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Understanding Disparities in Local Productivity in the UK: Are we using the right measure?

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What's the meaning of the 'mean' when looking at productivity? A closer look at LEP-level productivity

The pandemic has brought about difficult times for many businesses in the UK. Currently, with the onset of a second wave, and the end of the Brexit transition period nearing, the road to economic recovery looks arduous. Inevitably, the rate of job and firm destruction will increase but for those businesses that manage to survive, sustainable long-term productivity will be key to recovery and growth. However, are we using the right measure of an average when looking at productivity?

Aggregate vs Firm-Level Productivity

A number of commonly used productivity measures use either an aggregate average (total turnover divided by total employment) or a firm level average (firm-level productivity averaged over the region) using the mean average definition but the two can lead to very different results. Table 1 illustrates how aggregate averages vs firm level averages for a cohort of 250,323 surviving firms can lead to differing results; 31.9% growth in productivity when looking at aggregate versus only 6.6% growth when looking at firm level.

Table 1: Aggregate vs Firm-level Productivity (2008, 2015)

		2008	2015	2015/08
	units			% change
firms	number	250,323		
turnover	£bn	1,393.85	1,929.82	38.5%
jobs	000	9,656.1	10,137.4	5%
Turnover-per-firm	£m	5.57	7.71	38.4%
Jobs-per-firm	number	38.57	40.50	5%
average productivity: **'aggregate'**	£'000	144.35	190.37	**31.9%**
average productivity: **'firm-level'**	£'000	160.2	170.8	**6.6%**

Source: ONS Business Structure Database (2008-2015)

Arguably, firm-level productivity is a more reliable measure of performance (Haltiwanger 2011). However, even that is subject to issues when looking at productivity performance in regions, where firm-level productivity is averaged using 'means'.

Mean vs Median

The mean is the most commonly used average when looking at productivity, but the mean is greatly affected by anomalies and long tails in the distribution. We know that these long tails exist when looking at productivity distributions, where few frontier firms experience approximately 10 times more productivity than firms in the bottom 10%. This leads to a left-skewed distribution and a misleading mean. The median, however, is resilient to these long tails as it simply takes the 50th percentile in the distribution. With this in mind, let us have a look at how median and mean levels of productivity differ across the LEP network[1] in England.

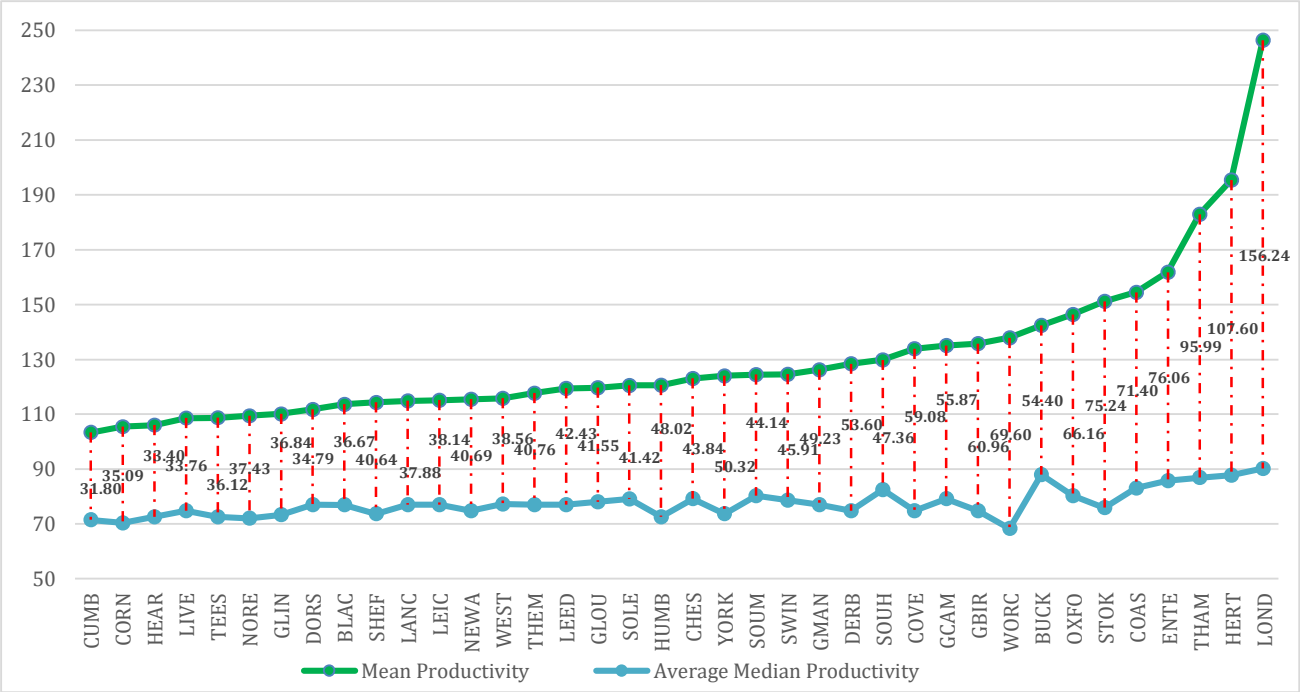
LEP-Level Comparison

Figure 1 shows the vast difference between the mean productivity and the median productivity (turnover per employee)[2], where the LEPs are in ascending order of mean productivity and the lines between the productivities show the raw difference between the two. Every LEP had a higher mean than median value, with London experiencing the biggest difference of 156.24. The differences between the high preforming LEPs (London, Hertfordshire and Thames Valley) and the low preforming LEPs (Cumbria, Cornwall and Heart of the South West) is striking when looking at the mean but in contrast, the medians have considerably less variation.

[1] For our latest look at the LEPs in England, please see our most recent Local Growth Dashboard (https://www.enterpriseresearch.ac.uk/publications/uk-local-growth-dashboard-2019/)

[2] It should be noted that the median productivity is an average median productivity, where the average of ± 5 firms (depending on whether there are an odd or even number of firms) around the median is used. This is to overcome disclosure issues when outputting data from the UK Data Service that requires at least 10 or more observations.

Figure 1: Mean vs Median Productivity by LEP (2018)



Source: ONS Business Structure Database (2018)

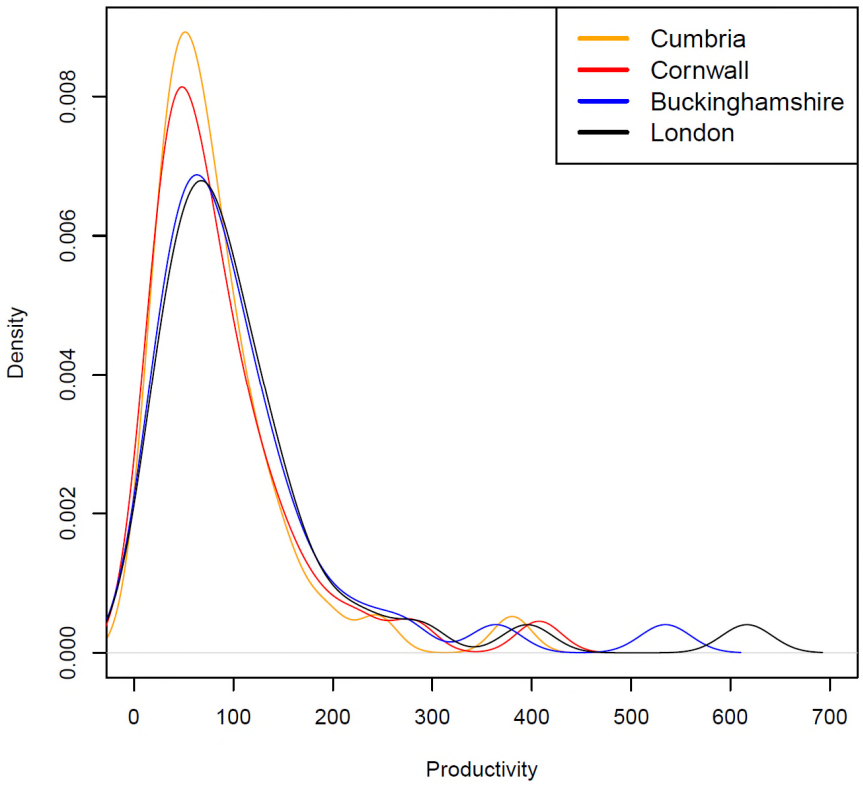
A stark example of how much the mean and median differ can be seen when looking at the Worcestershire LEP. Here, Worcestershire lies in the top 10 for mean productivity; however, if we look at the median productivity, Worcestershire lies in the bottom 5 . This is a glaring example of how a few highly productive firms can skew the mean productivity and give misleading conclusions on how firms in different areas are preforming. So how different do the distributions of productivity look?

Figure 2 shows the distribution of two low preforming LEPs (Cumbria and Cornwall) and two high preforming LEPs (London and Buckinghamshire). There are clearly longer tails on the right for all the LEPs but the tail is much longer for London and Buckinghamshire showing those few firms being highly productive. There are more firms falling into the peaks of the distribution in Cumbria and Cornwall (the peak is higher, and the tails are smaller) showing less variation in productivity across firms in these areas. However, when undertaking statistical testing[3], no difference was found between the LEPs. This means that despite the long tails, there is no overall

[3] Kolmogorov Smirnov (KS) test was used as a non-parametric test for when assessing whether LEP distributions of productivity were statistically different from each other.

difference in the distribution of productivity, as measured by turnover per employee, between high-preforming LEPs and low-preforming LEPs. This is for overall LEP performance but when looking at a split by size and sector, differences start to emerge.

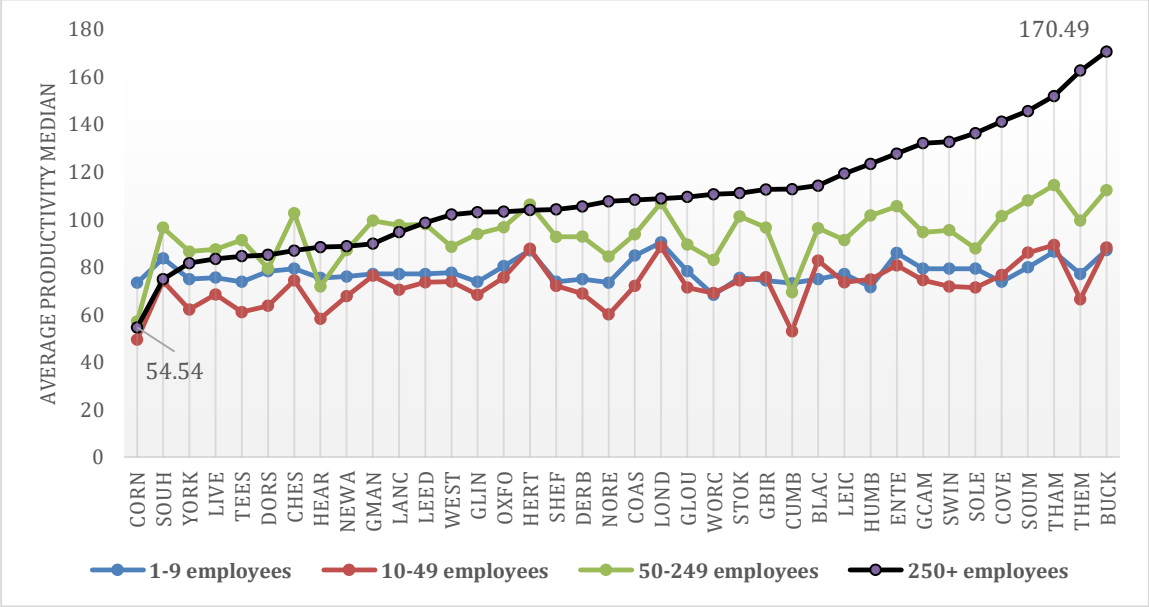
Figure 2: Density plot of productivity in Cumbria, Cornwall (low – preforming LEPs) and Buckinghamshire, London (high – preforming LEPs)



Source: ONS Business Structure Database (2018)

Focusing on 4 main size bands; 1 to 9 employees (micro), 10 to 49 employees (small), 50 to 249 employees (medium) and 250+ employees (large), Figure 3 shows the median productivity level in each LEP ordered by 250+ employees from lowest to highest. KS tests between micro firms in LEPs show no statistical difference but this changes when looking at larger firms. In particular, there is a large significant difference between the lowest preforming LEPs (Cornwall, South East) and the highest preforming LEPs (The Marches, Buckinghamshire) as shown in Figure 3.

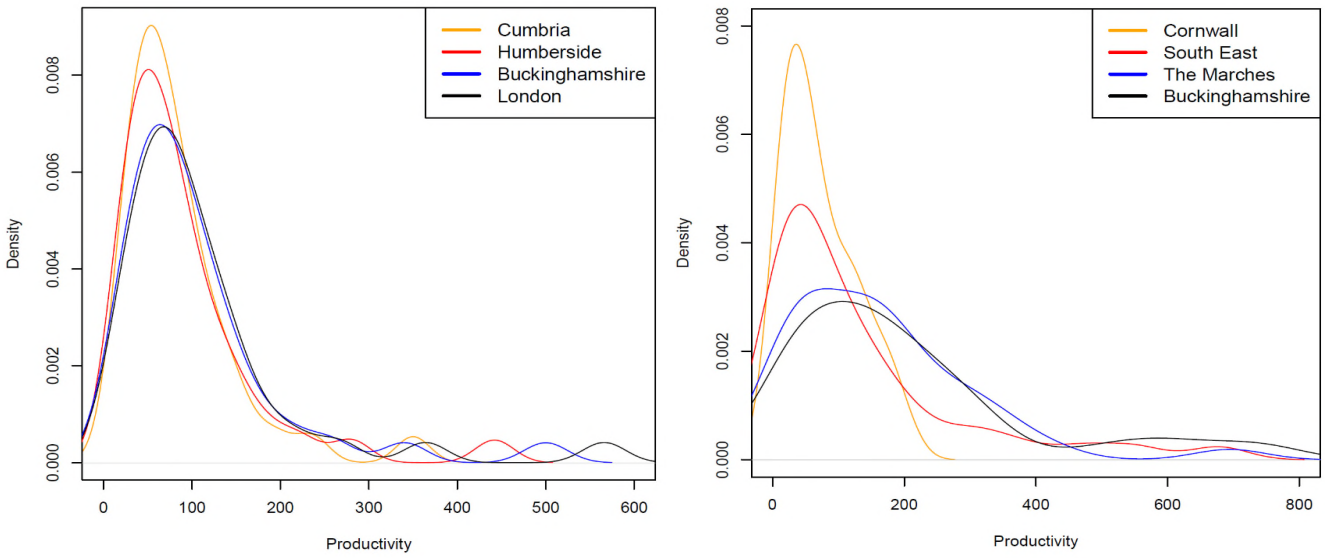
Figure 3: Average Productivity Medians by Firm Size in 2018 (LEPs are in ascending order using 250+ employees)



Source: Business Structure Database (2018)

When looking at the distribution of productivity across the highest and lowest preforming LEPs, Figure 4 shows the distribution of productivity of the highest and lowest preforming LEPs for 1 to 9 employee firms and 250+ employee firms. What is interesting to note are the similar peaks when looking at micro-firms. The distributions look similar across all LEPs, and when tested, there are no significant differences between them. When looking at 250+ employee firms, there are clear differences between the LEPs, where the peak is lower in The Marches and Buckinghamshire than Cornwall and the South East. This shows that better preforming LEPs have longer tails and more firms in those tails than low performing LEPs.

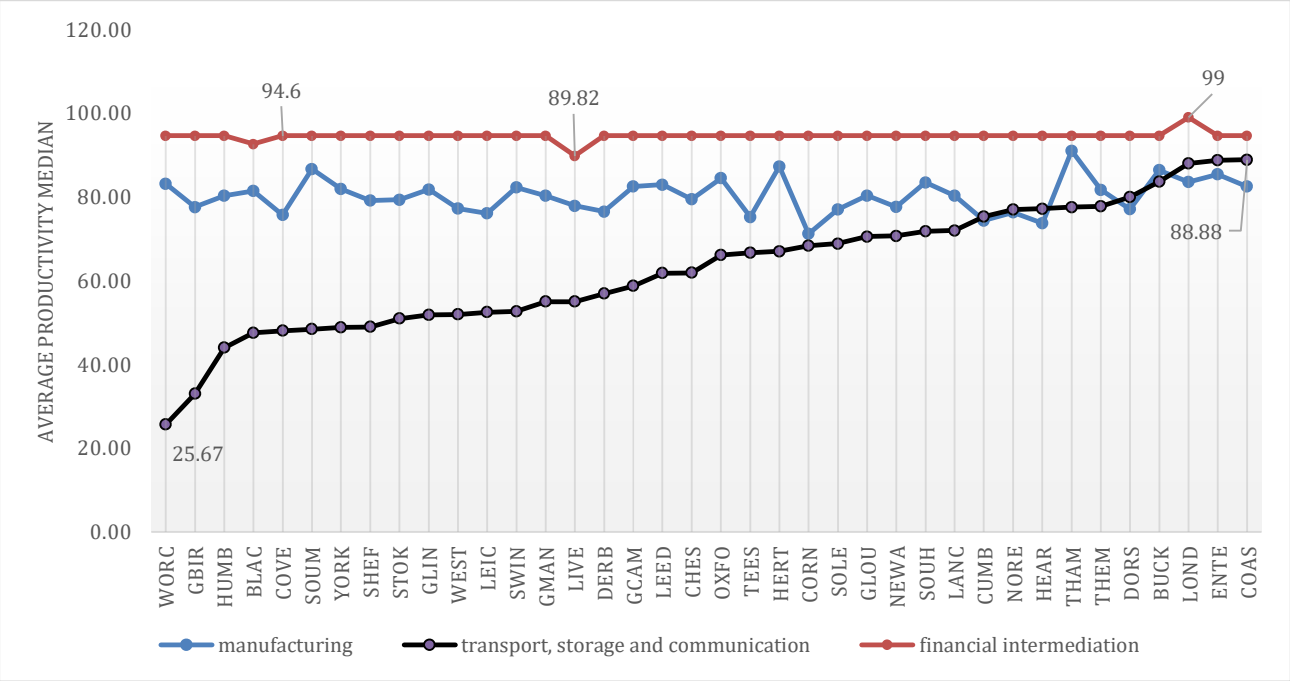
Figure 4: Density plot of productivity in low – preforming LEPs and high – preforming LEPs for 1 to 9 employee firms (left) and 250+ employee firms (right)



Source: Business Structure Database (2018)

Only two sectors showed significant productivity difference across LEPs; Transport, Storage and Communication sector and financial intermediation. These two sectors showed significant differences between the better and least preforming LEPs, as shown in Figure 5. Most interestingly is the financial intermediation sector, where in a majority of LEPs the median productivity was the same at 94.6. The difference is London, which has a statistically different distribution to the 3 LEPs in 2018 (Liverpool City Region, Sheffield City Region and Cumbria).

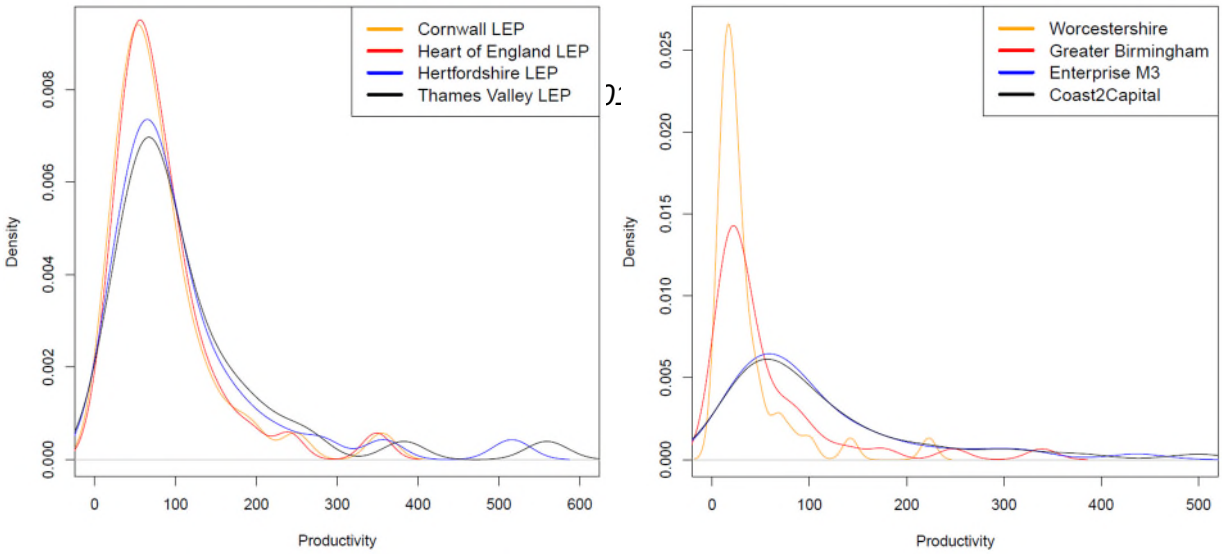
Figure 5: Average Productivity Medians by Sector in 2018 (LEPs are in ascending order using Transport, Storage and Communication sector)



Source: Business Structure Database (2018)

Figure 6 illustrates the differences in productivity distributions for the manufacturing sector and the Transport, Storage and Communication sector. The Manufacturing sector had no significant differences between any of the LEPs and this can be seen when looking at the distributions that look similar with only slightly smaller peaks for the better preforming LEPs (Hertfordshire and Thames Valley). Comparing this with the distribution for Transport, Storage and Communication sector on the right-hand side, there are clear differences between the low performing LEPs (Worcestershire, Greater Birmingham) and the high preforming LEPs (Enterprise M3, Coast2Capital). The peaks are much lower for the latter and have longer tails indicating that there a few firms that have abnormally high productivity levels. The distributions for Financial Intermediation are similar.

Figure 6: Density plot of productivity in low – preforming LEPs and high – preforming LEPs for Manufacturing (left) and Transport, Storage and Communication (right)



Source: Business Structure Database (2018)

So what does this all mean?

Future research should firstly look at the distribution of data of firm-level productivity before using any average measure. Noticeable long tails of distributions will affect mean measures and we argue that median averages should be used when this is the case. With productivity, there is an important need to move away from mean measures to ensure a more accurate estimate of local productivity in order to compare regions and assess productivity differences. Previous analysis focusing on mean measures can overestimate this, as can be seen from Figure 1. By focusing on median levels, productivity distributions and firm demographics, we have a better understanding of where differences in productivity lie when doing regional analysis.

Demographics such as sector and size play an important part in delving deeper into whether there are differences in productivity between regions. We have seen here that, overall, there are no differences in the distribution of productivity. However, when compare sub-groups of firms, particularly large firms, we start to see significant differences between the top and bottom performing LEPs. Although

there are further aspects to look at, such as age, ownership and single-plant vs multi-plant firms, as well as other tests of statistical significance, we have shown that distributions and medians should become more common place when measuring local productivity or indeed any regional estimate of a measure that has long tails in its distributions.

Appendix

Table A1: LEP Abbreviations and Names

LEP abbreviation	LEP Name
BLAC	Black Country
BUCK	Buckinghamshire
CHES	Chesire and Warrington
COAS	Coast to Capital
CORN	Cornwall and Isles of Scilly
COVE	Coventry and Warwickshire
CUMB	Cumbria
DERB	Derby, Derbyshire, Nottingham and Nottinghamshire
DORS	Dorset
ENTE	Enterprise M3
GLOU	Gloucestershire
GBIR	Greater Birmingham and Solihull
GCAM	Greater Cambridge and Greater Peterborough
GLIN	Greater Lincolnshire
GMAN	Greater Manchester
HEAR	Heart of the South West
HERT	Hertfordshire
HUMB	Humber
LANC	Lancashire
LEED	Leeds City Region
LEIC	Leicester and Leicestershire
LIVE	Liverpool City Region
LOND	London
NEWA	New Anglia
NOEA	North East
OXFO	Oxfordshire
SHEF	Sheffield City Region
SOLE	Solent
SOUH	South East
SOUM	South East Midlands
STOK	Stoke-on-Trent and Staffordshire
SWIN	Swindon and Wiltshire
TEES	Tees Valley
THAM	Thames Valley Berkshire
THEM	The Marches
WEST	West of England
WORC	Worcestershire
YORK	York, North Yorkshire and East Riding

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