3

THINKING OUTSIDE THE BOX (PART 2): REAL LABOUR PRODUCTIVITY

3.1 OVERVIEW

In this chapter, we consider the impact of regional price differences on gross value added (GVA). We attempt to develop regional purchasing power parities (PPPs), focussing on the creation of both lower-bound and central estimates thereof. We conclude that nominal figures understate the size of the real economy in northern regions and commensurately overestimate the size of the economy in London. This has important ramifications for regional policy, particularly in a post-Brexit environment. Moreover, similar patterns are likely to be visible across Europe, suggesting that future European Union (EU) policy will also want to take subnational price-differences into account. There are strong policy implications from this chapter, which we explore in more depth in Chapter 4.

- *Introduction* – This section outlines the importance and appropriate uses of GVA and briefly discusses the regionalisation process adopted by the Office for National Statistics (ONS).

- *Price levels*: As with other measures, GVA fails to adequately account for price differences across regions.
  - The theory of price-level comparisons: outlining the Eurostat-OECD methodology
  - From GVA to gross domestic product (GDP)…
    - A discussion of taxation and methods of apportionment
    - Setting upper and lower bounds…
  - Price comparisons in the household sector
    - Methods of apportioning household final consumption expenditure (HHFCE)
    - Calculating relative price levels (RRCPLs + rents – challenges re: national and domestic)
  - Price comparisons in the Government sector
    - Apportionment (easier?)
    - Calculating relative price levels (straightforward outside London but depends on London weighting and importance of wages)
  - Price comparisons for investment
    - Gross capital formation (GCC) and Gross fixed capital formation (GFCF): assume prices are constant for all industries except construction
    - Apportionment = data on construction AND remainder can use one of several methods (ONS data or DIY by industry?)

  - How to treat non-profit institutions serving households (NPISH)?
  - Net exports
- *Technical Issues*: Two further technical issues remain to be discussed – Financial intermediation services indirectly measured (FISIM) and imputed rents
  - *FISIM* – In Appendix 3, we outline why the size of the financial services sector is overstated and how this affects regional GVA
  - *Imputed rents* – Here we reprise the discussion of the previous chapter regarding the regionalisation of imputed rents and their implications for regional GVA
- *Putting it all together*: Establishing credible upper and lower bounds for price levels and GDP.
- Showing the impact on productivity.
- *Conclusion*: Time to reassess regional success?

3.2 INTRODUCTION

GVA can be thought of as a 'pure' measure of economic output[1] and is also sometimes referred to as GDP at basic prices. Like GDP, it is a measure of the value added within an economy. However, whereas GDP measures value added *at market prices* (i.e. the price paid by the end user), GVA measures value added at the prices received by the producer. The difference between the two is therefore equal to the value of taxes less subsidies on goods. In the UK, the majority of this is accounted for by value-added tax (VAT) with a lesser portion being accounted for by various duties (predominantly on fuel, alcohol and tobacco).

The importance of GVA should thus be clear. On an official level, GVA per capita is used to determine eligibility for

EU structural funding. The UK Government's Industrial Strategy Green Paper uses regional GVA per capita to illustrate the need for an industrial strategy with a spatial dimension (Department for Business Energy & Industrial Strategy, 2017). By the time of the publication of the White Paper, the UK Government was discussing regional differences in labour productivity directly – GVA per hour worked (HM Government, 2017).

More broadly, GVA is used as a key performance indicator for many Local Enterprise Partnerships and is being used as one of several internal targets by some combined authorities (see e.g. WMCA, 2016). Similarly, in the academic literature, GVA growth disparities and differences in labour productivity (GVA per hour) are widely used (and conceptually correct) both as justifications and objects of research in their own right. Indeed, within the economic profession, productivity is widely regarded as *the* key determinant of long-run living standards (Krugman, 1997).

Why does this matter beyond academic debate? Simply put, policy is made on the basis of these figures. As already discussed, they matter for funding allocations (particularly at an EU level) but they also influence policy in other subtle but important ways. If London's price-adjusted productivity is lower than official figures suggest then it becomes extremely difficult to justify the comparatively high levels of spending on transport and education that the capital enjoys. Our calculations suggest that such monies might give a better 'bang for buck' (at least in productivity terms) if invested in the 'Brexit heartlands' of the Midlands and North of England – a theme we investigate in greater detail in Chapter 4. Figs. 5–7 also add nuance to the argument that the vote for Brexit was driven by relative prosperity, as can be seen in the results of the previous chapters. Here, we consider the most appropriate and feasible strategies for deflating regional GDP.

GDP can be calculated in three different ways, namely on the basis of income, output and expenditure. Whilst in theory all three should be equal, it is clearly impossible to measure every single aspect of the economy with perfect accuracy. As a result, the ONS uses a 'balancing' framework in which all three are constrained to be equal. This process takes the most robust elements of each of the three in order to ascertain the most accurate figures possible. At the time of writing, the balancing process typically takes place two years in arrears.

Prior to this, the ONS uses information from each approach as it becomes available (one of the reasons why GDP figures are typically revised). Naturally, less information is available on a regional level. Accurately apportioning taxation to UK regions is extremely challenging. We also lack information on intra-UK exports and imports (e.g. goods or services produced in the North West but sold in the South East and vice versa). As a result, figures on regional GDP are not produced by the ONS.

$$\begin{aligned}
\text{GDP(I)} &= \text{Income from all sources} \\
&\quad + \text{Taxes on production } \& \textit{ imports} - \textit{Subsidies} \\
\text{GDP(O)} &= \text{Output of all industries} + \text{VAT} + \text{Other taxes} - \text{Subsidies} \\
\text{GDP(E)} &= \text{Household consumption} + \text{Government consumption} \\
&\quad + \text{Other consumption} + \text{Investment} + \text{Exports} - \text{Imports}
\end{aligned}$$

What *are* available, however, are figures that exclude taxes and subsidies, that is, GVA. As can be surmised, GVA can be calculated either on the basis of the income method or on the basis of measured output (at basic prices). The Regional Accounts team use a 'top down' methodology to apportion GVA to each region (West et al., 2016). This is done for both the income and output methods and takes place by component, industry and region (West et al., 2016). In essence, the national totals are 'regionalised' using appropriate 'regional indicators' (West

et al., 2016). These include a variety of measures, although the majority of indicators come from direct surveys of businesses (particularly the Annual Business Survey, the Business Register and Employment Survey and the Annual Survey of Hours and Earnings). The results then undergo a complex balancing procedure in order to ensure the resulting figures are as accurate and robust as possible (West et al., 2016).

3.3 PRICE LEVELS

The ONS therefore produce the best possible measure of nominal GVA given the constraints they face (both in terms of resources and due to the need to satisfy international and European standards). For many purposes, nominal GVA is indeed the appropriate measurement to use. Nevertheless, when assessing relative regional economic success, or relative productivity levels, it is *real* GVA (deflated by an appropriate PPP) that is needed. Crucially, whilst the ONS now produce estimates of real (as opposed to nominal) GVA growth over time, these are based on *national* deflators at an industry level rather than regional ones.

The upshot of this is that, given that industry inflation levels don't vary dramatically by region[2] the real GVA estimates produced by the ONS are likely to be a robust way of comparing a given region's economic performance over time. Unfortunately, they are not suitable for comparing the level of GVA across a set of regions at a given point. Given the absence of true regional industry-level price levels, it appears that calculating regional productivity adjusted for regional price differences is impossible. We argue that this is not the case. On the contrary, given appropriate assumptions, it is possible to develop a credible estimate of the *lower bound* for the impact of price differences on relative regional productivity levels.

One of the key empirical contributions of this book is to do precisely that. We then suggest a further set of assumptions to derive a preferred estimate of real regional productivity. It should be stressed at this point that these estimates should be seen as the beginning of a broader discussion of the issue rather than the final word. Further debate over the precise magnitude of the effect identified is to be welcomed and encouraged and future methodological innovations will hopefully enable researchers to capture it more fully. Nevertheless, our estimates undoubtedly represent a dramatic adjustment relative to the *status quo*, which does not adjust for prices at all.

As mentioned above, given the absence of regional price levels by industry it is not possible to calculate real GVA directly. What can be done, however, is to use a variety of data sources to calculate estimates of PPPs for regional GDP. This is the approach used to compare real GDP across countries and has proved a rich source of information for macroeconomists concerned with differences across countries and over time. In this chapter, we build on the approach adopted by Eurostat and the OECD, although due to differences in the data that are available our results are not precisely comparable to theirs.

On a cross-country basis, these effects are highly significant (even for countries that share a common currency). As an example, in pure Euro terms, France's GDP per capita is a full 38% higher than Spain's. In PPP terms, however, the gap falls to below 14%. In other words, most of the nominal disparity between French and Spanish GDP is purely due to price differences in the two countries. Since, for most purposes,[3] when comparing areas we are interested in the amount produced rather than its price – it is the PPP-adjusted figures that should be of interest to us.

As outlined in the previous chapter, we adopt the Eurostat-OECD Èltetö-Köves-Szulc (EKS) method to calculate PPPs for each Government Office Region. In order to do so, we

need regional GDPs calculated on the basis of the expenditure method. Two theoretical approaches suggest themselves: the first is to estimate a complete set of regional supply and use tables building on the work done by Thissen, Lankhuizen, Los, Oort, and Diodato (2017). Such an approach would enable us to estimate regional trade directly and thus calculate estimates of regional net exports.

Accurate calculation of regional imports and exports is one of the most challenging elements of any such analysis. Traditional methods based upon location quotients have tended to underestimate regional imports (Flegg & Tohmo, 2013). Cross-hauling is a further issue in the production of regional supply and use tables, although modern approaches seek to deal with this. Traditional methods have relied upon data on transport flows, particularly of heavy goods vehicles, to add data to location quotient-based estimates.[4]

Service 'exports' from one region to another present a particular challenge as very often no physical trace is left. If a company (or individual) based in the North East uses an accountancy firm based in the North West then no obvious trace is left of the transaction, although for our purposes it should be classed as an export from the North West to the North East. Transactions within companies or involving individuals visiting different reasons for leisure purposes are likewise almost impossible to accurately map and might be thought of as an extension to the cross-hauling problem.

Given that only a small subset of the total data available is of interest to us, an alternative route is available. Namely, following a similar top-down process to that adopted by the ONS, we can regionalise various elements of regional GDP via the expenditure method. This presents its own difficulties, but if all components (including GDP itself) can be regionalised then it does avoid the need to estimate regional exports at all.

3.4 REGIONALISATION

Regionalisation of each component of GDP(E) is done on a nominal basis and then deflated using the relative price level. In the following subsections we deal with regionalisation of each element in turn, before examining measures of relative price levels in each sector.

3.4.1 From GVA to GDP...

Given that *GDP = GVA + taxes less subsidies on products* and we know regional GVA in nominal terms, the challenge is to apportion taxes less subsidies on products. Nationally, GVA accounts for over 89% of total GDP (ONS, 2017h). Of the remainder, almost two-thirds are accounted for by VAT and the remainder are accounted for by other taxes less subsidies (predominantly duties on fuel, alcohol, tobacco etc., ONS, 2017h) No (UK) VAT or duty is applicable to products and services extra-regio (taxes on production, which are applicable to the continental shelf, are already included in GVA at basic prices), rendering GDP for this region strictly equal to its GVA. In any event, its total contribution (primarily offshore oil and gas) is modest.

For the other (onshore) UK regions, two options stand out. The first is simply to assume that VAT and duties are proportional to GVA (excluding extra-regio). This is superficially attractive – it makes intuitive sense to ascribe a VAT proportionally to the regions where value is added. It also has the advantage of matching the approach used by Eurostat (2018a). This approach forms a useful baseline and can be thought of as an extreme against which to compare other estimates. Indeed, we use this approach in our 'absolute lower bound' estimates for this very reason.

The second approach is somewhat more involved but ascribes to the principles on which VAT (and duties) are actually levied – namely at the point of consumption. In other words, this conceptual approach treats regions in the same fashion as countries for GDP purposed. On a European level, if a French company exports goods to Germany, the VAT is paid to the German government (by German consumers) and not France (and is thus part of German GDP rather than French GDP).[5] The same is not true for most services (broadcasting, telecoms and electronic services levy VAT at the point of consumption), where VAT is levied at the point of sale rather than at the point of consumption.

Of course, for most services, the place of sale *is* the place of consumption. Where things become complex is in the treatment of non-residents. Although cross-region commuters are unlikely to purchase a great number of VAT-able items (most supermarket sales of food and those of takeaways served cold are zero-rated), many tourists will. This is true of both domestic and international tourists. Given London's attraction as a national and international tourist destination, any estimates based upon the consumption of residents will probably underestimate the amount of VAT that should be ascribed to the region. In practice, all activities likely to be affected by this (namely transport, accommodation and food, and arts and recreation) account for less than 10% of the UK economy meaning that any distortion from the 'London tourist effect' is likely to be very small indeed.

Ultimately, therefore, we would argue that the most appropriate procedure to apportion VAT to the regions is to use the VAT proportions calculated by the ONS in their experimental statistics on country and regional public finances (ONS, 2017c). A similar procedure can be used to apportion other taxes less subsidies on products, generating an estimate of regional GDP. Ultimately, the overall proportions accounted

for by different regions change little: whether one uses the Eurostat apportionment procedure or our alternative will therefore make little difference to estimates of regional prices. The impact on measured (nominal) productivity is somewhat greater, with relative productivity increasing by 2.1% in Wales and falling by 2.6% in London. The remaining regions in Great Britain fall between these two extremes. These results (i.e. both those based on assuming regional GDP is exactly proportional to GVA and our preferred procedure) effectively bound nominal regional GDP from above and below.

3.4.2 The Household Sector

HHFCE represents direct spending by households as consumers and is by far the largest component of total GDP in the UK. Spending relates to that amount spent by residents (irrespective of the region in which it is spent). Given that GDP is a *domestic* concept, this at first seems paradoxical (as residency fundamentally relates to the *national* concept – or in our case the regional one). The answer lies in imports and exports: spending by tourists from region A in region B is counted as part of region A's HHFCE. The same amount is then subtracted from region A's GDP in the form of an import. Meanwhile, it does *not* count as part of region B's HHFCE but is rather an *export* from region B to region A. The net result is that the tourist spending is counted as adding to region B's GDP but not region A's. As can be imagined, regions which are net recipients of domestic tourists and commuters should enjoy a boost in exports relative to those who are net suppliers of tourists and commuters.

There are several ways of apportioning nominal consumer expenditure. The first is by population – simply assuming that the average person in each region spends the same amount.

This will systematically understate (nominal) consumption in areas where (nominal) income is higher. In other words, it will understate consumption in London and the South East and overstate consumption in the North. The other extreme is simply to assume that HHFCE is proportional to GVA. This will, naturally, overstate consumption in regions that see an inflow of commuters and that have higher nominal incomes as evidence suggests that saving is greater amongst higher-income individuals (Larrimore, Dodini, & Thomas, 2016).

A preferable approach to both of these is to apportion nominal spending by the nominal incomes of those actually resident in an area. In practice, this means apportioning spending on the basis of the ONS' estimates of nominal regional gross disposable household income (GDHI). This should be close to total consumption spending. Given the evidence of the previous chapter that real household incomes per capita are somewhat higher in London and the South East, one would expect individuals in these regions to save a larger proportion of their total incomes (Huggett & Ventura, 2000), suggesting that this will overestimate consumption in these regions.

Indeed, the fact that what limited data we have suggests that wealth in London and the South East is significantly higher than elsewhere in the country adds credence to this. Nevertheless, it is likely that the divergence in wealth across the UK is being driven by both differences in initial capital endowments (wealthy individuals are concentrated near London), high growth rates in asset values and the fact that real estate values in London and the South East have risen more rapidly than elsewhere. In any event, as price levels are based on *consumption* (a flow) rather than wealth (a stock), the ultimate effect of wealth divergences on the proportion of income consumed is unlikely to be large meaning that the net impact should be close to zero.

An alternative is to use the ONS' estimates of the proportion of VAT attributable to regions (ONS, 2017c).[6] This uses

data from the living costs and food (LCF) survey. Since VAT and consumption should be broadly proportionate to one another, this is likely to be an effective estimate of regional HHFCE. A particular weakness of this approach is the fact that VAT is not charged on rents (including imputed rents), suggesting that it is underestimating nominal consumption in regions where rents are more costly. Once again, this is likely to underestimate the proportion of total expenditure in London and the South East. It is reassuring that both the GDHI and VAT approaches give extremely similar figures for the proportion of HHFCE accounted for by each region.

As a result, we feel confident in asserting that the ONS' VAT estimates are excellent candidates for calculating a lower bound for the proportion of total HHFCE in London and the South East (and a commensurate upper bound in the North). The ONS estimates of the proportion of VAT attributable to regions exhibit some year to year variability, and for Scotland using GDHI as the basis of apportionment appears to match official figures better (Scottish Government, 2018). As a result, we use the GDHI figures for our central estimates.

Indeed, the final results are relatively insensitive to the method used to apportion HHFCE with the difference between the VAT-based lower bound and the GVA-based upper bound amounting to less than a one percentage point difference in the PPP for any region (the extremes being London, whose PPP increases by 0.8% and the South West, whose PPP falls by 0.5%). As a result, we are confident in the robustness of our approach and results.

3.4.3 Non-profit Institutions Serving Households

These comprise non-profit institutions that are not mainly financed and controlled by government. They provide goods

and services to households at prices that are not economically significant (or free). Examples include religious societies, clubs (including sports clubs), trade unions, political parties or organisations, etc. Charities tend to belong in this sector. Regionalising the spending of NPISH is extremely challenging. Given the absence of better data, we regionalise the nominal spending of NPISH by population, sourced from the ONS' official population statistics (ONS, 2018a). Given the small size of the sector and the fact that in our present estimates we assume zero cost differences across regions in the sector, this is an acceptable compromise. The NPISH sector is an area where future research may seek to refine these estimates.

3.4.4 Gross Capital Consumption

Gross capital consumption is primarily comprised GFCF (97%), plus changes in inventories and acquisitions less disposals. Given the minimal importance of the latter, we focus on GFCF and assume that changes in inventories plus acquisitions less disposals are proportional to GFCF. This is consists of transport equipment, other machinery and equipment (including information technology (IT) equipment), intellectual property, dwellings and other buildings.

The ONS provide regional estimates of GFCF to Eurostat, although the ONS has serious concerns about the quality of data (ONS, 2017i). It is noteworthy that, for Scotland at least, these estimates differ substantially from those used in the Scottish National Accounts (Scottish Government, 2018). Nevertheless, they remain the best estimates that we have available at present.

Of total UK GFCF, some £72,945m was on dwellings. Since total UK GFCF in the real estate sector was £91,536m, it's clear that dwellings represent some 79.7% of total real

estate investment. In the absence of any indication to the contrary, we assume that this proportion is the same for each region. Transfer costs (which represent the bulk of the rest of real estate GFCF) and investment in equipment are likely to be proportional to spending on dwellings so this seems an eminently reasonable assumption to make.[7]

For all other industries, we use data from the supply and use tables (ONS, 2017e) to ascertain on a national level what proportion of GFCF was spent on inputs from the construction industry. This varies from 4% in the professional services and support industries to some 52% in 'other services' (which includes creative arts, libraries and museums, sports organisations, etc.). Once again, in the absence of any further information we assume that these proportions are equal in every region.

Doing so we can divide capital expenditure into two parts for each region: the first being one in which prices vary (namely dwellings plus that proportion of GFCF spent on construction by industries other than real estate). The second part of capital expenditure is one for which prices do not vary. The relative weights for each region will differ due to differences in the industrial composition of regional GFCF. As a result, these weights can be used as an input into the EKS method.

3.4.5 Government Expenditure

Government expenditure is regionalised by using figures from the Country and Regional Public Sector Finances (ONS, 2017c). This estimates UK government expenditure by sector for each country and region for the 2016/17 tax year (which is closest to the 2016 calendar year). As we are solely interested in government final expenditure, we exclude those categories of expenditure that pertain to transfers or intermediate consumption.

Doing so yields estimates for the entire UK that are extremely close to the ONS Blue Book estimate of government spending (ONS, 2017h). Similarly our estimates for Scotland are extremely close to the official figures given by the Scottish Government (2018), which gives a degree of confidence in the robustness of our estimates. At present, we lack comprehensive data on relative regional prices in the government sector and so there are no benefits to regionalising components of government spending at present. In future, the same source data are likely to prove useful in seeking to regionalise the various components of government spending.

3.4.6 Apportioning Regional GDP

The table overleaf presents the results of this apportionment. To reiterate:

GDP = GVA + Taxes on production – Subsidies of production

To recap, GVA is regionalised using the Regional Accounts data, whilst VAT (which comprises the bulk of relevant taxes) is apportioned from ONS estimates of regional VAT payments (ONS, 2017c) and the remainder from estimates of other taxes and subsidies on production (ONS, 2017c)

HHFCE can be apportioned from either nominal GDHI data (ONS, 2018f) or the aforementioned VAT statistics. In either case the results are similar, but we prefer the former due to the greater stability of estimates over time. Output of the non-profit sector is regionalised using an estimate of population (ONS, 2018a), although this sector is small.

Gross capital consumption is regionalised using data from Eurostat (2018b) on regional gross fixed capital formation (which forms around 97% of total gross capital consumption), whilst government expenditure is regionalised using data from the Country and Regional Analysis (HM Treasury, 2018; ONS, 2017c). Net exports are thus the residual

Table 2. Estimated Regional GDP Proportions.

	HHFCE	NPISH	Gross Capital Consumption	Government	Net Exports
North East	73.1%	4.0%	20.8%	26.5%	−24.4%
North West	64.0%	3.4%	16.3%	21.7%	−5.4%
Yorkshire and the Humber	67.8%	3.7%	16.6%	22.8%	−11.0%
East Midlands	68.9%	3.7%	19.2%	21.0%	−12.8%
West Midlands	66.1%	3.6%	18.0%	22.0%	−9.7%
East	71.3%	3.2%	18.9%	18.3%	−11.8%
London	48.7%	1.7%	13.2%	13.0%	23.4%
South East	66.8%	2.8%	17.5%	15.5%	−2.5%
South West	71.9%	3.4%	20.9%	19.7%	−15.9%
Wales	73.4%	4.0%	18.3%	27.8%	−23.5%
Scotland	64.3%	2.4%	18.4%	23.3%	−8.5%
Northern Ireland	67.5%	3.8%	17.7%	29.0%	−18.1%

See note[8].

left over after completing this process. Table 2 shows what proportion of each region's nominal GDP is accounted for by each sector. These weights are important inputs into the EKS process used to estimate real regional GDP later.

3.5 REGIONAL PRICES

3.5.1 The Household Sector

This is both the most important and the easiest sector to derive prices for. We first note that, unlike for household incomes, GDP is calculated on a 'domestic' basis. In the absence of information on exactly how much is spent by consumers in each region, we use the data from the LCF survey to ascertain the proportion of total spending accounted for by each category. We adopt the same procedure as the previous chapter and utilise the same data sources. Indeed, the ONS RRCPLs are, if anything, more suited to this use (with the same methods and sources as we have). We then calculate the proportion of total spending accounted for by housing in the same manner as the previous chapter.

Housing costs can be derived in one of three ways. Firstly, the costs of social housing are estimated directly from the Family Resources Survey (FRS). This is true across approaches. Private sector and imputed rents then both use the figures given in the FRS covering the 2016/17 financial year, which aligns most closely to the 2016 calendar year. These are the most conservative estimates of rental cost differences, showing that rents in London are 111% higher than those in the North East of England.

There are good reasons to consider this a highly conservative estimate of London rents. Firstly, due to its comparatively small sample size, the figures for the FRS tend to

fluctuate quite significantly year-by-year. In the previous year, for example, renting in London appeared 140% more costly than in the North East. Indeed, the FRS data imply that rents in London fell by almost 7% between 2015 and 2016, contradicting evidence from the ONS' own Index of Private Housing Rental Prices (ONS, 2018c). In addition, the FRS data apply to *median* rents, whereas for the purposes of deflating GVA, *mean* rents are the more relevant measure.

The other potential option is to directly use GVA itself. This contains an implicit deflator because rental income (including imputed rent) is estimated for the real estate sector for each region as a component of regional GVA. Specifically, a component of GVA is the 'rental income of households and NPISH', which includes imputed rents. As is pointed out in the GVA methodology guides, these are regionalised

> *using estimates of median property prices by region from ONS and the devolved administrations, these are multiplied by regional dwelling stock obtained from DCLG, the Welsh Government, the Scottish Government and the Department of Finance and Personnel Northern Ireland. (West et al., 2016, p. 15)*

Since the figures for regional dwelling stock are readily available from the Ministry of Housing, Communities and Local Government (formerly the Department for Communities and Local Government – DCLG), it is straightforward to derive implicit estimates of relative regional rents from the Regional Accounts. These show a rather wider spread of regional rents than the FRS survey (with implicit rents in London being around 3.4 times those in the North East). Interestingly, this is a broadly similar order of magnitude to figures from the Valuation Office Agency (2018) on regional rents in England.

3.5.2 NPISH

In the absence of further information, we assume that there are zero price regional price differences for NPISH. The NPISH sector comprises around 3% of GDP and principally contains institutions of higher and further education (universities and colleges), charities, trade unions, religious organisations and political parties. Given that these organisations do not charge market prices for their services, their output has traditionally been valued at cost (ONS, 2014), although the ONS is currently reassessing the classification of universities as a result of changes to the tuition fee regime (ONS, 2018b).

It is likely that costs in London and the South East are at least as high as elsewhere since wages and salaries are higher in London and the South East than elsewhere (ONS, 2017b) and there is some evidence that commercial rents may also be higher in these regions (Colliers International, 2017). As such, we can be confident that our assumption of zero regional price differences for the NPISH sector is conservative.

3.5.3 Gross Capital Consumption

We assume that there are no regional price differences for GFCF comprised transport equipment, other machinery and equipment (including IT equipment) and intellectual property. The law-of-one-price can be expected to apply to these, which collectively comprise around 44.1% of GFCF for the UK as a whole. A further 5.2% of national GFCF consists of 'costs of transferring ownership on non-produced assets' (overwhelmingly buildings), which again are unlikely to vary much by region. The remainder of GFCF represents buildings.

The data we have indicate that the costs of construction are typically higher in London and the South East than elsewhere

in the country (Building Cost Information Service (BCIS), 2015). Specifically, we take the figures of the BCIS for 2015 (BCIS, 2015) as estimates of the relative cost of fixed capital in the form of buildings (whether residential or otherwise), with the exception of Northern Ireland where an unusually small sample size leads to estimates that are implausibly low (around half of the UK average). Estimates of relative construction costs range from 91% of the UK average in the North West to 112% of the UK average in London. Given known data on salaries (ONS, 2017b), these estimates are plausible and are the best data we have available to us at the present time.

We use the EKS procedure as outlined above using the weights derived in the previous section together with the BCIS cost data for construction. As can be seen, costs vary relatively little across regions (partly by design). Nevertheless, there is a trend for higher prices in the South and East of the country (particularly in London and the South East). More puzzling are the above average prices of construction reported in the North East and East Midlands. It is unclear what might be driving this – it is entirely possible that measurement error in the source dataset is to blame, particularly as they are not official statistics. Nevertheless, the figures suggesting that investment is on average around 10% cheaper in Wales, Yorkshire or the West Midlands relative to the capital and surrounding areas is certainly plausible. This is one area that future work on regional prices may want to concentrate on, although the ultimate impact is likely to be modest (at least in the UK where gross capital consumption accounts for under 20% of GDP).

3.5.4 Government Expenditure

Although major strides have been made to evaluate the output of government, this remains challenging (Pont, 2008).

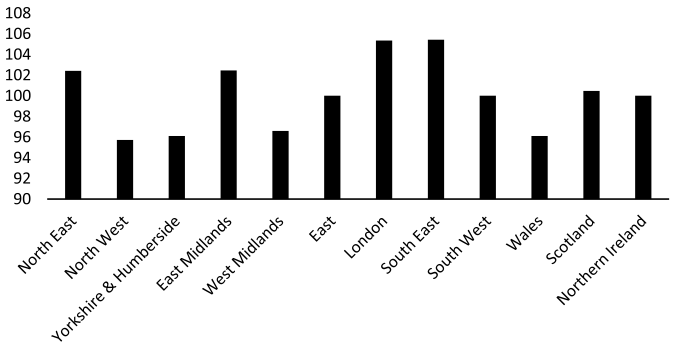

Fig. 5. Relative Costs of Gross Fixed Capital Formation.

In any event, national data are regionalised by the ONS using input costs – predominantly wages (West et al., 2016), suggesting that the appropriate measure of relative regional prices would be relative input costs. Outside of London, most public sector salaries are set on a national salary scale. Indeed, there are few data on relative prices in the government sector. Nevertheless, there exists a patchwork of rather partial information on prices of certain elements of government expenditure.

In particular, large parts of the public sector have negotiated a 'London weighting', whereby employees are paid more if they are located in the capital. This applies to staff in the NHS and education (Unison, 2017). Similarly, the Annual Survey of Hours and Earnings (ONS, 2017b) suggests that public sector employees in London earn some 30–40% more than their counterparts elsewhere in the country. It is difficult to assess the extent to which this is due to the London weighting rather than the fact that higher managerial functions are more prevalent in London than elsewhere (particularly in the civil service).

Equally, salaries in those parts of the economy that are dominated by public sector employees (notably health and education)

Table 3. Median Full-time Salaries (£) by Sector in 2016.

Region	Public Sector	Public Admin and Defence	Education	Health Care
North East	27,341	27,140	28,389	27,126
North West	29,326	30,554	28,810	26,824
Yorkshire and Humberside	27,878	29,888	28,061	26,791
East Midlands	28,011	27,962	28,775	27,028
West Midlands	28,462	32,124	27,409	26,336
East of England	30,748	31,781	30,778	27,972
London	36,632	37,630	35,000	34,334
South East	29,896	31,020	30,824	28,177
South West	29,588	30,044	29,591	26,911
Wales	28,490	29,923	27,664	28,180
Scotland	30,886	31,062	30,992	30,372
UK	30,540	31,914	30,347	28,408

Source: Annual Survey of Hours and Earnings (ONS, 2017b).

are around 20–30% higher in London than elsewhere in the country (ONS, 2017b). Outside of London, salaries for equivalent jobs are largely equal across the country (with a handful of minor exceptions in the East and South East in places that make up the so-called 'fringe' of Greater London).

Given these very limited data, the best course of action open to us is to assess how robust our results are to a variety of different assumptions about the cost of providing government services. In particular, in our central scenario we assume that costs are identical across the country. For all regions apart from London this is a sensible assumption. Given the preponderance of 'current expenditure' in government spending (ONS, 2018d) and the fact that most public sector salaries are subject to a national pay scale, this is logical.

The presence of the London weighting effectively guarantees that assuming equal costs will underestimate price levels in London. Median full-time public sector salaries in the UK are around £30,500, whilst those in London are £37,500 giving a difference of around 20%. London weightings differ substantially across the public sector – the NHS pay a 20% supplement for workers in Inner London, a 15% supplement for workers in Outer London and a 5% supplement for workers in the 'fringe' (Unison, 2017). Each of these is also subject to minimum and maximum thresholds (Unison, 2017) In contrast, Sixth Form Colleges typically pay a set £3,764 supplement (irrespective of salary or position) in Inner London and £2,508 in Outer London. Teachers have variable thresholds but these are typically more generous (e.g. £5,631–£8,579 in Inner London). For reference, Inner London was traditionally defined as being within four miles of Charing Cross (Unison, 2017).

According to the Regional Accounts, compensation of employees accounts for around 80% of total GVA in the three parts of the economy (education, health and public administration – the latter including fire services, policing, the courts and civil service functions) that are dominated by the public sector (ONS, 2017f). Moreover, apart from Northern Ireland, this varies little across regions (from 77% in the East of England to 81% in London). National Accounts data (ONS, 2017h) indicate that some 85.6% of total resources in the government sector are spent on wages and salaries or employers' social contributions (generally pensions and employer's National Insurance contributions). Since the latter are broadly proportional to wages (both are typically calculated as a percentage of gross pay) their costs are also proportionate to salaries.

As a result, we argue that a weight of 80% for wages and salaries as a proportion of total government output is conservative. We can thus investigate the sensitivity of our results to different

plausible assumptions about relative prices in the government sector. Specifically, we consider the following scenarios:

- Constant prices across the UK (our most conservative scenario) in the sector.
- A constant £3,000 London weighting for all public sector employees (equivalent to an 8.8% increase in employee costs in London, or a 7% increase in costs overall).
- A 20% increase in public sector London salaries vis-à-vis the rest of the UK, equivalent to a 16% in overall public sector costs.

3.5.5 Net Exports

Net exports are the simplest sector to estimate relative prices for. The OECD (2012) use exchange rates as proxies for the PPPs of exports and imports. Given that all regions use a common currency, the exchange rate in question is unity, that is, there are zero price differences across regions. Such a procedure is adopted in international price comparisons and is equally applicable here. In any case, it makes conceptual sense and is good economics – any price difference would imply that consumers and businesses were making systematic mistakes in how they source goods and services across regional boundaries.

3.6 REGIONAL PPPS: SOME INITIAL ESTIMATES

In this section, we combine our estimates for prices by expenditure sector with the weights derived previously in order to generate initial estimates of regional PPPs. This is important because it will enable us to assess the extent to which extant regional flows are justifiable on the basis of relative regional

productivity. We find that this is not the case and therefore there is strong evidence that funding flows should be redirected towards 'poorer' regions in the Midlands and North of England. Potential policy choices are discussed further in Chapter 4. We also find that the Scottish economy is larger than hitherto believed.

Although these are imperfect, we present a spectrum of different results and show that even the most conservative estimates significantly increase measured regional productivity in poorer parts of the UK. This is of particular importance when combined with the results of Chen et al. (2018): those regions of the UK which are most exposed to Brexit carry greater economic weight than hitherto believed. As such, any national policy vis-à-vis the UK's future relationship with continental Europe should give greater weight to the economic performance of these regions than it does at present. Moreover, this has interesting ramifications for academic studies combining both regional and national estimates of the potential economic impact of Brexit. Here, we consider a variety of different PPPs, all of which alter the balance of relative economic size and productivity within the UK.

3.6.1 The Lower Bound

At this point we are in a position to derive a lower bound for the size of the PPP effect. In effect, we deliberately design results that are biased towards zero price differences across regions. To do so, we apportion HHFCE to regions using the VAT estimates of the ONS. Regional GDP is assumed to be proportional to regional GVA (excluding the continental shelf). We use the first set of regional domestic price levels (using the RRCPLs and FRS data with its narrower regional differences). All other components of expenditure (Non-Profit Institutes Serving Households,

government expenditure, gross capital formation, net exports, etc.) are assumed to have zero price differences across regions.[9]

We are confident that this underestimates the true difference in relative prices. As noted in the previous section, all estimates of regional prices for gross capital formation and government consumption indicate that prices in the south of the UK are *at least as high* as those further North. As such, we can be confident that we are indeed establishing a lower bound for price differences across the UK. Using the same EKS procedure as previously (again following the OECD, 2012) we aggregate these different levels of expenditure using the weights and price levels outlined here:

As can be seen, price levels (in PPP terms) do appear to systematically differ across the UK. Even our lower bound figures indicate that prices in London are *at least* 10% above the national average (with those in the South East around 5% above the national average). Conversely, prices across the devolved administrations as well as the North and Midlands, are below the national average. As such, whilst London remains (by far) the largest and most productive region in the UK, its dominance is significantly attenuated.

In fact, there is a further issue here. If we accept the FRS as our preferred measure of rents (and imputed rents) then

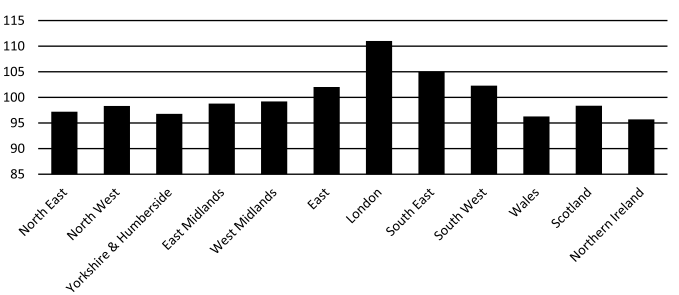

Fig. 6. Estimated Absolute Lower Bound PPPs by Region.

it should also be used to regionalise rents in the Regional Accounts. This has the effect of reducing (nominal) regional GVA in London by around 4% and increasing it in most other regions (the South West enjoys an uplift of some 3.2%). Ultimately the combined effect of both changes is rather similar to simply using the deflator implied in the Regional Accounts estimates of imputed rents directly, as we do below.

3.6.2 More Realistic Estimates

The most conservative of the four estimates below makes the same assumptions as our 'lower bound' – namely that the only prices that differ across regions are those of the household sector. All that is done differently is to use the measure of housing costs implied directly in the Regional Accounts' estimates of GVA.

Our second estimate takes this and adds the price differences calculated above for gross capital consumption. All other sectors (government, NPISH, net exports, etc.) are assumed to have no price differences. The third estimate goes one step further and adds a wage premium of £3,000 for every public sector employee in London (as a proxy for the London weighting), which amounts to a 9.2% premium for the same work in the capital. The final estimate includes a public sector London wage premium of 20% for the same work, that is, it assumes that 75% the entire London public sector pay premium in the Annual Survey of Hours and Earnings dataset (ONS, 2017b) is due to the London weighting. This implies a public sector London weighting of just over £6,500, which is probably somewhat high.

As can be seen, the results are relatively impervious to a variety of different assumptions, largely reflecting the overwhelming importance of HHFCE in GDP, alongside the fact that most price variation occurs in consumer prices (particularly of housing).

Table 4. Estimated Regional PPPs.

Region	Conservative	Plus GFCF Price Differences	Central Scenario	Larger Government Difference
North East	96.5	96.9	96.8	96.7
North West	98.7	98.0	97.9	97.8
Yorkshire and Humberside	96.8	96.2	96.0	96.0
East Midlands	97.5	97.9	97.8	97.7
West Midlands	98.4	97.8	97.7	97.6
East	101.4	101.4	101.3	101.2
London	114.9	115.7	117.1	118.4
South East	106.2	107.2	107.1	107.0
South West	102.2	102.2	102.1	102.0
Wales	95.7	95.0	94.9	94.8
Scotland	98.6	98.7	98.6	98.5
Northern Ireland	94.8	94.8	94.7	94.6

Unsurprisingly, differences in price levels in the government sector only have a significant effect on the PPP of London and even then, a large London weighting of some £6,500 (or almost 20% of salary) only has a 2.5% impact overall.

3.7 ESTIMATING REAL REGIONAL GDP AND PRODUCTIVITY

We are now able to estimate real regional GDP. Whilst a final, definitive assessment remains elusive, we can certainly derive a range within which nominal and real regional GDP lie. Moreover, we can show that the regional disparity in real

productivity (GDP per hour worked) is smaller than that of nominal productivity.

3.7.1 Model 1: An Absolute Minimum

Here we deliberately seek to underestimate the size of the effect to derive an 'absolute lower bound'. We thus assume that GDP is directly proportional to GVA and measure housing costs using the FRS. We further assume that there are no price differences in any sector apart from the household one.[10] It should be noted that if we are to deflate housing costs using the FRS then this should also be the measure used to estimate regional rents. For our absolute minimum we do not do this and therefore it should be noted that this model deliberately underestimates the price differences across regions.

Simply deflating regional GDP without adjusting the imputed rents portion of GVA already leads to an increase of some 6% in GDP in Yorkshire and an 8% fall in London's GDP. Indeed, even using this 'absolute lower bound' estimate significantly attenuates the productivity gap between NUTS1 regions and sees Scotland overtake the South East as the second most productive region in the UK.

3.7.2 Model 2: A Conservative Estimate

This model uses the same formulation as above with one key difference that should make it a more accurate measure of real regional productivity. In particular, we continue to assume that prices are uniform across all parts of the economy apart from the household sector. The critical change pertains to the treatment of housing costs. Instead of using survey data from the FRS, we use the deflator directly implied from the GVA data on rents.

We then compare this to an alternative estimate that involves reallocating rental income (including imputed rental income) to

UK regions using the FRS survey data (and data on total dwelling stock) before deflating this by the 'absolute lower bound' measure of prices calculated above. If one is to use the 'lower bound' figures as a measure of prices then this is the conceptually correct thing to do. Interestingly, the impact of using the FRS-based deflator combined with using the same source to allocate real estate rental income in GVA is almost identical to simply using the deflator implied by the regional GVA figures directly. As a result, we feel confident in using the latter for our estimates.

3.7.3 Models 3 and 4: Our Central Scenarios

In model 3, we use the 'conservative' model above but add price differences in the gross capital consumption and government sectors. The methodology is outlined in the previous sections, but fundamentally, the difference between this and the more conservative 'model 2' are extremely modest.

Our fourth and final model is somewhat more ambitious. Rather than simply assuming that regional GDP is proportional to regional GVA, we attempt to apportion VAT and other taxes/subsidies on production to different regions. To do so, the ONS' estimates of Country and Regional Public Sector Finances were used (ONS, 2017c). These contain direct estimates of the VAT attributable to regions together with estimates of a number of other taxes (from which taxes on products can be isolated and summed). It should be noted that all of these data are experimental estimates.

3.8 CONCLUSION: TIME TO RE-EVALUATE REGIONAL SUCCESS?

As can be seen, the overall impact is to significantly attenuate estimates of productivity differences across the UK. Even the

Table 5. The Impact of Different Rental Cost Deflators.

	GDP Impact (FRS Deflator Only)	GDP Impact (FRS Deflator & FRS-based Imputed Rents)	GDP Impact (GVA-based Housing Costs)
North East	5%	8%	8%
North West	5%	5%	5%
Yorkshire & Humberside	6%	7%	7%
East Midlands	5%	7%	6%
West Midlands	3%	5%	5%
East	1%	2%	2%
London	–8%	–12%	–11%
South East	–2%	–3%	–3%
South West	–1%	2%	1%
Wales	6%	9%	9%
Scotland	4%	5%	5%
Northern Ireland	8%	9%	10%

'absolute lower bound' with its deliberate underestimate of price differences accounts for about half of the total impact. Using a more realistic conservative estimate accounts for a further quarter of the total effect. As such, estimates of differences in the cost of government expenditure and gross capital consumption largely amount to little more than tinkering around the edges. Attempting to apportion VAT and other taxes to regions takes a further bite out of London's dominance (largely because in the EU most VAT is assigned to the government of the place where consumption occurs rather than where production occurs), although the absence of good data means that any realistic attempt to do so entails a degree of guesswork.

Several other factors stand out. London remains the most productive region in the UK by a significant margin.

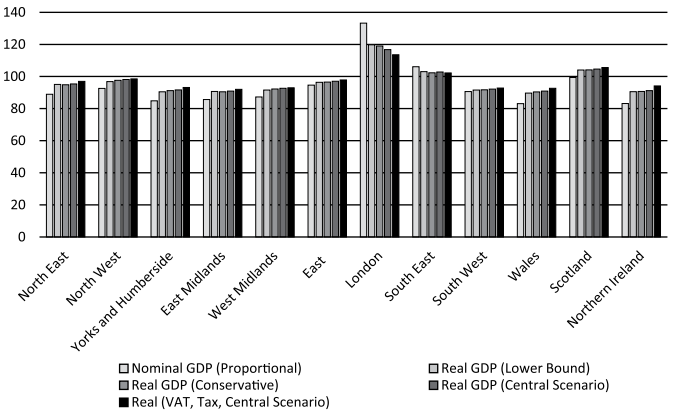

Fig. 7. Relative Regional Productivity in the UK.

The ranking of various regions also changes – Scotland overtakes the South East of England to become the second most productive region in the UK whilst Wales and Northern Ireland are within 2% of the South West in *any* sensible scenario. Indeed, even in our conservative scenario, the South East is just 5% more productive than the North West in real terms, as opposed to some 15% when measured in nominal terms.

This should cause us to fundamentally reassess our perceptions of regional economic differences in the UK. Rather than an unproductive North and a hyperproductive South, London and Scotland stand out. Indeed, in contrast to traditional perceptions the UK appears to have a 'hollow middle' alongside Wales and Northern Ireland. These are all areas that have been hit particularly hard by de-industrialisation. Indeed, this further reinforces the work of Beatty and Fothergill (2017) suggesting that not only do areas that experienced large-scale job loss in the 1980s and 1990s still have higher rates of worklessness, but that they might also pay a price in terms of productivity. We would tentatively suggest that

the strong performance of Scotland is possibly an indication that, done right, devolution can have a significant positive impact on productivity.

A considerable amount of space has been devoted to questions over the measurement of an issue that should prove important to all involved in regional policy post-Brexit. To reiterate the point made at the outset – we need price-adjusted measures in order to better assess what regions need to do in order to respond to the Brexit vote.

The record of the ONS in producing high-quality statistics is exemplary and in many areas they are world leading and their data underlies all of the estimates derived in this book. Unfortunately, nominal statistics on regional incomes and GVA, whilst very high quality and extremely useful for many tasks need to be complemented by real (price-adjusted) measures in order to assess regional success and failure.[11]

Now that we have considered two of the largest facets of regional economic performance, namely how much real disposable income residents have and how productive its workforce is (again in real rather than nominal terms), we are in a strong position to re-evaluate regional disparities. At this point, we are therefore able to consider the policy ramifications of our findings and what this means for regions in the light of Brexit. These crucial (and fascinating) issues are what the remainder of the book is devoted to.

NOTES

1. It is 'gross' in the sense of not making any allowance for depreciation.

2. The notable exception to this is the real estate industry (SIC2007 code 68) where housing costs have increased more rapidly in some regions than others.

3. There are notable and important exceptions to this rule. When calculating government debt (or the deficit) as a proportion of GDP, for example, it is nominal figures that are of interest.

4. Nevertheless, a great deal of interesting research has been done recently on input–output models, from global models (Steen-Olsen et al., 2016) to subnational analyses (Kim, Kratena, & Hewings, 2015). The work of Los, Timmer, and de Vries (2016) is important in being able to use such tables to understand the value-added component of gross exports.

5. There are some interesting exceptions to this rule, particularly for businesses that sell only a small amount in the second country (below the VAT threshold, even if they are above the VAT threshold in terms of the goods they sell in their own country). In addition, selling to businesses in a second EU country that do not possess a valid VAT number typically involves levying VAT at the rate applicable in one's home country. The interested reader is referred to Your Europe (2018) for further details.

6. There is no evidence that individuals in and around London are running down their stock of wealth more rapidly than those elsewhere to finance a more lavish lifestyle.

7. It is possible that transfer and equipment costs are broadly constant on a per-dwelling basis rather than a total expenditure basis but this is likely to have almost zero impact on our final estimates in practice.

8. It should be noted that these proportions are heavily affected by the very same factors that make GVA per capita a problematic measure. They are thus heavily distorted by tourism (including domestic tourism) and commuting. Any money spent by commuters in their place of work counts as an 'export' from their work region and an 'import' to their home region. The result is that, for example, any tube fares purchased by a commuter from Watford count as an export from London to the East of England as would any meals, coffee, etc., purchased in their workplace. Pensioners have a similarly distorting effect: a region full of retirees will produce very little measured economic output, but its consumption will be substantial. The inevitable result is that net exports will be negative. A progressive tax and benefits system that redistributes

from high income earners to those on lower incomes will have a similar effect.

9. A corollary of this assumption is that the apportionment of other expenditure components across regions is irrelevant. They all have the same relative price levels and can therefore be treated as a homogenous 'lump' (whether comprised government expenditure, investment, net exports, etc.).

10. In other words, we *assume* that there are no regional price differences in the not-for-profit sector or for government spending or investment (including building). This generates a deliberate underestimate of price differences, suitable for calculating a lower bound.

11. The absence of rigourous, timely and complete measures of regional prices (plus the absence of any measure of regional imports and exports or, alternatively, regional price levels by industry) that would meet their exceptionally high standards is one probable reason why the ONS does not produce the statistics that we have attempted to. Freed of the need to be 100% accurate and produce a single reference estimate, together with a little ingenuity, we have been able to posit a range of numbers within which we can be relatively confident the actual answer lies between.