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Institutional Facts and Standardisation: The Case of Measurements in the London Coal Trade

Aashish Velkar

Department of Economic History
London School of Economics

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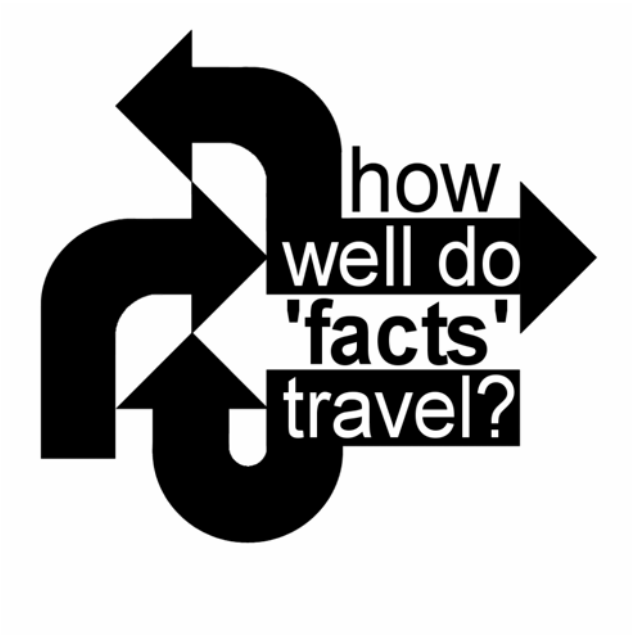

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Series Editor:

Dr. Jonathan Adams
Department of Economic History
London School of Economics
Houghton Street
London, WC2A 2AE

Tel: +44 (0) 20 7955 6727
Fax: +44 (0) 20 7955 7730

Institutional Facts and Standardisation: The case of measurements in the London coal trade.

Aashish Velkar[*]

Abstract

Measurement standards are like institutional facts – they enable the travel of information across different domains: geographical, social, institutional or contextual. Uncovering the reasons underlying how and why measurement standards are adopted can provide insights into how 'well' such facts travel. Using the example of measurements in the London coal trade c1830, I explore how measurement standards travel across different domains and why groups switch from one standard to another. In this specific example, I investigate how standardized measurements replaced the customary practice of heaped measures and, and argue that measurement standards replaced the system of public measurements as a mechanism to ensure transparency in transactions. I further argue that measurement standards were embedded in an institutional 'package' of artefacts, regulations and customary practices making this a process of negotiated change. Institutional facts are bounded by other institutional structures. In this case of measurement standards, facts appear to have travelled well when a change was made to the entire institutional context and not just the measurement artefact.

Measurements are an example of John Searle's 'institutional facts', i.e. they are facts because they depend upon human institutions for their existence.[1] Adoption of measurement standards is therefore evidence of facts travelling from one domain to another, whether geographical, social or institutional or even contextual. This paper investigates the evidence of travelling facts in the context of increasing use of standardized

[*] I would like to thank Mary Morgan, Peter Howlett and the audiences at seminars at the London School of Economics, Nuffield College, Oxford and the Economic History Society for helpful comments and suggestions on earlier drafts of this paper. This research was made possible by the generous help of the Carrus-Wilson Research Studentship.

[1] John Searle, *The construction of social reality* (London, 1995), p. 2.

measurements in the early nineteenth-century Britain. Standardized measurements depend upon the adoption of standardized weights and measures and in 1824 the Imperial system of weights and measures was introduced by statute with this intention. Nevertheless, some historians consider it to be a case of 'tidying up' the statute books of arcane laws rather than radically changing the multiplicity of customary weights and measures used throughout the country.[2] Indeed, the Weights and Measures Act of 1824 expressly stated that 'it shall [be] lawful [to] buy and sell goods and merchandize by any weights or measures established either by local custom or founded on special Agreement' provided their exact relation to the 'standard' units defined by the act was generally known.[3] In contrast, 'France had elected to mould its citizens to the law'[4] when the metric measures were declared to be obligatory throughout that country at the turn of the nineteenth century. If this interpretation of the events is accurate, then it would appear that the British state basically defined a set of standardized measurement units to which measurement units in customary and everyday use could be compared; implying that British metrology in the nineteenth century was a continuation of traditional and customary measurement practices. Thus, from our perspective, older measurement artefacts were not replaced by newer artefacts.

And yet, some significant metrological changes occurred in Britain around this time. Consider the practice of 'heaped measures'.

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[2] For example, Julian Hoppit, 'Reforming Britain's weights and measures, 1660-1824', *The English Historical Review*, 108 (1993), pp. 82-104, at p. 104. Also Rebecca Adell, 'The British metrological standardization debate, 1756-1824: The importance of parliamentary sources in its reassessment', *Parliamentary History*, 22 (2003), pp. 165-82, at p. 182.; William J Ashworth, *Customs and excise: Trade, production, and consumption in England, 1640-1845* (Oxford, 2003), p. 287.; cf. Ronald Edward Zupko, *Revolution in measurement: Western European weights and measures since the age of science* (Philadelphia, 1990), p. 176.

[3] Act on uniformity of weights and measures, 1824, 5 George IV C. 74.

[4] Ken Alder, *The measure of all things: The seven-year odyssey and hidden error that transformed the world* (New York, 2003), p. 328.

Traditionally, many dry goods, including grain, fruit, coal, etc, were measured for sale using capacity measures, often using vessels that were round in shape, and the practice of heaping quantities over the top of the vessel was customary.[5] In fact, the Weights and Measures Act of 1824 describes the manner of heaping dry goods in some detail, such that a buyer could expect a specified quantity within the heap.[6] Heaped measures were abolished by statute in 1835 as they were 'liable to considerable variation'.[7] Another example of significant metrological change is evident when we consider, for instance, the British coal industry. On the single largest trade route for this commodity from north-east England to London, very different measurement units were used at both ends for centuries: the unit of weight used in the north, whereas the trade in London used volumetric units. In 1831, the London trade switched over from volumetric measures to weight measures. The new units adopted were the Imperial weight units, abandoning customary measurement practices that had evolved over centuries of use. If the state did not intend to replace customary English measures, then the question is why important economic sectors, such as the coal trade, switched to Imperial measures in the nineteenth century.

These examples suggest that the standardization of the Imperial measurements were accompanied by other equally significant changes that were not only technological in nature. The above changes could be explained by the transition from a 'moral economy' to a modern market economy where transactions became less personal and more transparent as measurements became more standardized.[8] However, there are other

[5]Robert Dickson Connor, *The weights and measures of England* (London, 1987), pp. 178-9, 55-56.
[6] 5 George IV C. 74.
[7] Weights and measures (amendment) act, 1835, 5 & 6 William IV, C.63.
[8] Witold Kula, *Measures and men*, trans. R Szreter, (Princeton, New Jersey, 1986).; Ken Alder, 'A revolution to measure: The political economy of the metric system in the ancien régime', in M Norton Wise ed., *The values of precision* (Princeton, 1995).

equally likely explanations. One possible explanation is that the increasing complexity of market transactions in the nineteenth century, both in scale as well as geographical scope, induced merchants to adopt fewer and standardized units in place of the multiplicity of units that had worked well in the past.[9] Another explanation is that the government influenced the adoption of standardized units by using them for centralized administrative functions, such as collection of duties and taxes.[10] Yet another explanation revolves around increasing objectivity within the economic sphere, whereby objectivity, to mean less personal or arbitrary decision-making, depended upon increasing accuracy in measurements. The values of accuracy and objectivity depended upon demands of greater uniformity in measurements - recognizing fully that accuracy and uniformity are often used as instruments of rhetoric.[11]

It is likely that institutional changes, both formal as well as informal, in the role of measurements were occurring in England during the Georgian era. Julian Hoppit wrote that it is quite possible that fixed measures and variable prices replaced fixed prices and variable measures in parts of eighteenth-century Britain.[12] There are a few historiographical accounts of standardization of English measures, but we do not yet possess a systematic account of institutional changes that likely accompanied metrological standardization.[13] The foregoing

[9] Sidney Pollard, 'Capitalism and rationality: A study of measurements in British coal mining, ca. 1750-1850', *Explorations in Economic History*, 20 (1983), pp. 110-29.
[10] Ashworth, *Customs and excise*.
[11] Theodore M Porter, 'Objectivity as standardization: The rhetoric of impersonality in measurement, statistics, and cost-benefit analysis', in Allan Megill ed., *Rethinking objectivity* (London, 1994).; Simon Schaffer, 'Metrology, metrication and Victorian values', in Bernard Lightman ed., *Victorian Science in Context* (Chicago & London, 1997).
[12] Julian Hoppit, 'Income, Welfare and the Industrial Revolution in Britain', *The Historical Journal*, 31 (1988), pp. 721-31, at p. 730.
[13] Pollard, 'Coal measurements'.; Norman Biggs, 'A tale untangled: Measuring the fineness of yarn', *Textile History*, 35 (2004), pp. 120-9. Richard Sheldon, Adrian Randall, Andrew Charlesworth and David Walsh, 'Popular protest and the persistence of customary corn measures: Resistance to the Winchester bushel in the English west',

discussion implies that facts, embodied here by measurement standards, travel well if accompanied by institutional change. This could involve replacing older or existing institutional structures or even replacing old facts with new ones. The rest of the paper investigates this broad claim and explores some reasons as to how and why this occurred. It explores how standardizing measurements enabled objective, unambiguous facts regarding commodities to be transmitted through the market. Using the case of the London coal trade in c1830, it examines the historical events that led to the abolition of the heaped measures as well as dismantling the system of public metage that had existed for centuries. Building upon existing scholarly work[14], the historical events have been recreated using primary sources including the archives of Corporation of London Records Office (CLRO), evidence of various parliamentary committees, and letters to *The Times* in London. The paper seeks to demonstrate that standardization of measurements, to mean switching from older customary units to the new Imperial standards, was a form of institutional change in terms of replacing older mechanisms used to ensure transparency in transactions, such as the public metage system. This was achieved by abolishing heaped measurements and by switching measurement standards. I argue that measurement standards formed part of an 'institutional package' of artefacts, regulation and customary practices and therefore achieving uniformity in measurements involved making changes to the entire package.

The London coal trade had existed at least since the 14th century, with the Company of Woodmongers and Coal Sellers active since c1330.

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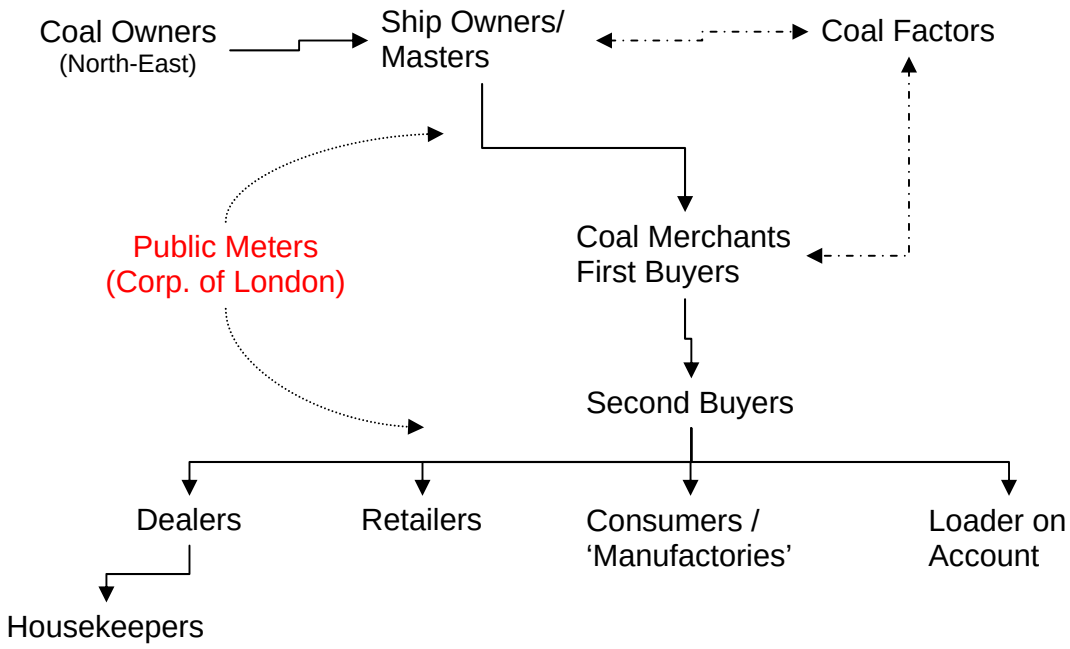
in Adrian Randall and Andrew Charlesworth eds., *Markets, Market Culture and Popular Protest in Eighteenth-Century Britain and Ireland* (Liverpool, 1996).

[14] Raymond Smith, *Sea-coal for London: History of the coal factors in the London market* (London, 1961). R A Mott, 'The London and Newcastle chaldrons for measuring coal', in J Philipson ed., *Archaeologia Aeliana* (Newcastle-upon-Tyne, 1962). John Hatcher, *The history of the British coal industry (Volume 1: Before-1700)* (Oxford, 1993), pp. 557-71.

By 1362, it appears that the government had begun to levy taxes on coal to finance its (military) activities.[15] London's precocious appetite for coal was supplied from the north-eastern coal fields and traffic along this route grew substantially over the centuries. Even in the 1810s, virtually all of London's coal came from Newcastle and Sunderland[16] and almost all of this cargo was transported via the coastal routes. For instance, in 1827 almost 1.6 million chaldrons were brought into London via coastal routes and only about 1,100 chaldrons was reportedly brought by inland navigation.[17] Significantly, for over 500 years coal was delivered in London using the London Chaldron (LCh) which measured in units of cubic capacity. However, in the north-east the measurements were made using the Newcastle Chaldron (NCh), which was based on units of weight. Converting from weight to volume persisted for at least five centuries until the trade in London switched to the Imperial units of weight in 1831.[18] Why did the trade shift from customary volumetric units to Imperial units of weight? The answers most likely lie in the events that took place in the 1820s, but first we take a quick look at the structure of the trade in London around this time and the measurement practices in use.

[15] Hylton B Dale, *The fellowship of woodmongers: Six centuries of the London coal trade* (London, c1922), p. 1.
[16] Account of coals shipped from the ports of Great Britain, 1818, London, Parliamentary Papers (PP) Vol. XIV, pp. 165-9.
[17] The figures for 1810 are 974,000 chaldrons and 6,000 chaldrons respectively; Number of chaldrons imported into London, 1826-27, London, PP Vol. XVIII, p. 495.
[18] Act for regulating delivery of coal, 1831, 1 & 2 William IV C.76.

Fig. 1: Supply Chain in the London Coal Trade (c1830)



From the north-east, the commodity passed through several hands before reaching the ultimate consumer (fig. 1). High quality coal, with strong demand in London, was produced in mines controlled by a highly organized group of *Coal Owners*. They had often combined to apportion between themselves the 'Vend' or quantity of coal that would be delivered to the market. At least three principal combinations were formed between 1700 and 1830 in Northumberland and Durham– the Grand Alliance, the Limitation of the Vend and the Joint Durham and Northumberland Coal Owners Association.[19] The intent of these combinations was to limit the output of coal and thereby maintain prices and profits.[20] The coal owners were also a politically powerful group counting among them Sir Matthew Ridley, MP, and Lord Londonderry, the Marquis of Londonderry.

[19] Michael W Flinn, *The history of the British coal industry (Volume 2: 1700-1830)* (Oxford, 1984), pp. 256-67.
[20] J A Jaffe, 'Competition and the size of firms in the north-east coal trade, 1800-1850', *Northern History*, 25 (1989), pp. 235-55, at p. 236.

Coal would be sold to the *shipmasters* of sea-going ships called colliers, who, until the late eighteenth century, transported the coal to London at their own risk. This apparently changed by the 1790s, when cargoes began to be consigned to commission agents of the coal-owners who were their first point of contact in London .[21] These agents were the *coal factors* who had emerged as an organized group of intermediaries acting as the link between the shipper and a) the buyers, b) the customs offices, and c) the labour pool. In 1800, there were 19 'houses' acting as coal factors in London[22] and these numbers had remained unchanged by 1830.[23] The factors would arrange the sale of cargoes, in the Coal Exchange at Billingsgate, to merchants known as *first buyers,* who numbered about 70-5 around 1800.[24] Thus, the trade was concentrated in the hands of a few individuals, the factors and first buyers, who functioned as a conduit for virtually all the coal that entered the London market. The business of the first buyer was to:

> purchase entire cargoes of coal from the factors, and to dispose of them [to] the loader on account; the dealer; the retailer; the consumer, and the housekeeper. The first is a person who [buys on credit]…the dealer buys of us to sell principally to housekeepers. The retailer keeps a shed, and sells them out by the bushel; and the consumer is confined to large manufactories.[25]

This heterogeneous group was sometimes also referred to as *second buyers*.[26] According to one contemporary estimate, the second buyers,

[21] Smith, *Sea-coal*, pp. 121-2.;Flinn, *Coal Industry*, pp. 277-8.
[22] Report from the committee on coal trade, 1800, London, House of Commons Reports (1785-1801) Vol. X, p. 553. Evidence of Thomas Gillespy.
[23] Report of the select committee on coal trade, 1830, London, PP Vol. VIII, p. 149. Evidence of James Bentley, coal factor.
[24] Report on Coal Trade (1800), p. 553. Gillespy's evidence.
[25] Ibid., p. 548. Evidence of Thomas Fletcher.
[26] A different terminology and arrangement is described by Dale, *Woodmongers*, p. 95.

excluding the housekeepers, purchased roughly five-sixths of the coal from first buyers.[27]

An important link in the supply chain was the *coal meters*. As the traffic into the port of London increased and duties on coal became an essential part of the state's revenue, the meters became an integral part of the customs infrastructure. They comprised of the *sea meters*, employed to measure coal delivered from the colliers, and the *land meters*, to measure coal sold on the wharves. The sea meters were appointed in c1330 or c1369, whereas the land meters were formed only by 1767, when a group of coal merchants successfully petitioned the parliament to secure permission to measure coal 'between the Tower and Limehouse Hole…inasmuch as the old Coal Meters of 1330 only operated in the City of London on the river'.[28] The duties of the sea meters on board the colliers were to account for the cargo delivered to the various (first) buyers on the basis of actual measurements made as the coal was 'heaved up' from the colliers into the lighters or barges.[29] The land meters were appointed to specific wharves and were expected to 'see all the coal … duly measured, and the due quantity served…and the whole quantity put into the waggon'.[30] The City charged a metage duty for this 'service' and the principal meters were expected to keep a correct account of the metage collected on behalf of the Corporation of London. The metage system actually performed three vital functions: the meters acted as 'delegated monitors' to measure the quantity of coal; the quantity measured served as a basis for collecting various duties on coal; and the metage duty was a source of revenue for the City. The functioning of this

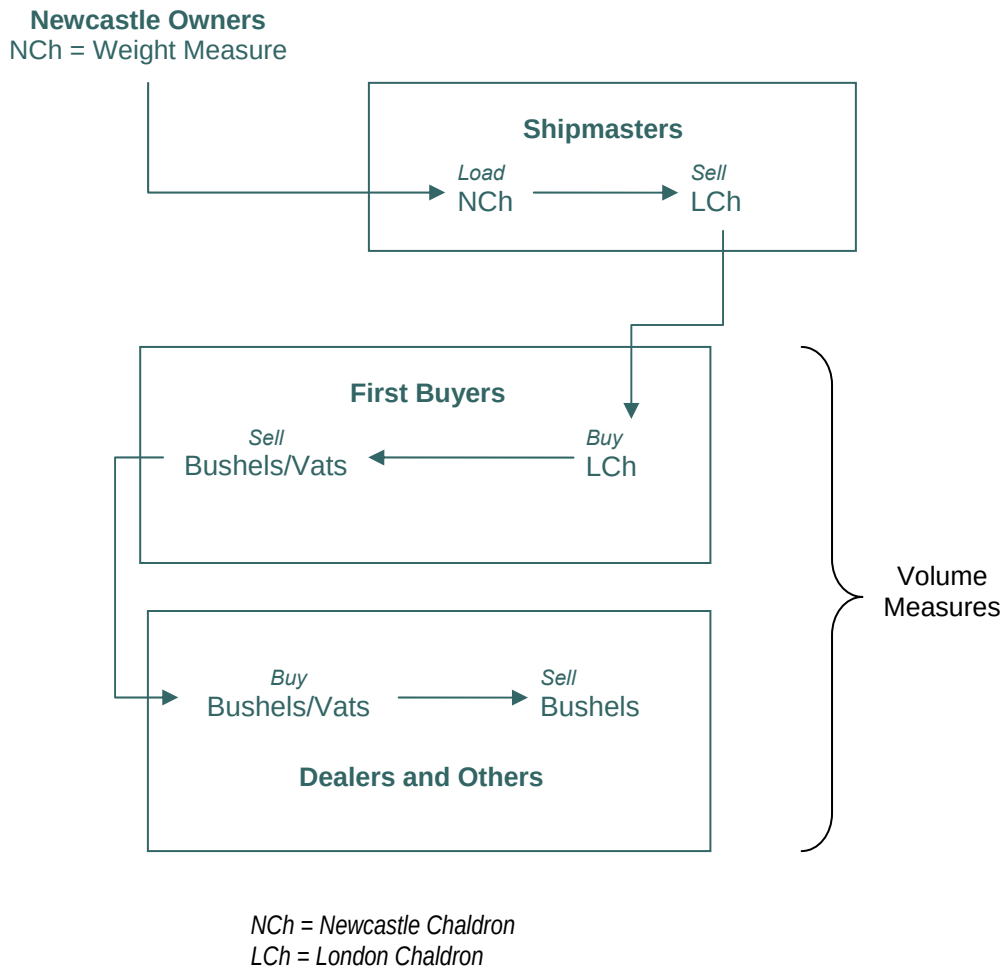
[27] Report on Coal Trade (1800), p. 553. Gillespy's evidence.
[28] Dale, *Woodmongers*, p. 1 & 82.; Smith, *Sea-coal*, p. 2 & 52.
[29] Report on Coal Trade (1800), p. 558. Evidence of Dixon and Richard Austen, deputy coal meters.
[30] PP 1830 Vol. VIII, p. 26. Evidence of John Bumsted, principal land meter.

system was not always smooth and was a source of constant consternation within the market, as we shall see later on.

Numerous measurement units were used by the London trade (fig. 2). The cargo was loaded on the colliers in the north using the NCh (Newcastle chaldron). This *weight* measure, was supposed to be equivalent to 53 *cwt*.[31] Coal was physically delivered from the colliers to the barges using a measure known as the vat. Four vats made up the *volumetric* measure of the LCh (London chaldron) and 9 bushels in turn made up the vat. There was no physical artefact representing the LCh,[32] whereas the vat and the bushel were represented by legal physical standards in the form of metal vessels. A 'pool measure' was used primarily by the first buyers to measure coal from the colliers. This measure involved 'giving ingrain' i.e. a score of 21 units instead of 20 units[33] and the vat was used to estimate quantity. On the contrary, the bushel was used to fill sacks by a 'wharf measure' once coal reached the wharves, with each sack containing the equivalent of three bushels.[34] No ingrain was provided in case of the wharf measure. There was thus an advantage to any merchant buying by the pool measure and selling by the wharf measure due to the ingrain.

[31] The quantity measured by this unit had increased by 2.5 - 3 times since the medieval years. Mott, 'London chaldron', in, pp. 230-5.
[32] In the north, before the mid-eighteenth century the NCh was estimated using a combination of 'bolls', 'wains' and 'cartload'. After the wooden wagon-ways developed, the NCh came to be estimated using wagons each constructed to hold the equivalent of 53*cwt.*; PP 1830 Vol. VIII. evidence of Robert Brandling (261) and John Buddle (285). Discussion of these units is beyond the scope of this paper.
[33] Ibid. Evidence of Joseph Holl (118) and Henry Woodthorpe, Town Clerk of London, (22).
[34] Report on Coal Trade (1800). See Appendix No. 32.

Fig. 2: Measurement Units used in the London Coal Trade (c1830)



How accurate were these measurement standards? Although the LCh was defined as being equivalent to 36 bushels[35], there was no consensus on exactly how much *quantity* was contained in this measure. Both contemporary experts as well as modern historians have differed in their estimates. As one historian remarked, 'immersion in the sources reveals that contemporary experts in the coal trade were at times scarcely less

[35] Act for regulating the delivery of coals, 1807, 47 George III, C.68.

bewildered [than] the historians who followed centuries after'.[36] Estimates of the LCh have ranged from 288 to 396 gallons, although recent research shows that the LCh was historically estimated to be either 384 or 396 gallons. Such variations are also evident when we compare the estimates of the weight of coal contained in one chaldron. One estimate concluded that the LCh attained its 'final' level of about 26.5*cwt* in 1530, another ascribed a weight equivalent of 25.*7cwt*, while historical sources seem to suggest that the weight estimates existing between 1793 and 1847 ranged from 26.*5cwt* to 28.*462cwt*. [37]

Which of these estimates is correct and why do they vary so much? One reason for the variation in the quantity contained in a single LCh was undoubtedly the custom of heaped measurements. The practice of heaping when measuring dry goods in general (coal, grain, fruits, etc.) dates back to medieval times. The additional quantity contained in the heap (as compared to the quantity contained within the measuring vessel) appears to have increased over the centuries, with one estimate stating it increased from about one-eighth of the quantity contained in the vessel to about one-quarter by the eighteenth century.[38] Nevertheless, in the case of coal, a statute of 1807 stated that they should be 'heaped up [in] the form of a cone, such cone to be of the height of at least six inches, and the outside of the bushel to be the extremity of the base of such a cone'.[39]

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[36] Hatcher, *Coal industry*, p. 557. Also John T Taylor, *The archeology of the coal trade* (Newcastle, 1858), p. 24.; Robert Edington, *Essay on the coal trade* (London, 1803), pp. 50-1.

[37] Mott, 'London chaldron', in, p. 230.; B Dietz, 'The north-east coal trade, 1550-1750: Measures, markets and the metropolis', *Northern History*, 22 (1986), pp. 280-94, at p. 284. Historical estimates by Hatcher, *Coal industry*, pp. 568-9.

[38] Connor, *English Measures*, pp. 156-7 & 79. Also Hatcher, *Coal industry*, p. 567.

[39] 47 George III, C.68. By this regulation the quantity contained in the cone of the heap was to be about 30% of that contained within the dimensions of the vessel. PP 1830 Vol. VIII. For this calculation, the inside diameter of the bushel is assumed to 19.5 inches, the volume is calculated to be 1,969 in^3 and the volume of the cone of the heap is assumed to be approximately 603 in^3. Before 1807, there were no precise definitions of the heap. 12 Anne Stat. 2 C.17 only mentions heaped measures without specifying dimensions.

This implies that the 36 bushels of coal that constituted the LCh, and were to be heaped bushels, in actuality should have equated to about 48 bushels.[40] In spite of such regulation, the merchants supposedly withheld the quantity that should have formed part of the heap and in consequence provided 'short-measure' to customers.[41] At times, given the nature and shape of coal, it was not possible to form identical cones in subsequent measurement instances, which also led to variability in quantity. Close monitoring, in the form of delegated monitors (the meters), was considered necessary to ensure that measurements meted out quantities as close as possible to those intended by both custom and regulation.[42]

Another issue that the trade had to deal with was the conversion from quantities measured in weight to volume. As long as an unchanging ratio was used conversion should not have become an issue in successive measurement instances. However, it was alleged around this time that there was no fixed or constant conversion ratio between the NCh and the LCh. Several contemporary estimates put the ratio variously at 8:15, 8:17, 11:21, 1:2, etc.[43] Converting from a weight standard to a volume standard involved another issue, that of variable density (or specific gravity) between different types of coal.[44] For example, coal known as the Northumberland Wallsend weighed about 78.97 pounds per cubic foot, whereas another type, the Welsh stone-coal from Milford, weighed about 89.38 pounds per cubic foot. Consequently, the general

[40] 48 bushels (not heaped) x 8.5 gallons of the coal bushel = 396 gallons; equally 48 bushels (not heaped) x 8 gallons of Winchester bushel = 384 gallons. Smith, *Sea-coal*, pp. 367-8.; Connor, *English Measures*, pp. 180-1.
[41] Report on Coal Trade (1800), pp. 559, 69, 600-1, etc.; PP 1830 Vol. VIII, pp. 52-3, 77, etc.
[42] PP 1830 Vol. VIII, p. 77 & 87.
[43] Various parliamentary reports; also Edington, *Coal Trade*, p. 51.; Taylor, *Archeology of coal*, p. 24.
[44] Specific gravity is defined as the density (weight per capacity unit) of a substance in comparison to the density of water. It is thus a dimensionless ratio where the density of water is assumed to be unitary.

consensus amongst the merchants and experts was that no two bushels of coal could be ‘made to weigh the same’.[45]

Just how large was this variation in density? John Buddle, a contemporary expert, consultant and colliery viewer, reported estimates of density variation in different types of coal traded in London at that time.[46] Analyzing his estimates shows that the variability in density was not considerable being under three percent. Moreover, if only the best quality coals are compared the variation was under one percent (table 1). Different quality of coals, differing on the basis of their specific gravity, fetched different prices in the London market. Moreover, density of coal also tended to change depending upon the size and condition of the individual pieces of coal. One estimate of c1850 claimed small coals to be about ten percent lighter than larger pieces of merchantable coals, or in other words, small coals occupied ten percent more volume than large coals of the same weight.[47] It was alleged around 1800, and again in 1830, that this fact was an inducement to load large coals in the north and to deliver smaller coals in London, coals having been broken deliberately during the coastwise voyage.[48]

[45] PP 1830 Vol. VIII, p. 122 & 305.
[46] Ibid., pp. 339-40. Evidence of John Buddle. Also Appendix Nos. 24 & 25.
[47] T Y Hall, 'Remarks on the coal trade', *Transactions of the North of England Institute of Mining and Mechanical Engineers*, II (1853-54), pp. 104-236, at p. 209.
[48] PP 1830 Vol. VIII, p. 13. Several witnesses testified to this and claimed that such ‘screened’ coals resulted in wastage as high as 25-30% of production.

Table 1 Specific Gravity Estimates of Coals Sold in London (from John Buddle's sample)		
	Main Sample	**Sub-sample of High Quality Coals**
Observations	77	21
Average Specific Gravity (Sp. Gr.)	1,277	1,263
Maximum Sp. Gr.	1,432	1,247
Minimum Sp. Gr.	1,235	1,278
Std. Deviation	37	6.6
Degree of Variation	2.9%	0.53%

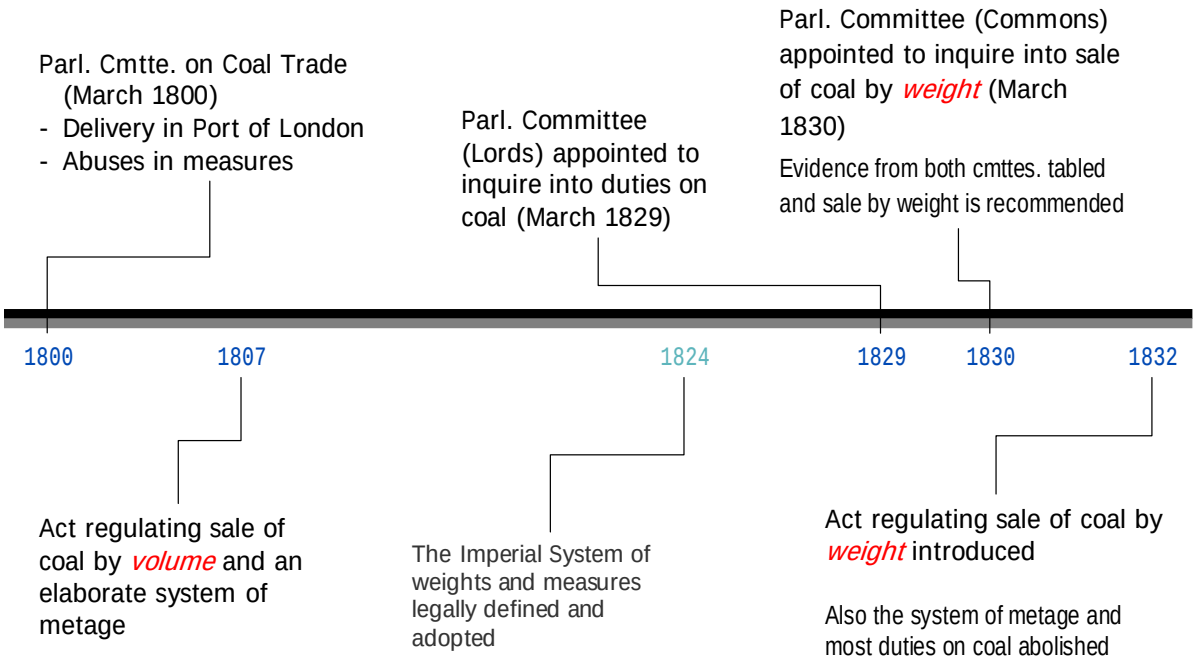
Source: House of Commons Report, *PP 1830 Vol. VIII*, Appendix nos. 24 & 25

Thus, the variation in quantity estimates could have been the result of converting the quantities from NCh to LCh or due to heaped measurements. Does historical evidence suggest that quantity variations due to these reasons were significant? Analyzing data regarding certified quantities in NCh in comparison with quantities measured in LCh across 22 voyages shows that on an average the ratio used to convert from NCh to LCh was 1:2.03, with a small variation of about two percent. An analysis of further 74 voyages, controlling for the individual ship, initial quantity and type of coal, shows that the extent of variation due to possible differences in the density of coal was less than four percent (see appendix for analysis). At the same time, considerable negative variation in the quantities certified and actually delivered on individual voyages is noticed, reflecting the normal business risks of transporting bulk goods via sea voyage. Notwithstanding deliberate under-reporting to avoid duties, this negative variation is likely to have outweighed any increase in volume due to density variation.

In London, apart from heaped measurements, variation in quantity could also be the result of withholding the 'ingrain', i.e. delivering by a score of twenty instead of twenty one units. My calculations show that a merchant, by withholding the ingrain or providing a substantially reduced heap, could give approximately one-fourth less quantity to the buyer than was expected by law and custom (see appendix). Empirical evidence to confirm this is not easily available. However, comparing instances of measurement frauds reported in 1800 shows that the extent of short-measure could be as low as five percent and as high as thirty-three percent in individual cases.[49] Thus, assuming that the proper physical artefacts were used to measure the quantity, the merchant sellers could still provide a substantial short-measure to the buyers. The question is why this became of relevance in the early nineteenth century. After all, if heaping was an old customary practice then such variability in quantity must have been expected if not accepted. Contemporary attitudes could be summed up in this remark: 'I buy all other articles by number, measure or weight, except these coals [is it] too much trouble to obtain satisfaction, that I am supplied with fair measure…I have no faith in the guessing work of the coalmen'.[50] By 1800, measurement problems in the London market became important enough to have formed the subject of two major parliamentary reviews, the first between 1800 and 1807 and the second between 1828 and 1832 (figure 3).

[49] Report on Coal Trade (1800). See Appendix Nos. 34 & 37.
[50] Letter to the editor of *Times*, dated 13 Feb. 1824.

Figure 3: Timeline: Review and Reform of the London Coal Trade (1800-1832)



II

In March 1800, a parliamentary committee was appointed to investigate the problems in the measurement, carriage and delivery of coal, along with other issues such as the combination between coal owners and the reasons for the disruption in supply of coal. The committee submitted a report after interviewing coal owners and merchants, ship-owners, factors, meters, large purchasers, market clerks and city officials, etc.[51] Whilst summarizing the 'principal evils' affecting the trade, the committee concluded that the practice of 'loading bare' (i.e. withholding the ingrain) and heaping were identified as important reasons for the measurement problems. The report stated that such frauds were committed either due to the inattention or with the connivance of the meter. It further stated that the payment to the meter was 'optional with

[51] Report on Coal Trade (1800), p. 538.

the ship owner' and often related to how satisfactorily the measurements were made by the meter. The committee further concluded that sacks were often filled without measuring by the bushel or were deliberately filled short of the proper measure of three bushels. The meter's office was considered ineffective in detecting offences the committee suggested that the land meters be abolished, with the consumers themselves being responsible for re-measurements of coal delivered, if desired, using the existing bushel measure.[52]

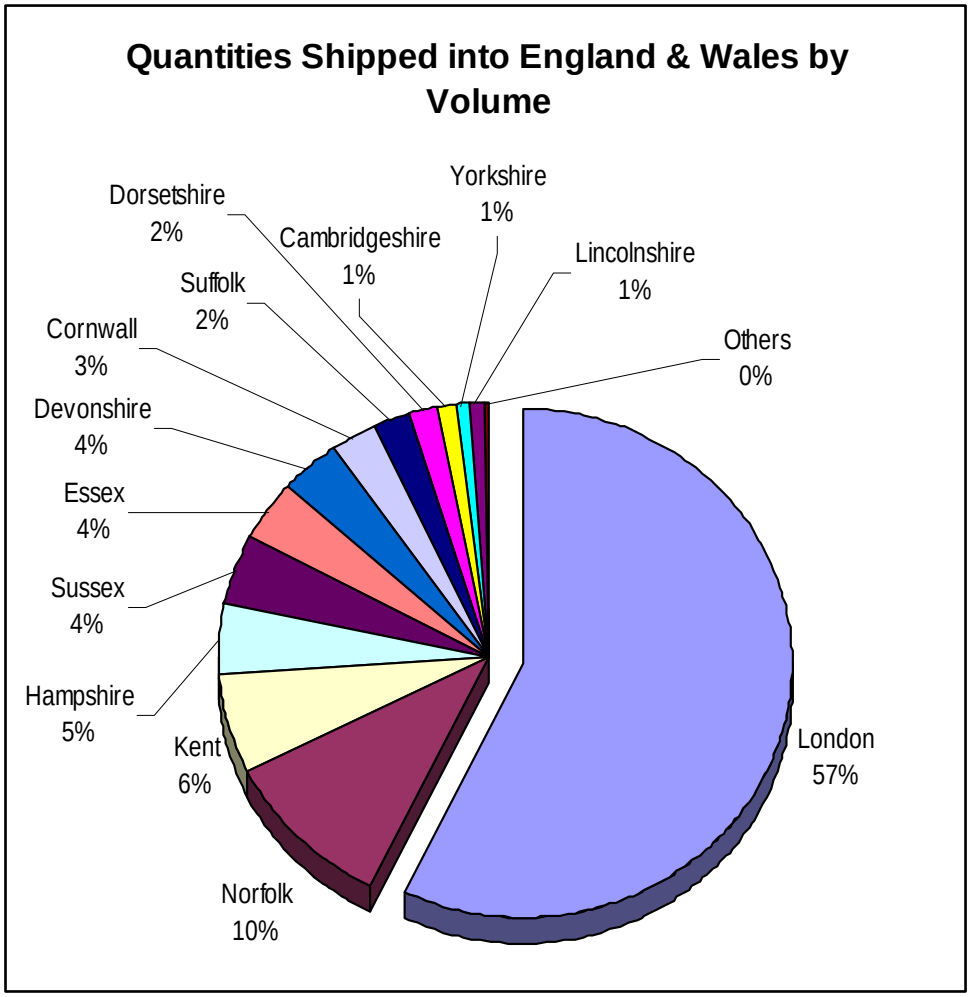
In response, the parliament introduced the statute of 47 George III, C.68 in 1807, which replaced all previous legislation regarding the delivery of coal. It was intended to iron out most of the problems facing the trade through increased regulation. For instance, the dimensions of the coal sack, the bushel measure, the dimension of the heap, etc. were specified by the act. The legislation further stated that coals could be sold either by volume or weight and the units used for the measurement by weight were also specified. Several customs and rules surrounding the quantities measured and delivered were re-enacted, made explicit or formalized into regulation; for example, the minimum number of chaldrons that could be sold on the coal exchange, the delivery of coal into barges using the ingrain, regulations regarding the re-measurement of coal if demanded by the customer, etc. were all specified in the act. The state also attempted to regulate the compensation structure of the meters; by specifying the wages and compensation to be given to the meters under various circumstances and regulated the giving of gifts to the meter.

However, the measurement infrastructure of the trade was left virtually unchanged – the measurement artefacts in use were the same, the monitoring technology in use remained largely unaltered and the rules and customs that were formalized were mostly based on long usage. It also left the choice of the measurement standard to the market i.e. sale

[52] Ibid., pp. 642-3.

by either volume or weight. The trade was free to choose either standard. Nevertheless, the bulk of the coal continued to be delivered using the volume measure, whilst a tiny proportion – mostly transported by canal and some coal brought coastwise from Scotland – was sold by weight (fig. 4).

Figure 4: Quantity of Coal Shipped into England (1829)
Source: Customs Returns, PP 1830 Vol. XXVII p. 131

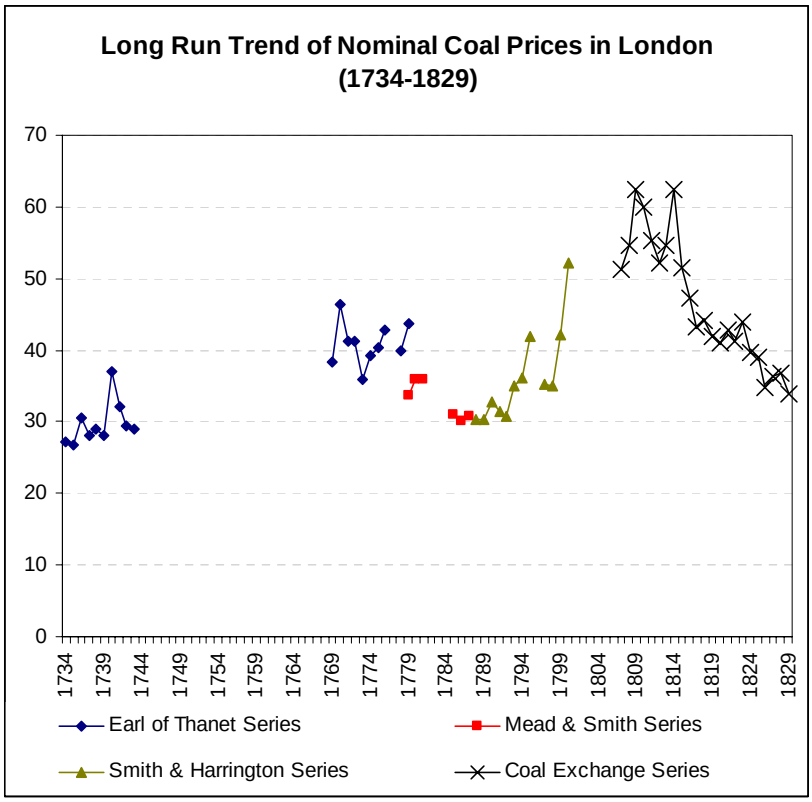


Quantity of Coal shipped Coastwise during 1829	**Volume vs. Weight**	
	Duty charged by Weight *Tons*	Duty charged by Volume *Chaldrons*
Total for England and Wales	210,495	2,706,828 (3,451,205)*
Quantity shipped into London	265	1,548,170 (1,973,916)*
* Equivalent figure in tons assuming 1 chaldron = 25.5 cwt and 20 cwt = 1 ton		

For nearly two decades thereafter, throughout the European war, things lay simmering below the surface. The quantity of coal shipped into London increased by about one-half in the first quarter of the nineteenth century.[53] There were occasional letters to the newspapers complaining about the continuing shortage of stocks, high-price of coal, measurement frauds, and short-measure.[54] After 1824, the trade in London once again began exciting comment and became the subject of public debate.[55] Part of the reason for this could be the fluctuating nominal price of coal between 1790 and 1825 (fig. 5). Others took this opportunity to point out the ineffectiveness of the meters in ensuring proper measurements.[56] In March 1826, a petition was made to the City of London which listed several ways in which the meters themselves hindered the measurement and delivery of coal.[57] Although, the allegations were initially dismissed, the petitioner appears to have been persistent and we find that in 1828 he continued to petition the Corporation of London.[58] Circumstances apparently demanded a fresh look at the London trade as many of the problems, that the 1807 reform had hoped to resolve, were recurring.

[53] PP 1826-27 Vol. XVIII, p. 495.
[54] Letters to *Time*s, London; 14 Aug. 1802; 5 Nov. 1804; 17 Oct. 1818; 19 & 20 July 1822; 13 Feb. 1824; 17 Feb. 1824, etc.
[55] See *Times*, London; letter to the editor dated 3 Feb. 1824, and a subsequent reply on 14 Feb.
[56] *Times*, London; 4 Jan. 1826; 26 Mar. 1827; 24 Aug. 1827; 29 Sep. 1829.
[57] Minutes of the court of common council, 1826-28, London, Corporation of London Records Office (CLRO), Common Council Reports, COL/CC/04/01/007. Entry for Mar. 16, 1826 referring to petition by Thomas Bradfield.
[58] Ibid. Entry for 24 Jan. and 21 Feb. 1828.

Figure 5:



Source: Data reported in various Select Committee Reports on the Coal Trade. The price series have been constructed as follows:

1. Data for Earl of Thanet series was taken from the trust accounts of the charities of Thomas, Earl of Thanet, containing average price paid annually for 100 chaldron of coal. (Appendix No. 13 of the select committee report of 1800, p. 588)
2. Mead & Smith series was constructed using data on the quantity of coal bought by the company of Mead and Smith on the Coal Exchange in London (Appendix No. 15 of the select committee report of 1800, p. 589)
3. Smith & Harrington series was constructed using data on the quantity of coal consumed at the Smith and Harrington Corn Distillery in Old Brentford, Middlesex (Appendix No. 16 of the select committee report of 1800, p. 589)
4. The Coal Exchange series was constructed using published selling prices of coal for the 1st day of each month from January 1807 to May 1829 on the Coal Exchange. Where possible the published prices for the Russell Wallsend variety of coal have been used (Appendix No. 7, PP 1830 Vol. VIII, p. 184-274)

Thus, in early 1828 we find the Corporation of London preparing to petition the parliament to alter the 1807 Act. An internal report from this time states that 'the provisions in the Act relating to coals sold by Pool measure, being inadequate to prevent fraud in the delivery of coals, it is expedient that they should be altered and amended and all coals measured by the Bushel'.[59] However, as the current session of the parliament was drawing to a close there was insufficient time to introduce a bill with these changes and the matter was adjourned.[60] In May 1828, the prime minister, Arthur Wellesly, the duke of Wellington, asked the mayor of London to inquire whether duties on coal brought into the port of London could be reduced.[61] As a result the Corporation formed a committee to investigate this possibility. The committee swiftly took the matter ahead and within a week held preliminary meetings with several prominent factors and coal merchants.[62] By June, the committee had reached the following conclusion:

> the public do not obtain that security in respect of coals [by] the appointment of [land meters] and in case the same were abolished the public would be better protected against fraud by looking to their own interests than by placing a reliance upon such uncertain and doubtful security.[63]

In July 1828, the committee further stated that a direct saving of at least six-pence per chaldron could be made by abolishing the land meters.[64] In this manner, it seems the corporation was hoping to help solve two problems – a reduction in the charges on coal, and the continuing problem of ineffective meters. Monitoring the meters was an on-going

[59] Ibid. Entry for 21 Feb. and 13 Mar. 1828.
[60] Ibid. Entry for 20 Mar. 1828.
[61] Ibid. Entry dated 23 May 1828, suggesting that Treasury officials were also present at the meeting.
[62] Minute book of the committee on charges upon coals, 28 May 1828 - 26 Oct. 1831, London, CLRO, Common Council Committee Papers, COL/CC/MIN/01/014 Misc. MSS 241.10 (1/3). Entry for 28 May 1828.
[63] Ibid. Entry for 19 June 1828.
[64] COL/CC/04/01/007, CLRO. Entry for 8 July 1828.

problem, as is evident from the various reports of the principal land meters. For instance, one memo states that '…the occurrence of minor offences among the labouring meters has of late been so frequent as to produce great inconvenience to the respectable Merchant and not seldom, considerable loss to the Public".[65] The memo lists the offences including absence from duty, drunkenness, making erroneous returns, giving short-measure, etc. and for which, the principals argue, there is no effective remedy. Thus, abolishing the land metage system was seriously considered by the corporation and this recommendation was made to the Treasury in July 1828.[66]

Around this time, the Committee of the Society of Owners of Coal Craft[67] had also made specific proposals to the Corporation for amendment of the metage system, including a recommendation to 'add a triangle gauge to determine the cone and allow the bushel to be put in a conspicuous place…in, under, or in the side of the waggon or cart'.[68] These merchants, together with the factors, further petitioned the Corporation in March 1829 to suggest that the existing coal laws be altered and that appropriate amendments made to the metage system.[69] Thus, by early March 1829 the merchants, factors and the Corporation had decided that the land metage system needed to be either reformed or abolished.

Meanwhile, the coal owners had begun to campaign for the reduction of duties on coal sold in London. The reason for this is likely to have been the threat of increased competition from other coal producing

[65] Papers of the committee on coal and corn meters, Jan. 1829 - Jul. 1830, London, CLRO, Coal and Corn Committee Papers, COL/CC/CCN/03/012. Entry for 1 Oct. 1829.
[66] COL/CC/04/01/007, CLRO. Entry for 8 July 1828.
[67] Comprising of the coal merchants of the City of London and likely to have included most of the first buyers; Dale, *Woodmongers*, p. 80 & 96.
[68] Papers of the committee on charges upon coals, 1828-31, London, CLRO, Common Council Committee Papers, COL/CC/MIN/01/014 Misc. MSS 241.10 (2/3). Undated memorandum.
[69] Minutes of the court of common council, 1829-30, London, CLRO, Common Council Reports, COL/CC/04/01/008. Entry for 12 Mar. 1829.

regions, which had a much lower duty structure compared to the trade from the north-east.[70] On 24 March 1829, the marquis of Londonderry called for a committee 'to take into consideration the whole state of the coal trade, and to ascertain how far the high prices were affected by the taxes [on coals]'.[71] The importance of this committee is that the feasibility and the desirability of the sale of coal by weight in London was extensively discussed. Robert Brandling, coal owner and Chairman of the Coal Committee at Newcastle, told this committee that the 'the way in which [coals] are sold here, by heaped measure, is a most uncertain mode of ascertaining the quantity of coals sold to the consumer, or the quantity on which government duty is paid; and that the only accurate measure is by weight'. John Buddle, the colliery viewer, stated that

> the coal would be sent in a better state to market if it was sold by weight …the revenue [to the government] would be better protected than it is at present…and that the duty would be more accurately ascertained by weight than by measure.[72]

William Dickson, comptroller of coal duties in the port of London, testified that a majority of the bulk goods arriving in London were charged duties on the basis of weight. This included goods such as sugar, cotton, hemp & wool, etc. He further observed that 'any [duty] taken by weight must of course be taken more accurately than any [duty] taken by heaped measure, as far as accuracy is concerned'.[73]

The Corporation of London, meanwhile, continued to pursue its own inquiry into the duties on coal. In March 1829, another internal report stated that:

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[70] Paul M Sweezy, *Monopoly and competition in the English coal trade: 1550 - 1850* (Cambridge, MA, 1938), pp. 52-3.; Smith, *Sea-coal*, pp. 158-62.; Flinn, *Coal Industry*, p. 26.
[71] Debate on coal trade, 24 Mar. 1829, London, Hansard Parliamentary Debates, New Series, Feb-Mar 1829, pp. 1409-13.
[72] Report from the committee on coal trade, 1829, London, JHL 61. Evidence of John Buddle (8 May 1829).
[73] Ibid. Evidence of William Dickson (20 May 1829).

> in order to afford the Public the means of protecting themselves against fraud…the purchaser of the coals, if dissatisfied with the appearance of the coals as to their measure, should be allowed to refuse to receive the same or to have them measured by the Carman…in the presence of two credible witnesses, one of whom should be a constable or Police Officer, and for that purpose every cart or waggon should have in some conspicuous part thereof a perfect legal bushel measure, with a triangle to define the proper height of the cone, and that the penalties…should be made recoverable before a magistrate.[74]

Thus, at the time that the coal owners were recommending the sale of coal by weight, the city merchants and the Corporation continued to seek ways of improving the existing volume measurement standard.

However, opinions within the Corporation seem to have changed by early 1830. In February 1830, Thomas Reeve and John Bumstead, the two Principal Land Meters of London, reiterated that there was 'more fraud in the Pool measure than on the Land [wharf] measure' and that 'the merchants [were] not sending the whole quantity'.[75] This implied that all the previous proposals about regulating the bushel measure and re-measurement by consumers would be inadequate if uncertain quantities continued to being sent from the colliers onto the wharves. Consequently, they recommended that weight measures would be a better method of estimating accurate quantities. Having made the decision to lobby for the abolition of the land meters, the Corporation from this point onwards became engaged in switching the trade to the weight standard. This assessment can be supported by the fact that immediately following the meeting of the two Principal Meters, corporation officials met with Richard Trevithick, the engineer and inventor, to discuss his recent innovation of a

[74] COL/CC/04/01/008, CLRO. Report dated 31 Mar. 1829.
[75] COL/CC/MIN/01/014 Misc. MSS 241.10 (2/3), CLRO. Memorandum dated 19 Feb. 1830.

portable steam engine for weighing coals.[76] Incredibly, there appears to have been no technology available for weighing coals on the colliers before being delivered onto the barges. This is confirmed by a copy of an advertisement that the corporation placed in the London newspapers in 1831 announcing a competition with a reward for the engineer that proposed a practical and portable machine for weighing coals.[77] It elicited an enthusiastic response with the Corporation receiving as many as 23 proposals.[78]

In February 1830, while the London merchants continued to lobby for an amendment in the coal laws[79], the Corporation officials once again met with the prime minister and treasury officials. At this meeting it was established that another parliamentary inquiry was necessary to 'enquire into the state of the Coal Trade and the system of Land Coal Metage before any change was made in the present law'.[80] A committee, appointed on 11 March 1830 to 'see if another method of selling coals…by weight instead of measure, might [be] of advantage to the public'[81], submitted its report in July 1830. The report concluded that the measurement problems lay not in effective monitoring but rather the manner in which measurements were made. The report stated that 'when coal of all sizes is to be placed in the bushel and piled in a conical form on the top, it is not easy to define when a bushel is full'.[82] This problem, the report concluded, could be solved if coal were to be delivered by

[76] COL/CC/MIN/01/014 Misc. MSS 241.10 (1/3), CLRO. Entry for 27 Feb. 1830; the committee also meets with other experts as per entry for 15 Mar. 1830.
[77] Papers of the committee on coal and corn meters, Sep 1830 - Dec 1831, London, CLRO, COL/CC/CCN/03/013. Copy of advertisement, dated 20 Apr. 1831. Also COL/CC/MIN/01/014 Misc. MSS 241.10 (1/3), CLRO. Entry for 16 April 1831.
[78] COL/CC/CCN/03/013, CLRO. Memorandum dated 26 May 1831.
[79] COL/CC/MIN/01/014 Misc. MSS 241.10 (2/3), CLRO. Letter by William Horne dated 9 Jan. 1829.
[80] Ibid. Report dated 1 Feb. 1830.
[81] Debate on coal trade, 11 Mar. 1830, London, Hansard Parliamentary Debates, New Series, Mar-Apr 1830, pp. 223-4.
[82] PP 1830 Vol. VIII, p. 10.

weight, and not by volume. Another reason why the sale by weight was preferable, according to the committee, was that it would 'diminish the inducement to [the] extensive system of breakage'.[83] The committee here was referring to the system of screening of coal and the deliberate breakage of coal during transportation with intent to increase the volume measure of cargo of a given weight (discussed earlier). Although, empirically the extent of variation due to breakage and variable specific gravity was likely to be quite small (see appendix), the committee nevertheless suggested that this issue was a problem that could be solved by a switch to sale by weight.[84]

In the months following this parliamentary review, the Corporation of London sent a petition to the House of Commons in November 1830 urging them to consider the repeal of the 'obnoxious tax' on coal, which is a 'grievous burden upon all inhabitants of the metropolis'.[85] It even tried to rustle up support from the parishes around London by urging them to petition the parliament to repeal the coal tax.[86] In October 1830, the coal merchants and factors petitioned the mayor of London to urge the parliament to make various changes to the coal laws in light of the report by the parliamentary committee, particularly the repeal of the various changes and duties as recommended in the report.[87] Meanwhile, the coal owners were keen to avoid being blamed for the price of coal in London and to avoid any anti-combination legislation targeting them. They attempted to create public awareness through a nineteenth-century version of public relations and media campaigning. Editorials appeared in the newspapers in the north claiming that the measurement practices in

[83] Ibid., p. 13.
[84] Compare table on p. 12 with Appendix No. 13 in Ibid.
[85] Papers of the Court of Common Council, 1830, London, CLRO, COL/CC/06/01/0357/1. Petition dated 25 Nov. 1830.
[86] COL/CC/MIN/01/014 Misc. MSS 241.10 (2/3), CLRO. Memorandum dated 9 Dec. 1830.
[87] COL/CC/04/01/008, CLRO. Entry for 30 Oct. 1830.

London were responsible for the high price of coal. The following extract from the *Newcastle Courant*, reprinted in *The Times*, is illustrative.

> practices in use in the Port of London [will appear] almost incredible to persons not conversant with the coal trade…[especially the] method by which the sworn meters on the Thames make a vessel deliver great or short measure, according to the extent of the fee given to them…when coals are measured, they can be heaped in such a manner that the measure shall appear just what it may please the will of the meter…the consequences of [the substitution of weight for volume] cannot be otherwise than beneficial, since not only will the price of coals in the south be much reduced, but the shipping interest of the north will be benefited, in its relief from a system of fraud and delay, of which it was principally the victim.[88]

Earlier in the year, other similar articles and editorials had also appeared. The *Durham Chronicle* had written that 'were coals sold by weight instead of by measure, the change would produce considerable relief to the consumer, and would suffer the coal-owner to lower the price, by enabling him to do away the wasteful practice of screening at the pit.'[89] An article in the *Edinburg Review* remarked 'though the attention of honourable gentlemen has been repeatedly called to the easy method of defrauding…it does not seem ever to have attracted the smallest portion of their concern. They have continued…to occupy themselves in stopping up the spigot, while the liquor was running out at the bung-hole.'[90]

The treasury and the customs offices, anticipating the changes in the coal laws, recalled the customs officials from the meter's office and began reporting monthly coal statistics in tons rather than chaldrons.[91] In August 1831, legislation reducing the duties on coal was introduced.[92] Shortly thereafter, in October 1831, the laws regulating the coal trade in

[88] Extract from the *Newcastle Courant* as appearing in *Times*, London, 30 Oct. 1830.
[89] Extract from *Durham Chronicle* as appearing in *Times*, London, 15 Feb. 1830.
[90] 'On the coal trade', *Edinburgh Review*, 51 (1830), pp. 176-93, at pp. 180-1.
[91] COL/CC/CCN/03/013, CLRO. Letter from Custom House, dated 21 Apr. 1831.
[92] Act to discontinue duties upon coals, 1831, 1 & 2 William IV C.16.

London were altered by the legislation, which abolished the metage system and directed that coals had to be sold in London by weight and not by volume measure.[93] Not everyone welcomed the switch to the weight standard. William Russell, the expert engineer appointed by the Corporation of London to evaluate the designs for weighing machines, preferred the volume measure rather than the weight measure, as the wetting of coals was likely to distort weight. He claimed that no weighing machine could accurately measure quantity by weight or prevent frauds in measurement due to this basic physical property.[94] This was echoed by another observer, writing anonymously, who also stated that the recommendation to switch to the sale by weight was in the interest of the trade – specifically the coal owner – and not the public.[95]

Why did the committee ignore this issue of wetting of coals in their report? During his testimony to the committee, William Horne had related the results of an experiment where he had taken eight samples of different types of coal, small as well as large, all of a constant weight of 2*cwt*, which were put into wet sacks and watered. Weight of each sample was taken immediately after wetting, again after one hour, three hours and finally after six hours. His readings showed that small coals seemed to increase in weight much more than larger coal, and that the weight of all samples after six hours had increased between one and seven per cent. Other witnesses testified that merchants tended to wet coals, to keep down dust levels, and that this practice tended to increase the weight of coal.[96] Even so, most agreed that detecting wet coals was relatively simple and that only very wet coals would retain a substantial

[93] 1 & 2 William IV C.76.. The Land Meters office was abolished, but technically the act only suspended the city's right to measure coal for seven years which actually was not renewed; see Smith, *Sea-coal*, p. 319.
[94] COL/CC/CCN/03/013, CLRO. Report by William Russell dated 9 Jun. 1831.
[95] 1831, London, Letter to Lord Althorp (Chancellor of the Exchequer), Guildhall Library Collection, A8.4 (4/70).
[96] PP 1830 Vol. VIII. summary of experiment by William Horne (90); also, evidence of William Turquand (68) and William Lushington (81).

amount of water weight. As a result the committee did not consider this issue to be a serious problem in the context of switching to a weight standard.

III

The review of 1828-31 resulted in at least three big changes in the London coal trade: the public metage system was abolished; the customary practice of heaping in the measurement of coal was made unlawful; and a *de facto* measurement standard was replaced with *de jure* measurement standard. Abolishing the public metage system made a fundamental change in the mechanism that ensured transparency in transaction. The emphasis shifted from a process-based mechanism, requiring personal discretion, to an artefact-based mechanism, where the measurement units were supposed to be less discretionary and therefore more objective. Heaped measurements were acknowledged as the source of great uncertainty in measurement quantity, as they depended upon personal discretion. By switching measurement standards the ambiguity of the heaped quantity was replaced by the relative transparency of the weight measure. Eventually, by 1836 heaped measurements for all dry goods were abolished in the country.[97] The LCh and the coal bushel were no longer used as measurement standards and the ton and the *cwt*, which had become recognized as Imperial units of weight in 1824, replaced these ancient customary units. These were the institutional changes that occurred in the measurements used in the London coal trade.

How can we explain these changes? Consider first the reasons behind the abolition of the public metage system. One explanation is that the Corporation of London was faced with the problem of monitoring its

[97] 5 & 6 William IV, C.63.

‘agents’ i.e. the coal meters. Fifteen principal sea meters were appointed by the City of London to supervise nearly 150 deputy sea meters. Similarly, two principal meters each for London and Westminster and about four for the county of Surrey supervised the work of between 30 and 40 labouring land meters in each district. As discussed earlier, there is evidence that the principal meters very often had trouble monitoring the effort and commitment of the other meters. The remuneration of the meters was fixed by the 1807 legislation. For instance, the deputy sea meters, monitoring the measurements on the colliers, were paid one penny per LCh or about a quarter of the revenues to the Corporation. On the other hand, land meters were paid a fixed wage per week of up to 28 shillings in London, or less if light work was involved, while those in Surrey were paid between 12 and 20 shillings a week, or less than 8 shillings if working occasionally.[98]

Thus, the sea-meters had an incentive to collude with the first buyers to provide short measure as it led to a direct increase in their earnings. As far as the land meters are concerned, their earnings were not directly based on how much quantity was measured out. It is therefore not clear what incentive the labouring land meters would have had to collude with the sellers or that they needed to supplement their income from this occupation. Many of them in fact had other occupations as publicans and small shopkeepers, which may partly explain why so many instances of absenteeism were reported among the meters. The merchants and factors constantly complained about the delays caused in deliveries or in ship-turnaround due to absence of meters. The Corporation responded to these complaints by increasing the number of land meters. Thus, two sets of problems could be identified. The first being the incentive to collude with the seller and provide short measure to the buyer. The second problem area, more likely to be associated with

[98] PP 1830 Vol. VIII. Appendix Nos. 8, 11, 16, 20, & 21.

the land meters, is the problem of absenteeism that created delivery bottlenecks. Errant meters were disciplined either through prosecution, fines or wage reductions. However, these methods were not always successful.[99]

The Corporation had a more important reason to reform the land metage system. Revenues from the charges collected by the sea meters were substantial. After deducting payments to the sea meters and other expenses, (maintenance, rent, management costs, etc.), nearly two-thirds of the sum could be transferred to the general account of the Corporation of London as revenue. In 1829, this surplus sum amounted to more than £17,000 on metage revenues of £26,559. The revenues from metage charges collected by the land meters just about covered their wages and salaries, and the city was generating very little revenue from this duty, (in 1829, the City of London faced a deficit of £666 on a metage revenue of £4,962). [100] Consequently, the whole elaborate system of land metage just was not worth it from the City's point of view.

Yet another reason for the abolition of the metage system revolves around the political economy of the price and taxes on coal. There were two opposing views on the perceived high retail price of coal in London. One view, held by most consumers in London, was that high price of the commodity was a result of combination and monopolistic practices of the coal owners. The other view, held by the coal owners, was that the price of coal was a result of the numerous duties and charges on the commodity sold in London. In fact, supplies from the northeast to London via the coastal route were subject to a unique tax known as the 'Richmond shilling'. The charges in London amounted to nearly 13*s* 9*d* per LCh, when the merchant paid about 35*s* per LCh on board the collier. In comparison, the coal-owner received about 15*s* per LCh before the

[99] COL/CC/CCN/03/012, CLRO. Letter by principal meters dated 1 Oct. 1829.
[100] PP 1830 Vol. VIII. Appendix Nos. 8, 10, 11 and 12.

coal left the northern ports.[101] Historians agree that of the two, the duties and charges on coal were more likely the cause of high retail prices than the monopolistic activities of the coal owners.[102] The coal owners were politically far more powerful than either the London merchants or the consumers. By 1828 they were able to put sufficient pressure on the government to get them to review charges and duties on bringing coal to London. The taxes on coal were fiscally very important to the government yielding the exchequer over £1,000,000 to the government's total revenue of £58.1 million in 1820, whereas the corresponding figures for 1789 were £552,000 and £16.7 million respectively.[103] Nearly half the revenue from taxes on coal was contributed by the London trade.[104] Nevertheless, the treasury, who was involved throughout the review process, did not resist the attempts to reduce the charges from coal. Along with the other duties on coal, the land metage on coal was also reduced, which the Corporation of London was willing to forego by abolishing the entire system of land meters. However, it is unclear just how willing the Corporation was to give up the metage collected by the sea-meters. It is hardly likely that the Corporation would have been content to forego that revenue even if confronted with problems of supervising the sea-meters.[105] From the correspondence and other papers, it seems that the Corporation was not expecting the abolition of the sea meters system, which was nevertheless suspended by the 1831 legislation.

Moving on to the reasons behind the abolition of the heaped measurements and the standard-switching, it is difficult to separate out

[101] Ibid., pp. 9-10.; COL/CC/MIN/01/014 Misc. MSS 241.10 (1/3), CLRO. Entry for 28 May 1828. COL/CC/04/01/007, CLRO. Report dated 8 July 1828. Also Flinn, *Coal Industry*, pp. 279-85.
[102] Thomas S Ashton and Joseph Sykes, *The coal industry of the eighteenth century* (Manchester, 1929), p. 224.; William J Hausman, 'Cheap coals or limitation of the vend? London coal trade, 1770-1845', *The Journal of Economic History*, 44 (1984), pp. 321-8, at p. 327. Also Sweezy, *Monopoly and competition*, pp. 140-5.
[103] Flinn, *Coal Industry*, p. 284.
[104] COL/CC/06/01/0357/1, CLRO. Petition dated 25 Nov. 1830.
[105] COL/CC/04/01/008, CLRO. Entry for 3 Sep. 1830 and report of same date (pp. 5-6).

the decisions and reasons behind each change. Simply eliminating the meters, which acted as delegated monitors on behalf of the ultimate consumers as well as the state, could have resulted in imperfect monitoring of measurement quantities. But, by switching the measurement standard from volumetric units to units of weight, thereby making the heaped measure redundant, the state hoped to alleviate the many issues arising from measurements. This made monitoring the quantity of coal delivered much simpler and short-measurements by the seller easier to detect. Thus, public monitoring was no longer considered to be necessary and in fact became redundant with the switch.

But why was it considered necessary to switch to a weight standard in order to solve the problem of monitoring measurements with the abolition of the metage system? Abolishing heaped measurements would have significantly reduced the monitoring effort without changing the measurement standard. Indeed, there were no demands from the London merchants or the public to change to a weight standard in lieu of a public measurement system. To explain this, we must once again consider the coal owners who were lobbying to reform the trade in London. They argued that the volumetric measures were perpetuating measurement frauds leading to price increases and suggested that a switch of measurement standards to weight units would reduce these problems. Similar arguments were subsequently taken up within the Corporation of London where the change of measurement standards was seen to resolve the problem of monitoring measurements once the public metage system was abolished. The corporation thus sought to replace one method of ensuring transparency in measurements, the public metage system, with another method – one that reduced the degree of personal judgement required of the measurer every time coal was measured. It is striking that just such a suggestion was made by the Carysfort Committee in its second report in 1759 where they stated that “the most obvious and

natural method, of discovering the quantity of such commodities [i.e. dry goods] is manifestly by weight…', while at the same time acknowledging that changing this general practice may not be straightforward.[106] It would be nearly seventy years before such a change was first made in the case of coal, and extended more generally to other dry commodities in 1835.

If this interpretation is true, it raises a further question. Why did the trade in London not voluntarily switch from volume to weight particularly when, if we recall, the choice of the measurement standard was left to the market? One reason could be that the first buyers, benefited from the ambiguity arising from the heaped measures. They had no incentive to switch to weight standards, particularly since there do not seem to be any large variation in quantities when converting from the weight to volume. Moreover, for the switch of standards to be most effective a significant majority (if not all) of the first buyers would have had to switch over to using weight standards. This would have involved overcoming major coordination issues between the merchants. Admittedly, the cost of switching does not appear to be very large when compared to the duties and charges that the trade paid to the state annually. For instance, although there are no estimates available of the cost of switch-over, we get an impression of the scale of investment required by examining the expenditure on machinery and equipment incurred after 1832 by the trade. The machinery and equipment needed to make a switchover included weights and scales, beams to support them and shoots (chutes) to deliver the coal from the colliers once they were weighed into the barges. In February 1833, it was reported that the total outlay for machinery, new barges and furniture for the previous year amounted to about £2,946 and the expenditure due to wear and tear (depreciation charges provided for) were about £862. By May 1834, the capital stock in

[106] Second report of the committee on weights and measures, 1759, London, House of Commons Reports (1738-65) Vol. II, p. 456.

terms of barges, shoots, beams, weights, sundry boats and office furniture amounted to £2,312.[107] In comparison, the trade had paid over £ 26,000 annually as metage duty to the Corporation of London around 1830.[108] This seems considerably larger compared to the expenditure on equipment required for switching measurement standards.

Although lumpiness of investment may not have been a source of co-ordination problems, lack of effective mechanisms to eliminate free rider problems may have prevented the switching of measurement standards. On the whole, it appears that the first buyers simply had no incentive to move from the volumetric units to weight units. But what about the second buyers, dealers and consumers; did they not have an incentive to switch to measurements by weight, particularly since the first merchants were liable to provide short-measure? The collective action problem may have been acute in this case, where the second buyers lacked the cohesiveness and even the political power to insist on a change of standard. Unlike the first buyers, who were organised into the Society of Owners of Coal Craft, the smaller merchants and consumers do not appear to have been similarly organized. It seems unlikely then that the market in London was willing or able to make a switch to measurements by weight. It was only with the reform of the public metage system and the pressure from the coal owners and the Corporation of London that the coordination problems for switching standards were overcome.

Interestingly, even though the first buyers had no incentive to switch measurement standards, they certainly found the mechanism of

[107] Reports of the sub-committees - Vol 1 (1831-1834), London, Coal Meters Committee (CMC), MS 10162. Report of the Subcommittee for superintending weights, etc. dated 26 Jan. 1832. Report of Subcommittee on beams and scales, etc. dated 13 Dec. 1831. Report of the River Committee dated 4 Sep. 1832. Report of the River Committee dated 12 Feb. 1833. Report of the Finance Committee dated 13 May 1834. Reports of the Finance Committee dated, 7 Aug., 6 Nov. and 4 Dec. 1832.
[108] Account of duties charged on coals in London, 1833, London, PP Vol. XXXIII.

'delegated monitoring' useful. This is supported by the fact that immediately following the abolition of the *public* meters in 1831, the first buyers decided that it was indispensable to appoint *private* meters. These acted as delegated monitors on behalf of the first buyers and the cost of this service was shared equally between the factors and the first buyers.[109] The private meters continued to be employed throughout the nineteenth century, although it is thought that their importance diminished gradually as technological improvements made mechanical or instrumental monitoring easier.[110] This desire to appoint private meters at first seems contradictory to the support of the first buyers to abolish the public metage system. However, it is likely that the merchants felt the need to have a monitoring mechanism that they would control, once the advantages accruing to them from the ambiguous London chaldron were nullified by the switch to weight standards. Additionally, the private meters most likely performed a broader supervisory role in the delivery of coal, rather than just a narrower monitoring function. These events suggest that the different social groups within the market had different concerns regarding transparency in transactions. They sought different solutions, not only according to their specific needs, but also in terms of their relative power.

IV

In this paper, we have seen that measurement facts traveled across at least two domains. The first instance was the 'fact', traveling from one social group to another, that weight measures were a more transparent way of ensuring standardized quantities in the delivery of coal

[109] Minutes of the coal meters committee, London, CMC, MS 30679. Minutes for 11 & 15 Oct. 1831, and for meetings between 22 Oct. and 13 Dec.
[110] Smith, *Sea-coal*, p. 319. Improved methods included automatic weighing during delivery either by derricks or hydraulic cranes.

than volume measures. The second instance was the travel of specific measurement standards, from the legal or metrological domain to the occupational or market domain of the London coal trade. This occurred when the ‘ton’ and the ‘hundredweight’ replaced the London chaldron and the coal bushel as the measurement units for the delivery of coal. This case of the London coal trade suggests that the travel of facts, i.e. the metrological changes in the early nineteenth century, were driven by complex factors. Beneath the veneer of continuity lay the turbulence of negotiated change. Older societies employed different mechanisms, other than standardized quantities, to ensure transparency in transactions; the use of public meters in the case of coal and corn in London is one such example.[111] The historical events studied here suggest that newer institutional facts of inflexible, uniform and standardized measurements replaced older mechanisms. Moreover, there was also a shift from context-based measurement units (qualified by occupation or function) to dimension based measurement units (representing the physical properties of objects). This reflects an increasing appreciation of quantities as ‘technologies of objectivity’[112] or increasing trust in measurement artefacts.

Such changing values likely had their origins in the political power wielded by economically motivated groups. The influence of rhetoric is evident throughout the case of measurement standards in the London coal trade.[113] It is useful to reflect on the social groups that valued transparency and the different reasons why they demanded it. Some of those concerns were solved by switching measurement standards, although the coordination to make the switch was not automatically

[111] For another example see James Davis, 'Baking for the common good: A reassessment of the assize of bread in medieval England', *Economic History Review*, 57 (2004).
[112] Porter, 'Objectivity'.
[113] cf. Sheldon, Randall, Charlesworth and Walsh, 'Popular protest'.

achieved by the market. Furthermore, the realization that greater transparency can be achieved by *less* state intervention, rather than greater regulation, is also clearly reflected in these historical events. In this case of metrological change, the transparency in quantities could be ensured not only by changing artefacts but also by altering methods in which the artefacts were used. Measurement standards were part of an institutional package accompanied by rules, regulations and customary practices – a package that was inherently 'sticky' in nature. Switching standards, introducing new ones, or achieving standardization required making changes to this entire sticky package. Thus institutional 'facts' are bounded by other institutional structures: trust, objectivity, social power, etc. In our case, standardized measurements enabled objective, unambiguous facts about coal to be transmitted through the markets.

Appendix

Analysis of Variation in Quantities Estimated by the London Chaldron

Two sources for quantity variation can be identified: conversion from weight units to volume units and the practice of heaping and loading bare (see main text).

Variation due to conversion

If q_n isthe quantity of coal measured in NCh and q_l is the quantity measured in LCh, the relation between the two is $q_l = rq_n$ where *r* is the ratio of conversion, and 0.47 < r < 0.53 (see main text).

Suppose q_n^i is the quantity in NCh of a particular type of coal *i*, and d_i is the density in weight per cubic capacity of coal of type *i*. Since q_n^i is in weight units, its volume equivalent is q_n^i / d_i i.e. weight divided by the density giving volume in cubic capacity units. Thus, quantity in LCh units is

$$q_l^i = r(q_n^i / d_i)$$

An error term ε captures the extent of variation in *r* and d_i from some initial values, say *r'* and d'_i. Thus,

$$q_l^i = r'(q_n^i / d'_i) + \varepsilon$$

The error term is composed of $\varepsilon = \varepsilon_r + \varepsilon_d + \varepsilon_b$ where ε_r is the variation due to the changing conversion ratio, ε_d is the variation due to differences in density of coal, and ε_b is the variation caused as a result of breakage. Under ideal circumstances $\bar{\varepsilon} = 0$.

Analysis of 22 observations (summarized in table2, below) suggests that the variation in quantity due to conversion was very small.

Table 2

Estimate of ratios used to convert quantities of coal from Newcastle Chaldron to London Chaldron

(data from voyages c1827-29 carrying the variety known as Pelaw Main)

Name of Ship	Quantity in Newcastle Chaldrons	Quantity in London Chaldrons		Ratio
		Certified	***Delivered***	***LCh:NCh***
Kate	107	220	225.75	2.06
Kate	108	216	228.75	2.00
Kate	108	216	225.50	2.00
Kate	108	216	229.75	2.00
Kate	107	216	237.50	2.02
Kate	108	216	231.00	2.00
Malta	120	240	270.75	2.00
Malta	114	224	247.75	1.96
Malta	116	232	246.00	2.00
Malta	116	230	248.50	1.98
Malta	116	232	249.75	2.00
Percy	132	272	286.25	2.06
Percy	132	272	288.00	2.06
Percy	132	272	285.75	2.06
Perseverance	85	176	190.00	2.07
Perseverance	85	176	172.75	2.07
Perseverance	85	174	186.00	2.05
Recovery	123	260	270.25	2.11
Recovery	125	256	276.25	2.05
Recovery	125	256	275.50	2.05
Recovery	126	256	269.30	2.03
Recovery	125	256	271.25	2.05

Source: House of Commons Report *PP 1830 Vol. VIII*, p. 12, and Appendix no. 13

In order to test further if the rest of the error term $\varepsilon = 0$ variation within the same voyage and across different voyages controlling for initial quantity, the type of coal and the individual ship was examined. Data, reported in Appendix 13 and the evidence provided by James Bentley

included in the parliamentary report on the coal trade (*PP Vol. VIII*, 1830), comprising of 28 and 46 individual voyaged were analyzed. The details of individual voyages are too numerous to be reproduced here but can be made available upon request. The datasets, however, do not permit a separate estimation of ε_d and ε_b, as to separate out ε_b observations with the same initial specific gravities is required, which was not available. Therefore, we have to be satisfied that the data capture the *combined* variation due to ε_d and ε_b. The overall variation in the first set of 28 voyages was 4% and from the second set of 46 voyages was 2% as summarized in the table below:

Table 3
Analysis of difference between certified quantity and actual quantity of coal delivered from colliers in the Port of London *(1827-29)*

	Dataset 1	Dataset 2
Location of data in the Select Committee Report	Appendix 13	p.140
No. of Ships	10	6
No. of Voyages	28	46
No. of Coal Varieties	4	10
Max. variation by individual ship	7%	5%
Min. variation by individual ship	-5%	-2%
Total Observed Variation	4%	2%

Source: House of Commons Report, *PP 1830 Vol. VIII*

Variation due to measurement practices in London

In analyzing the variation as a result of heaped measurements and the ingrain, it is assumed that no variation is caused due to the use of tampered or incorrect measurement artefacts. We can then express the issue generally as follows.

Suppose q_c to be the quantity in LCh and q_v to be the quantity in vats. Then,

$q_c = q' + q^h$ and,

$q_c = 4q_v$ (by definition)

where q' is the quantity measured by the internal dimensions of the measuring vessel and q^h is the quantity contained within the cone of the heap. Similarly, $q_v = q'_v + q_v^h$ where q'_v is the quantity contained within the dimensions of the vessel representing the vat and q_v^h is the quantity within the cone of the heap on top of the vat. Now suppose $q_h = 0.3q'$ and $q_v^h = 0.3q'_v$ (by dimensions of the heap specified by 47 George III, C.68). Thus,

$q_c = q' + 0.3q' = 1.3q'$ and

$q_v = q'_v + 0.3q'_v = 1.3q'_v$

If a first buyer A sells to a second buyer B five chaldrons of coal. The quantity that should be delivered to B is given by

$Q_b = 5q_c + q_v$

$Q_b = 5(4q_v) + q_v$ (by the ingrain given on 20 vats)

$Q_b = 21q_v = 21(1.3q'_v) = 27.3q'_v$

Thus, the quantity that buyer B should receive is 27.3 times the volume measured by the dimensions of the vat measure. A can deliver to buyer B less than $27.3q'_v$ in three ways as follows:

Withholding ingrain:

$Q_b = 5q_c$

$Q_b = 20q_v = 20(1.3q'_v) = 26q'_v$

i.e. about **5%** less than the required quantity

Not proving a heaped measure but giving ingrain

$$Q_b = 5q_c + q_v$$
$$Q_b = 5(4q_v) + q_v = 21q_v$$

As q_v=q'$_v$ so

$$Q_b = 21q'_v$$ i.e. **23%** less than the required quantity

Not providing heaped measure and withholding ingrain

$$Q_b = 5q_c = 20q'_v$$ i.e. about **27%** less than the required quantity

Substituting the bushel for the vat in the above analysis would yield similar results. The empirical evidence for short-measure provided in this manner is sketchy and is discussed in the main text.

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