

Confidence Limits and Enclosure Estimates: Some Comments

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Abstract

Walton criticizes my revision of the acreage enclosed by Parliamentary action by purporting to show that the margins of error of my sample are so great that Turner's much lower figure falls within them. However, the technique which he uses is inappropriate, since the data do not conform to the conditions which limit its use. Use of the bootstrap technique, which is appropriate in these circumstances, supports my original conclusions, as does direct comparison with Turner's individual parish figures.

THOUGH I would agree wholeheartedly with John Walton's view that we cannot have a totally accurate picture of the Parliamentary enclosure movement until each individual award has been abstracted, I am sure that he recognizes that this is a counsel of perfection, unlikely to be realized in the near future.¹ With the rapid strides in technology made in the last few decades, it is possible to envisage a time when on-line access to machine-read documents in record offices will make such a total coverage a practical proposition; in the mean time, we are left with the alternatives of doing nothing or attempting to refine our estimates by making use of whatever additional information comes to hand.

The sample which I used was not intended primarily for the purpose of calculating an overall enclosure total; it was devised to investigate aspects such as the proportions of different types of land, covered in the later parts of my article, and those such as landownership, and the efficiency of the process, which fell outside the scope of that particular paper.² None of the published statistics, including those in the Tate/Turner

Domesday,³ offers any detailed picture of these aspects, and I had little option but to treat the sample as exploratory of a population with unknown characteristics, rather than a confirmatory one, as Walton has sought to do in his comments. In these circumstances the techniques available for testing the confidence limits are restricted, and the graphical methods used in my paper are an accepted means of presenting these limits in comparisons between two sets of data, as indicated in footnote 30.⁴

The application of my sample to the question of the overall total of land enclosed arose because the figures derived from it implied that the Tate/Turner figures were an underestimate. Walton takes me to task for failing to offer confidence limits, but his own attempts to do so hardly serve to clarify the situation. A technique which purports to show that a 100 per cent sample is too small to be reliably representative of the whole population can hardly be regarded as a trustworthy indicator.⁵ Calculations of standard deviations are even more susceptible to extreme values than those of the arithmetic mean, and where the data have a highly skewed distribution, as in this case, standard deviation, by setting the same

¹ JR Walton, 'On Estimating the Extent of Parliamentary Enclosure', *Ag Hist Rev*, 38, 1990, pp 79-82.

² J Chapman, 'The Extent and Nature of Parliamentary Enclosure', *Ag Hist Rev*, 35, 1987, pp 25-35.

³ M E Turner ed, *A Domesday of English enclosure acts and awards by W E Tate*, Reading, 1978.

⁴ Chapman, *op cit*, p 32.

⁵ Walton, *op cit*, p 82.

value either side of the mean, tends to exaggerate the spread necessary to achieve the required confidence limits. Walton's method of calculation tends to underplay the value of a large absolute sample size in reducing the potential error. Had he taken issue with my Welsh figures he would have been on far firmer ground, for with the very small sample size involved there the potential impact of one rogue figure is considerable; indeed, I am at present attempting to refine the Welsh totals. The same does not apply to the English sample. The fundamental problem is that the test which Walton has used makes assumptions about the form of the data which are not valid in this case; furthermore, it is a test for confidence limits about the mean of a sample, and cannot be extended to construct confidence limits about a projected total, as in this case.

The question can, however, be approached in another way. The essence of Walton's argument is that because of the very wide range of values the total produced from any sample is liable to be unduly influenced by extremes, and that different samples will produce widely differing results. The technique known as bootstrapping offers a means of testing this. In brief, the method involves multiple re-sampling from the original sample, the results then being used to provide a sampling distribution against which the likelihood of any particular total being produced may be assessed.⁶ Unlike the technique favoured by Walton, it makes no prior assumptions about the distribution of the data. A bootstrap test was applied to the sample, using 1000 re-samples of 300 each, and calculating projected totals in the same way as in my original paper. From this the probability of the true value being equal to, or less than, Turner's figure was calculated at 2.7 per cent, or, in other words, there is

a 97.3 per cent probability that it is higher than Turner's total.

Further evidence is provided by direct comparison between my figures and those of the Domesday. If the Domesday totals are indeed correct, then the positive and negative errors contained in them must cancel out; if, on the other hand, I am correct in my belief, then underestimates must predominate. Comparison of my sample with the Domesday equivalents indicates that the latter is indeed the case.

There are significant theoretical problems in the comparison, for it is by no means clear exactly which total either the act or the award figures contained in the Domesday are intended to represent. My own calculations involved three separate totals, one for all land involved in the process, one for land contained in the initial allotment, and one for land which had previously been open or common, and for some individual enclosures these totals may be significantly different. It would appear that the enclosure estimates, whether in the act or the award, may represent any of these totals, and there are even cases where the act figure appears to be an estimate of one while the award figure refers to another. For example, the Biddlestone, Wiltshire, award appears to refer to the total allotted, while the act figure relates to land previously open.⁷ However, for the purpose of confronting Walton's calculations these theoretical points may be ignored, for by mimicking my calculations he has in effect chosen the 'total involved' as the starting point.

Using this basis, in 261 of the sample cases the Domesday figures understate, as against 205 which overstate, an excess of understatements over overstatements of approximately 12 per cent.⁸ These figures

⁶ For details of the rationale and method of bootstrapping see E W Noreen, *Computer-Intensive Methods for Testing Hypotheses*, New York, 1988.

⁷ W(iltshire) R(ecord) O(ffice) Enc. Aw. 88.

⁸ For the remainder of the sample, Turner gives either an identical figure, or none at all.

are in direct conflict with the commonly-stated assumption that the enclosure estimates must, if anything, overstate the acreage,⁹ though it must be noted that it is difficult to trace any ultimate authority for such an assumption at national level. Turner himself expresses the view that some *understatement* is likely, and there are very few instances in the literature of the actual errors being quoted for more than a few isolated enclosures.¹⁰ Wordie states that the Berkshire figures are an overestimate, though he quotes no precise figures, but this is hardly conclusive evidence for the country as a whole, for the errors are by no means random in time and space.¹¹ There is also the well-known fact that some acts give the acreage of the whole parish, rather than that of the area to be enclosed.¹² Again, however, this habit appears to be very rare nationally, and to apply largely to act rather than award. Other apparent evidence proves to be misleading. Wordie offers calculations of the errors, quoting an overestimate of 6.7 per cent, but these are in fact based on the differences between the act estimates and the award estimates, on the assumption that the latter are correct.¹³ In practice, it can be readily shown not only that the majority of the award estimates themselves are inaccurate, but that they are by no means always closer to the actual figures than those given in the act.¹⁴ In examples as widely spread as Trowle (Bradford), Wiltshire, Loweswater, Cumberland, and Chich St Osyth, Essex, the act figure is correct and the award wrong.¹⁵

It is unlikely that there is any single explanation as to why the award estimates

tend to understate, and any such explanations must be purely speculative at the moment. It is, of course, well known that customary rentals frequently misstated acreages, and it is possible that in those areas of the country where large customary acres were in use totals derived from this source might lead to frequent underestimates.¹⁶ Endacott presents evidence of the opposite process from Dorset, where the customary acre was smaller than the statute, though only in respect of the act figures.¹⁷ It is also highly possible that some of the award totals may have been misinterpreted. A common form of presentation of the award involved the separate treatment of certain lands, notably those set aside for sale, those allocated in respect of tithes, and those allocated for the lord's right of soil. A total is then provided for the residue. It may be suspected that it is this total which sometimes appears, a point to which Turner himself draws attention.¹⁸ Finally, it must be noted that treatment of old enclosed land which was exchanged varies greatly from award to award, and it was undoubtedly omitted from the totals in some, but not others. In allowing a deduction for such land, regardless of whether the original totals included it or not, Walton is undoubtedly lowering the real totals.

A further source of error exists in Turner's treatment of those enclosures for which neither act nor award offers any estimate, a total of 227.¹⁹ I have been unable to find any reference to his method, but back calculations from his totals indicate that missing figures have been supplied by substituting the mean figure for that group for the relevant county. Unfortunately many of the relevant groups have very few members, so means may be based on as few

⁹ J R Wordie, 'The Chronology of English Enclosure, 1500-1914', *Econ Hist Rev*, 2nd ser, XXXVI, 1983, pp 486-7.

¹⁰ Turner, *op cit*, p 50.

¹¹ J R Wordie, 'The Chronology of English Enclosure: a Reply', *Econ Hist Rev*, 2nd ser, XXXVII, 1984, p 562; J Chapman and T M Harris, 'The accuracy of enclosure estimates: some evidence from Northern England', *Jnl Hist Geog*, 8, 1982, pp 261-264.

¹² See, for example, M R Postgate, 'Field Systems of Breckland', *Ag Hist Rev*, 11, 1963, pp 87 et seq.

¹³ Wordie, *op cit* 1983, p 487.

¹⁴ Chapman and Harris, *op cit*.

¹⁵ WRO L 174, PRO MAF 1/968 and MAF 1/1077.

¹⁶ For example, J D Chambers, *Laxton*, 1964.

¹⁷ G B Endacott, 'The Progress of Enclosures in the County of Dorset in the eighteenth and part of the nineteenth centuries', Unpublished BLitt thesis, University of Oxford, 1938.

¹⁸ Turner, *op cit*, pp 49-50.

¹⁹ Excluding Monmouthshire. Figures from other sources, listed by Turner under 'Notes', have been ignored.

as two sets of data, as for example in his group B for Cornwall, or group B for Monmouthshire.²⁰ In the latter case, this results in a notional allowance for Tregug (Llangybi) of 4100 acres, from the mean between 4200 (for Wentwood, alias Trelleck) and 4000 (for Cwmyoy). Unfortunately, the actual figure is 399 acres, giving an error of 927 per cent, albeit in this case an overestimate. Since missing figures are clustered, as for example in Gloucestershire group A where 33 are lacking out of 129, so the potential for significant errors is increased. This is in no way intended as a criticism of Turner, who was faced with the perennial historical problem of patching holes in data sets. It does, however, offer a further explanation of the way in which some of the errors may have arisen.

I am, of course, aware that any random sample may produce a highly untypical result, for Murphy's Law operates as efficiently in statistics as in any other branch of human activity. I would be as surprised as anyone if the actual total of land enclosed should eventually turn out to be precisely 7,672,884 acres, as my sample would indicate. However, the bootstrap test produces a mean, 7,659,505 acres, and a median,

7,657,369 acres, only marginally below my original total, a mere 0.2 per cent at worst. Applying the same corrective factors to the mean as in my original paper, this would indicate a total of open land subjected to enclosure of 7,243,460 acres, scarcely significantly different from my suggested lower limit of 7.25 million acres.

Given that a high degree of precision is not yet possible, there is nevertheless sufficient evidence to support my contention that the Domesday figures represent a significant underestimate, and nothing in Walton's paper overturns this conclusion. The point which Walton fails to acknowledge is that even if his calculations were applicable, and the range at the 95 per cent confidence level were as large as he alleges, the central point would still be the best estimate, with the probability of any other value being correct falling with increasing distance either side. From both his calculations and mine, it is statistically far more likely that my total is an underestimate than that Turner's lower figure is correct. Pending the sort of comprehensive survey to which Walton refers, a figure of the order of 7.25 million acres remains, in my view, the best estimate.

²⁰ Turner, *op cit*, pp 82 and 176.

Notes and Comments

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PERIPATETIC AUTUMN CONFERENCE

Members of the British Agricultural History Society will know that we have traditionally run two annual meetings, an itinerant spring conference and a London winter conference. The Executive Committee has recently decided to add to these an Autumn Day School which, like the Spring Conference, will be held in a different location each year. We hope that our many members (and indeed, all interested in agricultural history) who rarely, if ever, attend the other two meetings will be able to take part in these meetings when they are in their locality.

The first meeting, on the subject of woodland landscapes and communities in the South Midlands, will be held jointly with the Oxford University

Department of External Studies in Oxford on Saturday 21 September 1991. The speakers will include Glenn Foard on Rockingham Forest in the Middle Ages, John Broad and Richard Hoyle on Bernwood Forest before and after disafforestation, Bill Stevenson on rural nonconformity, and Charles Watkins on the struggle for hedgerow timber in late eighteenth-century Herefordshire.

Details have already been posted to BAHS members, but can also be had from the Archaeology/History Course Administrator, OUDES, 1 Wellington Square, Oxford OX1 2JA.