New methodologies for the estimation of urbanisation in England c.1670 and c.1761[1,2]

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The United Nations estimates that the proportion of the world's population living in urban areas exceeded the population in rural areas by 2008 (United Nations, 2007). In Britain conventional estimates of the urban population of England and Wales and of Scotland indicate that this benchmark was reached by the mid-nineteenth century, the first national populations to achieve this level. This precocious urbanisation was in marked contrast to most of continental Europe, where urbanisation levels stagnated across the eighteenth and early nineteenth centuries (Bairoch & Goertz, 1986; de Vries, 1984; Wrigley, 2014). It is also especially remarkable because the British Isles, like the other fringes of Europe, lagged behind the continental average before the late seventeenth century. De Vries estimated that only 5.8 % of the population of England and Wales lived in towns of 10,000 or more in 1600, compared with 7.6 % for western Europe as a whole. By 1700 the comparable figures were 13.2 % and 9.2 %, and by 1800 a fifth of the population of England and Wales lived in such towns, compared with a tenth of the European population (de Vries, p. 39,64).

The British experience of urbanisation is often used as the standard exemplar or comparator for modern patterns of urbanisation elsewhere. We have a relatively clear picture of developments in nineteenth century Britain as a consequence of the instigation of decennial censuses from 1801. However we know far less about the previous two centuries, although it was in this period that the most profound changes to the urban system occurred. De Vries has depicted the anomalous growth of the British urban population in the eighteenth century as simply part of a 'catch-up' process of the Atlantic seaboard with older urban regions of Europe (de Vries, 1984). However British urbanisation was strikingly different from earlier urban growth in the Netherlands or northern Italy. In these regions high levels of urbanisation were achieved in the 16th and seventeenth centuries through a process of growth and elaboration of the existing urban network, with little change to the rank order of the largest towns. By contrast, in Britain the urbanisation of the seventeenth and eighteenth centuries was accompanied by a profound restructuring of the urban system, with industrial and manufacturing towns, many without any formal urban status, overtaking long-established county and provincial capitals. Of the twenty greatest towns in 1600, only London retained its unchallenged pre-eminence by 1801. The ports of Bristol, Newcastle and Hull continued to flourish, however old provincial capitals and county towns such as Exeter, Salisbury, Gloucester, Chester, Coventry, Worcester, Canterbury, Oxford, Cambridge, King's Lynn, Colchester and Ipswich had disappeared from the list, displaced by northern and midland towns including Manchester, Liverpool, Birmingham, Leeds, Sheffield, Nottingham, Sunderland and Wolverhampton (Wrigley 1985). The centre of gravity of the British population as a whole, and especially of the urban system, had swung decisively northwards.

This transformation of the urban hierarchy was associated with major changes in the transport infrastructure and economic activities, and offers a rather neglected perspective on the process of

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growth in the British economy (Langton, 2000). Recent GDP per capita estimates suggest relatively low and stable rates of economic growth before c.1820 (Broadberry et al., 2015), and male secondary sector employment was also remarkably stable over the same period (Shaw-Taylor & Wrigley, 2014). Shaw-Taylor and Wrigley estimate that secondary sector employment already accounted for 37 % of the male labour force by 1710, and rose only slightly to 42 % in 1813-20, and to 45 % by 1851, implying both very early development of the manufacturing sector, and substantial gains in productivity over the period. In contrast, they estimate that the tertiary sector grew over the same period from 12 % to 23 %, implicating the (synergistic) growth of towns and transport services as a major source of dynamism in the English economy this period.

However our current estimates of urbanisation rates are fragile. While we know the outline of changes at the top of the urban hierarchy, our knowledge of the total size and distribution of the urban population before 1801 is shaky. This reflects both the difficulties of the source materials available for population reconstruction before the official censuses, and conceptual problems with the measurement of urbanisation. We describe these two problems in reverse order.

First, while it is often intuitively obvious whether a settlement is a town or not, it is not straightforward to define urban settlements even now (United Nations, 2014), and it can be particularly difficult to trace towns historically from sources that were not designed for the purpose. Most urban historians and historical demographers have relied on population sizes to define towns, and have applied a single threshold over time. For example de Vries used a threshold of 10,000 population to define urban centres in his comparative study of European urbanisation before 1800, a level dictated largely by the availability of comparative European data.[5] Bairoch and colleagues employed a single threshold of 5,000 population in their listing of European towns for the period 800-1850 (Bairoch et al., 1988). Law and Robson used a threshold of 2,500 to define towns in nineteenth century England and Wales (Bennett, 2012).[6] Nineteenth century census takers took a slightly more nuanced view. The 1851 census for example included a listing of 'boroughs and principal towns'. This included towns with incorporated or parliamentary borough status, plus all towns with 2,000 or more inhabitants but without such status. The county Clerks of the Peace were consulted 'as to the places which are entitled to be deemed towns', and some settlements with population above the threshold were rejected from the list on these grounds (1851 census, vol. 1, p.xxii). The list therefore included a few towns (all Welsh) with fewer than 2,000 inhabitants but with the legal status of towns, and probably captured most functioning towns at this date (1851 census, vol. 1, Appendix, pp.cciv-ccviii).

As many urban historians have previously argued, population thresholds that suffice for the definition of nineteenth century towns may be quite inappropriate for identifying towns in earlier periods. In the British case even the use of a threshold as low as 2,500 inhabitants may have the effect of substantially underestimating the extent of urbanisation and the influence of towns before the nineteenth century. Where towns have instead been identified using other criteria such as the presence of a market, or legal status, then many smaller towns are revealed. For the early modern period Clark and colleagues used several contemporary listings of towns to identify roughly 600 'small towns' in England with populations under 2,500 in the late seventeenth century (or under 5,000 in 1811) (Clark et al., 1989). Langton extended their analysis to include small towns in Scotland and Wales, and estimated that nearly two-thirds of towns in late seventeenth century Britain fell below the 2,500 population

[5] De Vries presented data for English and Welsh towns of population 2,500 or more, but could not identify comparable data for all European areas (de Vries, 1984, p. 65).

[6] The criterion for inclusion was whether a town or other census unit exceeded 2,500 at any point in the nineteenth century.

threshold, and that such towns contained fully half of all the urban population of Britain in this period. By 1841 only a tenth of towns fell into this size category, and these accounted for only 9 % of the urban population (Langton, 2000: 463).

The apparent importance of small towns in the early modern urban heirarchy suggests that there is considerable scope for refining our estimates of the size of the urban population in Britain before the nineteenth century. However in including small towns in calculations of the urban population it is also possible that we may overestimate urbanisation, because the populations counted were not predominantly urban. Many small towns consisted of a single parish, and the town itself was often surrounded by large areas of agricultural land. In these cases the population of the town may have formed a small component of the total parochial population, where a high proportion lived in other hamlets or villages within the parish. Indeed even the inhabitants of the town may have been engaged largely in agricultural activities. These issues matter because if we omit small towns from our calculations of urban population sizes then we risk underestimating the extent of urbanisation during the centuries preceding the Industrial Revolution, which would cause us to over-estimate the speed of urbanisation in the nineteenth century. If however we include all small town populations uncritically in our calculations then we risk the opposite.

The second reason that we know relatively little about the processes of urbanisation in Britain before 1801 is that the historical sources for such information are regrettably sparse and ambiguous. Before the 1801 census the only sources with more or less national coverage for England and Wales are religious 'censuses' of 1563, 1603, and 1676, and the hearth tax returns for the periods 1662-65, and 1670-74.[7] For England and Wales we lack cross-sectional evidence for any date between 1675 and 1801. To remedy this lacuna Law drew together a variety of sources from across the eighteenth century to establish English urban population estimates for 1750 and 1775 (Law, 1972a). However for many towns he was forced to rely on educated guesses (Law, 1972a,b). This means that in the case of England we know least about the period of greatest change, between the late seventeenth and the early nineteenth centuries. The transformation of Britain from an apparently relatively rural to a predominantly urban society was clearly underway by the late seventeenth century, well before the classic period of the Industrial Revolution (c.1760-1830). However the timing of urban growth relative to other changes in the economy remains largely unknown in this crucial and extremely dynamic period.

Compounding this dearth of evidence is the quality of pre-census sources of population data. With the exception of local populations listings for some towns, the sources we rely upon for population estimates were not collected for demographic purposed, but to verify taxation status or to assess the extent of religious conformity. The units counted were household heads, adults, adult males, families or very occasionally 'Inhabitants' or 'Souls', and it is not straightforward to convert these into population counts. More importantly, it is rarely clear who was included in the listings and who was omitted. Even where the tax exempt or religious non-conformists are apparently listed these records may omit those so demonstrably poor that they did not require enumeration, or those who were not regarded as part of the local community. Moreover, even for records with national coverage, superficial conformity of records may conceal considerable local or temporal heterogeneity in the conduct and coverage of the listings. In the case of the hearth tax returns for instance, requirements regarding the recording of those exempt from the tax varied over the lifetime of the tax, making

[7] For Scotland the only comparable sources are the hearth tax returns of 1690-94, a private census of 1755, and the Old Statistical Account of Scotland, 1791-99.

comparison between returns of different years complicated. There was also apparently considerable geographical variation in the application of rules regarding tax liability, and in the manner in which exempt households were reported. Therefore national estimates based on the collation of county totals derived from returns of different dates are likely to be flawed.

These shortcomings mean that our estimates of urban populations are not only sparse but also shaky. Moreover, we know relatively little of the regional geography of urbanisation, because both the available numerators (urban populations) and the denominators (rural and urban population estimates combined) are seriously flawed. Langton produced estimates of urbanisation for counties and regions in the late seventeenth century, which indicated that, London excluded, the northern-most counties of England were the most urbanised, with over half their populations living in towns (Langton, 2000: 464). While this rather surprising pattern may reflect the outsized importance of Newcastle and Carlisle in a region of low rural population densities, it was also the case that Langton lacked reliable estimates of the size of rural populations with which to compare better established estimates for towns. Indeed Langton admitted that his estimates for England as a whole were only two-thirds of that estimated by Wrigley and Schofield using more robust procedures (Langton, 2000, pp. 461-2, fns. 48,49). Obviously any regional biases in the over-count of urban populations or the under-enumeration of the rural population would severely distort our understanding of the geography of urban growth.

In this study we propose two methods to (1) improve upon existing estimates of rural and urban populations for England and Wales in the late seventeenth century, and (2) provide new estimates of urban populations at the beginning of the Industrial Revolution period, c.1761. We demonstrate these methods using the county of Bedfordshire as an example (and Leicestershire for c.1670 estimates). We build upon the approach of Clark et al. and Langton to include all towns identified in contemporary listings of towns, regardless of size. For the late seventeenth century we use a triangulation approach to generate robust estimates of rural and urban populations at parish level c.1670 using hearth tax returns and other local census-type sources. We also exploit the unusually rich information in the hearth tax returns to estimate the proportion of the parochial population that was resident in the urban settlement, in parishes designated urban. For the mid-eighteenth century we extend an existing method developed by Wrigley (2009, 2011) that uses marriage counts to produce new estimates of urban populations c.1761.

Below we describe existing sub-national pre-census population estimates, and then discuss the sources available for reconstructing the population geography of England c.1670 and c.1760.

Existing sub-national population estimates for England and Wales

England is the only nation for which robust population estimates are available at the national level for the whole of the last half millennium (Wrigley & Schofield, 1989). The methodology employed involved 'generalised inverse projection', a form of back-projection from nineteenth century census counts of the population by age into previous centuries using a sample of high quality parish register counts of baptisms, burials and marriages and estimates of vital rates derived from family reconstitution of 26 parish populations (Wrigley & Schofield, 1989; Wrigley et al., 1997). Progress in obtaining sub-national estimates of population before the nineteenth century has been slower, because the techniques used to estimate the national population cannot be applied at finer levels of disaggregation, where internal migration exerted large effects, and where the sources required are often defective or lost. Wrigley has however used parish register data, in conjunction with the more robust national estimates, to construct population totals by county and by hundred (a sub-county,

super-parochial administrative unit) for selected years. These totals derive from the counts of baptisms, burials and marriages published in the censuses by the director of the first four censuses, John Rickman, for selected years before 1801. As Rickman acknowledged, these records were neither comprehensive nor always reliable. Marriage records were however of relatively high quality after the mid-eighteenth century. Hardwicke's Act of 1753 made the registration of marriage in an Anglican church a legal requirement for all except Jews and Quakers, and Rickman collected counts of marriages for every year from 1754, and reported these by hundred. Wrigley was able to use these marriage counts to estimate with some confidence both county and hundredal population totals for the decades between 1761 and 1801, after correction for various types of under-enumeration and potential biases (Wrigley, 2009; 2011). Rickman did not publish marriage counts for any years before 1754 because he judged them too unreliable, and for earlier centuries he collected counts of baptisms and burials only in short runs of years centred on each half century. Wrigley used the ratios of these counts between counties (with substantial corrections for bias and under-enumeration), constrained by robust estimates of national population, to produce estimates of county populations in 1600, 1700 and 1750 (Wrigley, 2009). We are therefore in the position now where we have reliable estimates of county and hundredal populations from 1761 to 1801, and plausible though fragile estimates of county populations at several earlier dates.

In the next section we describe the sources available for reconstructing parochial populations in the late seventeenth and the mid-eighteenth centuries.

Population sources for the late seventeenth century

The late seventeenth century would appear at first notice a very promising period for local population estimates, because of the exceptional coincidence of two national sources of census-type data for overlapping dates, the Compton census of religious conformity (1676) and the hearth tax returns of 1662-89. The two sources were collected for very different purposes and via different administrative hierarchies (church and state). This means that the sources should differ in their biases and deficiencies, and offers in theory the possibility of using each source to correct the deficiencies or biases of the other. In particular, the hearth tax returns often omitted or under-reported those who were exempt from the tax. The Compton census on the other hand may have been affected by under-reporting of non-Anglicans by incumbents who wished to downplay the extent of non-conformity in their parish, or by cursory reporting especially in the case of incumbents who were resident elsewhere. The hearth taxes in particular have been used extensively to generate local population estimates for local and county-level studies, including the Victoria County Histories and the Hearth Tax Project volumes. However the population estimates so generated have only rarely been properly cross-validated with other contemporary sources, in part because of the difficulty of matching consistent spatial units between sources of different provenance, a problem discussed further in the Methods section.[8]

The hearth taxes of 1662 - 1689

The hearth tax was introduced in England and Wales in 1662 as a tax on fireplaces, at a flat rate of a shilling per hearth every half year. The tax was levied on the occupiers of houses (unless the owner

[8] Comparisons between multiple sources have been used repeatedly, however the issue of comparison of exact units has only rarely been properly addressed: Arkell, 1992; Jenkins, 1990; Kirby, 1972; Parkinson, 1998.

was also responsible for paying the church and poor rates), and was levied by household rather than by house (Arkell, 2003). Local officials were required to draw up lists of those liable and exempt, and to issue where necessary certificates setting out the basis for exemption. Arkell (1987) has argued that three categories of households were broadly distinguished, in principle if not in surviving returns: (1) those who paid the tax, (2) those who were readily identified as too poor to pay because they were in receipt of poor relief or were not liable for church or poor rates, and (3) those who were exempted from the tax on specific grounds by the legislation, and who required an exemption certificate to demonstrate this status. The grounds for exemption changed slightly in the early years of the tax. In addition to the first two categories, exemption was originally granted to occupiers of houses with rental value of under 20 shillings p.a., as long as they did not also possess other goods and land worth more than 10 pounds, to bake-ovens and blast stoves (but not forges), and to almshouses and other charitable institutions with an income of less than 100 pounds per annum. The legislation was amended in 1664 to make landlords who subdivided properties to bring their rental value under the exemption ceiling liable for the tax, and to confine exemption under the rental value clause to households with fewer than three hearths Arkell, 2003; Parkinson, 2008). Elizabeth Parkinson has argued convincingly that the value of the dwelling came to constitute the main basis for exemption, a factor that may account in part for the very high rates of exemption in the most northern counties, where rents were generally low (Parkinson, 2008).

The exemption criteria therefore combined local definitions of poverty (pauperism and exemption from local rates) with a centrally imposed definition based on rental value of dwellings. Instructions on whether and how to record and report the exempt also varied over time, and together these factors resulted in great spatial and chronological heterogeneity in the levels and recording of exemptions (Arkell, 2003; Parkinson, 2008; Patten, 1971;).[9] For example, the Bedfordshire return of 1670 conforms very closely to Arkell's schema. It listed, for almost every settlement unit, the names of taxpayers (i.e. household heads) and their numbers of hearths, followed by the names of those 'exempt by certificate' and the numbers of their hearths, and then a simple count of the number of paupers, usually of the form '9 persons receive constant alms' or similar (Marshall, 1990). In this case then it would appear that amongst the non-payers both pauper and non-pauper households were enumerated, and that all those non-payers who were not actually paupers were listed as exempt by certificate.

For Bedfordshire we can have some confidence that the 1670 return reported the full spectrum of households. More commonly however only two categories were reported in hearth tax returns: those liable for the tax and those exempted. In such cases it is unclear whether all poor households were enumerated in the return.[10] Although originally only those exempted because of the low rental value of their dwelling required certification, instructions issued in 1664 required the receivers who took over the tax collection from Michaelmas 1664 to record all exempt households including those receiving alms. However it is not clear whether they followed these instructions, and whether the

[9] The stringency of collection also varied. At the county level the numbers of hearths reported could differ by a factor of two between different returns, depending on the rigour with which collection was pursued. Fortunately, the numbers of households varied far less, suggesting that it was the reporting of hearths, rather than households, which was deficient.

[10] Whether the enumeration of pauper and other non-paying households provides a good guide to the distribution of households and the population by poverty levels is discussed by Arkell (1987, 2003) and Husbands (1992).

same instructions were re-issued to later collectors (Arkell, 2003: 151). Those exempted on the grounds that they were in receipt of alms or already exempt from other taxes were intuitively the most likely to be omitted from listings, since they were easily identified, and did not initially require legal certification. Several researchers have attempted to test this assumption by comparing lists of the exempt in hearth tax returns with roughly contemporaneous poor law lists of paupers in receipt of relief. These studies have indicated the presence of paupers in receipt of relief recorded amongst the tax exempt in Norfolk (Wales, 1984) Suffolk (Evans, 2004) and Warwickshire (Arkell, 2003). While Evans regarded the correlation between the two sources as poor, she acknowledged Arkell's explanations for the incomplete matches between the lists. First, as Arkell demonstrated, many paupers would not have appeared in hearth tax returns, which were based upon dwellings, because they resided in the houses of others or in institutions. In addition, lists of the exempt included many were not paupers but who qualified for exemption on other grounds. More generally, all attempts at nominal linkage between historical sources in the English context suffer from incomplete linkage even when the dates of the records are very close. This seems to reflect the very high mobility of the population and the stochasticity of demographic events especially in the context of English marriage and household patterns, where household dissolution and creation was a common outcome of death, marriage or migration.[11]

Hearth tax returns survive for most of the country at various dates between 1662-66 and 1670-74, and offer the greatest hope of reconstructing local population totals for the late seventeenth century. Their most serious limitation is the uncertainty over the extent to which those exempt from the tax were enumerated. Tax-payers were always enumerated in Hearth Tax returns and assessments, and where only payers were listed then it has been general practice amongst those using the hearth tax for the purpose of estimating urban or county populations to assume that the exempt comprised around 30-35% of the total population. However Arkell has demonstrated marked geographical patterns in the proportions exempted, with higher proportions exempted in northern counties compared with the rest of England (Arkell, 2003). At the local level we might expect much more marked variations. Therefore the preferred approach is to identify returns that provide the fullest information regarding the exempt. While Meekings (1982) regarded 1664 Lady Day as generally the fullest of returns with respect to numbers of names, the returns produced in 1670 (covering three tax periods, the 1669 Michaelmas and 1670 Lady Day and Michaelmas collections) are often regarded as the fullest with respect to exemptions (Parkinson, 2008). The tax was farmed between 1666 and 1669, and almost no returns survive for this period. On resumption of collection of the tax by receivers appointed by the state, collectors were required to record the exempt on pre-printed certificates. While this practice was continued until 1674, after which the tax was farmed again, the 1670 collection appears to have been the most scrupulous (Parkinson, 2008).

The Compton census, 1676

The Compton Census was undertaken by Bishop Compton to assess the prevalence of religious non-conformity. Unlike similar religious censuses that were carried out in the early eighteenth century on a more local (diocesan) scale, the Compton census appears to have been taken across England and Wales, although it is unclear whether it was never conducted in some archdeaconeries, or whether no returns have survived for these areas (Whiteman, 1992). Unfortunately, the instructions issued were ambiguous. The bishop apparently intended that incumbents should report to him the numbers

[11] This issue is discussed further below.

and religious persuasions of adults aged 16 or above in each parish. However many of the incumbents chose instead to report the numbers of Anglicans and non-conformists by household, or for adult males only, or for all inhabitants. While in many cases the original return from the incumbent to the bishop probably stated the unit of reporting, most of this information has not survived. The main surviving document is the Salt manuscript, an official summary of the returns. In her monumental critical edition of the Salt manuscript Anne Whiteman went to great lengths to determine the type of count reported (household, all adults, male adults only, or all inhabitants), but she could only establish this information for a fraction of places. For most units we have no way of determining the correct multiplier to use to convert reported counts to estimates of population.

This problem, of variable reporting units in the Compton census, affects most of the country for which returns survive. The biggest problem is the sheer scale of variation, because incumbents in neighbouring parishes could report quite different units of population, producing a patchwork of unpredictable variation. The Compton census has been used to estimate local and county population totals, however when these are compared with estimates derived from more robust local sources then the fit is rather poor (Arkell, 1992; Parkinson, 1998; see Gritt, 2007 for a notable exception).

In addition to the Salt manuscript the original returns from local incumbents survive for some parts of the country, including parts of Leicestershire (Whiteman, 1986: 307; Wykes, 1980). In these local returns the incumbents usually stated whether the counts returned referred to households, adults, adult males or all inhabitants. Whiteman reported the incumbents' original numbers in the footnotes to her edition of the Salt manuscript, and we have used these here to estimate population totals for Leicestershire.

Local sources for the late seventeenth century

In addition to the hearth tax returns and the Compton census other more local sources often survive that provide quasi-census type information on a county or diocesan basis. While the Compton census was national the various English and Welsh dioceses also conducted diocesan religious censuses to gauge the quality of their provision and the extent of religious non-conformity. For the present paper we used Bishop Wake's censuses of Lincoln diocese, conducted annually between 1706 and 1715 (Broad, 2012). Other major sources, not used in this paper, include the Protestation Oath of 1641/2 (which was national but which survives for only some parts of England), militia ballot lists of adult males liable for military service, and more occasional household listings (Goose and Hinde, 2006, 2007).

Sources for mid-eighteenth century estimates of urban populations

In contrast to the late seventeenth century the mid-eighteenth century offers far fewer potential sources of census-type data at either local or national level for England (hence the tenuous nature of measures of urbanisation in this period). There are religious censuses covering the diocese of York in 1743 and 1764, and militia ballot lists that recorded every male between the ages of 18 and 45 survive

for several counties (Gibson & Medlycott, 1990).[12] However there is no national source with which to compare local sources, and limited potential for triangulation to validate estimates. However the legal restrictions placed on marriages after 1753 means that marriage registers constitute a relatively robust and ubiquitous source of demographic data for the second half of the eighteenth century, if interpreted carefully, as Wrigley has demonstrated (Wrigley, 2009, 2011). Wrigley created decennial estimates of hundredal populations from 1761 to 1841 using a method that used the crude marriage rate in 1801 (that is, the ratio of marriages to population in c.1801) to convert counts of marriages to population for the same hundred in earlier years, with corrections for missing registers and under-enumeration in the 1801 census. The method assumed that the crude marriage rate remained the same across the period 1761-91 as it was in 1801. The marriage counts that formed the basis of Wrigley's hundredal population estimates were reported in the early censuses by hundred and so cannot be used to produce sub-hundredal estimates. To apply Wrigley's method to estimate parish populations would therefore require the re-counting of marriages for every parish for the dates of interest, currently a prohibitive undertaking (see Walker, 2009, for an attempt to do this for Sussex). However the methodology can be adapted with greater economy to estimate the populations of towns in 1761, and these can be compared in some cases with estimates from contemporary private censuses and other sources.

METHODOLOGY

The sources

Bishop Wake's religious censuses of Lincoln diocese, 1706 - 15

The key source we used in this study to triangulate population counts from the hearth taxes was the series of religious surveys of Lincoln diocese conducted by Bishop Wake in the early eighteenth century. As well as collecting information on religious conformity these surveys collected information on the numbers of houses and families, local charities and education. John Broad has produced a critical edition and database of the surviving returns (Broad, 2012). Crucially for our purposes, the returns were explicit regarding the unit of population reported, which was usually families, but was also sometimes 'Souls', as in 1709.

The key virtue of the Wake censuses for our purpose is that they provide relatively comprehensive information on local populations in the early eighteenth century. In theory the religious censuses should not suffer from the biases towards the more affluent that are common in taxation sources (although we discuss the fragility of this assumption later in the paper). They are of course only as good as the incumbent's knowledge of his parish or willingness to exert himself to establish the local population with accuracy. The main potential bias is in the recording of non-conformists, where the incumbent may have had a motive to downplay the level of non-conformity in his parish. However where the surveys asked for the total population (or number of families), as well as by denomination (rather than for counts by denomination only), as was the case in the Wake census, then selective under-reporting seems less likely. There were however considerable variations in reported counts from year to year, as is the case with the hearth tax. This variation induced Broad to create his own

[12] Wales and Scotland are better covered in this period, with a private census at parochial level covering the whole of Scotland in 1755, and mid-century surveys of several Welsh dioceses.

estimates of population sizes, based on an assessment of the most reliable years. He speculated that some of the inter-annual variation may have reflected the occasional inclusion or exclusion of hamlets (Broad, 2012, p.xxvi). While both the original incumbents' returns and Broad's estimates display considerable heaping on rounded numbers, this does not undermine their validity, so long as the errors produced by rounding are unbiased. Moreover rounded estimates do not necessarily reflect ignorance or indolence on the part of the incumbent. Small populations show considerable variation in composition from year to year and even seasonally as a consequence of stochastic demographic events. Wherever records have provided sequential snapshots of British populations there is evidence of very rapid turnover and compositional change, the classic example being Laslett's study of Clayworth (Nottinghamshire) and Cogenhoe (Northamptonshire), where the annual turnover rates were around 5%, or one in twenty persons leaving or dying per year (Laslett, 1977). Similar rates have been reported for other English communities in the seventeenth and eighteenth centuries (Whyte, 2000). Therefore exact counts do not necessarily capture the average size of the population any better than a rounded estimate if the latter is based on a good knowledge of the community in question.

The major drawback of Bishop Wake's census data is that they date from a period roughly 40 years after the Hearth tax and Compton census data were collected. Therefore in using the Wake census data as a cross-check on population totals from the 1670s we confront the possibility that any discrepancies reflect genuine population change, rather than a deficiency in one of the sources.

The hearth tax returns for Bedfordshire (1670) and Leicestershire (1670)

We identified hearth tax returns for 1670 for two counties within the Lincoln diocese, for comparison with Bishop Wake's returns for 1706-15. For Bedfordshire we used the published hearth tax return for Michaelmas 1670 (mistakenly described as Lent 1671 in the original publication) (Marshall, 1934, 1990). In general the unit of reporting was the parish, however sub-parochial units were also reported, such as hamlets, and, for towns, wards.

The Bedfordshire return is distinguished by the apparent fullness of the return. In most cases three categories of inhabitants were reported: (1) a list of names of household heads liable for the tax, with the numbers of chargeable hearths; (2) a list of names of household heads 'exempt by certificate', with the numbers of hearths per household; (3) a simple count of paupers 'in receipt of collection'.

For Leicestershire the hearth tax return covering Michaelmas 1670 and Lady 1671 was identified as the most complete surviving return for the county. This was available only in manuscript form (TNA E179/240/279).[13] While the Bedfordshire return reported inhabitants in three categories (liable, exempt by certificate, and pauper), the Leicestershire return used only two categories, with the exempt were described under various headings, including 'paupers', but most commonly 'discharged by legal certificate'. The unit of reporting in Leicestershire was generally the parish, but also included sub-parochial units including hamlets, town wards, detached portions of parishes, and sometimes individual large houses.

[13] Farnham (1929-33) transcribed the Leicestershire Return for 1666, but this return did not list the exempt. Counts of households and exempt were reported by parish in the *Victoria History of the County of Leicester (*volume III, 1958, pp. 170-72), and we used these to correct our totals where the original manuscript was damaged. However this source did not report the distribution of households by hearth number, so we extracted this from the original manuscripts.

The Compton census of 1676 incumbents' returns for Leicestershire

In Leicestershire the surviving incumbents' returns to Bishop Compton for the county indicate that the vast majority of parishes reported the numbers of adult communicants and non-conformists (aged 16 and over). We extracted this information from Whiteman (1986: 328:340), and converted reported counts to estimates of the total population of the parish using an assumption about the ratio of the population aged under 16 to adults (see below).

Marriage registers

Transcripts of parish registers have been published for almost all Bedfordshire parishes (Emmison, 1931-1953). We counted marriages in all urban parishes in Bedfordshire (except Bedford Town, which constituted a separate unit of reporting in Rickman's parish register abstracts) for the ten years flanking our target years 1761 (1756-65) and 1801 (1796-1805). We used a ten year period to reduce the effects of inter-annual variability in small populations. A crude marriage rate was calculated for each town based on the marriages 1796-1805 per thousand population in 1801, and this was used to convert marriages in 1756-65 to an estimate of population in 1761. Each marriage entry also recorded the abode of the bride and groom and therefore it was possible in theory to exclude marriages where one or both parties were not resident in the town. This was relatively unusual in Bedfordshire parishes and was deemed unnecessary in this study.

We also included a study of Manchester marriage records, as an example of a 'worst case' in terms of complexity with respect to registration practices. We used Rickman's counts of marriages for the parish of Manchester (1796-1805) and the population of Manchester parish in 1801 to calculate a crude marriage rate. We then used this rate to convert counts of marriages of Manchester residents registered at the collegiate church for the period 1887-89 with a private census of the town conducted in December 1788 (Aiken, 1795). The choice of data is explained in the results section.

Table 1 describes the sources for each county.

Conversion to population counts

The hearth tax provided counts of households. To convert these to counts of persons required some assumption about household size. There is a large literature on average household size in England and Wales, and unresolved debates about the extent to which average sizes varied geographically and chronologically (Laslett & Wall, 1972; Schürer, 1992). In this study we used the overall mean household size of 4.75 persons derived from Laslett and Wall's sample of population listings of 100 English communities between the sixteenth and nineteenth centuries (Laslett & Wall, 1972). This is obviously a crude instrument, because at the level of the community the average household size varied considerably, and might be expected to vary systematically between communities with high proportions of pauper or wealthy households (as evidenced for instance by numbers of hearths per household). However community sizes also varied for purely stochastic demographic reasons, and local population estimates must always be assumed to have very large margins of error compared with estimates at higher levels of aggregation.

The Wake census provided counts of families or in some cases 'Souls'. In this study we used Broad's estimates of population size, which generally applied a multiplier of 4.75 to what he considered to be

the most reliable counts of families for a given unit of enumeration (Broad, 2012). This was the same household size multiplier as we deployed and therefore provided comparability between our hearth tax and Broad's Wake census estimates.

The incumbents' returns for the Compton census of Leicestershire reported adults aged 16 and over. In this case we assumed that adults comprised c.70% of the population (based on the national age structure estimated from generalised inverse projection for 1671 (Wrigley et al., 1997, p.614).

For population estimates c.1761 crude marriage rates c.1801 were used to convert marriage counts for earlier periods into population estimates on the assumption that crude marriage rates were similar in 1801 and 1761.

Table 1. Sources used in this study.

Source	Bedfordshire	Leicestershire	Counts	Multiplier to convert counts to population
Hearth tax return	Lady Day 1670 (Marshall (1931, 1990)	Michaelmas 1670-Lady Day 1671 (TNA, E179/240/279; Victoria County History, 1958)	Households	4.75
Compton census 1676		Incumbents' returns (Whiteman, 1986)	Adults aged 16+	1.43
Bishop Wake's censuses 1706-15	Broad, 2012	Broad, 2012	Families or Souls	4.75 or 1.0

Spatial matching of units

The hearth tax was a civil tax and was administered on a different geographical basis from the religious censuses. Constables were initially responsible for collection of the hearth tax (and later assisted the king's appointees, in periods when the tax was not farmed). The tax was therefore collected by constablewick or other comparable units, including tithings, in south-eastern England, wapentakes and townships. Confusingly, the poor and exempt were determined on a separate parochial basis, and certificates of exemption were required to be signed by churchwardens and the minister. In order to determine the total numbers of households both exempt and taxed it was necessary to aggregate taxation units into 'poor law units' that grouped the exempt together with tax-payers. In Bedfordshire and Leicestershire this did not cause major problems because taxation units were generally co-terminus with or nested within parishes and it was possible to identify 'poor law units' (usually parishes) where the tax-payers and exempt were correctly identified and grouped.[14]

The religious censuses (the Wake and Compton censuses) were collected by ecclesiastical units. These usually corresponded to parishes, in Bedfordshire and Leicestershire. However the censuses were conducted by diocese, and therefore any geographical units that were within the county but did not belong to the diocese (for instance, 'peculiars') were not recorded in the census. In most cases hearth tax units could be aggregated to match a single religious census unit, but units outside the diocese

[14] It was a much larger problem for counties where tithings overlapped parish boundaries, a problem recognised by some hearth tax officials at the time (Russell, 1981).

could be not be matched (for example, Woburn in Bedfordshire and St Margaret's parish in Leicestershire were peculiars outside diocesan control). For the purposes of comparing the sources, we restricted the comparisons to those units that could be clearly identified as referring to the same area in both sources.

In order to map population densities and population growth the units of reporting described above were linked to a Geographical Information Systems (GIS) dataset of mappable spatial units (the 'Cambridge Group Kain and Oliver GIS'), and mapped using ArcMap 10.4.1.

Identification of towns, and other variables

Towns were identified using a database of historical towns created at the Cambridge Group for the History of Population and Social Structure (Candidate Town Characteristics Database, Cambridge Group for the History of Population and Social Structure: https://www.campop.geog.cam.ac.uk/research/occupations/datasets/catalogues/other/). In the English context many towns, especially small ones, consisted of an urban settlement situated within a single larger parish, sometimes with additional settlements, or hamlets, that were not urban. The hearth tax returns often distinguished the town from the rest of the parish (or even enumerated the hamlets separately), making it possible in theory to establish relatively accurate measures of the genuinely urban population. This principle also applied to larger urban units comprised of multiple parishes. These component parishes often included rural elements, that were distinguished from urban parts of the parish in the hearth tax. However the religious censuses rarely reported totals below the level of the parish, and so for the purposes of comparison we have treated all parishes with urban components as urban.

The road and navigable waterway networks (Map 1) was derived from a dynamic GIS (Geographical Information Systems) of the historical transport network of England and Wales (https://www.campop.geog.cam.ac.uk/research/projects/transport/data). The population in 1801 was derived from an enhanced version of the published census created by Wrigley (Wrigley, 2011).

RESULTS

Comparisons of population estimates from hearth tax and other sources c.1670

Bedfordshire

Bedfordshire represented a 'best case' scenario for deriving estimates of population and the distribution of tax-payers, poor and pauper by parish, because the hearth tax assessment of 1670 appeared to cover the whole county, and to include all categories of household (paid, exempt by certificate, and pauper). According to this return, the county included 9,491 households in 1670, and a population of 45,082 (assuming a household size of 4.75). This was some 10% lower than Wrigley's estimate for the county in c.1700 of 50,163 (Wrigley, 2009).

When we compared population totals derived from the 1670 hearth tax with Broad's population estimates from Bishop Wake's religious censuses of 1706-15 then there was a remarkable degree of

agreement between the two sources. We could not compare the whole county directly at the two dates, because the religious censuses were conducted on a slightly different geographical basis. However for the 122 units that could be matched between the two sources (representing almost all of the county), the correspondence was very close (Table 2). These 122 units included an estimated population of 44,270 in the hearth tax, and 44,806 in the Wake censuses. The closeness of these two estimates, derived from surveys with very different purposes and potential biases, suggests that both sources provide reasonably complete accounts of the households in the county. It also implies very modest population growth of only 1.2 % in the county over a forty year period 1670 – c.1710, a plausible figure that is discussed further below.

Table 2. Population estimates for Bedfordshire and Leicestershire, for units that could be matched in 1670 and c.1710

	Hearth tax	Wake census	Change 1670 – 1710 (%)
Bedfordshire			
Total	44,270	44,806	1.2
Urban parishes	10,778	11,072	2.7
Rural parishes	33,492	33,734	0.7
% urban	24.4	24.7	
Leicestershire			
Total	71,497	74,414	4.1
Urban parishes	17,038	19,075	12.0
Rural parishes	54,459	55,339	1.6
% urban	23.8	25.6	

Sources: see Table 1.

More compellingly, the close correspondence between the hearth tax and Wake census sources for Bedfordshire at the county level was also evident at the level of the individual parishes in the sample. There was a broadly one-to-one relationship between parochial populations in 1670 and c.1710, and this was the case both for urban and for rural parishes (Figure 1a). Population totals are plotted on a log-log scale to display the smaller parishes more clearly. The dotted line is the line of best fit through the full sample. Urban parishes grew by nearly 3% on average, compared with less than 1% for wholly rural parishes (Table 2).

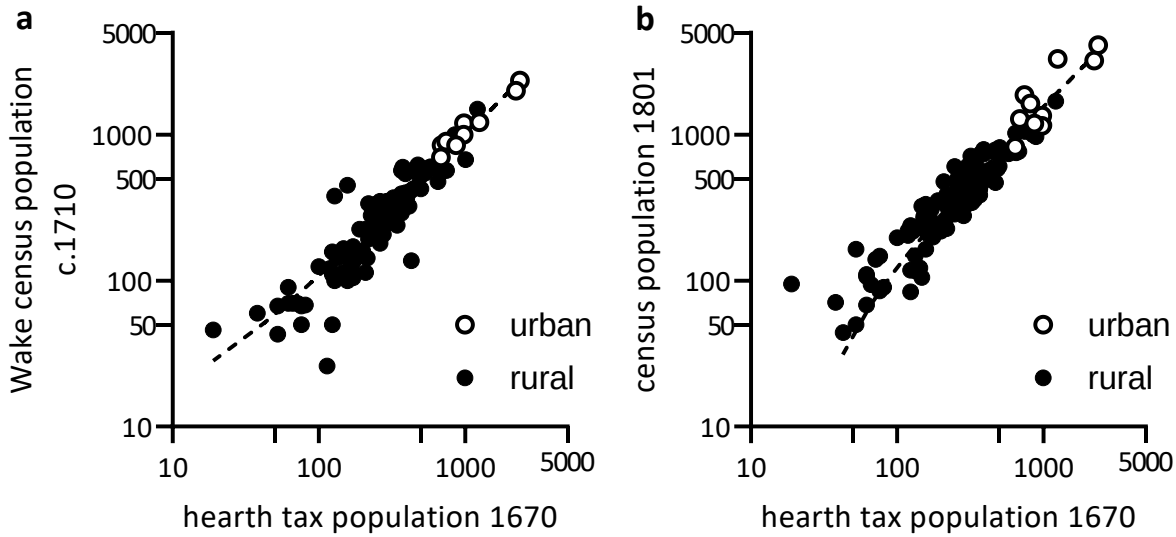

Figure 1. Parochial population estimates, Bedfordshire 1670 and c.1710 (a) and 1670 and 1801 (b). *Notes*: populations are plotted for units that were consistent between the two sources (usually the parish). The equation for the line of best fit through the full dataset (urban and rural combined) in panel a was: $pop_{1710} = 0.99 * pop_{1670} + 10$, $R^2 = 0.93$; panel b: $pop_{1801} = 1.59 * pop_{1670} + 23$, $R^2 = 0.89$. Sources: see Table 1.

Are these findings plausible? The Wake censuses were conducted roughly forty years after the 1670 hearth tax return was compiled. This raises an obvious problem of comparison, because any difference between population estimates from the two sources, hearth tax and Wake census, could reflect population growth or decline in this period, or errors and biases in the population estimates. This is obviously a major obstacle to the triangulation method proposed here. However the problem is much smaller than would be the case in other periods, because there was virtually no population growth nationally in this period (c.1670 – c.1710) (Wrigley & Schofield, 1989). Undoubtedly this national picture hides some sub-national reorganisation of population, that involved growth of some areas and decline in others. There was marked urbanisation during this period, and this probably occurred at the expense of localised rural depopulation, for example in West Yorkshire (Pickles, 1996). However the fact that urban settlements grew only slightly, and rural populations not at all, in Bedfordshire is consistent with the pattern of slow growth over the longer period 1670 to 1801 (Table 3, Figure 1b).

Table 3 compares population estimates from the hearth tax of 1670 with population totals reported in the first census of 1801. The figures differ from those in Table 2 mainly because the town of Woburn was not included in Table 2 because it was a 'peculiar' outside the jurisdiction of the diocese of Lincoln and so was not included in the Wake census. The inclusion of Woburn increased the proportion of the county population that was urban in 1670. By 1801 the population of Bedfordshire, in those areas which could be compared for consistent units between the two dates, had increased 49%, from 44,313 to 66,086, compared with an increase of 68.1% nationally (Wrigley et al., 1997: 614). The population of Bedfordshire in urban parishes had increased by 73% and in rural by 41%, so the urban component of the county population rose from 26.1 % to 30.2 %, if we include all urban parishes in our calculation. This seems a very modest rate of urbanisation by national standards in this period, compared for instance with the near-doubling of the urban percentage of the population of England and Wales estimated by de Vries (from 18.2 % c.1700 to 30.1 % by 1801). The latter estimate relates however

only to settlements of population 2,500 or more (de Vries, 1984, p. 64). If we use the same population threshold to define urban centres in Bedfordshire then the county contained *no* towns with a population of 2,500 or more in 1670. The county town of Bedford was the largest, at 2,366. By 1801 three towns, Bedford (with population 4,110), Leighton Buzzard (3,310) and Luton (3,227) surpassed the threshold, but together these comprised only 8.6% of the county population.

Table 3: Population estimates for Bedfordshire and Leicestershire, for units that could be matched in 1670 and 1801.

Population	c.1670 (hearth tax)	1801 (census)	Growth 1670-1801 (%)
Bedfordshire			
County	44,313	66,086	49.1
Rural parishes	32,766	46,122	40.8
Urban parishes	11,547	19,964	72.9
% urban	26.1	30.2	
Leicestershire			
County	72,599	130,910	80.3
Rural parishes	55,015	86,901	58.0
Urban parishes	17,585	44,009	150.3
% urban	24.2	33.6	

Sources: Table 1, and Wrigley, 2011.

At the level of individual parishes there was again a close relationship between population estimates in 1670 and the census populations reported in 1801 (Figure 1b). This pattern implied relatively uniform growth across the county between 1670 and 1801. This was consistent with the national pattern of rising fertility after c.1740, and implied a relatively stable geography of economic activity over the period in Bedfordshire.

In the discussion above we have used the terms 'town' and 'urban parish' interchangeably, however the towns in our sample were generally nested within larger parishes. The hearth tax returns also allowed us to examine how many people actually lived in the main urban settlement, in parishes deemed urban in our sample. The hearth tax return for 1670 reported households in multiple units below the level of the parish for a number of the urban parishes. Unusually, the exempt were also listed with the liable households for each unit. This made it possible in theory to estimate populations for towns and other settlements in the parish separately, on the assumption that where there were other non-urban settlements in the parish then these were enumerated separately. To test this assumption we examined early nineteenth century Ordinance Survey maps of the urban parishes in our sample. These confirmed that those urban parishes with no sub-parochial breakdown of taxation units contained a single nucleated town, while those with sub-parochial units reported in the hearth tax included identifiable settlements (clusters or strings of houses) outside the main town. We could thus use the return to separate the households in urban parishes into a 'town' component, and a rural residual. Of the 11,547 persons estimated to live in urban parishes in Bedfordshire in 1670, 9,923 (85.9 %) lived in the eponymous urban settlement within the parish. Whether these inhabitants of urban settlements can generally be regarded as urban is discussed further in the concluding section of the paper.

Leicestershire

For Leicestershire the hearth tax return of 1671 was at first glance less complete than was the case for Bedfordshire, because it enumerated households in only two categories, paying and exempt, and so it was unclear whether paupers were included with the other exempt, or were not reported at all. If we assumed that the enumeration of households was complete, and the average household size was 4.75, then the county population was estimated as 72,927.[15] This compared with 74,395 estimated for the county in 1700 by Wrigley (2009) (2.0 % higher than our hearth tax estimate). As with Bedfordshire, the county population totals derived from the Leicestershire hearth tax could not be compared directly with estimates from the Wake census because they were conducted on slightly different bases. However for the units that could be matched exactly, the population totals were 71,497 for the 1671 hearth tax and 74,414 for the Wake census c.1710, a difference of 4.1 % (Table 2). The main discrepancy between the two sources was amongst the urban parishes, where the population in c1710 was 12.0 % higher than in 1671. The estimated population in rural parishes increased by only 1.6 % between the two dates (Table 2).

At the level of individual parishes, the fit between our estimates for 1670 and c.1710 was again close (R^2 = 0.93, Figure 2a). The fit between 1671 and 1801 was not as close as in the case of Bedfordshire (R^2 = 0.85), and this may have reflected differential population growth within the county (Figure 2b). As table 3 indicates, not only was growth faster in Leicestershire than Bedfordshire, in both rural and urban parishes, but urbanisation was more rapid. The population living in urban parishes rose from a quarter to a third of the county population between 1670 and 1801. Using a more conventional measure, of the population living in parishes or multi-parish towns of 2,500 inhabitants or more, the urban percentage of the county total rose from 6.7 % to 23.3 %.

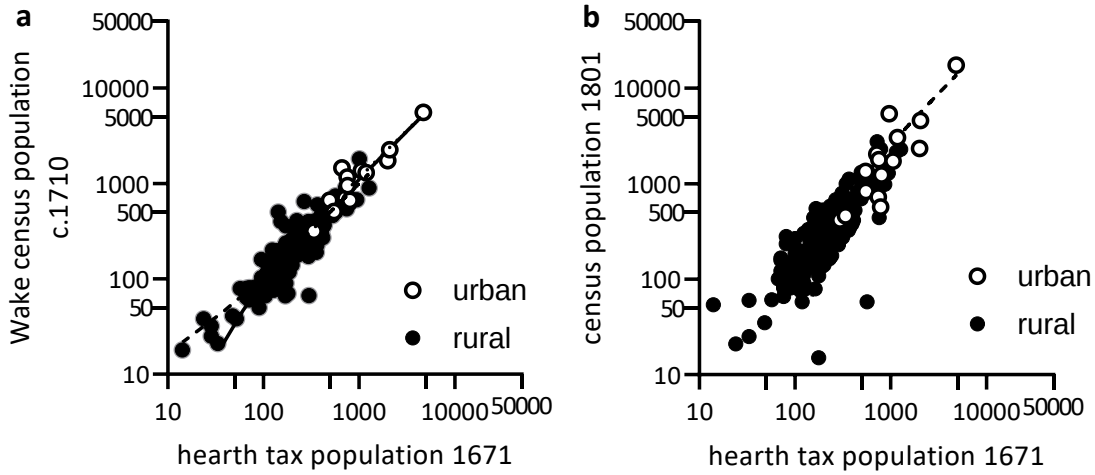

Figure 3. Parochial population estimates, Leicestershire 1671 and c.1710 (a) and 1671 and 1801 (b). Note: Populations are plotted for units that were consistent between the two sources (usually the parish). The equation for the line of best fit through the rural dataset in (a) was: $pop_{1710} = 0.99 * pop_{1671}$

[15] This number includes 58 households, or 276 persons, enumerated in extra-parochial units that were within the county boundaries of Derbyshire.

– 8, R^2 = 0.77. The equation for the line of best fit through the urban dataset in (a) was: pop_{1710} = 1.14 * pop_{1670} -7, R^2 = 0.95. The equation for the line of best fit through the full dataset in (b) was: pop_{1801} = 2.91 * pop_{1670} - 370, R^2 = 0.85.

In the case of Leicestershire our population estimate for 1671 was 4.1 % below that for 1710, at the county level, compared with a 1 % difference in Bedfordshire. This suggested three possibilities. First, up to c.4 % of the 1671 population was under-enumerated in the hearth tax. Second, Leicestershire experienced population growth of c.4 % between 1671 and c.1710. The third possibility was that the discrepancy between the two sources was due to both population growth and some under-enumeration. We can evaluate these possibilities from three angles.

First, we consider the likelihood that households were under-enumerated in the Leicestershire hearth tax of 1671 due to the omission of pauper households (those in receipt of relief), by comparing the percentages exempt on Bedfordshire and Leicestershire. Table 4 displays the percentage of households in each category of tax status, for rural parishes and towns in Bedfordshire. Those in receipt of collection (paupers) comprised around 7% of households in Bedfordshire, and this percentage was roughly the same for rural and urban places. Paupers and those exempted by certificate together comprised 30 % of all households in the county as a whole, and over a third (34 %) in towns. We could compare these latter figures with the percentages categorised as paying and exempt or non-paying in Leicestershire. The exempt in Leicestershire comprised 31.4 % of all households reported, and nearly a third (32.7 %) of households in urban parishes (Table 5). That is, the proportions of households that did not pay were very similar in both counties, and very close to the 30-35 % assumed by most historians to be a good approximation in cases where only households liable for the tax are listed. Therefore it seems plausible that the Leicestershire return for 1670 reported both paupers and other categories of the exempt together in the non-paying category. This is consistent with the instructions to the hearth tax collectors in 1664, to list all exempt households including the poor. If this were the case then the Leicestershire hearth tax return of 1671 could be regarded as a fairly complete enumeration of households. The discrepancy between the 1671 and 1710 population estimates could therefore be attributed in the main to population growth.

Table 4. Percentage distribution of households by taxation status in the Bedfordshire hearth tax assessment of 1670.

Category	All households	rural	Urban
Paid	69.6	70.9	65.9
Exempt by certificate	23.3	22.1	26.6
Pauper	7.1	7.0	7.5
Non-paying, total	30.4	29.1	34.1
Number of households	9,491	7,079	2,440

Table 5. Percentage distribution of households by taxation status in the Leicestershire hearth tax assessment of 1671.

Category	All households	Rural	Urban

Paid	68.6	69.0	67.3
Exempt	31.4	31.0	32.7
Number of households	15,353	11,766	3,587

A second approach is to evaluate the geographical patterns of population growth suggested by the data between 1671 and 1710. We would expect in this period that towns in general grew faster than rural areas, because the period witnessed significant urbanisation despite negligible population growth. However not all towns experienced growth: rather urban growth was concentrated geographically and confined to certain types of town. In Bedfordshire parishes containing towns grew by only around 3% between 1670 and 1710 (Table 2). In Leicestershire however, if we assume our population estimates to be correct, then the population in parishes associated with towns grew by 12 % between 1671 and 1710 (Table 2). This suggests that there may have been genuine urban growth in Leicestershire in the period 1671 – 1710, and this would largely account for the 4 % increase in population in 1710 compared with 1671.[16] This argument gains force when the growth of individual towns is compared. Of the fourteen towns in Leicestershire in this period (Ashby de la Zouch, Billesden, Burton Overy, Castle Donington, Hallaton, Hinckley, Leicester, Lutterworth, Loughborough, Market Bosworth, Market Harborough, Melton Mowbray, Mountsorrel and Waltham on the Wolds), only eight (Ashby de la Zouch, Burton Overy, Hinckley, Leicester, Lutterworth, Loughborough, Market Bosworth and Market Harborough) increased in population between 1671 and 1710, and these were all, with the exception of Market Harborough, located in the west of the county, in the areas where framework knitting developed in the late seventeenth century (Figure 3) (Mills, 1982). The industry appears to have grown very markedly between the 1660s and the early eighteenth century, on the evidence of parish registers and probate inventories (Levene, 1987: 133; Wykes, 1992). Framework knitting was a rural as well as an urban phenomenon in the eighteenth and nineteenth centuries. However it appears to have had its origins in Leicestershire mainly in the towns of Hinckley and Leicester itself (Wykes, 1992), and this is consistent with the concentration of growth (in terms of absolute population increases) in urban parishes between 1671 and 1710. There is no space here to investigate this issue further, except to note that new estimates of urban and rural growth between the late seventeenth and the mid-eighteenth century, as proposed here, will offer new light on the roles of towns, and on the issue of rural proto-industrialisation more generally.

A third approach is to use the Compton census incumbents' returns to evaluate the hearth tax estimates. The Compton census was taken in 1676, only five years after the 1671 hearth tax return used here, and any discrepancy between the two sources could provide evidence of under-counting in the hearth tax. For this exercise we matched a subset of geographical units for which the incumbent's return clearly indicated that adults aged 16+ were reported, and where the units could be matched unambiguously with hearth tax units. For this sample the hearth tax yielded an estimated population total of 23,617. The Compton census equivalent figure was 20,305 (14 % lower than the hearth tax total). Figure 4 shows the relationship between population estimates for individual

[16] Alternatively, paupers comprised a larger proportion of the population in urban than in rural settlements, and the hearth tax return therefore undercounted the population more in urban than in rural areas. However the similarity in the proportion pauper between urban and rural parishes in Bedfordshire did not support this thesis (Table 3).

parishes, derived from the two sources. While there was a fairly consistent relationship between the two sources (R2 = 0.83), the Compton census values were on average below those of the hearth tax return ($pop_{1676} = 0.75 * pop_{1671} – 35$).

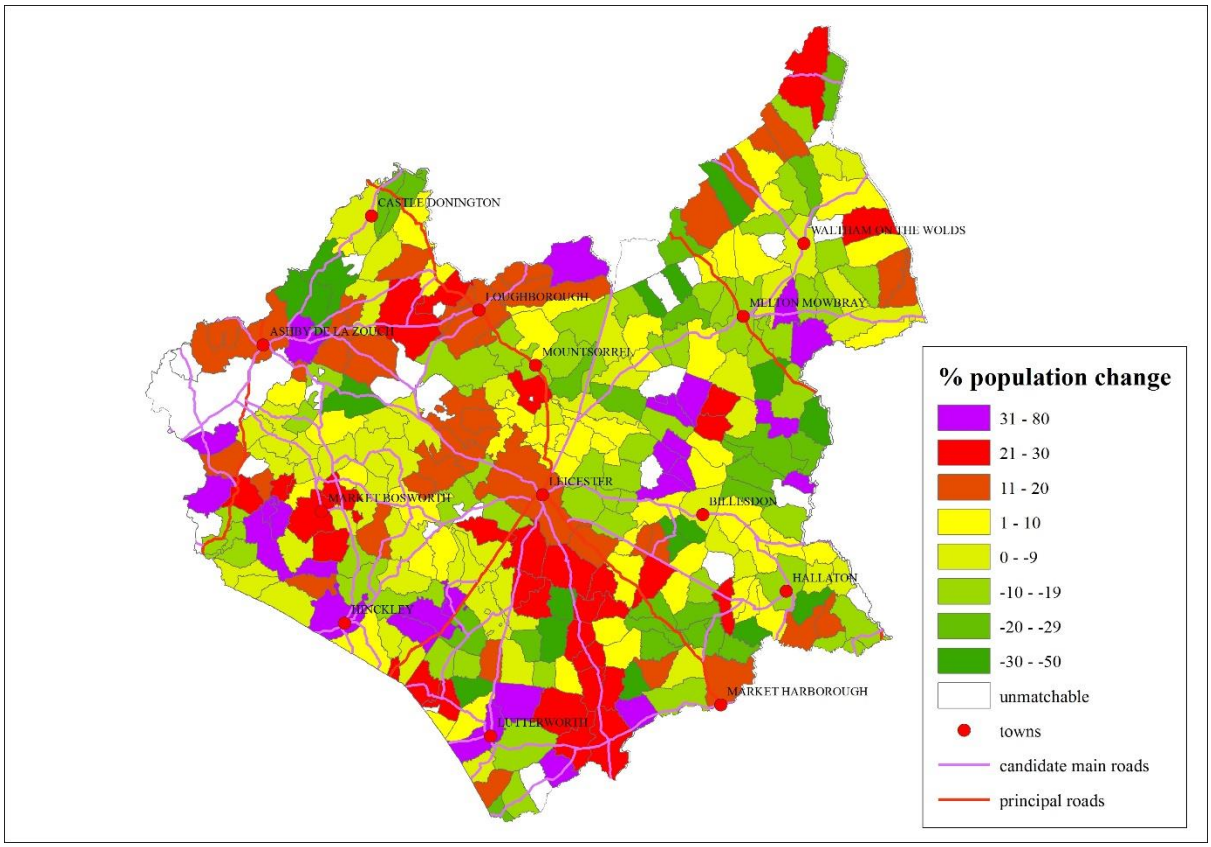

Figure 3. Population change in Leicestershire between 1671 and c.1710.
Notes: Data are plotted for 'poor law units', usually parishes. In some cases, as in Leicester itself, multiple parishes were aggregated to ensure comparability between the sources.

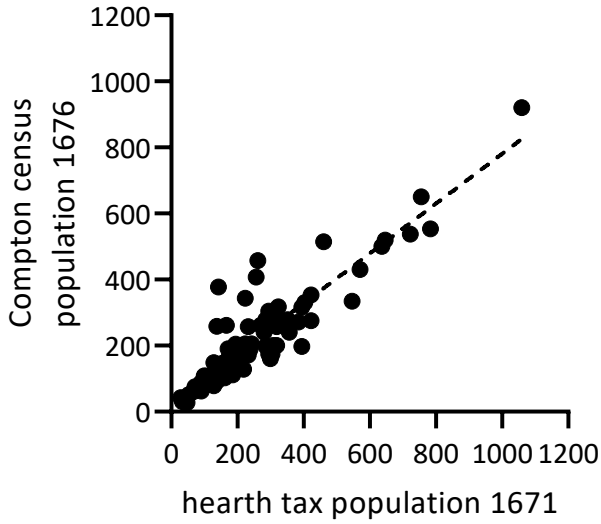

Figure 4. Parochial population estimates from the Leicestershire hearth tax return 1671 and Compton Census incumbents' returns, 1676.

Note: Populations are plotted for units that were consistent between the two sources (usually the parish). Data are plotted on a linear scale.

The results suggest an under-estimate of the population in the Compton census. One possible explanation is that the multipliers used to convert counts to population were inaccurate in the case of either the hearth tax or Compton census sources, or both. In the case of the hearth tax we converted counts of households to population totals on the assumption that the average household size was 4.75. The same assumption was used to convert the Wake census to population estimates, and so the two sources were comparable in this regard. However for Leicestershire the Compton census counts of adults were converted to population counts on the assumption that adults comprised two thirds of the population. If one or both of these assumptions are wrong then this would help to explain the discrepancy between the Compton census and hearth tax population estimates.

Obviously therefore, the discrepancy between our population estimates from the 1670 hearth tax and the Compton census could be removed by some combination of adjustments to assumptions about household size and age structure. However it is also the case that the Compton census was a less reliable source of evidence than the hearth tax, and this should be taken into account before proposing any other adjustments. The lower quality of the Compton census is evident in the preponderance of 'heaping' or rounding of population figures, to the nearest hundred in many cases. This suggests that many incumbents made an educated guess rather than a strict count. However this in itself should have produced 'noise', but not a consistent undercount, relative to the hearth tax estimates. Another possibility is that in Leicestershire at least the incumbents fairly consistently omitted some portion of the adult population. Whiteman raises this issue in quoting a seventeenth century observer, Peter Pett, who made use of the census but who thought that it under-enumerated the population because

> …none under the age of Communicants of 16 were return'd and but very few Servants, or sons, or Daughters, Lodgers, or Inmates.. .and the thing endeavour'd was that the heads of Families or Housekeepers, i.e. Man and Wife might be truly return'd…' (Whiteman, 1986, p.lxxx).

Whiteman did not consider this to be the case, and there is evidence in some very detailed but fragmentary returns from Lancashire and Gloucestershire that servants were indeed sometimes included.[17] However the exclusion of certain categories of person would account for the fairly consistent undercounts produced by the Compton census for Leicestershire. A similar phenomenon was reported by Parkinson (1998) in a comparison of hearth tax returns and the Compton census in Glamorganshire, which she attributed tentatively to a tendency to omit poorer households from the census counts.

On balance, these analyses suggest that the Compton census counts under-reported the population at least for some parts of the country, and confirm our impression that the Compton census is not a reliable source for local population estimates. However the exercise also flags the need to refine assumptions regarding household multipliers and age structures in future work.

[17] for example the return for the chapelry of Broughton, Lancashire, lists each household member, including servants, Whiteman, 1986, p.xlvi; Gritt, 2007.

On the basis of the arguments outlined above, we concluded that the 1671 hearth tax for Leicestershire provided a reasonably accurate count of households, and that some areas of the county, and especially urban parishes, experienced significant population growth between 1671 and c.1710.

Urban population estimates c. 1761 for Bedfordshire

The generation of robust estimates of parochial populations c.1670 made it possible to estimate population growth rates between 1670 and 1801. In the case of Bedfordshire the urban parishes within the county grew at almost twice the rate of the rural parishes (73% versus 41 %: Table 3). However this growth was not spread evenly. Of the ten towns in Bedfordshire (Ampthill, Bedford, Biggleswade, Campton, Dunstable, Leighton Buzzard, Luton, Potton, Toddington and Woburn) only five (Ampthill, Bedford, Biggleswade, Leighton Buzzard and Woburn) grew substantially faster than the rural population. Since population growth rates picked up rapidly in the country as a whole from the mid-eighteenth century this suggests that some towns only just kept pace with their rural hinterlands through natural increase or modest absorption of excess rural population.

To understand better the chronology and geography of urbanisation in Bedfordshire in this period we estimated urban populations in 1761 using counts of marriages for 1756-65 and the crude marriage rate c.1801. Table 6 displays our population estimates in 1670 and 1761 and the census population in 1801 for each of the ten hundreds in Bedfordshire, and for the ten towns in the county. Four of the hundreds contained no urban parishes. The town of Bedford was enumerated separately by Rickman and so we already have a population estimate for Bedford in 1761, derived from Wrigley's marriage-based estimates. The remaining five hundreds contained between one and four towns, and these are reported in the table together with the populations of the hundreds as a whole. Annualised growth rates for hundreds and towns are given in Table 7.

Table 6. Estimated populations of Bedfordshire hundreds and urban parishes in 1670, 1761 and 1801

Hundred	Unit	Population in 1670	Population in 1761	Population in 1801
Rural				
Barford	Hundred	2,765	3,493	4,145
Stoddon	Hundred	3,197	3,159	3,764
Willy	Hundred	4,532	6080	7,107
Wixamtree	Hundred	3,197	4,461	4,725
Urban				
Bedford	Hundred, town	2,366	3,103	4,110
Biggleswade	Hundred	4,627	6,069	6,721
	Biggleswade	741	1,289	1,876
	Potton	974	1,440	1,152
Clifton	Hundred	2,394	3,056	3,172
	Campton	641	637	826
Flitt	Hundred	5,971	5,588	8,356
	Luton	2,223	2,230	3,227
Manshead	Hundred	8,560	10,535	14,563
	Dunstable	983	1,016	1,351

	Leighton Buzzard	1,254	2,303	3,310
	Toddington	865	1,040	1,194
	Woburn	812	1,215	1,634
Redbournestake	Hundred	6,688	7,548	9,423
	Ampthill	689	888	1,284
Total (county)		44,297	52,092	66,086
Total (urban)		11,546	15,161	19,964
% urban		26.1	28.6	30.2

Table 7. Annualised growth rates of populations of Bedfordshire hundreds and urban parishes between 1670, 1761, and 1801.

Hundred	Unit	Growth 1670-1761, % p.a.	Growth 1761-1801, % p.a.	Growth 1670-1801, % p.a.
Rural				
Barford	hundred	0.26	0.43	0.31
Stoddon	Hundred	-0.01	0.44	0.12
Willy	Hundred	0.32	0.39	0.34
Wixamtree	Hundred	0.37	0.14	0.30
Urban				
Bedford	Hundred, town	0.30	0.70	0.42
Biggleswade	Hundred	0.30	0.26	0.29
	Biggleswade	0.72	0.68	0.71
	Potton	0.43	-0.56	0.13
Clifton	Hundred	0.21	0.27	0.21
	Campton	-0.01	0.65	0.19
Flitt	Hundred	-0.07	1.01	0.26
	Luton	0.00	0.92	0.28
Manshead	Hundred	0.23	0.81	0.41
	Dunstable	0.04	0.71	0.24
	Leighton Buzzard	0.67	0.91	0.74
	Toddington	0.20	0.35	0.25
	Woburn	0.44	0.74	0.53
Redbournestake	Hundred	0.13	0.55	0.26
	Ampthill	0.28	0.92	0.48
Total (county)		0.20	0.55	0.31
Total (urban)		0.30	0.69	0.42

Almost all towns and hundreds displayed higher annual growth rates in the forty years after 1761 than in the period 1670-1761, with the notable exceptions of the rural hundred of Wixamtree, and the town

of Potton.[18] Growth of towns outstripped the growth of rural populations in each period, for the county as a whole (bottom two lines of Table 7), and therefore urbanisation increased in both periods (Table 6).

These patterns are all highly plausible, and suggest on balance that the method used to derive urban populations in 1761 was valid. However we had no other contemporary counts of urban populations in Bedfordshire with which to compare and validate our estimates. Nor was Bedfordshire necessarily representative of other English counties with respect either to urban patterns or to the potential difficulties that the method might encounter. In Bedfordshire the estimation of urban populations c.1761 was relatively straightforward, because the marriage registers were published, and because abode information in the registers indicated that the marriages recorded referred almost exclusively to residents of the urban parish (that is, at least one partner to the marriage was a resident). To test the utility of the method under more demanding conditions we also estimated the population of Manchester township, and compared it with a contemporary private census.

Manchester was a much more difficult case than Bedfordshire towns because the town itself was located within a township within the ecclesiastical parish of Manchester. The parish of Manchester was very large, extending over 60 square miles, and included a number of townships that were later reconstituted as civil parishes. The collegiate church of Manchester served the entire parish and all marriages in the parish (except those of Jews and Quakers) were registered there until the nineteenth century (Cunningham, 1998). In order to estimate the population of the town of Manchester it was therefore necessary to distinguish residents of Manchester township (which largely consisted of the town itself) from residents of other parts of the parish. This was possible because the township of residence was recorded for both bride and groom in the marriage register. We used the registers for 1787-89 because these were published and because they coincided with a private census of 1788. However the registers for the period around 1801 were not published, and so we were forced to use the marriage counts reported by Rickman for the whole parish of Manchester. These gave a crude marriage rate of 15.8 marriages per thousand population, almost twice as high as the national rate, which suggested that not only Manchester but the parish population as a whole had a relatively young age structure and was growing rapidly by migration. Using this crude marriage rate to convert marriage counts to population c.1788 gave a figure of 43,945 in 1788. This compared well with the total estimated from a private census conducted by Aiken in 1788, of 42,821 (our estimate was 2.6% higher).

This exercise for Manchester suggested that our method was viable for towns with more rapid growth rates and more complex geography than towns in Bedfordshire. However it also flagged up the importance of determining whether marriages in a given register did in fact relate largely to the town of interest. In this respect Manchester is probably an exception in terms of the peculiarity of marriage registration practices, because the collegiate church enjoyed an ancient legal right to all dues for registration of baptism, burial and marriage in the parish, and so maintained an unusual control over marriages for a very large population Cunningham, 1998). However we don't yet the extent to which similar problems affected other towns in England and Wales.

[18] Potton experienced a major fire in 1783, which may account for its shrinkage in the period 1761-1801 (Parishes: Potton', in *A History of the County of Bedford: Volume 2*, ed. William Page (London, 1908), pp. 237-242. *British History Online* http://www.british-history.ac.uk/vch/beds/vol2/pp237-242 [accessed 10 April 2019].

DISCUSSION

This paper demonstrated two methodologies, one a triangulation method to validate parochial population estimates for c.1670, and the other that used marriage counts to generate new estimates of urban populations c.1761. Our analyses of the 1670 and 1671 hearth tax returns for Bedfordshire and Leicestershire indicated that both returns were apparently comprehensive with respect to the reporting of exempt as well as taxed households. This result supported the claims of Arkell and Parkinson that returns for the 1670s could provide relatively scrupulous descriptions of the assessed population. It also suggests the possibility that similarly robust estimates of local populations may be generated in a comparable manner for other counties. Two limitations obviously apply to this endeavour. First, hearth tax returns for 1670 have not survived for all counties, and where they have, they may not be of the same quality as those examined here. Indeed, this what we anticipated when we elected to compare the Leicestershire return with the more obviously high quality return for Bedfordshire. We expected to find that paupers at least were omitted from the Leicestershire return. However our triangulation method indicated that the exempt were document fairly completely in both counties. This illustrates the kind of bootstrapping that the method affords in cases where a triangulation source covers more than one county, and where at least one hearth tax return is fairly comprehensive. For example, the Wake census covered the whole of the Lincoln diocese. Having established the reliability of the Wake census in Bedfordshire we could then assess with some confidence the discrepancy between the Wake census and the hearth tax estimates for Leicestershire, and we could use the two categories of exemptions reported in the (also reliable) hearth tax return for Bedfordshire to assess the completeness of exemptions in Leicestershire. If there had been widespread discrepancies between the Leicestershire hearth tax return and these other sources then we could have estimated the extent of under-recording of the exempt, and considered whether this was sufficient to account for the discrepancy with the Wake return, or whether there was further under-reporting or population growth to be accounted for. Crucially, our capacity to map the units involved and to compare the same units over time made it possible to test whether patterns of apparent population growth between the hearth tax and the triangulation source were plausible. Furthermore, an additional check on population growth patterns is afforded by the hundredal and urban population estimates generated from marriage counts by Wrigley and by our own method, as well as census counts for 1801. For instance, if we found little or no growth between 1710 (the Wake census) and 1761, but a large apparent increase between c.1670 and 1710, then this would suggest that the latter discrepancy was probably not due to population growth but reflected some undercounting in the 1670 source. We could then test whether hearth tax exemption rates appeared unduly low, and inflate the hearth estimates to account for the omission of some exempt. Conversely, where towns or hundreds displayed robust population growth between 1710 and 1761 then there would be a case for making smaller adjustments to hearth tax totals, especially where larger adjustments produced unusually large estimates of the proportion of households that were exempt.

The second major potential problem with our triangulation method is the availability of local sources of quasi-population data of adequate quality. Our method worked in the cases of Bedfordshire and Leicestershire because we could identify a triangulation source, Bishop Wake's census, that appeared to be very reliable. The sources available for other counties may not be of similar quality. In this case we think it may be possible to detect the extent of under-reporting or bias by comparison with the

hearth taxes themselves, in cases where a source covered several counties, of which one at least also possessed a hearth tax return that was clearly quite reliable (as in the case of Bedfordshire). It would also be possible in many cases to identify other sources, perhaps more local or fragmentary in nature, that were sufficiently comprehensive as to allow identification of the flaws in the more ubiquitous source. That is, we would use a kind of iterative triangulation process to refine our understanding of the biases in our primary sources.

For the mid-eighteenth century we adapted Wrigley's method for estimating hundredal populations in 1761 to produce estimates for urban parishes. This method produced plausible estimates both for Bedfordshire towns and for Manchester. Its applicability can be tested further in other cases similar to Manchester where local censuses were taken in the second half of the eighteenth century, and estimates can also be calibrated against other local sources of population estimates such as militia lists and religious quasi-censuses. When combined with Wrigley's hundredal estimates our method can also be used to estimate rural populations at the hundredal scale (by subtracting the populations of urban parishes in each hundred), and to produce estimates of regional urbanisation levels c.1761.

What do the methodologies proposed in this paper offer to tell us about urbanisation and economic development in the period c.1670 to 1801? We think they provide three key benefits. First, comprehensive estimates of town populations in the late seventeenth and mid-eighteenth century will provide us with a much clearer picture of the development of the English and Welsh economies[19] between c.1670 and 1801, and allow us to test more robustly the impact of key developments in industrial technologies and transport industries. It is striking that most of the towns that grew so rapidly between 1670 and 1801 were inland towns that were not located on major natural waterways, in contrast to the most important older towns. Improvements in transport links must have been crucial to their development, but without interim estimates of urban and rural population growth we can't tease out the importance of developments in canals, road, coastal and river transport which occurred so rapidly across the period 1670 – 1801. Nor can we trace the importance of access to coal and how this shaped the fortunes of different towns and regions. Steam-powered technologies only became important in manufacturing and industry, outside coal mines themselves, in the late eighteenth century. However coal was an ever-increasingly important source of domestic and industrial fuel since the sixteenth century, and the reorientation of population and industry to the coalfields was already underway by 1670. The creation of highly spatially disaggregated and robust measures of population density and urbanisation in the late seventeenth and the mid-eighteenth centuries will make it possible to trace this development, and the roles that transport technologies and other factors played in the growth of the coal fields and the decline of older centres of manufacturing, before the nineteenth century.

A second benefit of highly disaggregated population measures with national coverage is that we can investigate regional developments in much greater detail, and in a nationally comparable manner. With respect to towns, we can therefore trace the shifting geography of urbanisation in a systematic fashion, and investigate intriguing differences in the types or patterns of urbanisation. For example,

[19] Hearth tax records also exist for Scotland for the period 1691-94, however they are acknowledged to be less reliable than those for England and Wales, and there are far fewer triangulation sources available with which to calibrate the returns. On the other hand, Scotland is far richer in comprehensive sources for the second half of the eighteenth century, including Webster' private census of 1755, and the Scottish Statistical Accounts of the 1790s.

Langton found the highest urbanisation levels in the late seventeenth century in the northernmost counties of England. Arkell also found striking north-south differences in the distributions of hearths between rural and urban settlements. In southern England in the late seventeenth century average hearths per household were relatively high, but there was little difference between urban and rural parishes (Arkell, 2003). In northern England however the average number of hearths was only a little over one per household for most rural parishes, but double that in northern towns. These figures suggest superficially that rural-urban relationships were different in northern compared with southern England. More comprehensive data on hearths and population, together with data on physical and economic geographical characteristics of parishes, within a GIS framework, would allow us to probe the validity and nuances of this pattern. Similar possibilities exist with respect to developments over time. For example, national cross-sectional population estimates for rural parishes in 1670 and 1801 will make it possible to test theories regarding the impacts of parliamentary enclosure on population growth. Estimates for urban populations in 1670, 1761 and 1801, together with hundredal population estimates for rural populations at the same dates, will make it possible to test the extent to which towns grew at the expense of their local hinterlands.

The third advantage that derives from using the hearth tax returns to estimate urban and rural populations is that the returns reported populations at the level below the parish. In some cases these will not provide robust estimates of sub-parochial populations because the exempt may be reported for the parish as a whole, and only tax-payers broken down by smaller settlements (in which case some assumptions will have to made about the proportional distribution of the exempt). However where as in Bedfordshire the taxed and exempt are reported for sub-parochial units it is possible to create very flexible measures of urban populations for urban settlements as well as for parishes and higher levels of aggregation. In our study the proportion of the population of urban parishes in Bedfordshire that did not live in the main urban settlement was very low (14 %), suggesting that in this county population totals for urban parishes provided a reasonable proxy for urban settlement sizes. This is unlikely to be the case where parishes were larger and where settlements were more dispersed. It is also the case, perhaps especially in areas of predominantly nucleated settlement, that town populations may have included a substantial component of agricultural households who worked the land within the parish. In future work we will compare the male occupational structure of towns of various sizes, where data exist, to test whether agriculturalists formed a larger proportion of smaller towns. Whether, where this is the case, this undermines the case for inclusion of small towns in calculations of urban populations, remains to be seen. It probably depends on what uses the estimates are put to. From an epidemiological point of view, urban populations may be characterised by their size, density, and connectedness to the wider population, and in this respect the composition of the urban population may be less important than the extent of connections to other settlements (something that can be included as an independent variable, derived from transport networks and distinct from population per se). Moreover the presence of large numbers of agriculturalists may also be a feature of larger multi-parish towns above the threshold of 2,500 population, where some of the parishes included substantial agricultural land.

CONCLUSION

Careful cross-comparison of hearth tax returns with other sources, for strictly comparable geographical units, has the potential to provide very high frequency spatial data for almost all of England and Wales in the late seventeenth century (and with less robustness for lowland Scotland:

Adamson, 1981). This exercise would provide a consistent and highly detailed overview of the British population and of urban growth in a period which is increasingly viewed as key to Britain's later precocious industrialisation. We have also argued that marriage records can be used to create new estimates of urban populations for the mid-eighteenth century. Together with existing estimates of hundredal populations these urban estimates would provide a consistent and fine-grained snapshot of the population and economy on the eve of the classic Industrial Revolution period. These methods require further development to address the complexities inherent in diverse local sources and in the hearth taxes themselves. Much of the work resides in the careful spatial matching of the different units of reporting employed in different sources. Although very time-consuming, this labour not only eliminates many of the apparent discrepancies between sources that arise from the mismatch of reporting units, but makes it possible to compare consistent units over long sweeps of time, and to harmonise population and urbanisation datasets with the rich array of GIS datasets on transport, occupational structure, enclosures, physical geography and other historical and ecological factors, thus allowing complex multivariate analyses that are not viable with national or county-level data.

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