THE
ECONOMIC HISTORY REVIEW

Economic History Review, 64, 4 (2011), pp. 1242–1265

Storage in medieval England: the evidence from purveyance accounts, 1295–1349[1]

By JORDAN CLARIDGE and JOHN LANGDON

As a contribution to the long-running debate concerning the extent and motivation of medieval storage, this article uses purveyance accounts to examine such facilities in England prior to the Black Death. Three hundred and fifteen cases of predominantly urban storage were recorded for 97 communities for the products of agriculture purchased by the purveyors, mostly threshed grains. When these 315 cases were analysed using an Excel database, it was found that, in contrast to the often magnificent barns on monastic and other lordly estates, this storage was much smaller and informal, often indistinguishable, it seems, from the domestic storage for families themselves. As modest as it was, however, it likely played an important role in the increasing commercialization of medieval England, even perhaps to the extent of making society at the time more susceptible to subsistence crises.

Storage is such a necessity in human activity that its existence seems as natural as breathing. Yet, for particular societies, discovering exactly how and why it was done can be elusive. This is certainly the case for medieval societies where storage has been the subject of a long but intermittent debate, ranging across a number of journals and working papers, concerning its place in the subsistence and commercial priorities of the times. The debate originally arose out of the larger issue of risk aversion in medieval agriculture. In a well-known piece, McCloskey first claimed that the avoidance of risk was the reason behind intermingled strips of peasant landholders in the classic medieval open-field system.[2] Fenoaltea countered by arguing that a more effective means of risk avoidance was simply to adopt effective storage, to keep grain produced in good times as a hedge against bad; he further claimed, on a small sample of measurements from 12 monastic barns, that medieval societies had facilities for storage in abundance.[3] Fenoaltea's article thus brought storage to the forefront and provoked a vigorous riposte by McCloskey, this time with Nash. Together they argued that medieval society must have had limited storage facilities because of high rates of interest—of 30 per cent or more, they claimed—that existed within medieval society. This, along with the costs of storage itself, made it prohibitively expensive to keep grain and other goods for any

[1] The authors are grateful for funding by the Social Sciences and Humanities Research Council of Canada for the collection of data during 1994–7 and to Matthew Eisler for a preliminary tabulation of the same. We would also like to thank Niall Brady for permission to cite from his Cornell Ph.D. thesis and Liam Blunt, Edmund Cannon, and Gregory Clark for permissions to cite from their working papers. Finally, we are grateful for the comments of three anonymous referees.

[2] McCloskey, 'Enclosure', esp. p. 19.

[3] Fenoaltea, 'Risk'.

extended period of time.[4] To bolster their argument, they noted that recorded grain carryovers from one harvest year to the next were remarkably scarce during the middle ages. Fenoaltea, as part of a long exposition against what he felt was a dismissive attitude on the part of McCloskey and others concerning the effectiveness of medieval agriculture, expanded his argument that storage was undoubtedly the best form of risk aversion policy, and indeed might have exacerbated distributional inequalities, since the rich could store more effectively than the poor.[5]

Up to the early 1990s the debate was carried out by those primarily trained in economics. A more historical approach was introduced by Komlos and Landes, who counselled that the largely economic modelling that had dominated the issue of storage to date ought to be balanced with a more realistic consideration of the way that medieval people actually thought and acted.[6] To Komlos and Landes, thinking in terms of interest rates was not only anathema to church teachings in the middle ages, but also something that most medieval people only dimly appreciated.[7] They also sensibly advocated the need for more empirical evidence to resolve issues around medieval storage (although they did not offer anything new themselves).[8] Since then, however, the issue of medieval storage has slipped back into the world of economic modelling. In 1999 Brunt and Cannon presented their analysis of medieval storage based upon price analysis. Taking the Komlos/Landes position as essentially one of 0 per cent interest obtaining in the middle ages, their econometric analysis of medieval grain prices suggested an interest rate of 12 per cent. The implication for storage is that, although this interest rate was high by modern standards, it was unlikely to militate as strongly against storage as McCloskey and Nash argued.[9] Finally, most recently, Clark, again using another analysis of prices, felt that there were significantly enough carryovers of grain from year to year to indicate the importance of storage for medieval society.[10]

What has been lagging behind these theoretical considerations of storage is evidence about the storage places themselves. Fenoaltea based his analysis upon references to 'old grain' from previous years being recorded in Carolingian accounts, and information involving 12 barns for the Cistercian Abbey at Beaulieu, which were estimated by Fenoaltea to have had a combined total of 720,000 cubic feet (or 26,667 cubic yards) of 'effective' storage, or 60,000 cubic feet per barn on average.[11] Extrapolating on the basis of these barns across monastic communities as a whole in England, Fenoaltea concluded that 'there is no doubt that storage capacity was considerable, and that desired inventories at least were correspondingly high'.[12] Recently Brady has expanded upon the presence of barns (*(h)orrea* or *grangiae* in the Latin) in the medieval English landscape, and, on the basis of the

[4] McCloskey and Nash, 'Corn at interest'.
[5] Fenoaltea, 'Transaction costs', pp. 200–9.
[6] Komlos and Landes, 'Anachronistic economics'.
[7] Ibid., p. 43.
[8] Ibid., p. 36.
[9] L. Blunt and E. Cannon, 'A grain of truth in medieval interest rates? Re-examining the McCloskey-Nash hypothesis', Univ. of Bristol working paper (1999) [WWW document]. URL http://www.efm.bris.ac.uk/ecesc/Articles/mn.pdf, esp. p. 13.
[10] G. Clark,'Markets and economic growth: the grain market of medieval England', Univ. of California, Davis, working paper (2001) [WWW document]. URL http://www.econ.ucdavis.edu/faculty/gclark/210a/readings/market99.pdf, esp. pp. 16–36.
[11] Fenoaltea, 'Risk', p. 138.
[12] Ibid., p. 139.

examination of almost 300 of them from surviving remains or as indicated in documents, he has argued for seeing them as ostentatious symbols of seigneurial status, strictly speaking not absolutely necessary, since much cheaper outdoor ricks might have served the same purpose.[13] Whether essential structures or not, these barns had substantial amounts of space to store grains. Brady calculated the amount of space available for storing grain in two large timber barns at Cressing Temple in Essex, both built in the thirteenth century and still surviving. According to Brady's measurements, the larger of the two, the barn for barley, had an effective storage area of 2,388 cubic metres, or over 84,000 cubic feet.[14] In his more extensive Ph.D. thesis on the subject, Brady estimated the effective storage size of 58 barns, for which he had length, breadth, and height figures. Although he did not give a mean or median size for these barns, he did show a distribution figure for them, which indicates that the median was probably around 1,700 cubic metres, or 58,358 cubic feet.[15] As Brady has already indicated, the number of these barns was clearly considerable across medieval England, particularly on ecclesiastical estates.[16] Campbell and Bartley also found 140 'barns' recorded among the inquisitions *post mortem* for lay tenants-in-chief of the king in England and parts of Wales before the Black Death, a number they felt was clearly under-recorded.[17] Barns would also feature on the lands of peasants, sometimes up to six bays in length, as indicated by court roll entries concerning peasant landholders of the late fourteenth and fifteenth centuries,[18] while earlier indications of barns among non-aristocratic landholders are also known.[19]

These barns, however, were clearly reserved for a certain type of storage. Grain on the sheaf, and sometimes hay, were very high bulk items needing a lot of space, which only substantial barns could supply.[20] Barns were indeed constructed to some extent for threshing and winnowing grain, sometimes having specialized threshing floors.[21] However, the grain, once threshed, led to a nether world of lesser storage, that of the granary, often a room or annex attached to the barn,[22] but also often a smaller stand-alone building existing among a complex of farm buildings. Thus, as an example, the extent for debt of Hugh de Louthre, knight, taken on 20 March 1355, listed the buildings at his manor of Lowther in Westmorland as 'one hall, three solars [upper storeys], three cellars, one chapel, one kitchen, one bakehouse and one brewery, four barns ['*iiij grangiae*'], one chapel [sic; repeated], one granary ['*unum granarium*'], four stables, one ox-house, one kennel and one dovecote'.[23] Some granaries may have been specialized buildings

[13] Brady, 'Gothic barn', esp. pp. 93–4.
[14] Ibid., p. 92. 2,388 cubic metres equates to 84,331 cubic feet.
[15] Brady, 'Sacred barn', pp. 120 (fig. 16).
[16] From which Brady, 'Gothic barn', draws most of his detailed examples.
[17] Campbell and Bartley, *England*, pp. 99, 103.
[18] Field, 'Worcestershire peasant buildings', esp. pp. 119–20.
[19] Thus, an extent for debt for a certain Robert Norman of 'Eltrugge' (possibly Aldridge Grove in Great Hampden), Buckinghamshire, in 1343, who owed £15 to Laurence de Lambeth, citizen and fishmonger of London, recorded that Robert had 'a certain messuage, with cellar, solar, kitchen, barn (*grangia*), ox-house and sheepcote with an adjacent garden and close valued at 4s. per year'; Robert had 73 arable acres spread in various fields plus two acres of pasture; TNA, PRO, C131/6, no. 19, m. 2.
[20] Brady, 'Gothic barn', pp. 80–1. See also the discussion of 'granges' below.
[21] Ibid., p. 81.
[22] Ibid.; see also below.
[23] TNA, PRO, C131/9, no. 17, m. 2. Hugh owed £200 to Thomas Ughtred, knight.

constructed on raised piers to reduce dampness, as well as insect and rodent infestation,[24] but many were probably built without this feature.[25] Certainly granaries were far less prominent in seigneurial operations: Campbell and Bartley found only four of them in the inquisitions *post mortem* of the early fourteenth century compared to the 140 barns mentioned above.[26] However, as we shall see, granaries were a staple of smaller households, especially in urban situations, where householders normally bought their grain already threshed. So far, the only appreciable information about this lesser storage is that contained in Campbell, Galloway, Keene, and Murphy's examination of the London food supply *c.* 1300.[27] Here 'granaries' at London seem to have been much smaller than the Beaulieu barns; even a fairly substantial amount of 420 quarters, as we shall see below, would only require 5,000 cubic feet of space,[28] less than one-tenth of the average size of the Beaulieu barns or those surveyed by Brady.

I

In short, we have a growing amount of evidence about the larger-scale storage in barns that characterized mostly rural society and of agricultural produce in its early stages, but little about the arguably much more crucial storage for those who had much less access to land and who bought most, if not all, of their grain in a threshed state. It is the lack of information on this category of storage that this study addresses. It uses the same information that the Campbell et al. study partly drew upon, purveyance accounts,[29] but looks at it over all parts of the country that purveyance covered.[30] Purveyance was the process by which kings gathered provisions for their military operations. The system was most visible from the 1290s to the advent of the plague in 1348–9. For each purveyance campaign, the king's officials meticulously recorded the purchase of grain (if wheat, often milled into flour) and other provisions and materials, and the various steps needed to transport them to the nearest port and, from there, usually to the Continent or Scotland, the two main theatres of war for kings during the period. Eventually, the unpopularity of the system would lead kings to entrust it to others, especially merchants, which effectively halted the production of records for the process in the 1350s.[31] For a period of about a half-century leading up to the advent of the Black Death, however, the records about purveyance are very plentiful. They consist of the individual sheriffs' and other officials' accounts in the E 101 class at The National Archives in Kew, London, and their enrolled copies, in somewhat sum-

[24] Brady, 'Gothic barn', p. 81, n. 17; idem, 'Sacred barn', pp. 66, 70–1.

[25] For example, as suggested by the recently excavated granary in an eleventh-century French rural complex in the Toulouse region of southern France. The granary was burned down in the eleventh century, only leaving a five-centimetre-thick layer of carbonized grain and plant remains. The authors make no mention of possible under-floor supports: Ruas, Bouby, Py, and Cazes, 'Burnt granary', esp. p. 420.

[26] Campbell and Bartley, *England*, p. 99.

[27] Campbell, Galloway, Keene, and Murphy, *Medieval capital*, pp. 101–4.

[28] From information given in ibid., p. 103.

[29] The Campbell et al. storage information from purveyance is, in effect, a preview of this study, since one of us supplied the 'Feeding the City' group with the London information from purveyance accounts many years ago, as they acknowledge in Campbell et al., *Medieval capital*, p. 101, n. 90.

[30] Purveyance tended to be most heavily concentrated in the south and east of the country, where supplies of grain, meat, and other goods were most easily secured and transported to the relevant ports; for example, Langdon, 'Inland water transport', p. 2.

[31] Prestwich, *Armies and warfare*, p. 257.

marized fashion, in the E 358 class (Miscellaneous Enrolled Accounts). This material has already been used in the past to estimate the cost of land versus water transport, as well as the extent of the commercial inland water transport system and the amounts that could be carried on it,[32] but it is also very rich in information concerning the storage of grains, flour, meat, and other goods considered necessary for a king's campaign. As these goods were purchased or otherwise commandeered,[33] they often had to be held in storage until they could be moved, usually down rivers, to the main port of embarkation, where storage also had to be found until ships were available to take them to their final destinations on the Continent or in Scotland.

A wide array of storage places were recorded in the purveyance accounts that could be called, variously, a granary (*granarium*, *granaria*, or *garnaria*), grange or barn (*grangia*), hall (*aula*), house (*domus*), upper storey (*solarium*), room (*camera*), cellar (*cellarium*), messuage (*mansio*), or inn (*hospitium*). Two reasonably explicit examples are as follows: 'And in two granaries hired at Ipswich [Suffolk] for 120 quarters of wheat and 100 quarters of malt for three weeks . . .'[34] and 'In one house hired from Alice de Orcham [Horsham?] in the city of Chichester (Sussex) for three weeks for putting the aforesaid 300 quarters of wheat, 20d'.[35]

These two citations might be considered as 'first order' references, because they indicate fairly specifically what was placed in the storage places concerned. 'Second order' references were those where the amount of grain or good was not indicated directly in the statement regarding the hiring of the storage places, but given elsewhere in the document by measurement and porterage costs to or from the storage places. 'Third order' references were those where the amount stored was inferred by the amount of goods purchased by the king's officials, which they indicated were kept in the storage place(s) hired. There were certainly some complications, particularly over 'advantage' grains (see appendix 1), but overall the accuracy of the amounts stored is likely within 10 per cent for most of the cases (more controversy arises over how much these goods actually filled the storage places hired: see also appendix 1). By sifting through the more than a thousand purveyance accounts that are in the E 101 and E 358 classes, a considerable body of information about storage in England was collected for the period from the mid-1290s up to 1349.

In sum, the storage world revealed in the purveyance accounts is that of the purchasers of threshed grain rather than the producers of it. Most of these instances occurred in what could be called 'towns' or even 'cities', but a few must have been little more than villages,[36] so that, although most of these storage cases might be classified as 'urban' in nature, the range of communities covered by them was extremely broad, from the capital of the country to places that may have

[32] Masschaele, 'Transport costs'; Langdon, 'Inland water transport'; idem, 'Efficiency'.

[33] The evils of the system, essentially one of forced sale, are powerfully detailed in Maddicott, 'English peasantry'.

[34] '*Item in duobus granariis locatis apud Gyppewicum pro CXX quarteriis frumenti & C quarteriis brasii per tres septimanas . . .*'; TNA, PRO, E 101 556/19a (for 1337).

[35] '*In vno domo conducto de Alicia de Orcham in civitate Cicestriae per tres septimanas pro predictis CCC quarteriis frumenti imponendis xxd.*'; TNA, PRO, E 101 588/7 (for 1338).

[36] Such as 'Hornferie', likely Horning Ferry on the Bure River in Norfolk, where two granaries were hired for keeping 24 quarters of wheat and 24 quarters of malt for 13 weeks in 1338, and then taken 'by boat' to Great Yarmouth; TNA, PRO, E 358/2, m. 29.

comprised only a few hundred people. Thus, although this sample is unlikely to encompass the complete range of storage facilities for threshed grains across English society as a whole, it seems likely to represent a significant subset of it, particularly more temporary, urban-oriented commercial storage. Some facilities, however, especially the seemingly more ad hoc ones involving people's homes, might also reflect more subsistence-oriented storage arrangements that just happened to be pulled into the purveyance machinery.

In order to be as precise as possible in relation to the volume of the storage places, it was decided to concentrate mostly on grain storage, where the amounts stored were universally expressed in quarters, bushels, and pecks (1 quarter = 8 bushels = 32 pecks), or on goods like flour, salt, and even meat on occasion that could be assigned an equivalent volume in quarters.[37] As such, it was possible to create an Excel database of 315 cases where the volume of the goods put into the storage place or places could be determined (over 103,000 quarters in the 315 cases). A good number of these cases also gave the amount charged for storage (as in the Chichester example above), so that some sense of the cost efficiency (or not) of storage can be considered. Finally, the geographical distribution of the sample is shown in figure 1, with those places having only one or two cases represented by open circles and those with three or more cases represented by solid circles. The 315 cases were distributed among 97 communities, ranging from 40 communities having only one case to Kingston-upon-Hull in Yorkshire having 20 cases over the period from 1297 to 1347 (see table 4). As figure 1 shows and will be discussed in more detail below, the distribution of places where the purveyors stored grain clustered around the major 'outflow' areas of the Humber, Wash, and Thames estuary, with lesser concentrations along the south coast and the Severn estuary.

Finally, it might be argued that looking at storage from the perspective of purveyance provides hardly the most ideal vantage point for assessing storage in the medieval economy. Certainly it arose out of circumstances where political concerns overshadowed and possibly distorted the economic, such that, as economists might say, transactions costs were driven up as purveyance disrupted normal patterns of commerce. Purveyance campaigns, however, were common enough during this half-century or so that the existing commercial network must have reached an accommodation of sorts. Indeed, purveyance campaigns might be seen as a sort of 'stress test' upon the nation's economic infrastructure, which not only involved storage but such things as, say, the practical extensiveness of inland water transport.[38] The other way in which purveyance helps historians is simply by broadening the perspective concerning medieval, or indeed all premodern, storage beyond the traditional views that grain (in particular) was stored by medieval societies solely to get from harvest to harvest, or as a form of insurance against the potential failures of subsequent harvests, or possibly as a form of speculation

[37] Salt, like grain, was measured in quarters. Flour and sometimes meat would be put into tuns (*dolia* or *dolea*). Here a conversion rate of 6.5 quarters per tun was used, following Langdon, 'Efficiency', esp. pp. 118, 123–4. Also on a few occasions, always when the amount of meat being stored was small in relation to the grain stored with it (less than 25%), one beef carcass was considered equal to a quarter and two bacons to a quarter, conversions roughly indicated in a number of the accounts.

[38] Langdon, 'Inland water transport'; idem, 'Efficiency'.

Figure 1. *Median quarters per storage place in various English communities as revealed by English purveyance accounts, 1295–1348*

Sources: TNA, PRO, E 101 550/1–597/31; E358/2–4. The Excel spreadsheet containing the information and individual document references upon which this and the following tables are based can be viewed in pdf form at: http://www.uofaweb.ualberta.ca/historyandclassics/JohnLangdon.cfm (click on 'Storage Database' at end of website).

against higher prices in the future.[39] Purveyance, on the other hand, suggests a system of storage that was *not* intended for any of the above purposes, but to help facilitate the movement of goods from producers to consumers. In other words, much of English storage at the time was already part of a logistical network transporting goods over long distances, including out of the country, and as such provides a useful extra dimension as to why storage was important to medieval society.

II

The general parameters for the total sample of 315 cases are as follows. Most cases (196) involved a single storage place: that is, 'one granary', 'one house', 'one room', and so on, but groups of two or more storage places mentioned in a single case were reasonably common (119 cases), the most prolific being the 16 'granaries' hired for storing $626^{1}/_{4}$ quarters of grain (as evidenced by porterage costs) at an average of 39.1 quarters per granary, at St Ives, Huntingdonshire, for five weeks some time in 1324–5.[40] Altogether a total of 587 storage places was represented in the 315 cases. The number of quarters per single storage place, regardless of type (granary, house, cellar, and so on) or good stored (but predominantly grain, flour, or malt), ranged from $16^{1}/_{4}$ to 2,000 quarters, the arithmetic mean for the 315 cases being 188.0 and the median 132.1. Averaging the cases this way treats those instances of more than one storage place in a case as a single entry. When the cases of multiple storage places were weighted according to the number of storage places they represented (so that, say, the average 39.1 quarters in the St Ives case above would be counted 16 times compared to once for the amount in a case with only a single storage space), the arithmetic mean dropped to 175.0 quarters per storage place and the median less dramatically to 130.0 quarters. However these figures are calculated, it would seem on the basis of this sample, and using the median as the best measurement of central tendency here,[41] that a typical storage place in early fourteenth-century England might hold around 130 quarters. However, the word 'typical' must be used advisedly here. As suggested above, the spread of the data concerning quarters per storage place is extensive with a large standard deviation (191.5) about the mean of 188.0 quarters and a coefficient of variation of 101.9, encompassing what looks to be a very broad range of both large-scale and small-scale storage facilities. The mode (in 18 of the 315 cases) was 100 quarters, but this only reflected the tendency of the king to order provisions in round numbers rather than revealing any particularly uniform storage place size.

Other key characteristics of the sample had to be calculated using smaller subsets of the data. The length of storage, in the 239 cases where it was indicated precisely, ranged from eight days to just under two years (100 weeks and one day),

[39] Fenoaltea ('Risk' and 'Transactions costs') and McCloskey and Nash ('Corn at interest') represent the first two of these tendencies; Clark (in particular, as in 'Markets'; see above, n. 10) the third.

[40] TNA, PRO, E 358/3, m. 7.

[41] Geometric means are an even better measure of central tendency, but Excel could not always handle the immensely large numbers involved in the calculation of geometric means, especially for the entire sample, so they have not been included in the various tables. When geometric means could be calculated for smaller samples—around 200 cases or less—they fell fairly closely to the medians (for example, as in the following note).

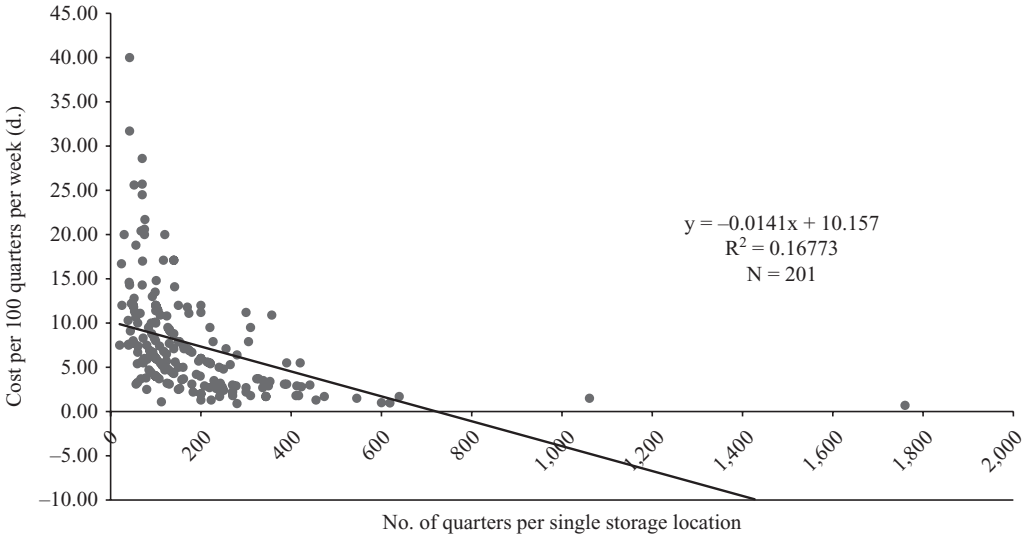

Figure 2. *No. of quarters per single storage location vs. cost per 100 quarters per week*
Sources: As for fig. 1.

with the median stay being eight weeks.[42] The cost of storage was generally expressed in the accounts as pence per week per storage unit, the median charge per storage unit (in the 201 cases where it was given directly in the manuscript or could be calculated) being 8d. per week, ranging from $1^1/_4$d. to 40d. per week per single storage unit. When these 201 cases were calculated in terms of the actual cost per 100 quarters of grain per week, the median was 6.0d. per 100 quarters per week, ranging from a low of 0.7d. per 100 quarters per week for the storage of 1,760 quarters of wheat at Stratford, Essex, for 12 weeks and six days in 1323 to a high of 40.0d. per 100 quarters per week for a short stay of 10 days for 42 quarters of wheat (for which 24d. was paid) at Hedon, Yorkshire, in 1339.[43]

Figure 2 plots these costs per 100 quarters per week versus the numbers of quarters in the storage place involved. The linear relationship between the x and y variables, calculated by the least-squares method and also shown in figure 2, indicates a distinctly negative correlation, for which the significance is very strong.[44] This reflects an apparent tendency for costs per quarter to decrease as the size of the storage place increased and thus some economies of scale attending to larger storage sites. However, the distinctively hyperbolic shape of the curve does reveal aberrations in the data. Those cases stretching up the y-axis, say above 15d. per 100 quarters per week, were possibly due to a number of inefficiencies or hidden costs (not to mention the potential dishonesty of officials).[45] These storage places may have only been partly filled, so that the Crown was paying for larger

[42] The arithmetic and geometric means being 10.3 and 7.4 weeks respectively.
[43] For the Stratford and Hedon cases, see TNA, PRO, E 101 571/10; 22/27.
[44] The Student's *t*-value, as calculated from an R of 0.410 (the square root of the R^2 in fig. 2) and N = 201 (the number of cases making up fig. 2), comes to 6.34, indicating a probability of less than 0.1% that the relationship was due to the chances of sampling.
[45] See below, n. 60.

Table 1. *Quarters per storage unit according to type of storage unit*

Type	*No. of cases*	*(No. of quarters per storage place)*				*Standard deviation*	*Coeff. of variation*
		Mean	*Median*	*Min.*	*Max.*		
Aula (hall)	2	194.5	194.5	133.0	256.0	87.0	44.7
Camera (room)	2	118.1	118.1	112.5	123.7	7.9	6.7
Cellarium (cellar)	10	194.7	130.0	91.0	489.5	142.4	73.2
Domus (house)	81	198.3	137.0	16.3	1,060.9	174.5	88.0
Granaria (granary)	208	180.1	129.5	20.0	2,000.0	201.3	111.8
Grangia (grange)	3	304.8	200.0	74.9	639.4	296.5	97.3
Hospitium (inn)	4	237.8	211.9	117.0	412.5	136.8	57.1
Mansio (messuage)	1	56.0	56.0	56.0	56.0	—	—
Solarium (upper storey)	4	301.6	311.7	100.0	483.0	199.3	66.1

Sources: As for fig. 1.

facilities than were strictly needed. At times they may also have included charges for carrying the grain or other products to and/or from the storage place involved or for spreading and airing the grain. However, since these carrying and spreading costs were often separately recorded and were reasonably significant relative to storage charges (see appendix 2), it seems in most cases—again, say, less than 15d. per 100 quarters per week—that the charge was for the space only.[46] On the other hand, those cases stretching along the x-axis, say, more than 500 quarters per storage place and certainly more than 1,000, might well have been examples of 'serial storage', where quantities of grain were continuously cycled through a single storage place, deceptively suggesting that the storage place was larger than it was (discussed more fully in appendix 1).

Clearly there were many different storage circumstances. Much of this was dependent upon the type of storage unit involved, for which see the data in table 1. The most commonly recorded type of storage structure was the so-called 'granary' (*granaria*). It might have been a stand-alone structure in many cases, but its designation in the records was very vague and imprecise, and it often seems to have been considered simply as a place where grain could be stored temporarily. As a result, there are frequent references to houses, rooms, upper storeys (solars), and even cellars being hired 'for a granary'.[47] Although these latter cases were not included in the 'granary' group for the purposes of the analysis, it does suggest that many of the instances where the record simply said 'granary' or 'granaries' were referring to a situation that did not equate to a stand-alone structure but a variety of places, often within larger structures, where grain could be stored for a short period of time. This was perhaps the case with the 16 'granaries' for the 1324–5 St Ives case mentioned above, which may have signified not much more than the

[46] Porterage charges for carrying grain into or out of a storage place mostly fell in the range of two to six quarters per penny (for example, in TNA, PRO, 552/11, 556/12, 556/26, 559/11, 568/10, 569/3, 569/7–9, 575/5, 575/16, and so on), the former, more expensive, rate being the most common found in the records. Even at the less expensive end of this range, however, the cost of carrying grain into *and* out of, say, the 'house' for the 300 quarters of wheat in the Chichester example in section I would come to $(2 \times 300)/6 = 100$d. This is far in excess of the 20d. that was actually charged for the house storing the grain, partly because the stay was relatively short.

[47] For example, the hiring of '*unius domus scilicet granar*" at Salisbury (Wiltshire) in 1344 (TNA, PRO, E 101 593/23); or the hiring of '*trium magnorum solariorum pro granar*" at Kingston-upon-Hull (Yorkshire) in 1337 (TNA, PRO, E 101 18/36); or, as a final example, '*In diversibus domibus & cameris apud London iuxta Byllyngesgate pro v granariis*' in 1324–5 (TNA, PRO, E 358/3, m. 8).

nooks and crannies of premises that their owners were willing to let the Crown use for the relatively short stay. In any case, 208 of the 315 cases mentioned 'granaries', either singly (in 113 cases) or in groups from two to 16 (in 95 cases), involving a total of 436 'granaries' in all. For all 208 cases with 'granaries', the arithmetic mean of the number of quarters stored in each of these granaries was 180.1, while the median—again a much better indicator of the central tendency here—was 129.5, with a range from 20 to 2,000 quarters per granary.[48] Again, if the cases with multiple granaries were weighted according to the number of storage places they represented, the arithmetic mean dropped to 166.0, although the median changed little at 130.0 quarters.

The second most commonly recorded storage type was the simple 'house' (*domus*), found in 81 of the 315 cases, with 64 cases involving one house and the other 17 cases in groups of two up to five houses and totalling 118 houses in all. Houses were marginally larger than granaries, averaging, for the 81 cases, 198.3 quarters apiece in the sample with a median of 137.0 quarters. Weighting for the cases of multiple houses lowered the arithmetic mean to 193.5 quarters, but raised the median to 143.3 quarters. Houses were more versatile than the storage places called granaries, often being used for bolting (sieving) flour after wheat in particular was milled and to store the resulting tuns of flour, presumably in cooler ground-floor rooms or cellars.[49] Since the purveyance officials were engaging what looked like the private residences of people, a certain amount of preparation of the premises was probably involved, as captured in recorded costs for Bristol, where a house was 'cleaned and repaired' for the storage of wheat and oats some time during 1294–6.[50]

Other storage types were concerned with handling large amounts of materials. One of these was the 'grange' (*grangia*) found in only three cases for storing specific amounts of grain in the purveyance accounts, all in Kent and in one document for the year 1319, ranging from 74.9 quarters of beans for a *grangia* in Dartford to 638.4 quarters of wheat in another *grangia* in the same town, with a third *grangia* at Faversham holding 200 quarters of wheat (all three thus having an arithmetic mean of 304.4 and a median of 200.0).[51] It seems likely that these 'granges' were multifaceted, often meant for the storage of goods other than grain, as in the *magna grangia* hired at Southampton for storing 230 cartloads of hay some time in 1324–5.[52] Other granges mentioned in the accounts had rooms or similar annexes for grain.[53] In short, these 'granges' were apparently the barns

[48] The upper end of this range was for a granary (*gernar*) hired at Boston, Lincolnshire, for 2,000 quarters of oats in 1335, while the lower end involved a single granary at Pitsea, Essex, holding 20 quarters of beans and peas in 1347; TNA, PRO, E 101 569/3; E 358/2, m. 25v.

[49] As in two houses hired in (Bishop's, now King's) Lynn in 1341–2, one for handling the flour resulting from 400 quarters of wheat and another to hold the 60 tuns of flour that resulted; TNA, PRO, E 358/2, m. 13.

[50] '*Et in una domo mundando & reparando apud Bristollum pro custodia eiusdem bladi* [100 quarters of wheat and 200 quarters of oats], *ijs.*'; TNA, PRO, E 101 585/1.

[51] TNA, PRO, E 101 566/9.

[52] TNA, PRO, E 101 593/7. This case was not included in the database, but since a cartload was normally considered capable of carrying up to three or four quarters of wheat (Masschaele, 'Transport costs', p. 269), then 230 cartloads of hay might be considered roughly equivalent to 690 to 920 quarters of grain.

[53] As at 'Weld' (probably South Weald), Essex, in 1349, where a grange, which was filled with hay and litter, also had a room attached for storing oats, beans, and peas; TNA, PRO, E 101 556/38. See also in the same account a reference to a grange hired 'with a certain granary included' at Chelmsford (in 1348–9).

cited by Fenoaltea, Brady, and Campbell and Bartley above, primarily only involved in storing hay or grain in sheaves and only secondarily for threshed grain.

Another type of large-scale storage involved those structures called *hospitia*. They are most often considered as 'inns' or 'guest-houses', but here it is probably best to characterize them more loosely as storage complexes, for both people and goods. They certainly had something of a professional quality to them, even if they might be no more than the dwellings of well-to-do merchants,[54] a good example being the hiring of a *hospitium* 'with six granaries and four low rooms and cellars' at Chelmsford, Essex, in 1345.[55] As with 'houses', *hospitia* were often involved in the production of flour, holding the wheat until it went to the mills and then storing the tuns of flour that resulted.[56] The four *hospitia* in the database held an average of 237.8 quarters apiece (median, 210.9), with the minimum being 117 quarters and the maximum 412.5 quarters. Storage of similar complexity is seen with the hiring of a 'hall' (*aula*) along with two rooms and a cellar at Dorchester, Dorset, in 1344 for 256 quarters of wheat, while a year later in 1345 a hall 'with five rooms' was hired in the same town for storing 133 quarters of wheat. In both cases the wheat was milled into tuns of flour, which were also kept at the same places.[57] Finally, another storage complex along the lines of the *hospitium* or *aula* was seen in a single case of a *mansio* hired at Stanford (le Hope), Essex, in 1347 'with diverse granaries for keeping the said wheat (56 quarters) and bolting the flour provided from it, and filling the tuns (eight in all), and keeping the same within for four weeks'.[58] *Mansio* is probably best translated here as 'messuage' or dwelling-house, and given its hiring at a modest 6d. per week and the relatively small amount of grain and/or flour stored within, it should perhaps be seen as similar in nature to the various *domus* discussed above: that is, a private dwelling that was turned into a storage place.

Also hired or used by the purveyors were specifically designated parts of larger structures: rooms, cellars, and upper storeys. In the database two 'rooms' (*camerae*), one at Cambridge Castle in 1333 and one hired at Berwick-upon-Tweed in Northumberland in 1334, stored 123.7 and 112.5 quarters respectively, giving a mean (and median) of 118.1 quarters, a little below the 129.5 for the median granary size but reasonably impressive. As to be expected, cellars (*cellaria*) were also prominent as storage places. In addition to being critical for preserving goods in cooler conditions, they could hold impressive amounts. Of the 10 cases in the database where the volume of goods going into cellars could be measured, the mean number of quarters per cellar was 194.7 (median, 130.0 quarters), all involving the storage of tuns of flour. The largest case involved two 'great' cellars hired at Kingston-upon-Hull in 1334–5, where 966 quarters of flour, into which were mixed 13 quarters of salt for preservation, were stored in 128 tuns, making an average of 489.5 quarters of flour and salt per cellar.[59] Upper storeys (*solaria*)

[54] An interpretation seemingly preferred by Campbell et al., *Medieval capital*, p. 103.

[55] '*Et in locatione cuiusdem hospitii apud Chelmersford cum vj granariis & iiij*^{or} *bassis cameris & celariis . . .*'; TNA, PRO, E 358/4, m. 16.

[56] As for the *hospitia* at (Bishop's) Lynn, Norfolk, and Ipswich, Suffolk, in 1345; TNA, PRO, E 358/4, m. 14v.

[57] TNA, PRO, E 358/2, m. 21; E 101 585/28.

[58] '*Et etiam in una mansione locato apud Stanford cum diversis granariis pro toto frumento supra dicto hospitando & flore inde proveniente bultando & doliis de dicta flore impletis usque cariagia eorundem intus custodiendis per iiij septimanas . . .*'; TNA, PRO, E 358/4, m. 16v. The *mansio* was hired for 6d. per week.

[59] TNA, PRO, E 358/4, m. 4.

could also be sizeable, and there is a suggestion here that upper storeys might have routinely been reserved for storage, while keeping living quarters at ground-floor level. In the 1334–5 Kingston case just mentioned, the incoming 966 quarters of wheat to be milled into the 128 tuns of flour were kept in two 'great solars', an average of 483.0 quarters of wheat per solar.[60] In the four cases of solars in the database, including this last one, the average number of quarters per solar averaged 301.6 quarters (median, 311.7), indicating an impressive size, but one that should be approached with caution given the small size of the sample. Finally, despite the tedious carrying involved, storage clearly extended to the very upper reaches of buildings. Consequently, in 1319 there was a reference to storing 124 quarters and $2^1/_2$ bushels of peas and beans and 300 quarters of barley 'in the high solar' ('*in alto solario*') of a granary at Sandwich, while porterage costs were recorded at Ipswich in 1337 for taking 100 quarters of wheat and 100 quarters of malt 'to the aforesaid granaries which are above the solar(s)' ('*versus predictas granarias que sunt super solar*'), perhaps a reference to attic space used as storage.[61]

III

How do these mean or median quarters of goods per storage place relate to the actual size of the buildings, rooms, or cellars in which they were stored? There are several issues that affect this, but a key one involves the manner in which the good was stored. In terms of grain, this depended whether the grain was in sacks when placed in a particular storage place or was spread loose in it. The former might seem more logical in that sacks of grain could be stacked virtually up to the ceiling in a 'granary', 'house', or whatever was used for storing them,[62] and there are certainly a handful of specific references to 'sacks' being purchased to hold the grain while it was seemingly being stored.[63] However, recorded more often in the accounts were references to grain being 'shovelled and aired' in the granaries, and one particular revealing case mentioned that this procedure was done twice a week.[64] Storing grain loose in granaries and other storage facilities was clearly an attempt to keep the grain dry and in good condition and to avoid conditions that could lead, *in extremis*, to spontaneous combustion and fire in grain storage areas. It may also have been more convenient for purveyors given the relatively short periods of time—the median stay being eight weeks, as noted above—for which

[60] Ibid. The exact correspondence of the 966 quarters of wheat into 966 quarters of flour is suspicious, since the milled grain products, including flour, normally had a much greater volume than the original grain. For this point and its implications concerning the honesty of the officials making up the purveyance accounts, see Langdon, *Mills*, pp. 152–5.

[61] TNA, PRO, E 101 566/9, 556/19a.

[62] As discussed in Campbell et al., *Medieval capital*, p. 103.

[63] A man was paid for lifting sacks on to the backs of porters in a granary at Grimsby, Lincolnshire, sometime in 1324–5, presumably when the grain was exiting the granary; TNA, PRO, E 101 568/34. Similarly a house (*domus*) was hired for storing 454 quarters, for which 40 sacks had been bought, again in 1324–5; TNA, PRO, E 358/3, m. 8v.

[64] '*Item solutio pro scopagatio & ventilatione bladorum predictorum per vices videlicet bis in qualibet ebdomada per tempus predictum, 10s.*' (for several London granaries in early 1325; TNA, PRO, E 101 571/13); for other good references to airing grain in storage places, sometimes expressed as 'throwing grain from one place to another' or 'to throw grain' (with a basket), see TNA, PRO, E 101 566/13 (Newcastle-upon-Tyne, 1333), 571/14 (Stratford, Essex, 1326), E 358/2, m. 22v (Cambridge, St Ives, Wisbech, and Lynn, 1345). For archaeological evidence regarding the loose storage of grain in an eleventh-century French context, see Ruas et al., 'Burnt granary', p. 425.

they needed storage. However, damage to grain would sometimes be reported regardless of any precautions taken, especially if it got wet or was held for too long, a situation that was similar to the damage to grain reported on sea voyages.[65]

The tendency to store grain loose had important implications for the amount of storage space needed. Shovellers could not expect to air grain effectively if the grain was at all deep or if the grain covered the entire floor area. Campbell et al. suggested that a foot and a half was as deep as could be expected in such circumstances, with only 68 per cent coverage of the floor surface of the granary so as to allow channels between piles of grain so that shovellers could have access to the entire amount of grain.[66] If these loading conditions are accepted to have been the case, then 100 quarters, with a total volume of 992 cubic feet,[67] would require an area of 973 square feet or roughly a room 31 feet by 31 feet. Loading more aggressively to two feet at, say, 75 per cent of floor area coverage would result in a smaller area of 26 feet by 26 feet. Either condition would fit room sizes routinely encountered in medieval houses.[68] Greater quantities of grain, up to, say, 500 quarters, would require larger structures, with a total floor space of 4,863 square feet using the Campbell et al. specifications of a foot and a half deep layer of grain and 68 per cent floor coverage, or about 70 feet by 70 feet, or 3,307 square feet at a two-foot depth and 75 per cent coverage of floor space, or about 58 feet by 58 feet (although it is possible that some of these cases of larger amounts being stored might be ones in which the grain was bagged rather than the storage place being substantially larger). Larger floor areas like this might fit stand-alone granaries or the larger storage complexes represented by *hospitia*, *aulae*, and *mansiones*. Flour storage in cellars was likely the most efficient, since tuns could be placed on top of one another, although some space between the barrels had to be allowed for. Taken altogether, these arrangements confirm the ability of an informal storage system to handle much of the unusual storage requirements of a purveyance campaign. On the other hand, the storage requirements of normal commercial activity might have been handled by the *hospitia* or more commercially oriented, less domestically focused granaries. However, separating granaries for domestic use versus those for more fluid commercial transactions, where granaries might have been filled and emptied on a much more frequent basis, is difficult, and perhaps we should not even try to draw such a distinction, since granaries might have been used for both purposes, as needs dictated.

[65] Thus, John de Maners, detailing the collection of 4,113 quarters $5^1/_2$ bushels of wheat along the east coast over 1335, reported that 63 quarters had been lost 'in devastation and drying out of the aforesaid wheat in land and water carriage and similarly while remaining in the granaries' ('*in devastationi et desiccacione frumenti predicti in cariagio tam per terram quam per aquam & similiter dum remanebatur in granariis*'); TNA, PRO, E 358/4, m. 4. A similar situation was reported for the collection of grain in Cumberland during 1341–2, where Thomas de Barton, the receiver at Carlisle, reported that 25 quarters and 2 bushels of wheat, 40 quarters of beans and peas, and 43 quarters and 7 bushels of oats were eventually sold in 1343 'because that grain in many ways was worsened as much through the inundation of sea water in carrying as through the length of detention of the same in the granaries' (referring to two 'houses' (*domus*) hired at Carlisle for keeping the grain) ('*eo quod blada illa multimode fuerunt peiorata tam per in undatione aque maris in cariando quam per diutinam detentionem eorundem in granariis*'): TNA, PRO, E 358/2, m. 21v.

[66] Citing a work of Jean Meuvret: Campbell et al., *Medieval capital*, p. 103, n. 98.

[67] From figures given for wheat in Langdon, 'Efficiency', tab. 4 (p. 123). Campbell et al., *Medieval capital*, p. 103, n. 97, suggest a slightly larger volume (by about 4%) for 100 quarters at 1,027 cubic feet, but do not give details as to how they arrived at this figure.

[68] Campbell et al., *Medieval capital*, p. 103.

IV

This all reinforces the feel of the medieval English storage system, especially for threshed grain, as a rather informal one, but it was no less effective for all that. It also indicates that the storage system was a very *private* one, with much less in the way of community-owned storage structures. Thus, even London would not construct a public granary (at Leadenhall) until 1440.[69] What served as large storage places before then were those owned by probably far less communally interested parties. Royal castles seem often to have functioned in part as storage places,[70] to be supplemented occasionally by 'a granary (or granaries) of the king', as at Salisbury, perhaps because of the often poor state of repair of the castle there.[71] A number of large storage places were also owned by merchants and were situated at particularly strategic points, especially along the major commercial axis running along the Thames River from Henley-on-Thames to London, where merchant granaries were prominent at both ends.[72] The owners of the hired storage places, large or small, are usually anonymous in the accounts, but some are named and often were clearly well-to-do, as in the case of Henry attehilde, from whom the purveyors rented 'one great stone house' at Faversham (Kent) for 21 weeks from March to August 1295, or William de Snoryngg, from whom the purveyors rented what looks to have been a sizeable granary in (Bishop's, now King's) Lynn for 24 days in 1339, which held 199 quarters of wheat, 398 quarters of barley malt, 14 quarters of beans and peas, 75 beef carcasses, 170 sides of bacon, 3 quarters of salt, and at least 2 lasts (equivalent to a volume of about 20 quarters) of herrings.[73] Multiple granaries were often rented from single people, as in the case of William Buk, who supplied the Crown with three granaries 'next to the gate' at Colchester in 1337, two for 250 quarters of wheat and one for 100 quarters of malt, or Henry de Betele, who supplied the purveyors with two granaries at Lynn in 1334 for 400 quarters of wheat and 440 quarters of oats.[74] Not all storage suppliers were men. Again in 1295, the purveyors placed around 100 quarters of oats in a granary or granaries hired in London from Cristina Box.[75]

[69] Ibid., p. 104.

[70] The purveyance accounts record storage at the castles of Cambridge, Corfe, Dover, Oxford, Taunton, and York, as well as the Tower of London and in a house next to the bell-tower at Westminster (this last for hay): Cambridge (1324–5: TNA, PRO, E 358/3, m. 7; 1327: TNA, PRO, E 358/3, m. 14v; 1333: TNA, PRO, E 358/4, m.2; 1334–5: TNA, PRO, E 101 552/14); Corfe (1346 (bis): TNA, PRO, E 358/2, m. 24; E 358/4, m. 17); Dover (1340: TNA, PRO, E 358/4, m. 8); Oxford (1346: TNA, PRO, E 358/2, ms. 25–25v; 1347: TNA, PRO, E 358/4, m. 18v); Taunton (1345: TNA, PRO, E 101 585/28); York (1346: TNA, PRO, E 101 597/31); Tower of London (1345: TNA, PRO, E 358/3, m. 13); Westminster (1326–7: TNA, PRO, E 101 556/12).

[71] 200 quarters were purchased and placed in *granar' domini Regis* at Salisbury in 1346, for which only supervisory costs were incurred; TNA, PRO, E 101 593/24. For the troubles maintaining the castle at Salisbury, see Crittal, ed., *History*, pp. 56–9.

[72] Especially at Queenhithe in London; Campbell et al., *Medieval capital*, p. 103. For merchant building of granaries and other storehouses at Henley, see Peberdy, 'Navigation', p. 323.

[73] TNA, PRO, E 101 5/14; 575/5.

[74] TNA, PRO, E 101 556/19a; 575/1. William Buk, originally from Mersea, was a well-to-do and active merchant and shipowner in Colchester from at least the 1330s to the 1360s; Britnell, *Growth and decline*, pp. 17–19, 32, 63–4, 110–11, 113. Henry de Betele seems to have been a member of a prominent Lynn family which supplied two mayors over the course of the fourteenth century, Hugh de Betele in 1342 and presumably another Henry de Betele in 1382: http://www.west-norfolk.gov.uk/Default.aspx?page=23009 and http://www.west-norfolk.gov.uk/Default.aspx?page=23010 [both accessed 21 Sept. 2009].

[75] TNA, PRO, E 101 5/14. The exact amount stored is unclear in the document and might range from 96 to 120 quarters; see also Alice de Orcham of Chichester, mentioned in section I above.

Table 2. *Quarters per storage unit by decade*

Decade	No. of cases	(No. of quarters per storage place) Mean	Median	Min.	Max.	Standard deviation	Coeff. of variation
1290s	13	263.6	200.0	43.6	600.0	187.3	71.1
1300s	16	251.4	206.1	76.0	1,060.9	232.3	92.4
1310s	20	303.0	231.5	74.9	639.4	180.6	59.6
1320s	60	197.8	146.8	20.0	1,760.0	229.7	116.1
1330s	98	176.3	109.2	16.3	2,000.0	222.7	126.3
1340s	108	153.5	121.8	20.0	670.0	105.6	68.8

Sources: As for fig. 1.

When examined over time from the 1290s to the 1340s (table 2), the purveyors seem increasingly to have brought smaller storage units into the net, as the median size shrank from around 200–20 quarters per storage unit (of any type: 'granary', 'house', and so on) in the 1290s and the first two decades of the fourteenth century to the 105–25 quarters per storage unit range by the 1330s and 1340s, a very significant decrease.[76] This may have been because smaller amounts needed to be stored, as the purveyance system as it was known initially gradually wound down, but it does bring up the possibility that more domestic storage was being gradually drawn into the net, so that the storage system that was seen in the 1290s tended towards a more elitist merchant one as against the more socially inclusive one seen in the 1340s. In both cases, however, as mentioned above, it pointed to an increasingly intensifying private, ad hoc system of storing threshed grain and other goods, one not ideally suited to deal with brutal subsistence crises of the sort encountered in 1315–17, but certainly adequate for the more normal needs of daily living and commercial activity. The exact role of purveyance in this is uncertain—was it simply revealing a more commercialized storage system already in place or actively pushing it towards that orientation? It is difficult to come down on either side of this, but purveyance, by its very nature, might have had some influence in making temporary storage more common than it had been before.

As a result, much of medieval English storage seems to have been drifting towards a system more suited for flexibility than insurance. This should not be seen as a situation where there was not enough capital—or that, because of high interest rates, capital was too expensive—to provide adequate storage facilities for sensible safety margins,[77] but one where storage reflected more immediate economic and social concerns. In this regard, Komlos and Landes's view that attitudes to storage have to be sought in reasons more consonant with the age than, say, interest rates seems more appropriate.[78] The purveyance accounts indicate that there were storage places aplenty, albeit of a somewhat informal kind. This system catered more to what we might call day-to-day (or at best month-to-month) storage

[76] *t*-test results on the data in tab. 2 show that the decrease in mean size of storage from the decades 1290s–1310s to the 1320s–40s was significant to at least the 0.5% level. We did wonder whether some of this decline might have been due to a possible outsize representation in the later 1320s–40s sample of places from the north-east, which had a lower mean size of storage place than any other part of the country (see below), but even excluding all the north-east places the difference in mean storage size between the two periods for the rest of the sample still remained significant below the 0.5% level.

[77] McCloskey and Nash, 'Corn at interest'.

[78] Komlos and Landes, 'Anachronistic economics'.

concerns than the much more longsighted policy of having food supplies about for the proverbial rainy day, which, as mentioned above in relation to the public granary at Leadenhall in London, only slowly began to form.

In any case, a more immediate concern was probably the worry about keeping grain or other goods around for too long. As McCloskey and Nash have pointed out, spoilage was a fact of life probably much more pressing upon medieval sensibilities than the possibility of a famine some time in the future. Modern estimates put annual storage losses for grain up to 10 per cent, and for storage even for a year or less it was critical to keep the moisture content of the grain below 13 per cent; otherwise, alongside the usual predations by insects and rodents, unwanted seed germination and fungus growth would abound, especially if temperatures rose.[79] Storage of grain for, say, a year could thus reduce its value by perhaps as much as 20 per cent counting spoilage and storage costs together (see appendix 2). Purveyance officials were accordingly given strict orders to keep all victuals of the king 'from putrefaction or great deterioration' ('*absque putrefactione aut magna deteriatione*') through suitable storage arrangements,[80] which, as we have seen, involved some care in monitoring the condition of the grain and keeping it well circulated by shovelling or throwing it from place to place by means of baskets. Although grain could be stored for years,[81] the purveyance accounts suggest that storage for over a year could lead to significant losses.[82] Wheaten flour held in wooden tuns was even more sensitive to lengthy storage and was liberally dosed with salt to prevent insect infestation and, above all, kept in cool conditions, pre-eminently in cellars, as the purveyance accounts again abundantly testify.

V

In addition to variations over time, there were also some regional variations in storage (table 3; for how the regions were defined, see the note on the table). For reasons that are not entirely clear but perhaps due to a less merchant-dominated system of storage, the north-east, essentially centred around the key port of Kingston-upon-Hull, to which goods as far away as Derby or Boroughbridge came along the Trent and Yorkshire Ouse waterways, stood out as having storage places significantly smaller than the rest of the country, at a median of 111.2 quarters per storage place (arithmetic mean, 135.0). This was at least 20 per cent lower than the south, and over 30 per cent less than the other three areas (east, London area, and west).[83] It was also the most expensive storage in the country, especially when measured in cost per 100 quarters per week; at a median of 10.1d. per 100 quarters per week, it was at least 20 per cent more expensive than the next closest

[79] McCloskey and Nash, 'Corn at interest', p. 182; Smil, *Energy*, p. 37.

[80] As John atte Fenum was warned to do for the storage of 2,205 quarters of wheat, 1,000 quarters of malt, and 525 quarters of beans and peas in 'diverse granararies' at Lynn, costing £14 16s. 1d., from June 1341 to March 1342; TNA, PRO, E 358/2, m. 21.

[81] An extent of debt for Swavesey Priory in Cambridgeshire, owing nearly £330 to William Fraunke in 1340, recorded 220 quarters of wheat, 260 quarters of barley, and 220 quarters of peas held at Swavesey itself, which the jurors claimed had been there for three years; TNA, PRO, C131/6/8, m. 2.

[82] See above, n. 65.

[83] *t*-testing shows that the lower mean size of storage in the north-east against all other regions was significant to the 0.5% level or less. No other region, when tested against all the other regions, yielded a significantly different mean storage size.

Table 3. *Quarters per storage place by region*

Region	No. of cases	(No. of quarters per storage place) Mean	Median	Min.	Max.	Standard deviation	Coeff. of variation
North-east	64	135.0	111.2	29.5	489.5	96.7	71.6
East	81	216.4	143.5	16.3	2,000.0	255.9	118.2
London area	95	192.6	150.0	20.0	1,760.0	210.5	109.3
South	37	192.2	132.1	20.0	462.4	124.1	64.6
West	38	201.3	165.8	30.0	558.0	139.2	69.2

Notes: Although there was an inevitable degree of arbitrariness in setting up these regions, the regions are for the most part (with the exception of the south) focused around the four key water outflows of the country: the Humber for the north-east, the Wash for the east, the Thames River for the London area, and the Severn River for the west. Thus, the north-east includes the storage places indicated for ports from Berwick-upon-Tweed down to Saltfleet Haven, Lincolnshire, plus all those places along or close to rivers feeding into the Humber (for example, the Trent and its tributaries and the Yorkshire Ouse), which involved places as far afield as Derby and Boroughbridge. The east involved basically all those places existing on or close to waterways, particularly the Ouse, Nene, and Witham, feeding into the Wash, and also various ports and towns in Suffolk and Norfolk. The London region featured all those places in the interior feeding towards London, or on waterways of the Thames basin, or in Essex or Kent. The south included all those places along the south coast from Sussex to Dorset or sending its goods there, as in the case of Wiltshire. The west was heavily focused around places in the Severn watershed, including the ports of Bristol and Bridgwater, Somerset; it also includes a single outlier case at Carlisle (see fig. 1).
Sources: As for fig. 1.

Table 4. *Quarters per storage place at key ports*

Major towns	No. of cases	(No. of quarters per storage place) Mean	Median	Min.	Max.	Standard deviation	Coeff. of variation
Kingston-upon-Hull	20	164.6	109.2	42.0	489.5	141.3	85.9
Boston	18	301.3	138.0	36.5	2,000.0	454.1	150.7
(Bishop's) Lynn	18	274.8	258.7	102.5	473.5	121.1	44.1
London	14	231.7	191.0	43.6	600.0	154.1	66.5
Southampton	12	260.1	220.5	100.0	462.4	145.0	55.8
Bridgwater	10	231.3	190.6	30.0	558.0	188.6	81.6
Bristol	14	235.9	268.1	30.0	501.3	136.6	57.9
All other places	209	160.7	120.0	16.3	1,760.0	164.2	102.2

Sources: As for fig. 1.

region in terms of cost, the south (median, 7.8d.), and up to twice as expensive as the remaining three regions (east, median, 4.8d.; London area, median, 6.0d.; west, median, 5.0d.), indicating again that economies of scale were made as storage places got larger.

The number of quarters per storage place did not only vary from region to region but also from place to place. Table 4 lists seven main ports clockwise around the country—Kingston-upon-Hull, Boston, (Bishop's) Lynn, London, Southampton, Bridgwater, and Bristol—and compares them to all the other places in the sample. Perhaps not surprisingly most of the seven ports had individual storage places that held more quarters of grain than in the sample at large. The one exception was Kingston-upon-Hull, which had smaller numbers of quarters per storage place reflecting the similar characteristic for its region, as mentioned above. Perhaps the most notable thing in table 4, as indicated by the coefficients of variation, is the much reduced dispersal of the data around the arithmetic mean in the case of six of the seven ports, compared to all the other cases in the sample. (The one exception was Boston, where a single case of 2,000 quarters per storage place badly skewed its distribution.) This suggests that the variation of data in

terms of quarters per storage unit may have been much greater *across* communities than within them. This was also seen in smaller places. A good example is Maldon, a small town on the Blackwater River popular with the purveyors, who hired storage there on a recorded 16 occasions between 1316 to 1349, since it served as a convenient outport for much of central Essex. The arithmetic mean for the 16 cases was 124.2 quarters per storage place (20 granaries and three houses were mentioned in the 16 cases) and the median 100.0 quarters, with a coefficient of variation of 65.9, where the quarters of provisions per storage place were, relatively speaking, narrowly concentrated in a range from 50 to 300 quarters.

In short, it seems that the capacity range of storage places for particular communities might be determined by their position within the economic network of their particular area. Sometimes regional storage characteristics might override that, as in the case of Kingston-upon-Hull, where the predisposition to small storage places in the north-east seems to have determined the storage characteristics of its main port.

VI

Overall, there seems to have been considerable storage capacity in medieval England, both at the large-scale end through the prevalence of barns in the countryside and, as is evident from this study, at the more small-scale end, particularly in an urban setting, for more finished products of agriculture, especially threshed grain and flour. Some of this latter storage was likely very informal, that is, living space occasionally given over to storage, particularly under the stresses imposed by purveyance. Whatever some economic theorists might think, it also indicates a very substantial investment in storage at the time, either in terms of the building of stand-alone structures like 'barns' or 'granaries', or of space in other structures reserved for it, for which people were willing to expend cash and other resources, despite the financial penalties imposed by putatively high interest rates or inevitable storage losses.

The question then shifts from 'was there storage?'—there was clearly a considerable amount of space devoted to it—to 'what was the central purpose of this storage?'. Should it be cast mainly in subsistence terms? It does not take much to imagine that many if not most families would require enough storage to carry foodstuffs from the end of one harvest to the beginning of the next. Whether they used storage to have a permanent grain supply on hand in case of a harvest failure or a succession of them is still largely unknowable. Clark's contention that there was likely an excess of grain carried over from harvest year to harvest year, particularly in those occasional years of low grain prices, is plausible enough, as it would function both as sensible entrepreneurialism and, consciously or not, as a form of insurance.[84] The experience of the great famine of 1315–17, however, shows that the cushioning effect of that insurance was relatively limited and certainly could not handle a climate-driven breakdown in food production that people of the time considered to be of biblical proportions.[85]

[84] Clark, 'Markets' (see above, n. 10), esp. pp. 25–34; see also app. 2.
[85] Jordan, *Great Famine*, pp. 7–8, 21–3.

However, it is also likely that there was another key purpose of storage at the time that cut deeply across subsistence concerns. In this regard, the purveyance campaigns functioned as a close analogue to marketing as a whole. In order to get grains from producer to consumer (in the case of the purveyance campaigns, the 'consumers' were troops overseas or in Scotland), the flow of these goods was hardly frictionless, but had to negotiate a number of holdups. Grains could not be left standing around on carts or packhorses while boats on rivers or ships on the open seas were arranged, but had to be stored, often for short periods of time, until such arrangements could be made or carried out—on the latter point, ships, for example, were often held up by bad weather either in getting to the port where they were required or leaving them.[86] The purveyance accounts reveal all this very well, although perhaps it was handled in a clumsy sort of way, hence requiring some space in people's houses that was not meant for such storage. It is entirely possible, indeed very plausible, for instance, that merchants handled these problems better than the king's purveyors, in arranging for timely transport and minimizing costly waits and other inefficiencies, so that as much as anything this was why purveyance was eventually entrusted to them from the 1350s onwards. On the other hand, it is interesting to speculate that purveyance was needed in the first place because the merchant infrastructure needed for handling this extraordinary flow of goods was not in place in the 1290s, and thus purveyance, instead of just passively reflecting a storage situation already in place, may have had a more active role in shaping it. In any case, certainly by the end of the period studied here, the purveyance accounts suggest a 'storage world' very different from that required for basic subsistence needs and one that was much more in tune with the developing commercialization that had been so much a feature from the late twelfth century onwards.[87] Commercialized storage did still intersect with storage for domestic, subsistence-oriented purposes, but arguably it was the former that had increasingly begun to dominate.

If the progression of storage is connected to a higher level of commercialism it throws up some intriguing questions. Did a new system of storage have to be created for the purposes of commercialization or was an old one based upon subsistence subverted to new requirements (as the purveyance accounts suggest in part)? Did this possible transformation of storage make society more vulnerable to food shortages? Put another way, were possibly increasing problems of subsistence not primarily ones of food production but more of an arterial transformation that suited the increasing commercial needs of the time but left society of the time more vulnerable to crises? One then might regard, say, the creation of the public granaries throughout Europe, even eventually England, as laggardly responses to fundamental changes to the demand for storage taking place over at least a couple of centuries.

This study can only be seen as an initial step in considering such questions. To us, it makes the issue of interest rates irrelevant, or at least a small part of a very much larger picture. It also shows how issues such as population increase and decline have to be seen in much more textured ways, taking into account issues that have hitherto been considered only lightly.[88] A close analysis of storage, as

[86] Thus, in 1319, a house (*domus*) was hired at the port of Hythe, Kent, to hold 195 quarters of wheat for four weeks because of contrary winds before the wheat was taken by ship to Sandwich; TNA, PRO, E 101 566/9.

[87] For example, Spufford, *Money*, esp. pt. 2; Britnell, *Commercialisation*, again esp. pt. 2.

[88] Such as the role of family income versus real wages; Langdon and Masschaele, 'Commercial activity'.

modest as it may seem in the larger scheme of things, offers a useful step in that direction.

University of Alberta

Date submitted *22 May 2009*
Revised version submitted *3 December 2009*
Accepted *10 May 2010*

DOI: 10.1111/j.1468-0289.2010.00564.x

Footnote references

Brady, N. D. K., 'The sacred barn. Barn-building in southern England, 1100–1550: a study of grain storage technology and its cultural context' (unpub. Ph.D. thesis, Cornell Univ., 1996).
Brady, N., 'The Gothic barn of England: icon of prestige and authority', in E. B. Smith and M. Wolfe, eds., *Technology and resource use in medieval Europe: cathedrals, mills, and mines* (Aldershot, 1997), pp. 76–105.
Britnell, R. H., '*Avantagium mercatoris*: a custom in medieval English trade', *Nottingham Medieval Studies*, XXIV (1980), pp. 37–50.
Britnell, R. H., *Growth and decline in Colchester, 1300–1525* (Cambridge, 1986).
Britnell, R. H., *The commercialisation of English society, 1000–1500* (Cambridge, 1993).
Campbell, B. M. S. and Bartley, K., *England on the eve of the Black Death: an atlas of lay lordship, land and wealth, 1300–1349* (Manchester, 2006).
Campbell, B. M. S., Galloway, J. A., Keene, D., and Murphy, M., *A medieval capital and its grain supply: agrarian production and distribution in the London region c.1300* (Historical Geography Research Series, 30, 1993).
Crittal, E., ed., *A history of the county of Wiltshire*, vol. VI (Victoria County History, Oxford, 1962).
Farmer, D. L., 'Prices and wages', in H. E. Hallam, ed., *The agrarian history of England and Wales, vol. II, 1042–1350* (Cambridge, 1988), pp. 715–817.
Fenoaltea, S., 'Risk, transaction costs, and the organization of medieval agriculture', *Explorations in Economic History*, 13 (1976), pp. 129–51.
Fenoaltea, S., 'Transaction costs, Whig history, and the common fields', *Politics and Society*, 16 (1988), pp. 171–240.
Field, R. K., 'Worcestershire peasant buildings, household goods and farming equipment in the later middle ages', *Medieval Archaeology*, 9 (1965), pp. 105–45.
Jordan, W. C., *The Great Famine: northern Europe in the early fourteenth century* (Princeton, 1996).
Komlos, J. and Landes, R., 'Anachronistic economics: grain storage in medieval England', *Economic History Review*, 2nd ser., XLIV (1991), pp. 36–45.
Langdon, J., 'Inland water transport in medieval England', *Journal of Historical Geography*, 19 (1993), pp. 1–11.
Langdon, J., *Mills in the medieval economy: England 1300–1540* (Oxford, 2004).
Langdon, J., 'The efficiency of inland water transport in medieval England', in J. Blair, ed., *Waterways and canal-building in medieval England* (Oxford, 2007), pp. 110–30.
Langdon, J. and Masschaele, J., 'Commercial activity and population growth in medieval England', *Past and Present*, 190 (2006), pp. 35–81.
McCloskey, D. N., 'The enclosure of open fields: preface to a study of its impact on the efficiency of English agriculture in the eighteenth century', *Journal of Economic History*, 32 (1972), pp. 15–35.
McCloskey, D. N. and Nash, J., 'Corn at interest: the extent and cost of grain storage in medieval England', *American Economic Review*, 74 (1984), pp. 174–87.
Maddicott, J. R., 'The English peasantry and the demands of the Crown 1294–1341', in T. H. Aston, ed., *Landlords, peasants and politics in medieval England* (Cambridge, 1987), pp. 285–359.
Masschaele, J., 'Transport costs in medieval England', *Economic History Review*, XLVI (1993), pp. 266–79.
Peberdy, R. B., 'Navigation on the River Thames between London and Oxford in the late middle ages: a reconsideration', *Oxoniensia*, 61 (1996), pp. 311–40.
Prestwich, M., *Armies and warfare in the middle ages: the English experience* (New Haven, 1996).
Ruas, M.-P., Bouby, L., Py, V., and Cazes, J.-P., 'An 11th century A.D. burnt granary at La Gravette, south-western France: preliminary archaeobotanical results', *Vegetation History and Archaeobotany*, 14 (2005), pp. 416–26.
Smil, V., *Energy in world history* (Boulder, 1994).
Spufford, P., *Money and its use in medieval Europe* (Cambridge, 1988).

APPENDIX 1: 'ADVANTAGE' AND OTHER ISSUES IN PURVEYANCE STORAGE

The prevailing practice in medieval England of giving a wholesale discount for grain purchases, 'advantage' as it was called, which meant giving a twenty-first quarter free upon the purchase of the first 20 quarters (or 5 per cent extra), does cause some problems for the calculation of storage.[89] It seems likely that this provision applied routinely in the Crown's purchases, but it is not clear how this was applied to what was recorded for storage. Indeed, it often seems that when, say, officials hired a granary to store 100 quarters what was actually being stored was 105 quarters. This is revealed in some of the entries where the amount stored was expressed from a number of perspectives. Thus, it was recorded in an account of William de la Pole that 27s. was paid in 1337 for hiring three 'great solars' at Kingston-upon-Hull (Yorkshire) to hold 460 quarters of wheat 'with advantage'. On the surface, it is not clear whether the 460 included the advantage grains or not, but is only revealed in the account when this wheat was sent for grinding into flour at a nearby mill, and the statement was made that the multure (that is, the rate for milling) was paid on 483 quarters, that is, 5 per cent above the declared 460 quarters: in other words, the three solars were holding 483 quarters, not 460.[90] Similarly, in 1346, 135 quarters of wheat were allegedly stored in two *hospitia* at Newark, Nottinghamshire. Here there was no indication of advantage, but the account also recorded that a cart was hired to carry 'the said wheat with advantage, namely 141 quarters 6 bushels (or 5 per cent over the afore-stated 135 quarters)',[91] again indicating that when the officials recorded a certain amount of grain to be stored in hired storage places, they were not including advantage grains, even though these were being stored as well. When it was clear that this was happening, the amounts including advantage were entered into the database, but when there was no other information indicating advantage, the amounts stated were taken at face value, even though it is likely, in some cases at least, that advantaged grain was included as well. This suggests that the amounts recorded for the various storage places might have been routinely understated by 5 per cent.

Another issue is whether the purveyors used the granaries or other facilities they hired efficiently, or whether they filled them only partly. The habit, often seen in the accounts, of using separate storage arrangements for each type of crop, and the usually round numbers of quarters put into them, suggests that there may have been a certain wastage of space,[92] as does the tendency of some cases in figure 2 above to extend up the y-axis. Only once was it indicated in all the accounts examined that granaries might have been too tightly packed.[93] On the other hand, considering the 'granaries' and 'houses' in the database, where two or more were hired to hold crops, their means and more pertinently their medians were not too

[89] For the background to buying with 'advantage', see Britnell, '*Avantagium mercatoris*'.

[90] TNA, PRO, E 101 18/36.

[91] TNA, PRO, E 101 580/33.

[92] For example, at Maldon, Essex, in 1344, four granaries were hired, one for 100 quarters of wheat, one for 100 quarters of malt, one for 60 quarters of peas and beans, and one for 100 quarters of oats; TNA, PRO, E 101 556/27.

[93] In an account for 22 Edward I (1293–4), 300 quarters of oats out of 2,686 quarters and 6 bushels of oats and barley, which had been stored in various granaries (the number was not given), were moved to another house 'because they were too densely thrown' ('*quia nimis dense iacebant*'): TNA, PRO, E 101 4/30. Because of the uncertain number of granaries and the uncertain location of the 'house' (but probably Portsmouth), this instance was not included among the 315 cases in the database.

substantially different than the means and medians of those cases where there was only one granary or house.[94] Since the hiring of multiple granaries (two or more) probably meant that they were being filled to a reasonably high level, the fact that the medians for these group hirings did not differ consistently from those cases where only one granary was hired suggests that *all* hired granaries, single or group, were being filled to a reasonably efficient level, even when very large numbers of seemingly small storage places were hired.

There is, however, another possibility that could lead to a serious underestimating of the size of storage places from the purveyance evidence: did the purveyors hire entire storage places or just parts of them? This might seem to occur for very tiny amounts being stored, such as in the two granaries hired at the small port of Pitsea, Essex, for two weeks in 1347, one to hold 40 quarters of oats and the other 20 quarters of beans and peas.[95] On the other hand, given the purveyors' reluctance to mix different types of grains in the same storage place, it would seem odd that they would lightly countenance storing the Crown's grain with any other that would be in the same place. Certainly, there is no directly stated evidence that the purveyors put their commandeered grain into storage places that still contained grain belonging to other people, nor is there indirect evidence of it through the purchase of hurdles and other equipment for separating and protecting goods, as was the case on ships.[96]

In any case, all of the above considerations will tend to underestimate the size of the storage place in our statistical exercise. They might be countered by occasional tendencies to inflate the size of storage, such as the tendency towards what one might call 'serial storage', which may particularly affect what appear on the surface to be very large storage places. Thus, it was recorded in an account from the sheriff of London and Middlesex that a single granary was hired at Stratford, Essex, from 27 March to 24 June 1323, a total of 12 weeks and six days inclusive, to which, according to the account, 1,760 quarters of wheat were sent from granaries in London. However, the account also indicated that this wheat was sent on to mills at Stratford, and the resulting flour was bolted in a house or houses (the account is unclear about the number) hired for the purpose, put into tuns, and placed in a 'garden', also hired, next to the mills until they were to be fetched for the king's war in Scotland.[97] On the face of it, the granary at Stratford would seemingly hold 1,760 quarters, but a more likely scenario is that, for the nearly three months for which the granary was hired, the wheat arrived piecemeal from London, each lot being stored for perhaps a few days or at most a week or two before moving on to the mills, the bolting house(s), and the holding garden. The amount of grain that the granary actually had to handle at any one time, and hence probably its capacity, was undoubtedly much less than the total 1,760 quarters of wheat processed. It is also notable that the cost per 100 quarters per week recorded for this particular storage episode (at 0.7d.) was the lowest in the 201 cases for which this calculation was possible, indicating that the granary was likely much smaller than that required for

[94] See section II above.

[95] See esp. as expressed in TNA, PRO, E 358/4, m. 16v.

[96] For which 'bridges' (*pontes*: gangplanks), hurdles (*claiae*), racks, canvas, and other storage aids were routinely employed. At the start of the Hundred Years War in 1337, for example, the king's purveyors hired a 'place' (*placea*) in Portsmouth to keep 'bridges', hurdles, racks, and canvas in preparation for shipping; TNA, PRO, E 358/2, m. 6.

[97] TNA, PRO, E 101 571/10.

the 1,760 quarters it was alleged to hold. Indeed, if it is assumed that the cost per 100 quarters per week for this storage place was actually equal to the median 6d. for the 201 cases for which cost data were available, then the 160d. total cost for storage over the 12 weeks and six days would imply that the granary only held an average of 206.7 quarters at any one time over the period.[98] In short, as figure 2 shows, caution should be exercised in dealing with the extremes of our database.

APPENDIX 2: COSTS OF YEARLY STORAGE FOR A QUARTER OF WHEAT

Assuming that a quarter of wheat was priced around 5s., or 60d., over the course of the early fourteenth century,[99] then spoilage at 10 per cent would reduce the value of that quarter by 6d. If we add the cost of storage, using the median figure for the country as a whole from the purveyance accounts of 6d. per 100 quarters per week, this would amount to another 3d. per quarter or so over a year (that is, $(6 \times 52)/100 = 3.1$d). There were also associated labour costs with carrying the grain into and out of the storage place and periodically airing it with shovels or bushel baskets. The middle range of porterage seems to have been about a farthing per quarter,[100] which would add 0.5d. for transporting the quarter of wheat into and out of the storage place. Spreading and airing grain seems to have cost about 3d. per 100 quarters per week (three examples for a number of London granaries in 1325 gave figures of 1.8, 2.7, and 4.1d. per 100 quarters per week for airing grain),[101] which would add another 1.5d. or so to the yearly storage cost of the quarter (that is, $(3/100) \times 52 = 1.6$). Adding these approximate labour costs to those for spoilage and basic storage would give $6 + 3 + 0.5 + 1.5 = 11$d. Although some of the latter storage and associated labour expense may have been considered costless in family-run operations (that is, using space and labour readily available in the household), we should probably see spoilage and storage costs as potentially reducing the value of a quarter of wheat by something approaching a shilling (that is, 6d. for spoilage plus whatever was perceived as out-of-pocket expenses for storage and its associated labour). This suggests that medieval grain producers *might* consider storing grain for sale the following year when grain prices were approaching a shilling less than 'normal', or, in the case of wheat, at about 80 per cent of the average 5s. or so per quarter. But, again from Farmer's figures, a reduction in wheat prices to 80 per cent or less from 'norm' only occurred in seven of the 55 years during the period of this study. In short, price-oriented opportunities for profiting through keeping grain from one harvest into the next, especially when considering potential problems of selling year-old grain in competition with that newly harvested, would seem to have occurred too infrequently to have justified the investment of maintaining storage facilities specifically for that purpose. Shorter-term storage to take advantage of possible higher prices within the same harvest year made more sense and, in any case, was probably inseparable from keeping grain and other foodstuffs for subsistence purposes.

[98] That is, $(160/12.9/6) \times 100 = 206.7$.
[99] From Farmer's figures, in 'Prices and wages', pp. 790–1.
[100] See above, n. 46.
[101] TNA, PRO, E 101 571/13.