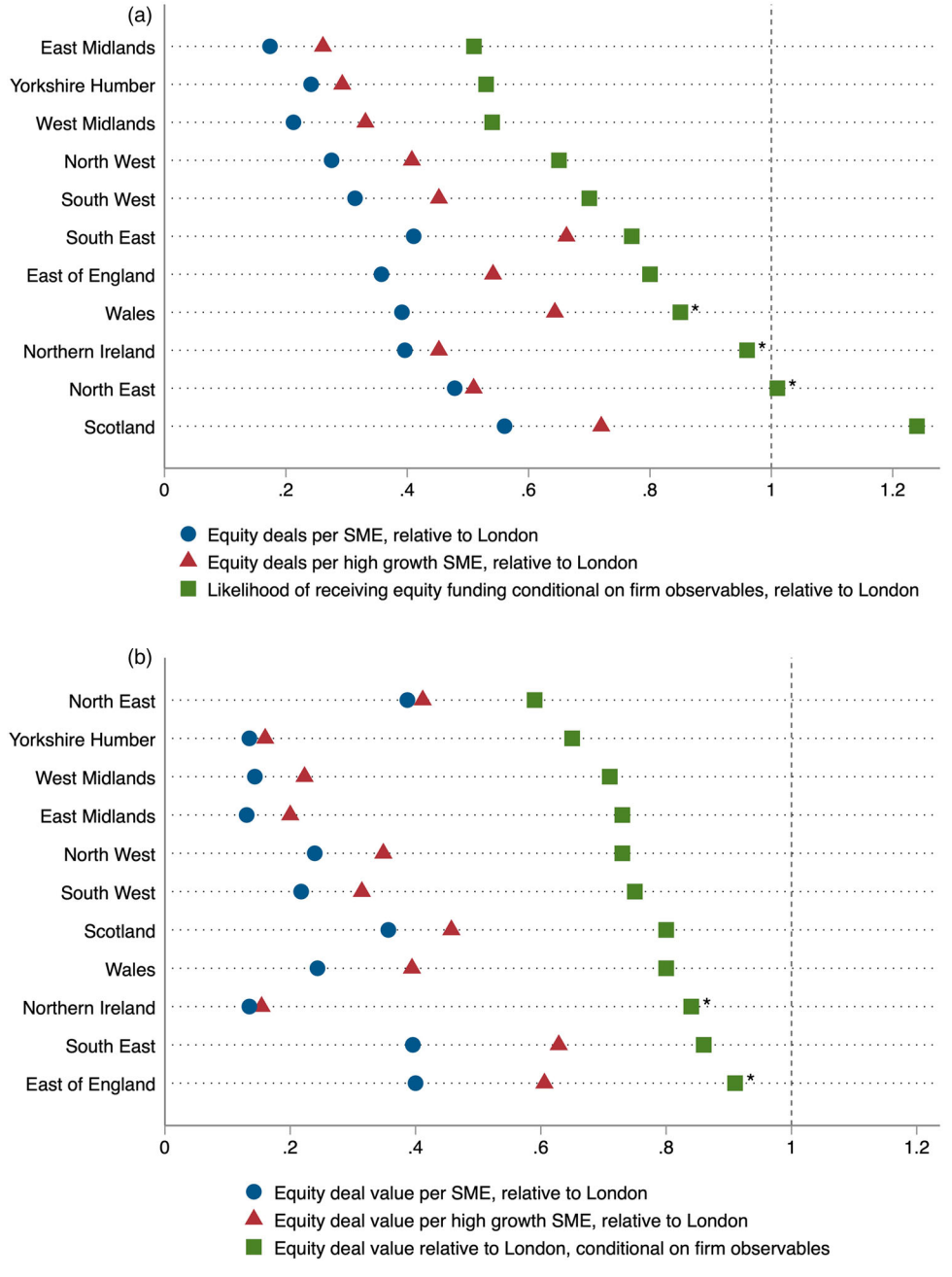

Figure 16. Equity investment likelihood and deal size by region, 2011–17. Panel A: Likelihood of receiving equity investment. Panel B: Equity deal size. Source: Authors' analysis of estimates from Wilson et al. (2019).

Note: Equity deals / deal value per SME or per high growth SME are reported directly in Wilson et al. (their Table 6). Coefficient estimates in Panel A (green squares) are odds ratios calculated by Wilson et al. from regressions of whether a firm received equity funding on firm characteristics and region dummies (their Table 18); coefficient estimates in Panel B (green squares) are regression coefficients on regressions of log deal size on firm characteristics and region dummies (their Table 21). Asterisks denote not significantly different from 1 at the 5% level.

these practices across the UK appears minimal: according to the 2019 and 2020 Management and Expectations Survey, the average management practice score was 0.6 in London, with very similar scores for the East Midlands (0.6), West Midlands (0.59), North East (0.59) and North West (0.58), and the range across all regions was narrow (0.55–0.62). Regional variation is similarly small even at the 75th percentile across firms and when looking at specific industries (Appendix Table 2).[33] It is harder to evaluate whether there is a lack of entrepreneurial capacity. There is much more start-up activity in London, as well as more 'creative destruction' as businesses fail at higher rates (per OECD Business Demography data). But – particularly in light of our analysis on constraints on growth – these disparities could be a function of a lack of profitable opportunities, rather than a lack of entrepreneurial capacity. Moreover, there may be a link between regional access to finance and the development of entrepreneurial capacity, to the extent that relationship banking and access to mentorship from investors can develop businesses' ability to start and to grow (Mayer et al., 2021) – meaning a broader lack of the entrepreneurial ecosystem necessary for high-growth SMEs to flourish.

Overall, our analysis in this section has found no evidence on any metric that access to bank lending is more difficult for otherwise equivalent firms outside London versus in London, suggesting that a generalised lack of high return economic opportunities is much more likely to be the constraint on growth for the UK's lagging regions – as opposed to an abundance of opportunities, but a lack of access to finance to take advantage of them. We do find some evidence consistent with constrained access to equity financing in some regions, for the very small subset of high-growth-potential SMEs who use equity financing. But more evidence is needed to disentangle whether this is truly a result of constrained access to equity financing, rather than differential future growth trajectories. This section concludes our analysis of policy inputs to growth, and in the next section we turn to a slightly different question: even in the absence of high growth in the UK's poorer regions, why have we not seen regional income convergence through labour mobility?

7. Why hasn't labour mobility narrowed regional income differentials?

Our focus in sections 3, 4, 5, and 6 is on reducing regional economic inequality by boosting productivity in the UK's lagging regions. But even without boosting productivity, spatial equilibrium implies that at the margin economic gaps between regions should shrink over time as people move from lower- to higher-productivity regions (Blanchard & Katz, 1992).[34] Moreover, the opportunity to move is an important escape valve for people from lower-productivity regions: if their region is not thriving economically, the option to move to higher-paid jobs is particularly important. Why then has labour mobility not narrowed regional income differentials in the UK? There are two sets of possibilities: either UK residents have a low propensity to move, such that even large income differentials are not sufficient to incentivise mobility, or the true economic return to moving is small because of cost of living differentials.

We find no evidence to suggest a particularly low propensity to move in the UK. According to OECD Regional Statistics 2014–2019, 2.2% of residents of the UK had moved from a different UK region in the previous year – only a little lower than the US at 2.3%, and substantially higher than other G7 countries (Appendix Figure 24). Moreover,

unlike in the US – where falling internal migration can help explain persistent regional economic inequality (Austin et al., 2018; Molloy et al., 2011) – there is no evidence to suggest there has been a fall in interregional migration in the UK. Champion and Shuttleworth (2017) find no change in the propensity to move more than 10 km between 1971 and 2011, and Alvarez et al. (2021) find no trend decline in interregional mobility more recently 1996–2018.

On the other hand, there is strong evidence that for many there is no net economic benefit of moving to London because of high housing costs. Using ONS data on incomes and rents for private rental sector tenants across English regions over 2017–19, in Figure 17 we show renters incomes' at the 25th, 50th, and 75th percentiles, and estimated renters' incomes net of housing costs at the 25th, 50th, and 75th percentiles.[35] Incomes are substantially higher in London than other regions at all three points, but the London earnings premium is entirely erased by high rents for the 50th percentile households, and at the 25th percentile London is actually one of the lowest-income regions net of rent. Similarly, Agrawal and Phillips (2020) find that median household income in London is 14% higher than the UK average before housing costs, but only 1% higher after housing costs. This means that for the marginal lower- or middle-income mover, there is little net economic incentive to move to London: high housing costs prevent regional income convergence occurring through migration.[36]

These regional differentials in housing costs may explain the unusual pattern of internal migration in the UK: on net, people move from high-productivity London to other lower-productivity regions. This is not just people moving to the commuter belt: there is net internal outmigration from London and the South East and East of England for all age groups except people in their twenties (Appendix Figure 22). London's

Figure 17. Income net of rent costs for private renters, 2017–19. Source: ONS Private Rental Affordability data.

population continues to grow because immigration outweighs these outflows (McCann, 2016). The UK's internal mobility patterns are unusual in international perspective: across the G7 the UK and France stand out with high internal outmigration from their most productive capital city regions (Appendix Figure 23). In the absence of substantial declines in housing costs in London, therefore, we cannot expect interregional mobility to narrow income disparities between regions.

8. Concluding remarks

Regional inequalities have risen across most industrialised countries, suggesting the common influence of structural economic changes: deindustrialisation, and the rise of knowledge-intensive services and large urban agglomerations. There is relatively little evidence of highly successful regional economic development policies in the face of these structural challenges (Ehrlich & Overman, 2020), and the UK's structural challenge may be stronger than most: it was more regionally exposed than peer countries to these sectoral shifts. Yet Germany's experience since reunification – with rapid, albeit partial, convergence of former East and West, supported by policy and large-scale fiscal transfers – suggests that at least some narrowing of large regional disparities is possible (see e.g. Henkel et al., 2021).

In this context, what should policy focus on? At the start of this paper, we characterised five key stylised facts about the UK's regional economic inequality problem, which together suggest a central focus should be boosting productivity in regions outside London and the broader South of England, particularly on high productivity potential urban agglomerations.

What are the most promising avenues for policy intervention to boost productivity in the UK's lagging regions? In this paper, we use a growth diagnostic lens to analyse four (non-exhaustive) inputs to growth – education, infrastructure, R&D, and access to finance – attempting to identify which specific areas may represent binding constraints which can be alleviated effectively through policy. We also analyse the role of migration in narrowing regional economic inequalities. We find little evidence consistent with several common arguments in the UK policy debate: (i) that low tertiary education shares remain the primary constraint on growth for the UK's regions; (ii) that there is a generalised issue with access to finance for firms outside the South East; or (iii) that low or falling regional migration rates are to blame for the persistence of the UK's regional economic inequalities. Instead, we find evidence consistent with (i) specific shortages of degree-level STEM skills; (ii) binding transport infrastructure constraints within major non-London conurbations; (iii) a failure of public innovation policy to support clusters beyond the South East, in particular through the regional distribution of public support for Research and Development (R&D); and (iv) missed opportunities for higher internal mobility due to London's overheating housing market. We also find suggestive evidence of constraints for high-growth-potential SMEs accessing equity financing in some regions, but further analysis is required to establish whether this reflects differential growth prospects.

Our analysis suggests three particularly promising avenues for policy intervention to boost productivity in the UK's lagging regions. First, improving and expanding STEM education to meet rapidly growing private sector demand (alongside ensuring that general

education and skills keep pace with firms' demand). Second, improving the scope and efficacy of the transport network to expand the effective size of certain non-London cities with the potential to become high productivity economic agglomerations. Third, increasing public support for R&D in lower-income regions with demonstrated innovative and absorptive capacity. Finally, our analysis on migration suggests that, alongside boosting productivity in non-London regions, there may be an important role for policy in improving housing affordability to allow people to move closer to high-paying jobs – enabling greater ability to move to opportunity for people from non-London regions.

Notably, outside education (where huge increases in attainment have occurred), the large-scale, systematic, and consistent policy action necessary for any of these avenues has not in recent decades been undertaken in the UK. Transport investment has been consistently low outside London; public R&D spend has been heavily skewed towards London and the South East; and little has been done to ease London's housing supply constraints. Policymakers seeking to tackle regional economic inequality would do well to seek to alleviate constraints on each of these areas.

Replication package

A replication package is available as online supplementary material.

Notes

1. The UK government's 2022 *Levelling Up White Paper* (HM Government, 2022) set out a framework of 'six capitals', four of which correspond to our levers in this paper (human capital, physical capital, knowledge capital, and financial capital). We do not examine social capital and institutional capital due to the difficulty of doing so quantitatively. In our companion contemporary history paper (Turner et al., Forthcoming), we analyse institutional and governance aspects of UK regional economic inequality.
2. More detail on the logic of the growth diagnostic approach, and how to use these market signals to identify binding constraints, can be found in Hausmann, Klinger, and Wagner (2008).
3. Gibbons et al. (2014) find that over two-thirds of the spatial variance of wages in the UK is explained by worker characteristics and occupations. See also McCann and Vorley (2020) and Overman and Xu (2022).
4. Region wage differentials may partly be driven by sorting on unobservables. While we are unable to estimate this in our data, Overman and Xu (2022) estimate Mincer-type wage premia at the travel to work area (TTWA) level, alongside estimating TTWA wage effects when controlling for individual worker fixed effects. They find that 1/3 of the max-min difference in region wage premia for TTWAs is explainable by sorting, and the remaining 2/3 represents a true region effect. Applying this to our estimates would imply a 20%, rather than 29%, region wage effect for London vs. the North East.
5. In 1980 there was little correlation between a region's employment share in finance and business services, and its productivity; by 2018, this correlation was very strong across Western European regions, with an R-squared of 55% (see Appendix Figure 4).
6. See Appendix Figure 7 and Appendix Table 1.
7. This remains true if using narrower industry categories (Oguz, 2018; Zymek & Jones, 2020), or if analysing cities rather than regions (Martin et al., 2019). Note, however, that some of the gap in within-sector productivity can be closed by accounting for differential occupational mix across regions (Beatty & Fothergill, 2019), which is consistent with the idea that - for example - finance and business services establishments in London carry out different

activities from those outside London. Morevoer, note that specialisation in tradable industries can spill over into higher productivity in non-tradables which can mean that a simple counterfactual decomposition may understate the role of sectoral composition (Rice & Venables, 2023). Differential within-industry productivity across regions fits evidence that the share of firms belonging to the national 'productivity frontier' is highest in Greater London and the South East (Haldane, 2016; Kierzenkowski et al., 2017).

8. We regress the log gross hourly wage on an indicator for whether someone has a university degree interacted with their region of workplace, with dummies for age and gender, and region-by-year fixed effects. We also incorporate dummies for highest level of educational attainment, where the omitted category is A-levels. Robust standard errors are clustered at the region level. Non-UK born individuals are included in these regressions. They made up over 14% of the UK population by 2019 (Wadsworth, 2019); running these regressions with only the UK-born gives us very similar results.
9. For the whole UK, Blundell et al. (2022), find that the median university wage premium (relative to GCSE recipients) did not fall over 1993–2016. Boero et al. (2021) in contrast find a decline in the UK graduate earnings premium in recent decades.
10. This continues the trend found by Duranton and Monastiriotis (2002), who found that skill premia rose in London relative to other regions in the 1970s–80s. Britton et al. (2021) also find higher graduate earnings premia in places with high graduate shares.
11. This pattern of results is robust to estimating with GCSEs instead of A-levels as the omitted category, or with using only 25–34 year olds (Appendix Figure 10, Appendix Figure 11).
12. See Appendix Note A3 for detailed classification.
13. We choose the LFM group following Britton et al. (2022) who show that the returns to 'LEM' degrees (law, economics, and management) are very high. Since we cannot break out economics separately for all years in our data, we instead create the LFM category.
14. We illustrate this by estimating region-specific average annual growth in relative demand for STEM, LFM, and other degrees, following Goldin and Katz (2010) and Autor, Goldin, and Katz (2020). See Appendix Figure 12.
15. Moreover, if improved schooling increased students' preparation for university, the average quality of graduates might increase.
16. Advanced further education includes all qualifications which are above the level of A-levels, NVQ level 3, or equivalent: the most common qualifications in 2014–19 in this category were Higher Nationals/BTECs, Diploma in higher education, nursing qualifications, NVQ level 4, and teaching qualifications. It corresponds to the category called 'higher education' (but no university degree) in the Labour Force Survey.
17. People who grew up in a region are defined as people who took their GCSEs there in state schools in 2002–2005. See Britton et al. for more details. These estimates likely overstate 'graduate drain', since older graduates may be more likely to leave London (Swinney & Williams, 2016).
18. The supply of university graduates in a region is also affected by immigration: 14% of the UK population was born outside the UK, and immigrants are more likely to have a university degree (Wadsworth, 2017; 2019). Since immigrants very disproportionately move to London, with less immigration the divergence between the graduate wage premium in London and the rest of the country would likely have been even greater.
19. Though the UK's smaller landmass means fewer kilometres of road are needed to connect the population in an equivalent fashion.
20. Data from ONS Method of Travel to Work database, using the 2011 Census. Outside London, the cities with the highest share of bus commuters are Manchester (23%), Nottingham (21%), Liverpool (20%), Newcastle (19%), and Birmingham (18%).
21. Obtained by regressing log congestion on log city population and dummies for UK and Western Europe. Older studies similarly suggest high congestion in the UK (Christidis et al., 2012).
22. We visualise the TomTom and INRIX measures, alongside a measure of road congestion from the UK Department for Transport (average delay per vehicle mile travelled), for UK cities only in Appendix Figure 15. These measures illustrate that, while London has the most congested

roads, levels of congestion close to those in London are found in Edinburgh, Belfast, Manchester, and Bristol.

23. See Appendix Figure 18. In contrast, there is no significant regional difference in cancellations. For buses, reliability is similar in most cities outside London as it is in London (per Department for Transport statistics on waiting time for frequent bus services, and punctuality for non-frequent bus services). See Appendix Note A6 for details on EU vs UK reliability.
24. Forth (2019) showed that the effective size of Birmingham at peak times is much smaller than its population figures would suggest: 0.9 million people can reach the centre of Birmingham by bus in 30 min at rush hour. This can explain most of Birmingham's apparent productivity shortfall relative to French cities of similar sizes.
25. Public transport links are much less frequent between major UK cities in the North of England than they are between the major cities of the similarly-sized Rhine-Ruhr region in Germany for example (Swinney, 2016).
26. For this analysis we use smaller regions (TL3), and data only from 2009–2016 (the longest period for which data on these smaller regions is available), using Gothenburg Quality of Government EU Regional data set. Results are similar for large regions.
27. The effectiveness of public sector R&D depends more broadly on how regional innovation ecosystems are supported (McCann & Ortega-Argilés, 2013). Innovation is one example of a wider set of coordination externalities. Hidalgo et al. (2007), Hausmann et al. (2013) – and in the UK Mealy and Coyle (2022) and Rodrigues and Breach (2021b) – highlight high value added industries that existing regional economies could branch towards given their existing industrial structure, which a coordination infrastructure (such as innovation) could facilitate.
28. See Appendix Note A7. Also, Forth and Jones (2020) provide suggestive evidence of 'home bias' by large research funders.
29. Data from the BVA BDRC SME Finance Monitor, based on 18,000 SME interviews in each year 2016–2019.
30. There is evidence that some peripheral smaller regions, like parts of the South West and Scotland, do face difficulties accessing bank lending (Hutton & Lee, 2012; Lee & Brown, 2017; Mayer et al., 2021).
31. 'High-growth firms' are companies with more than 10 employees and average annual employment growth of 20% or more over 3 years.
32. The observables controlled for are: log total assets, intangible assets to fixed assets, profit and loss account reserve to total assets, cash to total assets, bank overdraft and long-term liabilities to total assets trade creditors to total liabilities and net worth to total assets, number of charges on assets, age, board size, directors' age, directors' age diversity, directors' tenure, directors' experience, founding directors' experience, proportion of female directors, proportion of foreign directors, number of directorships, proportion of non-institutional directors, family firm, previous experience with equity funding, SIC 2007 industry sectors, Hirschman-Herfindahl sector competition index, and year.
33. Vyas (2018) found that a 0.01 higher management score was associated across firms with 1–1.5% higher value added per worker in the UK in 2016. This suggests that management practices may play some role in closing regional gaps in productivity, but are not large enough to explain most of the differential.
34. If regional aggregate demand effects are not too large.
35. Calculated as income at the *i*th percentile minus rent at the *i*th percentile.
36. Cavalleri et al. (2021) show that interregional migration flows in the UK are highly responsive to both regional differentials in GDP per capita and house prices. The fact that high rents offset high earnings in richer places may explain smaller spatial disparities in reported well-being than in incomes (Overman & Xu, 2022).

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