The Blacketts

A northern dynasty's rise, crisis and redemption

Greg Finch

2021-2

Appendices and Bibliography

Appendices

Appendices: Introduction

The deductions, speculations and conclusions set out in this book rely heavily upon a foundation of quantitative analysis in the key aspects of business undertaken by the Blacketts: trade, coal and lead. In each of these areas, the changing scale, costs, income and profitability of the family's activity must be set in the context of the wider business environment. The data available to support this analysis is limited and each source is beset with problems of coverage, accuracy and interpretation. Nevertheless I believe it is usually possible to navigate a path towards estimates that are good enough for my purposes. Appendices 1-3 describe those paths, the sources of information they rely upon, the methods used to chart a course forwards and the assumptions made along the way, so that others can decide for themselves whether the correct destinations have been reached.

Appendix 4 takes a similar approach to estimating the wealth of the three William Blacketts at their death, and of Walter Blackett at the close of the period covered by the book, the late 1730s. Appendix 5 discusses the family portraits at Wallington Hall, now owned by the National Trust, and attempts to identify the principal sitters. Appendix 6 gives more detail on the members of the Blackett, Chapman and Kirkley family trees presented in abridged form in the book.

Abbreviated and contracted footnotes used in support of the appendices are explained and expanded in the preface to the book.

Appendix 1 Trade

The principal concern here has been to determine the overall level of Newcastle's overseas and domestic trade from the 1630s to the 1660s. This period covered William Blackett I's apprenticeship and the years in which his trading activity was his main business. An attempt is also made to value his trade in 1661.

1.1 Newcastle's trade

The only commercial traffic to and from Newcastle that can be measured is that carried by sea. For all the dismissive comments that the state of the roads and the cost of overland transport ruled out much land carriage, sufficient anecdotal evidence survives to indicate that this cannot have been the case, and a flavour of this is given in chapter 1. However, other than inferences regarding lead carriage discussed in Appendix 3 below, there is no basis to estimate its volume at any point, still less to determine how this changed through time. While this must leave a significant gap in our understanding, the importance of Newcastle as a seaport means some sense of the changing commercial tempo can be obtained from charting the volume of its shipping movements. It is not possible to reconstruct a complete record of the volume of seaborne traffic, but a variety of sources can be used in combination to indicate broad trends and some idea of its structure.

The main sources of data available from which the number of shipping movements can be estimated through time are the Exchequer Customs Port Books, the Newcastle Corporation's Chamberlain accounts, Trinity House records and the Sound Toll records.

1.2 Exchequer Port Books

Throughout our period customs officials in English and Welsh ports were required to record details of coastal and overseas ship voyages and to submit completed 'port books' to the Exchequer in London each year. The port book year started at Christmas, but the very small observed amount of marine traffic during the last, winter, week of each modern calendar year means that for all practical purposes they cover the calendar year commencing January, and they are referred to as such hereafter. The port books are now in The National Archives in Kew (record class E 190). Their usefulness and drawbacks are worth considering at length for they constitute an important source of information on the rise of the North-east lead industry as well as for the general level of overall shipping movements.

For the purpose of levying and collecting customs duties on various overseas exports and imports the collector of customs recorded the details of each receipt – or coquet - issued under their seal. Separate books were expected to be kept by the customs searchers and 'tide waiters' who had powers to inspect cargoes with the intention of preventing smuggling. Customs were levied only on exports and imports, but the ease with which vessels might slip across to European ports meant that all coastal traffic was also recorded, in separate books, and 'transire' certificates issued to skippers. These would be cancelled when the cargo was accounted for on arrival at a domestic destination.

Each overseas port book entry documents the name of the ship and its master, the merchant's name (and whether indigenous or alien), description and quantity of goods, duty paid (in the collector's overseas port book), the ship's destination or port it had arrived from, and the date duty was paid. Although this last date was not necessarily the same as the date of sailing or arrival it's reasonable to assume it was usually shortly before (for exports) or after sailing (for imports) because coquets for exports would only be issued and imported goods released after payment. Coastal port books were meant to record the same information except for the duty payments and the name of a bondsman certifying that the goods were not for export (which might have been that of the shipmaster rather than the merchant).[1]

---

[1] See TNA's guide to the E 190 class of records: http://www.nationalarchives.gov.uk/help-with-your-research/research-guides/merchant-trade-records-port-books-1565-1799/, and J.H.Andrews, 'Two Problems in the Interpretation of the Port Books', *EconHR,* 9.1, (1956), pp.119-22. A good recent guide to the use of coastal port books as a source for economic historians is Hussey, *op cit,* (2000).

Completion and submission of the port books was the responsibility of each head customs port, Newcastle in our case. In common with most other head ports, Newcastle was responsible for a long stretch of coastline, ninety miles in its case, and therefore included a number of smaller outports or member ports and even smaller creeks. No commercial traffic was permitted from any other harbours. During the 17th century Newcastle's outports and creeks were Blyth, Seaton (Sluice), Cullercoats, Sunderland, Hartlepool, Stockton and Whitby.

In principle, this class of records offers enormous potential to analyse changing patterns of internal and external trade, but port books suffer from a number of problems. Firstly, few of them have survived and some of those are scarcely legible. Amongst the Newcastle port books, for some years we have only the coastal or one of the overseas port books, but not both, and for many years, particularly before the 1670s, neither. Table A1.1 indicates those covering Newcastle and the major outports of Sunderland and Stockton, that have been used in this work. Where possible the focus has been on those years for which both overseas and coastal port books survive.

Table A1.1. Exchequer Port Books selected for analysis

Year	Newcastle	Sunderland	Stockton	TNA Reference E 190/
1639	O-EI-c	O-EI-c	O-EI-s	192/3,4
1640	O-EI-s	O-EI-s		192/6
1652	C-E			192/10
1655	C-E			192/11
1661	O-EI-s	O-EI-s		193/1
1666	O-EI-s C-EI	O-EI-s C-EI	O-EI-s C-EI	193/9, 194/2
1673	O-EI-s/c C-EI	O-EI-s/c C-EI	O-EI-s/c C-EI	195/7, 11,13
1674	O-EI-s C-EI	O-EI-s C-EI	O-EI-s C-EI	195/15, 196/1
1675	O-EI-s	O-EI-s	O-EI-s	196/2
1676	O-EI-c C-EI	O-EI-c C-EI	O-EI-c C-EI	196/6, 8
1679	O-EI-c C-EI	O-EI-c C-EI	O-EI-c C-EI	198/3, 5
1686	O-EI-s C-EI	O-EI-s C-EI	O-EI-s C-EI	201/8, 202/3
1694	O-EI-c	O-EI-c	O-EI-c	204/5
1695	O-EI-c	O-EI-c	O-EI-c	204/8
1696	O-EI-c C-EI	O-EI-c C-EI	O-EI-c C-EI	205/3, 6
1702	C-EI	C-EI	C-EI	209/1
1712	C-EI	C-EI	C-EI	218/7
1720	O-EI-s/c C-EI	O-EI-s/c C-EI	O-EI-s/c C-EI	224/6, 7, 8

Key: O –overseas, C-coastal, E-exports, I- imports, c-customer/controller, s-searcher

This coverage allows comparisons to be made over time although it is prey to the dangers of documenting trade during years that might have been exceptional for various reasons such as the impact of war. Other measures of traffic (see below) give some context that can help some such exceptions to be identified.

Accuracy and completeness

As far as the accuracy and completeness of the information recorded is concerned, port books potentially suffer as a trade record from the deliberate avoidance of customs duties through unrecorded voyages, the under-reporting of cargo volumes in recorded voyages and misrepresentation of destinations. On the one hand, there were various quayside subterfuges amongst masters and merchants, undoubtedly more important than romantic tales of smuggling, but also negligence, incompetence and corruption of customs officials. Michael Blackett gave instructions to his apprentice John Wilkinson, travelling in 1679 with a cargo to Yarmouth, to 'desire the men to hide the tarr as much as they can and you will give them a drink for the doeing thereof'.[1] In 1676, when the export of leather was prohibited, Ralph Grey carefully hid some pieces amongst kersey cloths in a shipment to Rotterdam, and wrote with fingers crossed to his correspondent there that the ship 'hath passed Newcastle & I hope will Shields'. The corresponding entry in the Newcastle port book duly recorded the kerseys, but no leather.[2]

The Treasury and the commissioners of Customs were well aware of the problems they faced around the coasts in recording and collecting their revenue. Collection had long been farmed out to contractors, but from the 1670s the state increasingly recruited its own salaried customs officials, and commenced inspections of the ports. Only one of these reports, covering the south-west of England and south Wales in the early 1680s has survived, which reported widespread negligence, incompetence and corruption, but Giles Dunster, a Surveyor-General of the Customs, undertook at least three tours of inspection of the northern and eastern coasts in the 1670s.[3] The imminence of a visit from Dunster was held out by Michael Blackett as a threat to a corrupt customs official in Yarmouth in 1679 to repay a bribe extracted from a local merchant that the merchant passed on to Blackett as one of his expenses.[4]

This all suggests there must be serious doubts about the reliability of the port books as a record of trade. It has, however, been possible to test this on a sample basis as far as outwards shipments from Newcastle are concerned during the 1670s. The letterbooks of Ralph Grey and Michael Blackett contain many details of consignments made to coastal and overseas destinations. Since these had to be consistent with their invoices it is reasonable to assume they were accurately documented, although precise weights were not always included in the letters. Many of those consignments took place during periods covered by coastal and overseas port books, so it is possible to compare the completeness of the latter records.[5] Forty two such consignments between 1674 and 1679 can be clearly identified, 33 to overseas destination, 9 coastal. There were three others that it seems likely referred to shipments on Blackett's behalf from Yarmouth or London, so they have been excluded. Of the 42, all but two (one coastal, one overseas) appear in the port books, suggesting that as a record of outward voyages the customs records are reasonably complete, albeit derived from a small sample. Port books were public records, open to inspection by local merchants who would have been quick to notice and call out the omission of any voyages freighted by their rivals, that must have acted as an incentive on the customs officials to document them.[6] The continued vigilance of the town's corporation in protecting its monopoly of trade on the Tyne might also have helped to mitigate the temptations of shipmasters to load and unload cargoes downstream from the quay.

If whole voyages were difficult to overlook, the accurate recording of all cargoes and their weights was perhaps more susceptible to under-recording. The 42 Grey and Blackett voyages from their letters included 59 individual commodities. The corresponding port book records picked up 49 of these (83%), a noticeably lower proportion of the total than of the voyages themselves. Grey's hidden leather was not the only such omission. Measures were given in the letters for 40 of these cargoes, of which 32 (80%) were recorded accurately –or, at higher levels- in the port books, and eight under-recorded.[7] Of the short measured cargoes, six were of coal and five of these were being sent overseas, thereby attracting duty. Curiously, the under-measurement was

[1] MB to John Wilkinson 31 Oct 1679.
[2] Ralph Grey to William Peacock, NRO 753/J: 7 Mar 1676; TNA E 190/196/6.
[3] W.B.Stephens, *The seventeenth-century customs service surveyed: William Culliford's investigation of the Western Ports 1682-84*, (2012), pp.3-5,162
[4] MB to Edmund Thaxter 9 Aug 1679. Blackett was clearly annoyed that the bribe was unnecessary for he claimed to have fully declared the shipment on leaving Newcastle the previous year. The Yarmouth official, one Bell, evidently did not respond to the threat for Blackett wrote again to Thaxter on 9th September that 'Mr Dunster will doe my business, who shortly will be att your towne.'
[5] Grey: NRO 753/J; Blackett: MBL. Port Books for 1674 (coastal only), 1675 (overseas only), 1676 and 1679 (coastal and overseas); references given in Table A1.1 above.
[6] See for example, MB to William Blackett 27 Nov 1675.
[7] Where the port book measures were higher than those quoted in the letters, it is typically because other consignments of the same commodity were included in the voyage, and counted together.

mostly around 20%, almost suggesting a conventional allowance being granted to merchants in view of the difficulties of weighing coal accurately, as discussed in Appendix 2. If so, this would have implications for the true quantity of coal exported from Newcastle in this period, but a non-random sample of five such consignments is no basis for speculation.

Lead was another heavy and laborious commodity to weigh and this is considered further in Appendix 3. For now it should be noted that while all but one of the 21 measures of lead shipments given in Grey and Blackett's letters were reflected reasonably accurately in the port books, in 11 of them the only count given in both records is of the number of pieces, and these could vary in weight. However, where a direct comparison can be made, for two of Grey's consignments, a consistent or heavier weight was recorded in the Port Book.[1]

A comparison between merchant correspondence and port books for a small number of observations concerning two men within a single decade is hardly a sound basis upon which to draw conclusions on the accuracy of the customs record as a whole. However, for what they are worth, they suggest that nearly all voyages were recorded, the right cargoes identified in more than four fifths of instances and measured with tolerable accuracy in just under that proportion. In the 1670s the Newcastle port books documented the minimum amount of marine commerce, but probably accounted for most of it. It is more hazardous to assume that the same relationship between record and reality held during earlier decades, although since the collection of customs was leased out to 'farmers' until into the 1670s, those farmers would have had an incentive to collect as much as possible in order to reap profits above their fixed fee to the Customs commissioners. Few port books survive for earlier decades, but – as shown below - the number of voyages recorded in six months of 1652 are consistent with those that can be counted elsewhere.

<u>Misrepresentation of destination</u>

Some caution is also needed regarding the destinations as given in the port books. Shipmasters might reserve the right not to be tied to a single port for practical reasons, as in the case of Batholomew Kirkhouse in October 1675. While endeavouring for Rotterdam '*if the wind will not serve we must give him leave to go for Amsterdam*'. For English customs purposes, distinctions between foreign destinations rarely mattered and the major Dutch ports were an obvious first destination across the short stretch of the North Sea across from Yarmouth. But vessels might then head east with their cargoes if market conditions in these entrepots were poor. Thomas Bayle of Stockton came through the Sound in May 1676 with lead on board, having moved eastwards from Rotterdam (see Sound Toll Records, below). This was all harmless enough, but for as long as the chartered companies sought to police their claimed monopolies of trade to certain overseas destinations by recourse to the port book record merchants sometimes sought to hide their interloping intentions. The Eastland Company thanked their Newcastle agent in 1663 for alerting them to the '*abuse*' of Henry Alvey, master of the Patience, for 'fraudulently entring his ship for Amsterdam when she was designed for the East [ie. the Baltic ports] which is a peece of fraude wee sometimes meete with here alsoe and can hardly finde any way to remedye'.[2] Ralph Grey was making the same allusion when he claimed in 1673 that Blackett 'clears for Hambrough but they goe elswhere' but the Eastland Company effectively abandoned its monopoly in the same year.[3]

There must also be some suspicion that embargoes were broken during wartime as trade sought ways to markets offering high prices. In 1666, for example, during the Second Anglo-Dutch war there was a remarkably high level of lead exports to the normally very quiet destinations of Bruges and Ostend, not far from the ostensibly closed Dutch entrepots. In 1695, when England was at war with France, the Dutch ports received more than double the quantity of lead from the ports of the English north-east compared to ten years

[1] 20 Nov 1675: 300 pieces to Bordeaux, weighing 386 cwt (Port book: 18.5 fothers, which at the customary Newcastle 21 cwt to the fother = 388.5 cwt); 4 Oct 1676: 300 pieces to the same destination, weighing 374 cwt (Port book: 20 fothers 9 cwt, = 429 cwt).
[2] MA Records-2, p.144.
[3] MB to Wm Blackett 19 Oct 1675; Grey to an unknown correspondent: NRO 753/J, 20 Dec 1673; Sellers, *Acts, op cit,* pp. xlviii-ix.

earlier, some of which was surely destined for sale into French markets. Of greater concern to the English customs authorities were shipments for domestic destinations that went overseas instead, despite the attempts to prevent this through the coastal port books. Michael Blackett wrote to John Horsham in Plymouth that he had ordered a shipmaster to pretend he was bound for Bristol when actually heading to La Rochelle to avoid export duty on the coal he was carrying alongside lead for which duty *had* been paid. There were also quite legitimately declared coastal cargoes that we know from his letters Michael sent to freight forwarders in London for want of ships for Marseilles and Livorno from Newcastle.[1]

Consequently there are a number of reasons why the stated destinations of export shipments in the Exchequer port books might be subject to inaccuracies. It is unwise, therefore to use them as exact measures of overseas market share rather than as broad estimates. It is also likely that the balance between domestic and overseas destinations overstated the former to some unknown degree. Nevertheless, as long as they are borne in mind, these reservations, alongside those discussed above, need not prevent the use of this valuable record of the scale and pattern of trade from 17th-century Newcastle, especially as other sources can be called upon.

1.3 Newcastle corporation chamberlain's and Trinity House accounts

Among the principal sources of Newcastle corporation's revenue were tolls collected from ships clearing the quay, on ballast deposited and coal shipped out. They were recorded in varying detail in the town's chamberlain's accounts (NCA).[2] Their value is compromised by a variety of exemptions in respect of ships and cargoes owned by freemen of the town and there are a few short periods in which the ship totals are not included, that means hazardous inferences must be drawn from the revenue collected alone. Howell provides a useful summary of ship movements for the years 1647-61 but there are gaps between May 1648-July 1650, September 1650-September 1652, and June-December 1655.[3] In her introduction to the chamberlain's accounts for 1508-11 Constance Fraser gives a short summary of the complicated charging regime in the early Tudor period and there is no reason to suppose it was simplified over the next 150 years.[4] Of potential concern here is the impact on the completeness of the record that might have arisen from various exemptions granted as privileges to freemen.

The records of Trinity House allow some check to be made on this. Trinity House was responsible for marking the estuarine river Tyne with buoys and beacons and levied charges on all ships to pay for this. Their Newcastle accounts (THA) survive monthly for the period between March 1650 and December 1652, thereby allowing a comparison of their data where this overlaps with the NCA and the 1652 coastal port book (see Table A1.2).[5]

The time periods for which the data are available do not match precisely. The THA monthly figures have been used to adjust for this. The actual figures for the slightly different THA figures are shown in column (2) of Table A1.2, and the daily averages observed during months of overlap have been applied on a *pro rata* basis to give adjusted figures in column (3) in order to compensate for the difference in periodicity with the NCA figures, that are given in column (1). On this basis the NCA count was around 4% higher than the THA for the earlier period of analysis and 5.5% lower for the later period.

The Port Book recorded 1,513 coastal shipping movements between the same period as the NCA dates over the summer of 1652. The THA, which distinguished between coastal and overseas destinations, counted 80 of the latter between 5th April and 23rd August, to which 8 has been added in column (5) on the same *pro rata* basis as described above. Exact matches can hardly be expected. However, the reasonably close alignment between these three separate sources of data in one short period of time suggests that the longer series of NCA shipping data do not suffer from exemptions on a scale that render them useless as a basis for indicating the approximate level and trends in Tyneside shipping during the middle decades of the 17th century.

[1] MB to John Horsham 7 Jan 1676; MB to James Gould and Hubert Aylwyn in London, summer 1679, *passim*.
[2] TWA MD.NC/FN/1/1/13-15.
[3] Howell, Table VI, p.355.
[4] C.Fraser, *The Accounts of the Chamberlains of Newcastle-upon-Tyne 1508-11*, (1987), pp.xiii-xv.
[5] Trinity House accounts: TWA GU/TH/109/3.

Table A1.2 Newcastle: outwards shipping 1651-2

Chamberlain's accounts		Trinity House accounts			Exchequer Port Book			
Period	Vessels	Period	Vessels	adj	Period	Vessels		
						coastal	Over-seas	all
	(1)		(2)	(3)		(4)	(5)	(6)
21 Sep 1651 – 25 Mar 1652	**1,044**	22 Sep 1651 – 4 Apr 1652	1,148	**1,005**				
25 Mar- 4 Sep 1652	**1,594**	5 Apr – 23 Aug 1652	1,509	**1,687**	25 Mar – 4 Sep 1652	1,513	88	**1,601**

Sources:
Howell, Table VI, p.355 TWA GU/TH/109/3 TNA E 190/ 192 / 10

1.4 Newcastle shipping movements

Columns (3) to (5) of Table A1.3 give approximate estimates of Newcastle's shipping movements covering the years of William Blackett I's apprenticeship and the rest of the Commonwealth period during which his business interests focused on trade. Additional data have been included for some later years for further comparison. NCA counts of ships clearing from the quay, drawn from the original accounts (1643-7, 1649-50) and as summarised by Howell (1647-61, with gaps), provide the basis for the period, using the corporation's accounting year that ran from 1st October. Since the majority of shipping took place in the summer months, this data is labelled for convenience by the following year (eg. data for corporation year Oct 1645-6 is labelled 1646). Gaps remain but a few can be filled from the other direct sources discussed above: Trinity House records for 1650-2, overseas port books for 1639 and 1640 (rounded estimates of the actual vessel totals given multiple cargo entries for many voyages) and coastal port books for 1652 and 1655. For the years after 1661 the Exchequer Port Books have been used. Earlier Trinity House records, apparently since lost, appear to have been Brand's source for the coastal and overseas ship clearances he gave for calendar years 1641 and 1644.[1]

Some short gaps in the NCA record of ships clearing can be filled using corporation revenue as a proxy measure.[2] If it were not for the fact that the majority of corporation revenue derived from shipping this could not be attempted at all. In years where both revenue and outwards shipping data survives the 'revenue per ship' can be crudely calculated, and this is given in column (2). In 1646 observed revenue per ship was £2.64; in 1650 £2.66. This ratio has been used to estimate total shipping in years where direct shipping counts have not survived. Proxy values for this ratio have been interpolated for 1647 and 1649 reflecting the upwards movement in this ratio, yielding projected shipping totals that have been rounded in column (5) of Table A1.3. All such interpolations and the estimated shipping derived from them are shown in italics in Table A1.3. Clearly this is not a satisfactory basis for reliable estimates. However, given the importance of shipping tolls to the town's public revenue, it is perhaps acceptable to use it to hazard rough projections between years for which we can have slightly more confidence. Recognising these dangerously weak foundations, the data is never used to give more than a general impression of trends in activity. This calculation approach has been used for the values shown in Table A1.3 for 1635, 1636, 1647, 1649, and 1655. Years for which not even these estimates can be provided are omitted from the table.

[1] J.Brand, *op cit*, Vol 2, pp.37-8.
[2] Howell, Table VII, p.356. Shown here in column (1) of Table A1.3.

Table A1.3 Newcastle shipping movements 1635-86

Year	Corporation revenue		Ships clearing			Notes
(from Oct 1 in prev yr)	£	£/ship	coastal	Over-seas	total	
	(1)	(2)	(3)	(4)	(5)	(6)
1635	5,196	*2.60*			*2,000*	Revenue:TWA MD.NC/FN/1/1/13 f93
1636	4,099	*2.60*			*1,600*	As above, f264
1639				350		Overseas Port Book E 190/192/4 (Cal yr)
1640				300		Overseas Port Book E 190/192/6 (Cal yr)
1641			2,823	337	3,160	Brand, *op cit*, (1789), vol 2, p.38 (Cal yr)
1643	1,200				458	TWA MD.NC/FN/1/1/14
1644			7	30	37	TWA MD.NC/FN/1/1/14, Brand, *op cit*, p.38
1645					2,127	TWA MD.NC/FN/1/1/14
1646	5,884	2.64			2,184	TWA MD.NC/FN/1/1/15
1647	5,542	*2.64*			*2,100*	
1649	7,591	*2.64*			*2,875*	
1650	7,221	2.66	2,500	210	2,710	TWA MD.NC/FN/1/1/17
1651			2,635	325	2,960	
1652			2,574	165	2,743	
1653	5,214	2.30			2,264	
1654	6,435	2.85			2,257	
1655	10,652	*2.80*	3,540	*260*	*3,800*	
1656	10,084	*2.41*			4,190	
1657					3,331	
1658	10,163	3.27			3,110	
1659	8,772	2.80			3,132	
1660	8,873				3,110	
1661	6,048	2.03	2,742	210	2,974	
1666			1,900	180	2,080	Calendar year
1674			2,850			Calendar year
1675			2,873	260		Calendar year
1676			2,600	300	2,900	Calendar year
1686			2,362	380	2,742	Calendar year

Sources: (except as stated in the Notes column). Corporation revenue: Howell, Table VI, p.355; ships clearing – as indicated in notes to Section A1.1.2 above.

There are very few years for which coastal and overseas departures can be distinguished, for this distinction relies upon the additional detail provided by the limited coverage of the Trinity House records and the port books. Within the Chamberlain's accounts, only the name of ship, master and home port are shown, which cannot be used to infer destinations. For 1655, the port book provides a calendar year total for outbound coastal shipments. The overall figure is derived from the corporation revenue, but the large difference in the crude ratios of shipping to revenue observed for 1654 and 1656 make this problematic. However, taking the partial coverage provided by NCA and the coastal port book, the projection of 3,800 seems plausible, especially in the context of recovery from the Anglo-Dutch war, and the even higher shipping figure observed from the NCA for 1656. On the assumption that the October-December quarters of 1654 and 1655 saw broadly similar traffic volumes (for the war was over by the autumn of 1654) it might be acceptable to estimate overseas traffic from the difference between the estimated total traffic for Oct 1654-Sept 1655 and the calendar year total of coastal traffic, ie. 260 voyages. This lies between the observations from the Trinity House records for 1651 and 1652 and therefore plausible for the first full year of recovery after the Anglo-Dutch war.

Although there are few years in which traffic can be isolated from the coastal figures but it is clear that the volume of traffic was dominated by coastal vessels. In value terms, however, coal was bulky but cheap. It typically cost 3s/ton as it moved from keel to ship, but even if valued at the price fetched in London of approximately £1, a 180 ton cargo was worth £180 – but most of the average return cargo was worthless ballast. On the other hand, a typical consignment of 100 kersey cloths from Newcastle in the 1650s might, conservatively, sell for £500 and a return cargo of rye and flax could be worth over £1,000. So, while there were ten coastal journeys for each one to overseas destinations, it is likely that in value terms Newcastle's overseas trade was worth nearly as much as the coastal trade.[1]

Some reassurance regarding the trend in overseas departures can be obtained by considering the evidence of the Sound Toll registers for this period.

1.5 The Sound Toll Registers

These registers contain accounts of the toll levied by the King of Denmark on shipping passing through the narrow bottleneck between Elsinore and Helsingborg between the North and Baltic Seas. Historians of trade in northern Europe between the 16th and 19th centuries have good reason to be grateful for the efforts of those who have transcribed much of the contents of the registers and made them available online.[2] For each passage, the ship's master, cargo and toll levied are shown and often also the master's home port, point of departure and onwards destination. It is amusing to view the written results of Danish officials' efforts to commit to paper the dialect pronunciations given by Newcastle's master mariners as they trooped to the toll office at Elsinore in the Sound. For example in 1652 Reichaert Elbrouch (Richard Elbrough), Heinrich Kirethussen (Henry Kirkhouse), Allen Ruedaeck (Alan Redhead), and Joris Grej (George Grey) all passed through on their way to or from Danzig, Konigsberg, Riga and Stockholm. Unfortunately merchants' names were not taken at the toll house.

As with the records of any tax, there have to be concerns regarding completeness and accuracy of compliance for the reasons explored in the context of the Exchequer port books above. The Sound was not the only route into the Baltic by sea, although it was by far the least perilous to navigate. Danish vigilance in the narrow straits made it difficult for ships to avoid detection. Swedish shipping was exempt from the tolls between 1660 and 1720 and therefore unlikely to have been recorded, but for the purposes of Newcastle's trade this probably had little impact for English ships increasingly dominated the Baltic trade in this period. Under-recording of cargoes on shipmasters' bills of lading was likely to have been more of a problem. However, while there were surely always some masters, or the merchants they carried for, willing to take the risk of random inspection and compulsory purchase of the cargo as stated to avoid paying full toll, many others might conclude that the tax rate of 1-2% hardly justified the risk. Nevertheless, as with the port books the Sound Toll records are probably more reliable as a record of traffic than of cargoes and should be regarded as minimum levels of trade.

[1] Domestic shipments: £180 outwards value of coal (see Hatcher, pp. 573-85), and assuming £20 return to cover the approximate cost of shipping, giving a total of £200. Outbound Sound Toll shipments from Newcastle average to around 100 cloth pieces 1639-57, valued here at £5 each (D. W. Jones , 'The "Hallage" Receipts of the London Cloth Markets, 1562-c.1720', *EconHR*, 25, (1972), p.584). Inbound Sound Toll shipment of 40 tons of rye valued at £12, and 20 of flax at £40 (based on 5d/lb in Newcastle inventories). £500 outwards, £1,280 return = £1,780 in total.

[2] An introduction to the Sound Toll project, the toll, and context on the circumstances in which the toll was levied and the registers kept is available at http://www.soundtoll.nl/index.php/en/over-het-project/sonttol-registers (extracted 24 June 2019).

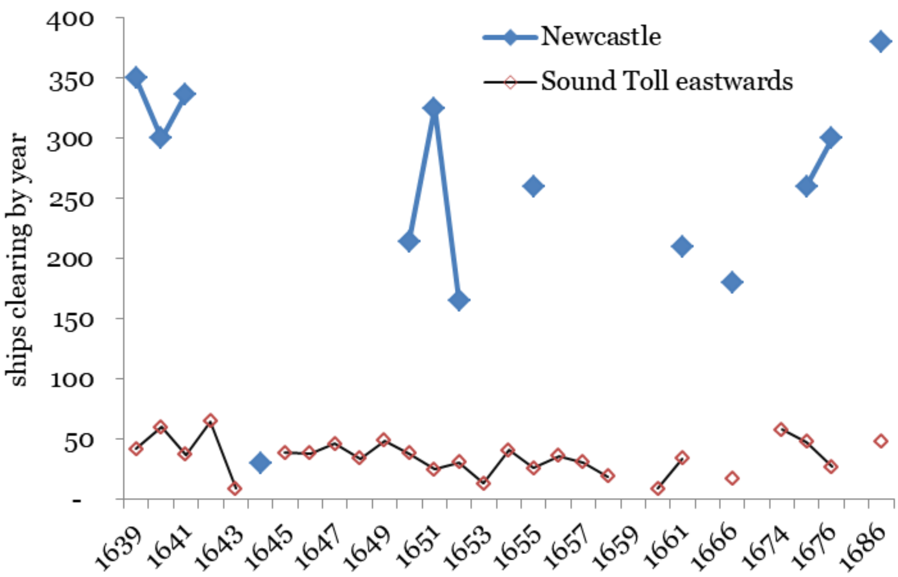
Table A1.4 Newcastle overseas shipments and recorded though the Sound

Year	Overseas departures from Newcastle (1)	Newcastle departures through Sound (2)	(2) as % of (1) (3)	Year	Overseas departures from Newcastle (1)	Newcastle departures through Sound (2)	(2) as % of (1) (3)
1635		*49*		1651	325	25	8%
1636		*56*		1652	165	31	19%
1637		56		1653		13	
1638		61		1654		41	
1639	350	42	12%	1655	*260*	*26*	10%
1640	300	60	20%	1656		36	
1641	337	37	11%	1657		31	
1642		65		1658		19	
1643		9		1660		9	
1645		39		1661	210	34	16%
1646		38					
1647		*46*		1666	180	17	9%
1648		*34*		1674		58	
1649		*49*		1675	260	48	18%
1650	*220*	*38*	18%	1676	300	27	9%
1651	325	25	8%	1686	380	48	13%

Table A1.4 compares the few estimates of total overseas departures from Newcastle (column (1), drawn from Table A1.3 above) with counts of all ships recorded at the Sound Toll giving Newcastle as their place of departure in each calendar, in column (2). As expected, given the importance of the principal Dutch ports and Hamburg to Newcastle's trade , it appears from column (3) that never more than a fifth of ships clearing from Newcastle for overseas destinations were recorded passing eastwards into the Baltic Sea. This also means that such traffic is of limited value as a check on the total volume of Newcastle's overseas trade throughout this period. Any structural shifts in trade volumes between European destinations cannot be detected by the records kept at the gateway to the eastern end only. However, this was a period during which more trade flowed directly from the Baltic to England, rather than via Amsterdam or Hamburg.[1] So at a time when direct traffic from England was increasing, the relatively static level of Newcastle's shipping eastwards through the Sound during the middle part of the 17th century is broadly consistent with trends in the overall level, as shown in Table A1.4 and Figure A1.1. The composition of cargoes might have changed and the size of ships increased, but there is no indication that shipping traffic levels from Newcastle to overseas destinations increased between the 1630s and 1660s. Outbound overseas shipping from Newcastle did appear to increase thereafter, but this was not reflected in traffic through the Sound.

[1] Åström, *Cloth to Iron, op cit,* pp.29-31; L.Müller, 'Britain and Sweden', *op cit*, pp.61-6.

Figure A1.1 Newcastle and Sound Toll shipping



1.6 The Ship that came home

Can the Sound Toll and Port book records identify the mythical flax 'ship that came home' described in chapter 1? This was the ship with a large cargo of Blackett's flax allegedly detached from a convoy feared lost due to enemy action, news of which had driven the price of flax to a great height. If this really did take place towards the start of Blackett's career, the mention of enemy action could place it during the 1652-4 Anglo-Dutch War, although he had been in business for seven years at the start of that conflict. There is also the small matter of his not being a member of the Eastland Company until a decade later. The Eastland Company controlled trade between England and the Baltic ports, the source of most flax, although this control was not strictly enforced during the Commonwealth period.

Nevertheless, a cargo carried by George Grey, recorded at the Sound Toll on 13th May 1652, catches the eye. In his hold were 67.5 lasts of flax, about 63 tons, substantially larger than the usual consignments of 10-30 lasts. Grey had cleared through the Sound on 23rd March *en route* eastwards from Newcastle with northern kerseys, dozens, woollen stockings and salt on board and was now coming back from Koenigsberg with flax, hemp and iron, just as the Anglo-Dutch war was breaking out. No other vessels were recorded headed back to the North Sea from the Sound that day, so if this was the ship it was already on its own, with the most dangerous part of the voyage lying ahead.

What might 63 tons of flax be worth in England in normal conditions and what might the price have risen to in the expectation of a sudden supply shortage? There is little price data but a 1647 Newcastle merchant's probate inventory valued two parcels of flax at 4.8d and 6d per pound. At a crude average of 5.4d, a 63 ton cargo had a sale value in England of nearly £3,200. As for a scarcity premium, the impact of a wild speculative frenzy is always unpredictable and we have no guide to the flax market. Price series have been reconstructed for grains in the 16th and 17th centuries. Even when harvests were severely deficient prices seem not to have doubled from their long-term average.[1] Since grain supplies must have been far more critical, and price-inelastic, than flax – even though it was the raw material for the linen needed for ship sails under pressure of wartime demand - it seems unlikely that price might have risen by quite as much. Suppose the price rose by

[1] C.J.Harrison, 'Grain Price Analysis and Harvest Qualities, 1465-1634', *Agric History Review*, 19, (1971).

50%. A merchant able to offer a supply at that price might reap a £1,600 windfall profit over and above the expected and probably far more modest return on the voyage.

The cargo cannot be linked to Blackett, and we can do more than wonder about the course of the English market for flax in 1652, or in any other year for that matter. However, the Sound Toll register does suggest that 63 tons was the largest cargo of flax shipped westwards during these years, and we can estimate very roughly the 'normal' retail price. If a 50% premium in a tight market is a reasonable guess, then a windfall in the region of £1,600 was possible. While a substantial sum, it did not, however, constitute a fortune.

1.7 Valuing Blacketts trade in 1661

Summary estimates for the value and direction of William Blackett's overseas trade in 1661 are presented in Chapter 5, based on the outwards and inwards cargoes registered in his name in that year's port book.[1] These have been derived from the measures and prices discussed in this section. As indicated in Chapter 5 these can only be approximate values. In some cases this is because the cargo quantities are unclear, but the main defect lies in the scarcity of price information. To calculate the profitability of a year's trading accounts we would ideally need to know the purchase and sale price of each exported and imported commodity traded, relevant currency exchange rates and all customs, tolls, freight and commissions charges incurred, an impossible task. The approach taken here is to ascribe possible sales values to the principal cargoes, listed below. From this an estimate for Blackett's turnover is generated, upon which assumptions can be made regarding the rate of profit margin obtained.

Table A1.5 Estimated value of William Blackett's overseas trade in 1661

Exports				**£3,300**
Goods	*Quantity*	*Price used*	*Notes*	*Approx. value*
Cloth - total	1,191 pieces			£2,410
single dozens	180 ps	£5	As rated in Customs Book of Tables 1662-3: M.Priestley, 'Anglo-French Trade and the `Unfavourable Balance' Controversy, 1660-1685' *Ec HR*, (1951), p.43.	£900
Penistons	120	£4 10s	As rated in 1662-3 (as above/ Priestley).	£540
nthn kerseys	180	£2 10s	Rated at £1 13s in 1662/3 (as above/ Priestley), but a parcel in Dordrecht 1659 equiv to £6 (Dendy, *op cit*, (1899), p.xv.) Traditionally reckoned to be worth half the value of dozens: R.Davis, *The Trade and Shipping of Hull 1500-1700*, (1964), p.22. £2 10s used here.	£450
nthn cottons (Kendal cottns)	650	11s	Newcastle probate valuations of 6d/yard in 1668 (Richard Kitchin DPR1/1/1668/K3); set at 22 yards/cloth 1551 Manchester – N. Lowe, *The Lancashire Textile Industry in the Sixteenth Century*, (1972) p. 79, thus 6d x 22 yds = 11s.	£358
single bays	41	£2 15s	Rated in 1662-3 at £2 15s (as above/ Priestley).	£113
½ short cloths	20	£2 10s	No direct data found but charged customs at slightly higher rate per piece than for northern kerseys in 1676 (TNA E 190/196/6), and priced the same as kerseys here.	£50

[1] Newcastle Overseas Searcher Christmas 1660-1661, E 190/193/1.

Lead	44 fothers	£14	See Appendix 3.3	£616
Butter	112 firkins	17s	Michael Blackett was quoting butter at 15-17s 6d/firkin in Newcastle late 1675, when possibly lower than in 1661: Table A.V Animal Products Price index, 1640-1750, by P.Bowden, in J.Thirsk, (ed), *Agrarian History Of England & Wales, Vol V.II*, *1640-1750 Agrarian Change*, (1985), pp.843-4. 17s used here .	£95
Coal	125 chalders	12s	12s/chalder in Newcastle 1656. Price slightly higher in Hull in 1661 than in 1656 but 12s used here: Hatcher, Tables B.1, p.573 and B.4, p.578.	£75
Stockings	1,416 pairs (118 doz)	16s	Newcastle probate valuations of 3s6d, 1s4d, 2s/pair in 1660 (John Preston, DPR1/1/1660/P3). Taking lower end gives 16s per dozen pairs	£94

This takes a conservative view as the prices used are – as far as it is possible to determine - those current in England, rather than at the overseas destination. Although overseas markets and exchange rates could move in an adverse direction it seems reasonable to assume that higher sales value could be realised, even if only to recover the cost of freight, customs and port tolls. The valuation given in the table above of northern kerseys in Dordrecht in 1659 is a single example, and resulted from a petition so might have been embellished, but it is significantly higher than the £1 13s at which the cloth was rated for export customs purposes.

Table A1.5 Estimated value of William Blackett's overseas trade in 1661 (cont.d)

Imports				**£3,600**
Goods	*Quantity*	*Price used*	*Notes*	*Approx. value*
Wine	75 tuns	£30	Quoted at £24-36/ tun (of 250 gallons) by Ralph Grey in 1673-5, eg. 20 Dec 1673, 23 Jan 1674, 8 Jun 1675: NRO 753/J, passim. According to Davenant in 1711 a tun of wine was rated for customs at £36 in the 1660s: Priestley, *op cit* (1961), p.50. £30 used here.	£2,250
Rye	32 last	£19	Quoted at '£19 10s per last to the merchant' by Grey 21 Nov 1674 and £16 1 May 1675: NRO 753/J 1 last = approx. 5/8 of a ton. Bowden's grain price indices show high prices in 1661, perhaps 25% higher than in 1674: Ag Hist, *op cit,* Table A.I, pp. 828-9. £19 used here.	£608
Iron	36 tons	£14	£14/ton in London in 1664: Roseveare, *op cit*, p.24.	£504
Miscellaneous				£241
Prunes	51 puncheons	£1 4s	Range of 12s (Ralph Grey 19 Dec 1673) to 36s (Michael Blackett 15 Oct 1675), and no earlier data. Crude average of 24s used here. Total to right also includes £24 for 15cwt of raisins.	£85
Deals and spars	74 deals and 300 small spars		Deals valued at 6d in various inventories and spars at 5s.	£77

Tar and pitch	2.5 last tar, 1 last pitch	£11	£14/ton in 1664: Roseveare, *op cit*, p.577.	£39
Whale fins	8 cwt	£5	£100/ton in 1670s: Roseveare, *op cit*, p.477; used in the absence of earlier data.	£40

In quoting English prices the valuation of imports is less likely to be understated than is the case with exports. At face value Blackett's imports were worth £400 more than his exports in 1661, which would be consistent with the notion that proceeds on export sales were used to buy the commodities imported (albeit, as noted in chapter 5, using international bills of exchange to buy in, say, Bordeaux, using the proceeds of sales in Hamburg). Bear in mind, however, that the overseas purchase cost of those imported goods must have been significantly lower than the sale price in England to make the ventures worthwhile. Taking this point alongside the cautious valuation of exports, it is perfectly possible that Blackett realised significant profits on exports alone, over and above the sums required to buy his imports. The £3,600 valuation of his imports is therefore probably at the low end of estimates for Blackett's direct overseas trading turnover for the year. It is impossible to say by how much lower. A 20% rate of profit on £3,600 – as discussed in chapters 4 and 5 - implies a total net trading income of £720 for the year. Even if the actual profit rate achieved was lower, the conservative turnover projection suggests that an absolute profit of around £700 might easily have been achieved and even exceeded.

Appendix 2 Coal

For coal, the 17th-century context is reasonably clear given the amount of research on Tyneside mining over many years. A number of key works provide the regional data on coal production and prices that provide context for examining the Blacketts' coal business. Hatcher's first volume in the History of the British Coal Industry series provides a modern solid foundation but other important aspects of the rise of the Tyneside industry are covered by Levine and Wrightson, by the authors of *A Fighting Trade*, and Hodgson's unpublished Durham thesis, all produced at roughly the same time.[1] In varying degrees they also cover the structure, pay, grim working and living conditions of the large and growing colliery workforce, which is beyond the scope of this work. However, in the search for greater confidence on the economics of coal mining during this period, vital to a proper appreciation of the Blackett enterprise, the survival of some contemporary financial accounts and further price information have been invaluable, and these are considered further in this appendix.

2.1 Weights and measures

For clarity, modern units of weight are used throughout the work so a note is needed here on the assumptions used to convert from contemporary measures. For coal this has always been problematic, for as a bulky and cheap commodity it could not justify the cost of weighing it. Consequently it was traditionally measured by a variety of volume measures, often for different stages of the operation – getting or working (ie. mining), leading to the river, keel capacity, or sales and shipping, within the same coal field. This was examined at length for Tyneside by Hatcher and his conclusions are followed here, supplemented by some local accounts.[2] In summary, the Newcastle chaldron, usually quoted as the unit for sales purposes, is assumed to have weighed 2.65 tons (53 cwt) during the 17th century and, therefore, a 'vending tenn' of ten chaldrons to have weighed 26.5 tons. Thus, coal sold at 9 shillings per chalder is expressed here as 17p per ton (9s = 45p / 2.65 tons/chalder = 16.98p).

This much was at least reasonably consistent across Tyneside during this period, but the measures used for getting and leading coal could vary from mine to mine, depending on the customary size of the baskets or 'corves' in which hewn coal was moved from coalface to surface and the vehicles in which it was moved to the riverside. Overall, however, production can usually be estimated based on what was shipped, the vending tenn, reducing our reliance on local measuring idiosyncracies within the pits. Waggon capacity within the Sir George Vane's Stella Grand Lease accounts (see section 2.2.2.1 below) was given in leading tenns, but the variable rate at which these were converted to vending tenns was also stated in the accounts, leading tenns being between 1.30 and 1.35 times larger.

2.2 Coal Production

2.2.1 Regional Production

The regional context for coal production is taken from Hatcher's review of the various sources, and his tabulation of coal shipments from the Tyne. These rely heavily upon either direct or indirect totals drawn from the port books.[3] As noted in Appendix 1, there must be some doubts as to the accuracy of cargo volumes recorded. In the 1650s, Ralph Gardiner claimed that George Dawson, the Newcastle collector of customs and part of the clique that controlled the town's institutions, was defrauding the customs. The average declared volume of coal per vessel calculated from the 1651-2 port book does appear lighter, at 114 tons, than that of 1639 (139) and 1655 (127), apparently supporting Gardiner's accusation against Dawson, but not flagrantly so.[4] Two decades later, letters from the Newcastle customs officer Anthony Isaacson to those who farmed the Crown's shilling tax on each Newcastle chaldron show a constant battle to catch up with under-reporting of

---

[1] Hatcher; Levine and Wrightson, *op cit*; *Fighting Trade*; Hodgson, thesis, *op cit*. Nef's *Rise of the British Coal Industry, op cit,* is still useful, not least for the original source material it reproduced.
[2] Hatcher, Appendix A, pp. 557-71.
[3] *ibid*, Table 14.1(a), pp. 486-92.
[4] Gardiner, *op cit*, (1655), p.103; Newcastle coastal port book 1651-2, TNA E 190/192/10; 1639: Hatcher, p.474, 1655: port book TNA E 190/192/11.

coal cargoes in vessels clearing the Tyne for London.[1] The common practice of giving 'gift coals' and 'over-measure' to shipmasters, particularly during poor trading conditions, implies a degree of informal acceptance of such under-reporting. Appendix 1 found a hint that overseas exports of coal in the 1670s might have been under-recorded by 10-20%, although exports, with the high levels of duty it attracted, were hardly ever more than 10% of the level of coastal shipments.

A larger omission from the production record is likely to have been that consumed locally. The salt industry probably accounted for the largest share of this and, indeed, owed much of its viability to the availability of cheap low-grade pan-coal not considered of sufficiently 'good and merchantable' quality to be sent as sea coal or shipcoal to London and other markets. Taking Ellis's estimates of the level of salt production on the lower reaches of the Tyne and allowing 7 tons of coal to every ton of salt produced, the industry could easily have consumed over 50,000 tons of coal during the 1670s, enough to add 7-8% to the volume of coal recorded as being shipped out coastally and overseas, and this is without considering the low-grade coal consumed by other industries and as domestic fuel.[2] Hodgson's assessment for the 1630s was that local consumption, led by the salt industry was about a quarter of total production.[3]

However, such coal output figures as remain to us from individual mines suffer from the same omission. Periodic attempts to agree quotas under cartel arrangements were only interested in the sea coal that could be 'vended' and mine accounts show the same focus, for the conversion of chaldrons into revenue use the price of sea coal. The logical place to sort between the sea coal and lower grade 'dross' was at the staiths, and this is hinted at in the Stella accounts by the varying rate at which the 'leading tenns' brought down in wains or on the waggonways were 'made out' at the staiths into vending tenns, as the coal quality itself varied. Consequently, since we have either mine quota or vending coal figures at individual mine level, and shipping figures from the customs record, the safest like-for-like basis for assessing Blackett production in its regional context is to use the sea coal figures alone. Both sets of figures, therefore, underestimate total coal production.

2.2.2 Blackett coal

It is fortunate that a variety of sources can be interrogated to build or at least infer estimates of coal produced by Blackett family members from the 1660s, some more conjectural than others. They are best discussed mine by mine.

.1 Stella

The Bishop of Durham had let the coal mining rights in Ryton manor to a consortium led by Sir Thomas Tempest of Stella as long ago as 1615 and it was renewed as the Stella Grand Lease in 1632. It was therefore far from being a new venture when Blackett took up his 1/12th share in 1660. One reading of the 1636 ship tax assessment for the Lease claimed it represented output above 53,000 tons, a level sustained 'until the Restoration'. Furthermore, the specific mention of Kyofield in the 1632 lease, at the far western corner of the lease area, suggested that coal was already being exploited here, over three miles from the staiths.[4] Hodgson, on the other hand, reasoned that the 'value' assessed for the ship tax derived from the information most readily discoverable by a contemporary investigator: the output that was known about and had already attracted taxation in the past – 'vended' shipcoal recorded through the port books. Comparing the nearest available port book totals with the overall colliery ship tax assessment allowed a rough apportionment of value by colliery, with the Stella Grand Lease share coming to 25,500 tons.[5] Kyofield was also mentioned in the 1615 lease, a time at which it is highly improbable that coal could be economically worked there given the distance

[1] Clayton papers, MS 899, John Rylands Library, The University of Manchester.
[2] Ellis, 'Salt Industry,' *op cit*, pp.45-58; Hatcher, p. 434.
[3] Hodgson, thesis, *op cit*, Vol II, Appendix 9, p.224.
[4] *Fighting Trade, op cit*, Vol 1, pp.50-1. This assumed the assessment was based on profits, and at the rate of £1 per tenn of coal (Vol 2, p.v) and from this inferred output of well over 2,000 tenns. This would equate to a minimum of 53,000 tons.
[5] Hodgson, thesis, op cit, Vol II, Appendix 5, pp.180-2. He also assumed that vended coal was just three quarters of total output, the rest of poor quality used in the salt pans and for other local consumption.

from navigable water. Its specific inclusion in both leases is far more likely to reflect, for the avoidance of doubt, the outcome of a legal challenge in the 1560s to the Bishop's claim to the land.[1]

Hodgson's conservative interpretation of the 1636 ship tax assessment seems plausible in the light of direct information on mining activity within the Grand Lease that survives from the 1650s. Lionel Maddison had a 30% share of the lease then, which was in the hands of his son-in-law Sir George Vane by the 1670s. Several 17th and 18th-century deeds, financial bills, accounts, receipts and other correspondence from agents for the Maddisons and Vanes have survived amongst the papers of the Silvertop family.[2] Between 1st January and 11th November 1653, 35.5 'leading tenns' were worked at Stella, that, following Appendix 2.1 above, made out to 46 vending tenns, 462 chalders, or 1,225 tons. Even if production in the rest of 1653 continued pro rata, output would scarcely have cleared 1,400 tons. Assuming that the lease was worked in common in the 1650s, as it was in later years, Maddison's 30% share meant that overall Stella Grand Lease production was under 5,000 tons. The 1654 account showed a marked improvement but still implied production of perhaps 12,700 tons. Reaching this total assumes that the 779 chalders sold for Maddison in that year were augmented by just over 51 leading tenns remaining at the pitheads at year end, roughly equivalent to a further 663 chaldrons. What we see here is probably the impact on the coal trade of the first Anglo-Dutch war. Its effects on the level of shipping from the Tyne have already been seen in Appendix 1. The 663 chaldrons stockpiled at the pitheads could reflect a recovery underway after the war's end: coal produced late in the year and yet to be moved down to the Stella staiths.

It is equally plausible that the more benign trading conditions of the later 1650s saw a recovery. No direct evidence survives for the period during which Blackett took up his share of the lease but in early 1662 the recently installed - and aggrieved - Bishop Cosin claimed that the Stella Grand Lease was worth £2,400 per year to the partners.[3] Allowing for some exaggeration, the true figure might have lain between Cosin's claim of £2,400 and the £1,700 assessment of 1636 and could indicate production of around 30,000 tons by the early 1660s. On this reading Blackett would have bought in at a production share of 2,500 tons per year.

Vane's accounts allow something of the level of his coal production, operating costs and receipts to be reconstructed for a few calendar years from the 1670s (see Table A2.1), and they show a dramatic increase in scale. It is a matter of simple arithmetic to extrapolate from Vane's share to total production and then back by Blackett's 1/12 share to determine the extent of the latter's involvement.

Table A2.1. Stella Grand Lease coal production 1654-83

	Maddison/Vane		Total	Blackett	Source
	chaldrons	tons	tons	tons	NRO ZCO
1654	1,442	3,821	12,738	-	IV.47/1
1662			*30,000*	*2,500*	*Cosin*
1675	9,500	25,175	83,917	6,993	IV.47/4
1676	8,500	22,525	75,083	6,257	IV.47/5
1679	10,300	27,295	90,983	7,582	IV.47/9
1680	9,390	24,884	82,945	6,912	IV.47/10
1683	9,620	25,493	84,977	7,081	IV.47/17

Note: the calculated figures in this and other tables in the appendix are shown to the nearest unit in order to support audit tracing, rather than being rounded. The consequential apparent accuracy is therefore spurious.

As far as the Stella Grand Lease waggonway is concerned Bennett *et al* cite compelling evidence that it was laid in the 1630s, making it one of the earliest on Tyneside. It would have been a logical development in the wake

[1] W.W.Thomlinson, 'Chopwell Woods', *AA*, 2 ser, 19, (1898), p.258.
[2] Now in Northumberland Archives: NRO ZCO I/15: Blaydon deeds 1698-1700, NRO ZCO I/23.a.d Stella, Kyofield and Ryton deeds 1632-1792; IV.47/1-30 Stella etc colliery accounts, VIII.1 Stella colliery correspondence 1653-1732.
[3] Cosin's survey, DUL Add MS 1930.

of the renewed lease of 1632. Although a Stella Grand Lease waggonway route south-westwards from the Stella staiths up the ridge through Greenside dates from at least 1710 it is unclear whether this was the first such way within the lease territory. Although it can only be speculative, a far more logical route would have been directly westwards along flatter terrain at the foot of the ridge where the Low main coal seam outcropped (as suggested in map in Figure 11.1) and could perhaps have been shared with the Crawcrook lease operators. The coal could presumably be worked 'from the dip' along the ridge foot, benefiting from free drainage. By 1676 the vast majority of Stella coal was moved to the staiths by waggon rather than wain, suggesting that a waggonway connected the majority of open pits or working levels.[1]

.2 Winlaton

Being adjacent to the river with seams rising away to the south-west Winlaton had been worked over a much longer period than Stella and the easier seams were almost certainly worked out by the early 17th century, if not before. Major drainage investments by the owners might have taken production to some 40,000 tons a year by 1627. Hodgson estimated Winlaton's 'vend' at 33,000 tons in 1636, suggesting that its best days had already passed.[2] The colliery's tenants claimed in 1653 that it could not be worked because of the war with Holland and sought relief from the rent otherwise the cost burden of draining the mine while it was not producing would bankrupt them.[3] Winlaton's mine might have been down, but it was not out. The next direct evidence of its level of output is from much later - the mid-1680s, in the form of accounts presented to Sir Edward Blackett, inheritor of a quarter of the manor and its colliery. Around 7,000 tons of sea coal were taken away from his Blaydon staiths in each year, equating to around 28,000 tons from the colliery as a whole. Comparing this to the approximately 33,000 tons of fifty years earlier gives an impression of stability or slow decline.

Some idea of William Blackett I's expectations of the colliery in 1668-9 can be guessed at from the rent he was prepared to pay for 7/8 of the manor and colliery. The headline gross rent was £1,072/yr, from which an allowance must be stripped out for the sub-rental income Blackett received. A surviving account of his income from the Selby half of the manor in 1671 shows that after various encumbrances, head rent and other charges he was left with £260 net income.[4] On the assumption that the other 3/8 of the manor he rented provided remuneration on the same scale his net income overall would have been around £450. An allowance should also be made for the staiths at Blaydon, important for his lead business, and that he would otherwise have had to rent – say £50. Deducting this notional £500 from the rent he was committed to leaves £572 as an estimate of the annual colliery rent. What level of coal production would reduce this to an acceptable unit cost? This depends upon the other costs of operating the mine, the price at which the coal could be sold, and the level of profit expected by Blackett, none of which is known. However, on the assumption that the unit cost of mining was likely to increase through time, the 14.5p/ton Winlaton coal cost in 1684-5 (see Table A2.4 below), we might allow a penny or so less for the 1660s. This happens to be the cost implied in the complaint lodged regarding Winlaton colliery in 1653. During the stand-off with London in 1665-6, the price of a ton of coal was as low as 13p (7 shillings per chalder), but the price trends at Hull suggest a higher level in 1668-9 (see Figure A2.3 below), equating to perhaps 8s (40p)/chalder at Newcastle. It is reasonable to assume that Blackett had an optimistic view of the market outlook given the commitment he was making at Winlaton, but surely could not have hoped to see a price above 9s (17p/ton). At that level, and if he was prepared to accept just 10% as a profit rate on turnover (ie. 1.7p), then rent would have to cost him no more than 1.8p/ton at an assumed mining cost of 13.5p/ton (13.5p + 1.8p + 1.7p = 17p). This could be achieved if £572 net rent was spread over 32,000 tons of coal from his 7/8 of the colliery, implying production of 36-37,000 from the colliery as a whole.

[1] *Fighting Trade*, I, pp. 50, 58, 60; L.Turnbull, *Railways Before George Stephenson*, (2012), p.154. In 1676, 97% of coal led to the staiths for Sir George Vane was carried in wagons: NRO ZCO IV.47/5.
[2] Hodgson, thesis, *op cit*, Vol II, Appendix 5, p.182; E.Clavering and A.Rounding, 'Early Tyneside Industrialism: The lower Derwent and Blaydon Burn Valleys 1550-1700', *AA*, 5th ser, Vol 23, (1995), pp.250-2. This article gives a general survey of coal mining and industry in Winlaton in the 17th century.
[3] R.Welford, *Compounding, op cit*, (1905), p.287.
[4] NRO ZBL 273/16.

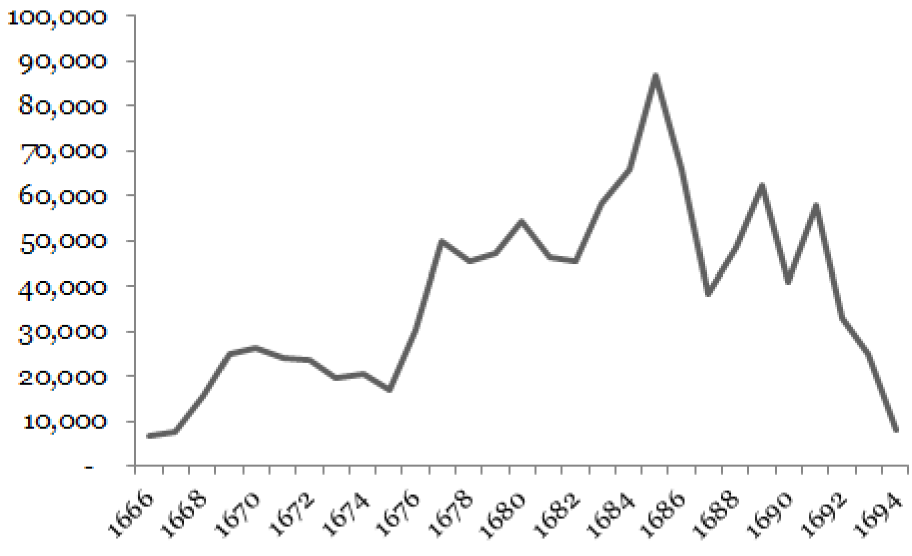
This is all speculative although not hugely higher than estimated production in the 1630s and 1680s. Nevertheless if Blackett was being optimistic about the price of coal he surely was also regarding the potential output that could be wrought from Winlaton.

A continuing pattern of slow decline can be seen in intermittent notices and accounts in the later 1680s and 1690s. Annualised production was still at around 30,000 tons in 1688, but 22,000 in 1689, 13,000 in 1690 and around 11,000 in 1692.[1] It was possibly sustained at around this level into the next century, for a cartel of Tyneside coalowners agreed quotas amongst themselves that allocated about 10,500 tons to Winlaton in 1708 and 1710.[2] By the late 1720s, however, presumably aided by greater investment in drainage and a second waggonway being laid in the 1710s, production was running at around 45,000 tons per year.[3]

.3 North of Tyne

This name is used for convenience to cover the mines owned and controlled by Blackett on the north of the Tyne, following his marriage to the widowed Margaret Rogers in 1675, and named by him in his will as Whorlton, Newburn, Newbiggin and Brunton. The only information regarding their output is that wrought at Whorlton Moor and carried to Lemington and Denton staiths under a 21 year lease from the Earl of Northumberland – owner of the Newburn lordship - originally taken out by Blackett's elder brother Christopher in 1665. It appears that Rogers was involved there from around 1668, from which point coal output rose from under 10,000 tons/year to around 25,000 tons (see Figure A2.1).[4] The detailed surviving accounts do not record any other mine worked at Newburn during these years. There was a surge in output on Whorlton Moor from 1676 once Blackett was directly involved in Rogers' half share of the mine, rising from under 20,000 tons in the year to September 1675 to 50,000 two years later. It stabilised at around this level until 1683, when it surged to reach around 87,000 tons in the last year of the 21 year lease. It looks very much as though William Blackett II was seeking to exploit the lease while he had it and he appears to have left the partnership with his step-brother John Rogers II when a new lease was taken in 1686.

Figure A2.1. Whorlton Moor coal production 1666-94 (tons, approx.)



We have no information regarding coal from Newbiggin and Brunton, which lay outside the Earl's lordship and the interest of his meticulous accountants. They were probably also being worked by Rogers from the

[1] NRO ZBL 273/16.
[2] *Fighting Trade*, II, Table 3, p.vi; Hughes, *North Country Life, op cit*, pp.167-8.
[3] NRO 672/E/1B/1 Journal 1727-8, based on chaldrons sold from Sir Wm Blackett's quarter share of the colliery; *Fighting Trade*, II, p.17.
[4] DN Sy: M.VI.13.d and Sy: C.X 2a(1); Milburne vs Blackett and Rogers, 1680, TNA C 10/483/192.

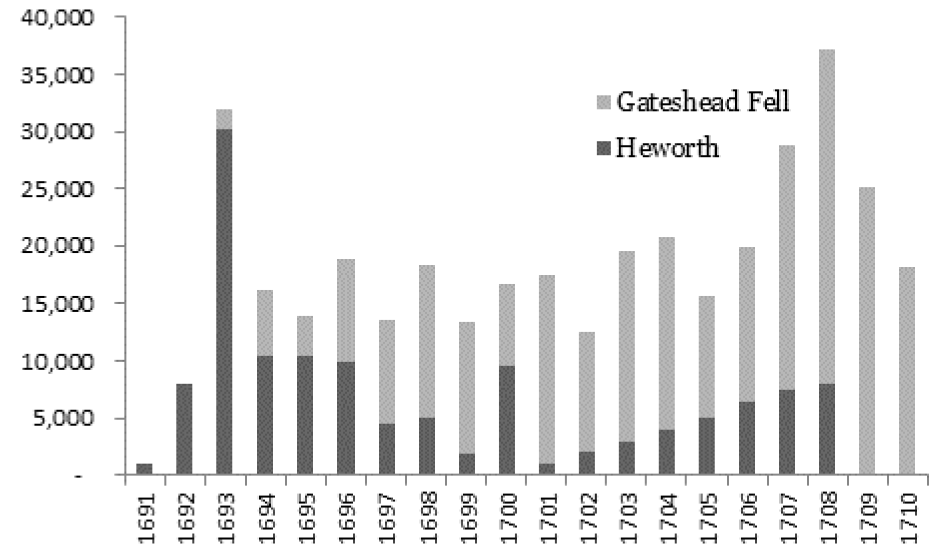
1660s, if not earlier, although the evidence is little more than circumstantial, so none of them were new mines in the mid-1670s.[1] The output from Whorlton Moor should therefore be taken as the lower bound of Blackett's production levels on this side of the Tyne.

.4 Kenton

John Blackett had taken a seven year lease from Martin Fenwick of the East Kenton colliery in 1683 but sold his workgear and stock of coal to his cousin William II soon after the latter bought the estate for £6,000 in December 1688. The high main coal seam outcropped in the southeastern corner of this estate, more or less at the junction of Kenton and Grandstand Road today, on the northern edge of the Town Moor. Coal had been worked under Common Council licence on the town moor. To start with at least the coal must therefore have been easy to work and Blackett was ambitious enough to build a waggonway 3.5 miles down to the Tyne at Scotswood, probably in 1692-3. However he might have found it harder to boost output to a level that made the waggonway economic although in early 1694 he leased the mine in the adjacent estate of West Kenton from Robert Lilburne.[2] The rent there was fixed at £210/year, based on 300 tenns at 14s (70p)/ten, which would have been about 10,000 tons. On the assumption Blackett was comfortable with this fixed threshold he was probably already exceeding it in East Kenton but perhaps not by much. There are no other indications of production before data used to allocate cartel costs in 1701 and quotas granted under cartel agreements in 1708 and 1710. Blackett had led 9,298 chaldrons to Scotswood staiths in 1700, or under 25,000 tons.[3] Casting back over old ledgers available in the office in 1731 Joseph Richmond said that Blackett had 'seldom wro[ugh]t. above 800 X a year for the whole Collry', possibly around 28-30,000 tons of coal.[4]

.5 Heworth and Gateshead Fell

Figure A2.2. Heworth/ Gateshead Fell coal production 1691-1710 (tons, approx.)



[1] John Rogers' long standing acquaintance and partner Jeremiah Tolhurst was mentioned as a lessee at Newburn in 1663: Newburn rental quoted by *HN* 13, p.149. Brunton was owned by Heselrig, with whom Rogers can also be closely associated in Newcastle in the 1650s (*ibid*, pp.369, 373), and Heselrig's family had a long lease of Newbiggin from the Earl of Carlisle in 1655, reconfirmed in 1663: F.W.Dendy, 'Extracts from Privy Seal Dockets', *AA*, 2 ser, 24, (1903), pp.211-2.
[2] Welford, 'Local Muniments', *AA* 3 ser, V, (1909), p.108, *HN* 13, pp.364-5, TWA MD.NC/1/3 f.190v., L. Turnbull, *Railways before Stephenson*, p. 115; waggon horses for Kenton were paid for in May 1693 and coals led down the way in June: Kenton account book, NRO 11619.
[3] NRO ZCO IV/47/19; Hughes, *North Country Life*, *op cit,* pp.167-8.
[4] J.Richmond to L.Allgood, 2 Feb 1732: NRO 673/2.

Sources: DULASC, DCD/K/LP5/6-95; TWA DF.COT/CK/2/325-460. Estimated tonnage derived from tenns of coal led, for rental calculation purposes. Internal evidence indicate 36.8 tons of coal per tenn. Heworth- interpolated estimates only 1701-07.

In February 1691 William Blackett II took on an existing lease of 7/8 of the mining rights at Heworth, owned by the Durham Dean and Chapter, on the south bank of the Tyne east of Gateshead in Jarrow parish. A few months later he was left a share of Deckham Hall, not far away to the south-east, by his uncle Matthew Kirtley and in June 1693 he took on rights on the adjacent Gateshead Fell via trustees.[1] The detailed accounts kept by the Dean and Chapter's agent show that Blackett was mining at 'Heworth Swards', on steeply rising land a mile inland and probably just beyond a fault where the High Main coalseam was raised towards the surface. Notes left by his later agent John Wilkinson a decade or so later show that a drift was driven into the favourable terrain to assist with draining but evidently not before a great deal of trouble with draining the shafts that reached the High Main and 'Three quarter' coal.[2] The lease had been running since 1661; there could not have been any coal left at the surface. The accounts which survive for the 1690s from both Heworth and Gateshead Fell allow Blackett's production to be tracked, as shown in Figure A2.2 above. Production rose rapidly to a peak in 1693, which was never achieved again. Indeed while Blackett had committed to rent on Gateshead Fell based on a minimum of 300 tenns of coal per year (c. 10,500 tons) he did not reach this level until 1698, a stark indication of the gap between hope and reality. The accounts also show that his first waggonway there was in operation from late 1693 and later notes show that a second was constructed to Felling Shore in c. 1706-8 by John Wilkinson, trustee and agent during William III's minority. He presided over a further increase in Gateshead Fell production during this first decade of the 18th century. This is reflected in the increase in the Blackett/Wilkinson 'Felling' quota between 1701 and 1708 from 17,300 to 37,000 tons.

2.2.3 Summary Estimates of production

The foregoing section set out the basis for the production estimates from each of the coal mines owned and operated by the Sir William Blackett I-III that are combined in Table A2.2. Estimates taken directly from the foregoing discussion are shown in plain text. Amounts for intervening years are interpolated on a straight line basis and shown in italics. The Tyneside production total is taken from Hatcher as also discussed above. The totals are amended based on the assumed shares of each colliery held by family members at different times as set out in the notes to the table.

Table A2.2 Blackett approximate sea coal production 1660-1729

	tons	1660	1670	1676	1680	1684-5	1690	1700	1710	1725-9
Stella	1660-	*2,500*	*4,000*	6,300	6,912	7,081	*5,500*	2,600	3,100	7,925
Winlaton	1668-		*30,00*	*18,650*	*16,875*	7,000	8,880	*6,000*	5,300	11,100
N of Tyne	1665-86		13,200	30,300	45,000	50,800	-			
Kenton	1689-						*10,000*	24,600	34,400	
Heworth	1691-							17,300	23,033	14,576
Total		2,500	47,200	55,250	68,787	64,881	24,380	50,500	65,833	33,601
Tyneside	'000 tons	470	510	476	580	620	400	540	490	*700*
Blackett %		0.5%	9.3%	11.6%	11.9%	10.5%	6.1%	9.4%	13.4%	*4.8%*

Notes and assumptions regarding Blackett shares of the collieries. Directly estimated values given in italics.

1. Stella Grand Lease: 1/12 throughout, drawing on Table A2.1 where data exists.
2. Winlaton: 1668-75: 7/8, in three separate leases; 1675-79: 9/16, ie. the half share purchased from Selby and a further 1/16 leased from Haggerston for up to 5 years from 1674, ie. until 1679, the full term being assumed here; 1680+: Wm Blackett I's half share was divided equally between sons Michael and Edward. Michael's share devolved to Wm II after his death in 1683, shown here as a quarter share after 1680. Edward Blackett can be assumed to have held an equal share, not shown here.

[1] DULASC, DCD/K/LP5/6-95; TWA DF.COT/CK/2/325-460, NRO 2762 /E/Deeds/C61.
[2] John Wilkinson, draft notes c.1706: NRO 324/W.3/17.

3. North of Tyne: It is assumed here that Blackett was working with his brother Christopher in respect of Whorlton from the outset (or in charge) and then Rogers took half of the lease in 1668. Christopher died in 1675 and his half share was inherited by sons William (Blackett's ex-apprentice) and John (his agent at Fallowfield). John wrote to his uncle about Whorlton in June 1676.1 Blackett also had full control of Roger's share between 1675 -8, while Margaret Rogers' children were minors; 1678-80: 2/3 following the majority of John Rogers II; 1680+ 1/3, on the assumption that Blackett's widow took control of her daughter's share until their marriages, leaving the remaining third inherited by Wm Blackett II under his father's will. He did not renew the lease in 1686. Newbiggin and Brunton not included.
4. Kenton: East Kenton only 1689-93 and then West Kenton leased.
5. 'Heworth' includes the separate leases of Heworth from the Durham Dean and Chapter (from 1691) and Gateshead Fell from the Durham bishopric's rights holder, from 1693. In each set of accounts un-named partners of Blackett are mentioned but it is assumed here that all production was his, thereby possibly overstating his actual coal output.
6. 1700, 1710 data from Coal Office quotas: see *Fighting Trade*, II, p.vi, Hughes, *North Country Life*, pp.167-8. Given the low level of total shipments in 1710, it seems likely that using Blackett's quota as a proxy for actual production overstates the true position, especially at Kenton. As a share of production 13.4% seems unrealistically high.
7. 1725-9 data from accounts in NRO 672/E/1B/1.

Taken in the round, the figures given here for Blackett coal production result from adding conjectured interpolation upon assumptions that have themselves been erected around a thin foundation of known facts. Rounding the final numbers does little to reduce the risk of spurious accuracy. Against this, the figures for each mine seem reasonable in view of the rough scale of each through time and probably err on the conservative side, such as with the 'North of Tyne' figures, which exclude production at Newbiggin and Brunton in the 1670s. They can, therefore, perhaps be used to gain a general impression of the Blackett share of the Tyneside trade and to give a starting point for projections of their financial and management importance within the family's overall business. This is addressed in the following three sections, which consider the evidence for prices, costs and profitability.

2.3 Prices

For all that coal is sometimes regarded as a cheap and undifferentiated commodity, claims were made for the superior burning qualities of the produce of certain seams and mines – albeit usually by their owners - and this could have affected the prices at which they were sold. It is certainly the case that not all of the coal raised on Tyneside in this period was suitable to be shipped as 'good and merchantable sea coal' and retailed to London households, as discussed in section 2.2.1 above. However, once the sea coal had been separated from the remainder, none of the prices quoted in letters from the Newcastle merchants Ralph Grey and Michael Blackett in the 1670s make any further distinction. It was all just coal. Both men were of course in the business of selling coal, so there is a slight risk that their quotations were on the high side, but they were consistent with each other and both men would have been subject to the self-regulation that came from knowing that many such price quotations were provided in the correspondence of other merchants. Any sharp practice would soon be detected and called out. Furthermore, their quotations can be compared with those of actual sales from the Vane share of the Stella Grand Lease for a few years in the 1670s, to which they bear a reasonable comparison (see Table A2.3 below). Note, however, that from 1679, very few coal prices were given in the correspondence. Prices can be calculated for 1683-5 from actual sales made from Sir Edward Blackett's part of the Winlaton colliery.

The data for this short period can be augmented by a few spot prices for coal from certain Tyneside collieries collected by Hatcher, and mentioned in Newcastle commentaries and longer series of prices for London.[2] Figure A2.3 depicts the data from various purchasers in London by Hatcher and Flinn for their respective volumes of the history of the British coal industry. These are presented as indexed values, with London set to 100 in 1665 and Newcastle to 50, simply to allow them to be viewed as separate series. After 1700, Flinn's index of London prices has been rebased here to the Hatcher series to enable visual continuity. Over such a

[1] John Blackett to Wm Blackett, 24 June 1676, NRO ZBL 193.
[2] Hatcher, Appendix B: Newcastle/ Tyneside pp. 573-5, London pp.583-5.

long time period, the changing availability of source data could lead to biases entering the calculated trends, so this should only be used to give a general impression of the course of coal prices.

It might actually have been the case that the apparent increase of Newcastle prices compared to London between the 1660s and 1680s was real, but, if so, this was not the case in the last years of the century, by which time the price paid for coal in London was probably higher than 20 years earlier, but not so in Newcastle. It is unfortunate that no Tyneside price points survive for the early 1690s to see if they tracked the apparently sharp increase in London, but toothless orders from the Hostmen's company in March 1691 that coal should not be sold for less than the prices obtained in 1688 and 1689 suggest they did not. Rather, the growing practice of giving gift coals to shipmasters, effectively discounts, indicate a local market struggling to cope with a substantial reduction in demand.[1] More than 600,000 tons of coal left the Tyne in 1688 but it was a level not to be reached again until after 1700. In the early 1690s it was rare for more than 450,000 tons to be shipped out. There was no decisive increase in sales until 1697. Broadly speaking, there is no indication of any dramatic long term increase or decrease in the price of Tyneside coal between the 1670s and 1730s. A slightly higher price was probably being commanded towards the end of the period, although apparently without driving up the relative price in London.

Table A2.3 Tyneside coal prices 1674-85

	Sales		Quotations	
(p/ton)	Stella	Winlaton	Avg price	Obser-vations
1674			18.3	7
1675	17.7		18.1	11
1676	14.0		14.0	9
1677			13.8	4
1678	17.0		16.4	6
1679	16.9	11.5	15.7	3
1680	16.9			
1681			17.5	2
1682			17.0	1
1683	17.9	16.3		
1684		17.8		
1685		17.9		

Sources: Stella Grand Lease – actual price received for Vane family sales, usually upwards of 20,000 tons/year: NRO ZCO IV/47/2-17; Winlaton – actual price received for Sir Edward Blackett's sales of c.7-8,000 tons/year: NRO ZBL 273/18; price quotations in various copy letters from Ralph Grey (NRO 753/J) and Michael Blackett. All prices originally quoted in shillings/chaldron. 'Observations' are the number of separate price quotations available in each year.

[1] *Hostmen,* pp. 147-150. The amount said to have been commonly offered in 1690 was equivalent to a 20% discount and both 1691 and 1692 were little better: Hatcher, pp.538-9.

Figure A2.3 Coal price trends in London and Newcastle, 1650-1730

Sources: Table A2.1 above, Newcastle/Tyneside, indexed to 50 in 1665: Hatcher, Appendix B: pp. 573-5; additionally: 1661 (Nov/Dec): TNA C 10/67/53 (8s (40p)/chalder); 1710: Stella coals for overseas: Hughes, *North Country Life*, pp.174-5; 1725-27: actual sales from Felling: NRO 672/E/1B/1 f32; 1730: Richmond to Allgood 2 Feb 1731, NRO 673/2, (DD). London, indexed to 100 in 1665: 1666-1702: Hatcher, pp.583-5; 1700-33: Flinn, *op cit*, (1984), Table 9.4, p.303.

2.4 Costs

Attempts to model the costs of 17th-century coal mining on Tyneside (and elsewhere) are hazardous, not least because they were subject to variation between pits and through time thanks to the complications of geology and terrain. Those few financial accounts that do survive cannot therefore be taken as representative of the costs of mining in general and are in any case usually an incomplete record of all the costs incurred by operators. However, what we do have affords some glimpses of the variation in direct operating costs between a few collieries, which can be assessed in terms of what is known of their situation and history. So, to proceed from the known to the unknown, Table A2.4 summarises the operating costs that can be calculated from the surviving accounts.

The accounts prepared by William Iley for the Vane share of the Stella Grand Lease in the 1670s provide the most useful material now available for the period during which Blackett was building up his coal interests.[1] They give the cost of mining and carrying coal to ships below the bridge at Newcastle and receipts from sales. Mining, draining and land carriage to the staiths was shared between the partners. 'Working and leading' costs were given as an overall amount for each 'leading tenn', that varied slightly from year to year (columns 1 and 2 in Table A2.4) evidently calculated from detailed accounts kept on behalf of the partners of mining, waggon and wain carriage now lost. For the year from November 1674-5 (shown as 1675 above) the account also includes Vane's interest in two separate leases at Whickham, which illustrate the higher costs compared to

[1] The same collection contains a further partial account from the Stella Grand Lease for 1652-3, but its coverage is unclear and so is omitted from consideration here.

Stella. They were nearly half as much again as the equivalent costs at Stella in the same year. At the far western end of the Stella Grand Lease territory, not far from Prudhoe, a tenn of coal from Kyo Close cost just £2.85, not much more than half of the Whickham charge. This shows two things: that actual mining and draining costs were much lower, and that a waggonway already reached as far as Kyo Close. Otherwise, any benefits of lower mining costs would have been outweighed by the higher cost of moving coal four miles by wain or cart to Stella staiths.

Table A2.4 Coal mining costs, Stella, Whickham, Winlaton, 1674-85

		Working and leading					Other	Total	Ref
		£/tenn	tenns	Tons	£	p/ton	p/ton	p/ton	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	
Stella GL (Vane)	1675	£3.66	697.2	25,279	2,656	10.5	1.5	12.0	NRO ZCO.IV 47/2
Kyo Close	1675	£2.85	36.6						
Whickham	1675	£4.90	541.4	18,651	2,653	14.2	1.3	15.5	
Stella GL (Vane)	1676	£3.20	654.0	22,530	2,093	9.3	2.3	11.6	NRO ZCO.IV 47/5
Stella GL (Vane)	1679	£3.00	769.0	26,492	2,307	8.7	2.4	11.1	NRO ZCO.IV 47/9
Stella GL (Vane)	1680	£3.15	711.0	24,494	2,240	9.1	2.5	11.6	NRO ZCO.IV 47/10
Stella GL (Vane)	1683	£3.20	735.0	25,321	2,352	9.3	2.4	11.7	NRO ZCO.IV 47/17
Winlaton	1684-5			14,045	2,041			14.5	NRO ZBL 273/18

Although working and leading costs are bundled together in these accounts, it is possible to infer a rough idea of waggonway transport costs from later accounts. In August 1693 coal was led at 1.1p/ton/mile from Kenton by waggonway to Scotswood staiths. Between 1700-6 at Hedley Colliery, west of the Stella Grand Lease, carriage to Stella staiths cost around 1.2p/ton/mile along the Chopwell waggonway, including wayleave rights.[1] Elsewhere in the region horse or wain carriage rates appear to have been in the range of 3.5-4p/ton/mile (see Appendix 3 below). The difference between these rates is consistent with the finding of Bennet *et al* that waggon carriage cost about a third of the cost by wain.[2] Allowing 1.2p/mile at Stella for carriage by waggon over an average of –say- three miles means that when 3.6p is deducted from the 'working and leading' charge of around 9p/ton between 1676 and 1683, the direct mining costs were 5.4p/ton.

Partners were responsible for their own costs once coal reached the staiths, mainly comprising staith rent (from the Tempest landlords), staithman's wages, keel rent, keel transport, fitter and book-keeper's wages. In 1675 staith rent, wayleaves and the staithman's wages were bundled in to the 'working and leading' charge, but devolved to each partner thereafter, that explains the change in the balance between the 'working and leading' and 'other' charges from 1676. The 'led tenns' were made out into vending tenns at the staiths, and these have been converted into tonnages in column 3 as described in section 2.1 above. Two thirds of the 'other' costs were for the keeling of coal onwards to Newcastle.

Overall then, the observed costs of mining in the Stella Grand Lease in five years between 1675 and 1683 varied in a narrow range between 10.9p and 11.7p/ton. This compares to 16.5p at Whickham in 1675, and with 14.5p at Winlaton in 1683-5. Both latter figures probably cover sufficiently similar cost elements to permit such a comparison. Those for Whickham form part of one of Iley's accounts to Sir George Vane and clearly presented to invite such a comparison. The detailed Winlaton accounts were drawn up for Sir Edward Blackett by his steward at Blaydon, George Harrison. As described in chapters 6 and 11 Whickham and Winlaton were

[1] Kenton: NRO 11619; Hedley: Derived from colliery accounts extracted from DN Sy: Cx.2.a(2) ff.7, 9, 20, 22 by Les Turnbull, to whom I am grateful for sharing the data with me (*pers comm*, 4 Feb 2019). The unit cost assumptions are my own.

[2] *Fighting Trade*, I, pp.8-9

older collieries than Stella, and undoubtedly burdened with the costs of deeper shafts and more extensive drainage needs. The economic impact of this can now be seen in the form of direct unit costs of coal delivered to Newcastle that were some 40% (Whickham) and 25% (Winlaton) higher than at Stella in the 1670s/80s.

However, we need to take other costs into consideration on which the accounts appear to be silent, particularly capital expenditure and rent. Coal mining was one of the most capital intensive sectors of the pre-industrial economy in terms of the fixed assets and infrastructure required in Tyneside's mature coalfield. Any omission of initial outlays on shafts, levels, drainage equipment, waggonways, waggons, wains, horse and staiths could significantly understate the true cost of mining as shown in the direct expenditures captured in annual accounts. This is, however, potentially mitigated in two ways. Firstly, some of the capital goods described above were hired by operators rather than owned, and therefore itemised in the accounts. At Stella, the staithroom was rented from Tempest and the keels hired on annual terms from their owners. Secondly, most direct capital expenditure in this period took the form of manual labour and supplies much the same as that needed to hew coal and carry it. Shafts were sunk by hand. Financial accounts hardly ever distinguished between what today we would class separately as capital and operating expenditure.[1] It was all just accounted for on a cash basis. The capital cost of creating and renewing the fixed assets of mining at Stella is therefore probably included under the umbrella of 'working and leading' spending. A remaining problem, however, is that the accounts only cover a few years. Capital assets might last for much longer. The expense of their creation might be invisible to us, having been incurred years earlier, while the benefit continued to be enjoyed. On the other hand, because coalmining could extract vast quantities of material in fairly short order, new shafts had to be sunk frequently. Hatcher concluded that the value of such assets was probably exhausted within three to five years in large mines and less time in smaller ones, a high rate of annual depreciation.[2] As such it is possible that more of the capital cost of asset replacement was included than not in the space of a few years accounts. Even waggonways, the routes of which could last for years, needed constant maintenance attention given the wear and tear caused by heavy waggon traffic. Wooden rails, sleepers, footings, waggons and wheels probably all needed to be replaced over a cycle of five years or so. It is quite possible that the great majority of capital spending is captured on a cash basis within the accounts that remain to us.

The leasing or rental costs of the mining rights enjoyed are, on the other hand, not seen in the Stella or Whickham accounts (other than the Stella staithroom rent and wayleave provision). Both of the Grand Leases were taken from the Bishop of Durham. The annual rent levied at Stella was a pittance at £6 13s4d (£6.67) per year plus £1 6s8d (£1.33) for each working pit. There would have needed to be over 80 of these at work each year for it to match the still scandalously low £117/year charged at Whickham.[3] The Stella lease ran for three lives, the term of which could therefore vary unpredictably. It was renewed on this basis in 1664, subject to an initial charge or entry fine that went some way towards compensating for the low annual rent. Cosin had apparently turned down an offer of £1,500 from the partners for this but the final amount is not given. Let us assume that he settled for £2,000, that the three life term would extend for 25 years, similar to the observed elapsed time between earlier leases, at the existing low annual rent with, say, 20 pits open. Spreading the £2,000 entry fine over 25 years, ie. £80/year, would bring the annual cost of mining rights to £110. At this rate, it would have added little more than 0.1p to the cost of producing each ton of coal by the 1670s, when the colliery was producing 75,000 tons of coal each year. Cosin had every right to be upset in the 1660s, but it is bemusing that he did not hold out for better terms. It was only a few years later, in 1668-9, that William Blackett was prepared to pay around £572/year for 7/8 of the Winlaton mining rights, and this shortly after the embargo crisis of 1665-6. Even if he had achieved an output of 30,000 tons per year, rent would add nearly 2p to the direct cost of each ton. In each case the rent was fixed, which gave an incentive to operators to extract as much coal as possible. Hatcher found that by the late 17th-century royalties, which varied with output, were a much more important component of rental income, accounting for 1-2.7p/ton. This approach was the general rule on the Earl of Northumberland's estates throughout the century and the Whorlton mines paid

[1] Edwards, *Financial Accounting*, *op cit*, p.83, where the point is also made that actual cash outlays on 'wear and tear' gave a more practical view of what actually mattered compared to applying an abstract rate of depreciation.
[2] Hatcher, pp. 337-8.
[3] Cosin's survey: Durham Cath Library, MS Sharpe 173, f.172; Levine and Wrightson, *op cit*, p. 56.

50p/production tenn under the 1665-86 lease, or roughly 1.2p/ton of coal.[1] Downstream of the Tyne Bridge, William Blackett II was charged 25p/led tenn by the Dean and Chapter for the Heworth lease in the 1690s, about 0.6-0.7p/ton, which appears comparatively low, especially when set next to the dues incurred on the adjacent Gateshead Fell of double that amount, but there is no sign in the accounts that any additional rent was to be paid.[2]

Table A2.5 Blackett coal mining operating costs 1660-1730

p/ton	1660	1670	1675-6	1679-80	1684-5	1690	1700	1710
Stella	*11.5*	11.5	11.6	11.4	*11.5*	11.5	11.5	11.5
Winlaton		*13.9*	*14.0*	*14.5*	14.5	14.5	14.5	15.0
N of Tyne			*14.5*	*14.5*	*14.5*			
Kenton						*11.2*	*17.6*	*17.8*
Heworth							*16.3*	*16.3*

Table A2.5 uses the calculated values for direct unit mining costs from the Stella and Winlaton accounts. Rent and any capital expenditure not captured by the operating cost accounting are not included. Figures in italics for those collieries extrapolate for intervening years. It is assumed that costs/ton in Stella were no lower in 1660 than in the mid-1670s. Mining costs might have been lower then if more easily worked coal was available to work before the intensification of the next 15 years, but against this further capital investment might have been required in the wake of the Restoration. An analysis from 1712 indicates that the unit cost of mining remained at the same level 40 years later.[3] At Winlaton a gentle rise in costs is assumed in the years before the accounts available for 1684-5 and thereafter. No information on the cost of mining is available for the North of Tyne pits. Here I reason that the geology was as favourable for mining as at Stella, with easy access to the High Main coalseam north of the 90 fathom dyke, but that coal had not been worked for as long and could therefore be obtained more cheaply still. However, there was no waggonway, so two miles of wain carriage at 4d (1.7p) /ton is allowed (slightly lower than the much longer run observed at Tanfield in 1711) and the known rental cost per ton is also included.

There is no data for Kenton other than a unit cost calculation prepared by Richmond in 1731, which suggests coal could be worked and led down to Scotswood staiths for 14.7p/ton. By then the mine had been flooded for at least 16 years so a costly drainage charge would be req uried on top of this. However, assuming Richmond's estimate was a realistic view on the ongoing charges once this had been done it would still reflect the additional cost of working the coal at depth. This was possibly avoided in the early days of Blackett's venture, when it could perhaps still be won much nearer the surface, so a 20% reduction is assumed for 1690. Costs were higher by 1701, because of royalties charged on the western half of the estate, taken in 1694, and levied at 70p/tenn (ie. approximately 2p/ton) and it is further assumed that drainage costs increased steadily thereafter. We are even more in the dark regarding mining costs at Heworth and Gateshead Fell but it is assumed that transport costs were lower there, for the mines were half of Kenton's distance from the river, but that working costs were the same as the coal was found at depth. Then there was the cost of expensive fixed infrastructure. Kenton's waggonway was four miles long, which probably meant an annual depreciation charge of £1,000 (see section 2.5.2.1 below), or over 4p/ton at 1700 levels of output, a cost possibly missed in Richmond's 1731 estimate, taking 1700 unit costs to the estimated 17.6p shown in Table A2.5. The Heworth/ Gateshead waggonway was shorter, but drainage problems were only overcome by driving a level that was possibly up to a mile long.[4] At 60p/yard – roughly the rate seen in lead mining - this would have cost over £1,000 alone, which might be depreciated over ten years, say. Taking all this into consideration the unit cost of each ton of Heworth/ Gateshead coal is assumed to have cost 16.3p in 1700. Here and at Kenton, these high

[1] Hatcher, p.280; DN Sy: C.X.2.a (1).
[2] DULASC, DCD/K/LP5/5-95; TWA DF.COT/CK/2/325-460.
[3] George Iley, 18 Feb 1712: NRO ZCO VIII/1.
[4] It was driven from 'Midford's Field', north of Deckham, according to Wilkinson's notes from c.1706: NRO 324/W.3/19.

levels reflect the impact of recent heavy investment and failing to achieve high annual production to make full use of the capacity laid down.

This can now be brought together with the selling price estimates in section 2.3 to generate a rough indication of the profitability of the Blackett coal business at different times.

2.5 Profitability

Two dimensions of business health need to be considered: the profit margin on sales and the return on capital. The former measures the rate at which revenue is more than covering the cost of sales and allows the business to be compared with the performance of other concerns in the same industry. But it does not enable an owner to determine whether it represents the best use of capital resources compared to allocating them to other trades. In seeking to assess the Blackett business in the round the second dimension is therefore also important. Clearly the measures are related, for if there is no margin on sales, no profit, there is no return on capital.

2.5.1 Profit margin

In Table A2.6 the output, price and cost estimates developed earlier are combined to indicate overall profitability. The unit operating margin figures shown for 1675-6, 1679-80 and 1684-5 average the coal price and cost in each year. Actual values for 1725-9 are taken from Joseph Richmond's accounts. Even though the resulting calculation can do no more than give a rough indication of orders of magnitude the superior profitability of the Stella Grand Lease is clear, but its contribution to the overall Blackett coffers was diluted by the larger Winlaton and North of Tyne collieries taken on at later dates.

Table A2.6 Blackett coal business – estimated operating profit

	1660	1670	1675-6	1679-80	1684-5	1690	1700	1710	1725-9
Output (tons)	2,500	47,200	54,497	66,505	64,881	24,380	50,500	65,833	31,200
Stella	2,500	4,000	6,647	7,247	7,081	5,500	2,600	3,100	4,000
Winlaton		30,000	24,200	17,158	7,000	8,800	6,000	5,300	11,700
N of Tyne		13,200	23,650	42,100	50,800				
Kenton						10,000	24,600	34,500	
Heworth							17,300	23,033	15,500
Gateshead Fell									
Operating margin	p/ton								
Stella	3.6p	1.7p	4.4p	5.2p	6.4p	3.6p	5.5p	5.5p	
Winlaton		-0.7p	2.0p	2.1p	3.3p	0.6p	2.5p	2.0p	
N of Tyne		-1.3p	1.5p	2.1p	3.4p				
Kenton						3.9p	-0.6p	-0.8p	
Heworth							0.7p	0.7p	
Revenue	£377	£6,234	£8,740	£11,042	£11,581	£3,680	£8,575	£11,179	£4,802
Operating cost	£288	£6,544	£7,591	£9,416	£9,198	£3,040	£8,319	£11,029	£4,596
Operating profit	£90	-£310	£1,149	£1,626	£2,384	£640	£257	£150	£206
	24%	-5%	13%	15%	21%	17%	3%	1%	4%

The thin margins show how vulnerable the high cost mines were to price fluctuations – and fluctuate they did, as illustrated in Figure A2.3. A two shilling (10p) swing in the price of a chaldron of coal in Newcastle (3.7p/ton) occurred often enough, and could easily make a difference between profit and loss. Just such a range of variation is observed in the average prices found in each of the six years between 1675 and 1680. Extending the operating margin calculation to 1677-8 by further interpolation of costs and output generates an average operating profit margin of 10% of revenue between 1675 and 1680 as a whole. For 1700 and 1710 it is assumed –perhaps optimistically – that coal was sold on Tyneside at 9s (45p) per chaldron.

Remember that these figures do not include leasing or rental costs at Stella and Winlaton. In the circumstances it is hard to see how any profit could be made at Winlaton at all if rent was up to 2p/ton (section 2.4) except in years of very high prices. However a further exclusion needs to be borne in mind as mentioned in section 2.2.1 above: cheap coal consumed locally. The output figures and prices relate to sea coal. If, as Hodgson estimated, a quarter of all regional production was consumed by the salt and other industries and for domestic heating, it would make a material difference. There is no obvious record of revenue from such sales but the costs of mining it were almost certainly captured, for poor quality coal came out of the mines and down to the staiths with the good, where it could be sorted aside by the staithman as the vending tenns were made out. Variations in the proportions might explain the slight observed variation in the 'making-out' rate at Stella staiths from year to year. From her work with Cotesworth's papers Ellis concluded that pan coal could be bought for around half the price of sea coal. In the early 18th century it was sold for around 8p/ton at the staiths. Cotesworth calculated that pan coal sales would increase his Winlaton profits by 14%. [1] Figures such as these could have made Blackett's larger collieries appear more attractive. However it is a speculation too far to include them now, for want of any information on the amount of low-grade coal mined and how it was exploited. In taking this approach revenue might be understated to a degree, but so too are costs because of the unknown amount of rent expense. The operating margin figures produced in Table A2.6 therefore exclude small amounts on both sides of the income statement that would thereby tend to overstate the operating margin fractionally. Operating profits in the range of 0-25% of sales, and perhaps averaging near 10%, were unspectacular, but they also need to be considered as a return on the capital needed to generate them.

2.5.2 Return on assets

.1 Fixed asset infrastructure

The amount of capital employed is unknown. It is all very well to carry the brave assumption that the costs of frequent renewal and extension of fixed capital assets are buried within the cash-based expenditure accounts, but this does not tell us the value of the stock at any one time. Admitting similar apprehensions, Hatcher formed the view, from his own analysis of surviving accounts nationally, that each ton of output in the late 17th and 18th centuries was backed by between 2-3 shillings of fixed capital, 10-15p.[2] This must have varied enormously based on the circumstances of each mine – how deep the workings, the number of shafts and drainage engines, whether dedicated waggonways were involved and so on.

We can come at the problem from a slightly different angle by estimating the construction expense of key parts of this mining infrastructure in the northeast (see Table A2.7). This example, loosely modelled on what is known on Stella Grand Lease, is hypothetical but nevertheless instructive. It takes 30,000 tons as the level of production, which is possibly the level seen in the early 1660s. A higher level of output is considered in the next section.

The mining and miscellaneous assets (rows 1-6 in table A2.7) add up to just over £1,300. This abstract figure means little on its own, but it is interesting to consider it alongside the cost of laying and equipping a waggonway. Even if the direct mining and staith infrastructure fixed capital was *double* that guessed at above, which seems highly unlikely, it was probably still eclipsed by the amount represented by the waggonway. As

[1] Ellis, *op cit*, (1981), pp.47, 49
[2] Hatcher, pp.336-8.

more of them appeared on Tyneside, snaking away deeper inland from the staiths, they must have accounted for a dramatically higher share of the industry's entire fixed asset base, particularly when adding the cost of equipping each with sufficient waggon and horse capacity to carry the output. Stella's certainly must have dominated the capital structure of the Grand Lease, but even there, a combined fixed asset total of £4,375 was within the 10-15p/ton bounds proposed by Hatcher, at 14.6p/ton when divided into 30,000 tons of coal.

Table A2.7 Illustration of colliery fixed asset value (30,000 tons of production)

	cost			Deprec (yrs)
			£4,249	
Working shafts	£85	4	£340	3
Headgear	£30	4	£120	5
Horses	£7	24	£168	8
Drainage shafts	£85	2	£170	6
Drainage engines & pumps	£80	2	£160	4
Horses	£7	12	£84	8
Misc			£150	5
Waggonway	£750	3	£2,250	5
Waggons & horses	£22	37	£807	4

Notes and assumptions:

1. Number of shafts. *The Compleat Collier* of 1708 (attributed to 'JC') reckoned 21 score corves of coal to be a good day's work in a sixty fathom (360ft) pit (p.32). At his measure of 14-15 pecks/corve (about 1.9 cwt) this is 40 tons per day. Over 10 months of six day weeks this adds up to 10,000 tons. However 360ft was exceptionally deep; production could perhaps be higher if coal did not have to be winched so far to the surface. But to err on the side of caution 7,500 tons/pit/year is used here, ie. four working shafts for 30,000 tons of output. Two drainage shafts are allowed for; one might well have sufficed if the viewer planned the colliery astutely and – of course - none if coal could be worked 'up from the dip' via an adit or level.
2. Sinking and lining shafts. JC claimed that shafts could be sunk for between 50-60s (£2.50-£3) per fathom (6 feet) though noted that sinking through the exceptionally hard whinstone costs would be much higher. In the Tyne basin west of Newcastle the accessible coal measures lay above this stratum (pp.12-3). Shafts of a depth of 120ft or more were common in mature collieries; each could therefore cost around £60 to sink. To be conservative another £25 is added here in case wooden lining and access ladders /ropes were omitted. Working shafts are assumed to have had a life of no more than three years, before the coal they could sensibly reach was exhausted but well placed drainage shafts are assumed here to have remained valuable for twice as long, which could easily be an underestimate.
3. Drainage engines and pumps: Hatcher claimed these were relatively cheap, and that few cost more than £100 in the 17th century (p.213); £80 is allowed here.
4. Good mine horses could be purchased for £6-7 according to JC (p.34) and used to winch coal to the surface in pairs working 4 shifts per day. However, at shallower depths perhaps 3 shifts rather than 4 would suffice, meaning 24 in total. Assumed on same basis for the drainage shafts. It is assumed they had a working life of 8 years.
5. Headgear. £30 allowed for each shaft to cover miscellaneous equipment, which might be generous given other provisions already made. Depreciated over 5 years.
6. A further overall allowance of £300 is included to cover staith pilings, hard standing, winches/cranes to load keels, and other miscellaneous capital outlays associated with the mine and its transport infrastructure.
7. Waggonway. Allowed for at £750 per mile, assuming some was double-tracked given density of traffic, to survey, level and construct and requiring full replacement after 5 years. This draws upon examples quoted by Levine and Wrightson (1991, pp.50-1). This example is based on Stella, where it was probably 3 miles long. No allowance included for wayleave costs, which could be onerous.
8. Waggons and horses. £7 per horse as before, and £15 guessed for a waggon, which lasted no more than 4 years. In the late 1670s 33 were employed by Vane to move his 30% share of 90,000 tons of coal per year, ie. implying 110 in total. Scaling back in proportion for 30,000 tons gives 37 waggons.

Hypothetical examples cannot substitute for the unknown reality of fixed capital investment, but they can give a sense of how different features of the collieries might influence capital requirements. The absence of a waggonway serving the North of Tyne mines in the 1670s, for example, would have reduced the capital cost of Blackett's pits there compared to Stella. If, as newer mines, the coal was easier to get at either directly through lateral driving into the seams or from galleries branching from shallow pits, this too would have eased demands for fixed capital. At Winlaton, on the other hand, deeper pits were probably required, although possibly not in great number. In the late 1680s, six were normally at work at any one time, producing 25-30,000 tons/year between them, with a new one appearing every six months or so.[1] A waggonway seems to have been in operation there from the 1630s, possibly running no more than a mile inland near the Blaydon Burn.[2]

The upshot of all this as far as the 1670s is concerned is that the ratio of fixed asset value to output was probably at – or even below - the low end of the range quoted by Hatcher at the North of Tyne mines, at the higher end at the Stella Grand Lease and in between at Winlaton.[3] But before concluding, operational scale needs to be considered too.

.2 Economies of scale

Because coal mining was one of the more capital-intensive industries in pre-industrial England it offered the possibility of increasing returns as production was raised. As the Duke of Northumberland's agent pointed out in 1610 drainage costs were constant, so would be reduced the more pits were working.[4] Pursuing the hypothetical example used in the previous section, this has been modelled based on two scenarios: annual production of 30,000 and of 90,000 tons of coal, using observed ratios of expenditure to output and other specific assumptions set out below. The results are given in Table 2.28. The usual caveats regarding the appearance of spurious accuracy apply.

The model and assumptions are hypothetical but grounded in actual accounts and realistic unit costs prevailing in the Restoration period on Tyneside. Crude as the projections are, the economies of scale resulting from more intensive use of fixed assets are clear. Where there was underused capacity in fixed assets, a threefold increase in production and sales could be accompanied by a noticeably smaller rise in fully depreciated costs (148% vs 200% increase in this model). The main contributions to this were the fixed rent and, most importantly, higher utilisation of the waggonway. The carriage of around 22-25,000 tons of coal per year was probably needed to make it viable. This must have been far below the physical capacity of the line. If it could be operated for six days a week over ten months, an average of 60 waggon-loads per day would suffice to move 25,000 tons in a year.[5] If we further assume ten hours of daily operation at a speed of three miles per hour, the waggons would be spaced half a mile apart on the tracks. All else remaining equal, the waggons would still be 250 yards apart in carrying the 90,000 tons being produced by the end of the 1670s. An allowance for extra wear and tear must be made. This assumes all coal was moved by waggon from the distant railhead whereas in reality some would have been mined nearer the staiths, and loaded from spurs to the main railway. There can be little doubt that nearly all the active pits in the lease were served by waggonway, for only 3-5% of the coal arriving at the staiths in 1676-9 was carried there by wains lumbering along the rutted and muddy lanes. If asset life was reduced from 5 to –say- 4 years through more intensive use, the annual charge became £563 instead of £450. Nevertheless, the waggon transport cost per ton would reduce from 4p/ton at 25,000 ton of annual carriage to under 3p at 90,000 tons. As illustrated in Table A2.8, scale brought a significant boost to profits.

[1] NRO ZBL 273/18. For what it is worth, the new pits therefore appeared at a rate consistent with the stock having to be renewed every three years, as suggested by Hatcher.
[2] *Fighting Trade*, 1, p. 48
[3] There is also the question of valuing leases as assets. At Stella, the entry fine paid at the outset or renewal of leases was a large sum compared to the annual rent and a level of £2,000 is assumed in section 2.2.2.1 above for the 1664 renewal. This effectively became an asset which reduced over the term of the lease (although the notional calculation of this is difficult under a three life lease of unpredictable duration). At Winlaton there was no entry fine when Blackett took his leases in the 1660s, but an element of the purchase price in 1674 should theoretically be ascribed to the coal rights. We don't know if entry fines were paid for the North of the Tyne mines. Given the uncertainty this aspect of the capital commitment is excluded from the discussion, other than as the cost of mining rights (see Table A2.8).
[4] Quoted from DN Sy: Q.VI.80, 93 by Hatcher, p.265.
[5] The Stella accounts show that waggon capacity was about 1.7 tons.

Table A2.8 Illustration of colliery economies of scale, 1670s

				Tons of coal		% increase
				30,000	90,000	200%
Costs				**£4,117**	**£10,193**	**148%**
Variable				**2,720**	**8,161**	**200%**
	'Working'		5.4p/ton	1,625	4,875	
	Shafts	Depreciation		158	475	
	Transport	Waggon expense	1.5p/ton	460	1,381	
		Depreciation		202	605	
		Keel expense	0.9p/ton	255	765	
		Keel hire		65	195	
'Fixed'				**1,351**	**1,898**	**40%**
	Drainage			269	450	67%
	Waggonway	depreciation		450	563	25%
	Rent	Mining rights		230	230	0%
		Staiths/wayleave		64	80	25%
	Management			229	407	77%
	Other	depreciation		109	168	69%
Revenue	*assuming*	*8.25s/chaldron*	**15.6p/ton**	**£4,670**	**£14,009**	**200%**
Profit				**£553**	**£3,816**	
Profit %				12%	27%	

Notes and assumptions:

1. Variable costs. The rates per ton are derived from the actual costs as shown in the Stella GL accounts for 1679 and 1680, when annual production was at the level of 90,000 tons. Waggon transport, which accounted for the vast majority of land carriage is divided between allowances for the actual cost of transport by a man and a horse, and the depreciation/wear and tear of the waggons and horses, which are assumed to have lasted four years before being replaced. The cost per ton and waggon, horse and keel capacity are assumed to have closely followed the volume of production. Working shafts are assumed to have increased in proportion to output, so too their depreciation charge.
2. Drainage. The annual operating expense is set at 0.5p/ton in the 90,000 tons scenario, which fits with the remainder of the observed rate per ton taken for 'working and leading' costs in 1679-80. It is less than 10% of the direct mining costs as modelled here. Stella probably benefited from comparatively low drainage costs compared to, say, Whickham (the impact of which might be captured in the operating cost comparison in Table A2.4). Although drainage costs might be held constant even as new mining shafts were added, it depended upon the precise geology and sinkings at any one mine. Here it is assumed that drainage costs increased with output, but only at one third the rate of growth. This is worked back from £450 to give a figure of £270 at 30,000 tons of production, at which rate drainage costs were over 16% of mining costs.
3. Waggonway depreciation. At the higher level of usage implied by 90,000 tons of annual production, wear and tear surely increased, requiring full renewal in, say, 4 years, equating to a depreciation charge of £563.
4. Rent. The annualised rent and entry fines payable to the Bishop is taken from section 2.2.2.1 above, and is assumed to have been fixed.
5. Staiths/wayleave rent is stated to be £80 in 1679/80. Because 'staithroom' rent was charged based on the number of keels that could be accommodated, it is assumed to have been slightly lower at lower volumes rather than fixed. £64 is arbitrarily used here. This category of cost is small enough to make little material difference to the model.
6. Management. This is assumed to comprise a fitter (£60/year), staithman (£25), book-keeper (£20), a viewer (£50), and an overman (£21) for each working shaft. The first three annual salary costs are taken from the 1679-80 Stella accounts and the last two from *The Compleat Collier* (p.44). The number of overmen is increased as the number of shafts increases (from 4 to 12), while the others remain the same.
7. Other. This amount is introduced to allow for the possibility that the cash-based accounts of Stella do not fully capture all the wear and tear/maintenance and replacement of fixed colliery assets within the limited years now visible to us. The assets are assumed to be as follows, (following section 2.5.2.1 above and extending Table A2.7)

Table A2.9 Illustration of colliery fixed asset value

	cost	30,000 tons		90,000 tons		Deprec (yrs)
			£4,249		£7,425	
Working shafts	£85	4	£340	12	£1,020	3
Headgear	£30	4	£180	12	£360	5
Horses	£7	24	£168	72	£504	8
Drainage shafts	£85	2	£170	3	£255	6
Drainage engines & pumps	£80	2	£160	3	£240	4
Mine horses	£7	12	£84	18	£126	8
Misc			£150		£250	5
Waggonway	£750		£2,250		£2,250	4
Waggons & horses	£22	37	£807	110	£2,420	4

Working shafts and headgear are added in strict proportion to output.. There is no obvious basis to assume higher underground production per shaft simply because total output was higher. The same principle applies to the waggon capacity. A further drainage shaft is added, which raises the number of mine horses in tandem. Depreciation in the two scenarios is based on the asset values and life shown in tables A2.7 and A2.9. 'Other depreciation' is the balance remaining after the separate itemisation given elsewhere in the table. Total costs/ton are 11.3p/ton, slightly above the 11.1p calculated from the 1679 accounts when 90,000 tons of coal was produced. This seems reasonable given the likelihood that some elements of depreciation did not get picked up in the annual accounts.

8. Revenue. As discussed above this varied greatly. For the purposes of the model it is set at 8s 3d/chaldron, for illustrative purposes, this being within the range seen in the later 1670s.

The results of these scenarios are summarised in Table A2.10. The lower 'fixed' costs drop straight through to profit, greatly increasing their value and the percentage operating margin. It is accompanied by more than a 50% reduction in the burden of fixed assets at the higher level of production modelled, mainly because of greater utilisation of the waggonway. The conjecture made at the end of section 2.5.2.1 above regarding the varying load of capital assets at the different Blackett collieries in the 1670s therefore needs modification. The ratio of fixed asset value to output at Stella was probably at or below the low end of the range quoted by Hatcher, as also at the North of Tyne mines, but for different reasons. The North of Tyne mines are assumed to have been working at lower depths, had no waggonway and therefore required less capital. The Stella Grand Lease was much more capital-intensive, but scale spread this burden across high output. As an older, deeper mine, Winlaton could therefore have seen the highest ratio of fixed assets to output of the three of them.

Table A2.10 cost/ton summary

p/ton of coal	30,000 tons	90,000 tons
Revenue	15.6	15.6
Variable Cost	9.2p	9.2p
'Fixed' Cost	4.5p	2.1p
Profit	1.8p	4.2p
Profit %	12%	27%
Fixed assets	14.2p	8.3p

.3 Working capital

In addition to the capital committed in the form of fixed assets, funds were needed to cover the time lag between expenditure and receipt of income, the principles of which were laid out in chapter 4. For the

Tyneside coal industry the majority of expenditure was on labour, whether toiling underground or on the surface to mine and move the coal or on creating and maintaining the capital goods of shafts, engines, waggons and ways. It's unclear whether 17th-century labour contracts followed the form of annual 'bindings' prevalent in later years, that might have allowed some deferred payment of wages but here it is assumed that pay was made no more than a month in arrears and that the same applied to the purchase of mining supplies, although two to three months credit would have been usual.

Receipts, on the other hand, would have been delayed by the time it took to move coal from pithead to staiths, by keel to ships and by ships to markets and then the time required to extract payment from distant merchants, either directly or via a Tyneside fitter, who can be expected to have charged for the privilege of giving early payment. Transport was impeded during the winter, although the port books show conclusively that the coastal and overseas coal trade did not halt completely. However, getting coal to the ships could be difficult. John Blackett's letter to his uncle William I in 1676 suggests that coal was not moved from Newbiggin to Lemington staiths after early November, presumably because the wain roads could not take it.[1] One of the benefits of waggonways was that the land carriage season could be extended. Coal that was not tied up at the pithead through the winter, but could be on its way to London, reduced the burden of working capital strain. A supposition that the average elapsed time between payment of expenses and receipt of income was four months, a third of a year, means this, crudely, is the amount of income to be covered by working capital at any one time. Thus, extending the scenarios modelled in Table A2.8, income of £4,670 from 30,000 tons at 15.6p/ton meant £1,557 in working capital and for 90,000 tons £14,000 of revenue needed £4,670.

.4 Rate of return

The range of assumptions and calculations in the foregoing sections are now brought together to project a rate of return on capital (see Table A2.11). Given the pyramid of ever more heroic assumptions it is built upon, this remains of illustrative value alone. Nevertheless it demonstrates the effect of greater fixed asset utilisation on returns. Under the low output scenario, the greater weight of fixed assets bears down on revenue and profits such that the return on capital is lower than the profit on turnover. A 3% return would have been lower than the cost of capital, for which a minimum of 6% might be assumed as the cost of lending or borrowing at interest. In contrast, in the high output scenario, more efficient use of assets, especially the waggonway, means that the return on capital is higher than profit on turnover. Note also that fixed assets account for a smaller share of capital in the high output scenario.

Table A2.11 Illustrated rate of return on capital

	30,000 tons		90,000 tons	
Revenue	£4,670		£14,009	
Profit	£553		£3,816	
Profit %	12%		27%	
Capital employed	£5,805		£12,095	
Fixed assets	£4,249	73%	£7,425	61%
Working capital	£1,557	27%	£4,670	39%
Return on capital	10%		32%	

How might this be used to hazard a guess at the capital employed by William Blackett I in his coal business in the late 1670s? The mechanism shown in Table A2.12 converts the estimates given of total production in Table

[1] J Blackett to W.Blackett, 24 Jun 1676, NRO ZBL 193.

A2.2 above for each of his collieries into a figure for fixed assets based on broad estimates regarding their cost per ton of production arrived at in section 2.5.2.2.

Table A2.12 Blackett – capital employed in coal, late 1670s

	Stella Grand Lease	Winlaton	North of Tyne	Total	
Production (tons)	7,247	17,158	42,100	66,505	
Revenue				£11,581	
Profit				£1,626	
Profit %				14%	
Capital employed				£9,990	
Fixed assets (p/ton)	8.25p	12p	8.25p		
Fixed assets (£)	£598	£2,059	£3,473	£6,130	61%
Working capital (33% of revenue)				£3,680	39%
Approx Return on capital				16%	

This was calculated above as 8.25p/ton at Stella and the same figure is used for the North of Tyne mines and 12p at Winlaton. However, since it appears that production was slowly declining at Winlaton, the amount of fixed capital already installed might have weighed more heavily than shown here. Against this, the North of Tyne mines, quite possibly working into the exposed high main seam at shallow depth, did not require deep shafts and extensive drainage, then 8p/ton is too high, especially given the absence of a waggonway – and this weighs more heavily into the total given its production share. If fixed assets are overstated by a new penny per ton there, but understated by the same amount at Winlaton, the net effect is to lower total fixed assets by £400, and thereby raise the rate of return by half a percentage point. Such are the sensitivities implied by this illustrative modelling. The assumptions used here suggest that Blackett's capital was earning slightly more as a return (16%) than his profit on turnover (14%) but it could easily have ranged in either direction and certainly did from year to year as the coal price fluctuated. Overall it might have been lower than 15%, but given what is known of output and prices, and the costs and capital needs of his specific collieries, it would rarely have exceeded 20% and certainly not if any significant proportion of the Winlaton land purchase was to be included among the mining fixed assets.

Table A2.13 William Blackett II – capital employed in coal, 1700

	Stella Grand Lease	Winlaton	Kenton	Heworth/ Gateshead	Total	
Production (tons)	2,600	6,000	24,600	17,300	50,500	
Revenue					£8,575	
Profit					£257	
Profit %					3%	
Capital employed					£17,576	
Fixed assets (p/ton)	19p	25p	25p	38p		
Fixed assets (£)	£500	£1,500	£6,150	£6,574	£14,718	84%
Working capital (33% of revenue)					£2,858	16%
Approx Return on capital					1.5%	

If the bleak assumptions made for 1700 can be trusted the return on capital was much lower by 1700 because of the expense of installing new capacity at Kenton and Heworth/ Gateshead yet failing to exploit that investment to the full, as projected in Table A2.13. It is assumed here that as production fell at Stella and Winlaton fixed assets might have fallen as depreciated assets were not fully replaced, but not as quickly as the fall in production. The cost per ton of output therefore rose. For Kenton and Heworth capital is roughly estimated based on the cost factors described in the notes to Table A2.7 and A2.8 above, adding a 15% contingency to cover the unknown additional charges from equipping deeper collieries. In the case of Heworth/ Gateshead this is partially validated by a figure of £9,000 'principal money and interest' included in a draft of a letter from John Wilkinson to the Dean and Chapter of Durham c.1706 requesting a renewal of the lease, a figure that might well have been exaggerated given the petitioning context in which it is found.[1]

This illustrates clearly the effect of low production compared to the assets employed, particularly at Heworth/ Gateshead with a return even lower than the poor level of profitability, and the overwhelming dominance of fixed assets compared to working capital. The recovery achieved by 1708-10 at Heworth/ Gateshead further illustrates the effect of scale economies. By then production had more than doubled to around 37,000 tons. Assuming the same price of 17p/ton and fixed capital of £6,600, an operating profit of around £1,200 can be inferred, taking the return on capital to around 15-16%.

[1] NRO 324/W.3/19.

Appendix 3 Lead

3.1 Weights and Measures

As with coal, modern units of weight are used throughout this work, so some explanation is needed here regarding the traditional measures used for lead. Although bings of lead ore and fothers of smelted lead are obscure terms today, converting them to more intelligible measures is straightforward compared to the task for coal, because lead was valuable enough to be worth weighing. A bing of dressed lead ore traditionally weighed 8 hundredweight (cwt), so a ton of ore comprised 2.5 bings. However, there were claims in the 1680s that in Weardale a bing was customarily only 7 cwt, and sometimes yet other weights. There must, however, be a suspicion that this was a deliberately confusing invention in a dispute over the Bishop's dues. Certainly by the late 1720s, given the precision of Joseph Richmond's measurements of production, there is very little doubt that a Weardale bing was counted as 8 cwt.[1] Ore was typically carried from mines in one cwt sacks, or 'pokes', two of which could be carried by a single horse. Lead was smelted into pieces or pigs of varying size, as discussed in section 3.2.4 below. This meant that a discrete number of pieces did not always add up to the usual measure of lead, a fother, but neither was a fother of standard weight. Nevertheless we do know the customary weight of fothers in each of the ports from which lead was shipped. In Newcastle it was 21 cwt, 22 cwt in Stockton, 21.5 cwt in Bawtry and Stockwith on the Trent, and 19.5 cwt in London.[2] It was probably a result of bewilderment on the part of new buyers that led Michael Blackett frequently to confirm in his letters that a Newcastle fother comprised 21 cwt, each of 112 lb.

Lead shipments in the Newcastle port books are given in fothers and cwt. However, it is clear from the examination by Professor Pete Lee of the overseas shipments on which customs were levied in 1676 that a fother was charged at a rate implying a weight of 20 cwt, or one ton. I am grateful to him for making his work on this topic freely available to me. The figures drawn from the port books quoted hereafter therefore conservatively assume this lower weight, so it is possible this understates volumes by 5% from Newcastle and Sunderland (assuming a 21 cwt sales fother) and 10% from Stockton.

3.2 Lead production and trade

The changing scale and geographic distribution of lead production before the 18th century in England has attracted little of the attention bestowed on coal by economic historians.

3.2.1 English production

At national level there is a snapshot from the 1630s, in the form of an undated estimate found amongst state papers but possibly created c.1636. This suggests annual production of around 13,000 tons, aggregated from the regional estimates given in Table A3.1. The likely context for this paper was the provision of background information to support a tax imposition, so the author had no incentive to understate the level of production. The amounts are recorded as fodders, that in most cases would mean 19.5cwt or 20cwt ie. one ton or just below, and since these are clearly all rounded estimates to start with, expressing production in tons is not going to make a material difference. However, the estimate for Derbyshire explicitly gave its source as 'the book kepp at Batree' ie. Bawtry, a major transhipment point on the River Idle for Derbyshire lead from overland carriers to boats. Here a fother was 21.5cwt, which converts 7,600 fodders to just under 8,200 tons.[3]

Burt estimated production in 1705/6 to have been approximately 28,000 tons. This is substantially more than the total of just under 16,000 tons he aggregated from the port books of Hull, Newcastle, Stockton, Chester and Bristol and suggests some combination of under-recording of untaxed coastal shipments at the customs ports, omission of other significant coastal outlets, local consumption of lead, and overland carriage.[4] If

[1] Depositions in Crewe vs Wharton, 1686: TNA E 134/2Jas2/Mich 42; Richmond accounts: NRO 672/E/1B/2.
[2] Burt, 'Lead Production' *op cit*, p.268.
[3] TNA SP 16/41/130, quoted in Kiernan, *op cit*, p.228.
[4] Burt, 'Lead production', *op cit*, Tables 1, 4, pp. 257,265.

nothing else it reminds us that port books recorded the minimum amount of traffic. The 1630s total could well also be an underestimate, but it remains possible that there was significant growth in total production in the subsequent seven decades, even if not the doubling implied by these incomplete or hazardous snapshots from single years in a volatile trade. The sources and methods used to estimate the effect of two specific changes in demand for English lead are discussed in the next two sub-sections.

Table A3.1 English lead production, mid-1630s

	Fodders	Tons	
Total	12,600	13,200	
Derbyshire	7,600	8,200	21.5 cwt/fother at Bawtry
Mendip Hills	3,500	3,500	20 cwt/fodder [1]
Wales (lead and lead ore)	1,000	1,000	20 cwt/fodder at Chester
Yorkshire	500	500	19.5 cwt/fodder at Hull

3.2.2 Changes in the Baltic lead trade

The extensive records of cargoes and toll payments at the Sound allow the pattern of the lead trade in and out of the Baltic Sea to be reconstructed, subject to the caveats discussed in Appendix 1.5. The online transcripts of the registers have been examined for all vessels recorded as carrying any one of the ten commonest variations in the spelling of the Danish word for lead, 'Blye', through the Sound between 1635 and 1730. It is possible that other esoteric spellings have been missed but it is likely these were of marginal importance. The total shipments have been extracted (2,660), but their cargo volumes are taken on a sample basis for the principal departure ports (Danzig, London, Hull, Stockton and Newcastle) within either five year periods (when traffic was light), or annually, from which average cargo sizes were calculated by port and time period, and applied to shipments recorded without showing cargo weights. A cursory examination of the sample cargo shows general consistency of size sufficient to lend some confidence to the use of calculated averages. Around half of recorded lead cargoes were denominated in fodders and all but a tiny fraction of the remainder in Danish skippunds (ship pounds). In the absence of evidence to the contrary, the fodder is assumed to been the same as used in England, and converted to one ton. Various works indicate that the skippund weighed 320-330 Imperial pounds, and 320lb has been adopted here.[2] The resulting data is summarised in Table A3.2. Details are omitted for Amsterdam, Lübeck, Copenhagen and Koenigsberg as they accounted for just 8% of shipments and 1% of lead cargo volume during this period.

[1] M.C.Gill and W.S.Harvey, 'Weights and Measures used in the lead industry', *Northern Mine Research Society Memoirs*, 61, (1998), p.137 quote weights of 2,400lb and 2,240lb for a Bristol fother, but this difference might be explained – as was the case elsewhere - by the hundredweight comprising either 120lb or 112lb, making a fother of 20 cwt in each case.
[2] Henryk Zyns, *England and the Baltic in the Elizabethan era*, (1972), pp.196-7.

Table A3.2 Lead shipments through the Sound 1635-1729 by selected port of origin

	Total		Danzig		Newcastle		Stockton		Hull		London	
	No	Tons	No	Tons	No	Tons	No	Tons	No	Tons	No	Tons
1635-9	37	422	32	409								
1640-4	57	428	54	421	1	1						
1645-9	25	128	23	122								
1650-4	10	111	4	10	1	2			2	35	2	48
1655-9	13	70	1	3	2	17			5	40	1	6
1660-4	20	89	1	8	4	28	1	2	8	44	1	1
1665-9	13	57	3	11	5	19			2	15		
1670-4	20	165	1	2	9	79	1	2	6	52	1	22
1675-9	34	304			13	93	2	8	11	178	2	10
1680-4	37	361			13	143	2	29	14	168	3	13
1685-9	50	632			20	333	2	29	16	232	4	20
1690-4	21	512			12	323	1	21	3	113	2	39
1695-9	32	689	1	3	13	247	1	50	7	285	4	61
1700-4	35	499	1	1	15	276	1	9	7	123	5	75
1705-9	19	313			6	63	1	17	4	181	3	33
1710-14	23	467			11	211			4	175	1	25
1715-9	22	389			7	170			5	136	4	55
1720-4	36	361			12	136	1	4	9	97	12	119
1725-9	29	299			13	134	1	7	7	67	9	90

Annual average shown for each five year period. Total shipments (2,660) and tonnage is greater than sum of individual ports shown as smaller ports are omitted.

3.2.3 Lead and the rebuilding of London

The reconstruction of a great deal of London following the Great Fire of 1666 must have demanded a great deal of lead, particularly as the fire itself melted much of the existing stock. The approach taken here is to estimate, conservatively, the amount of lead required for different classes of new building, the share of each of the total number of properties constructed, and the aggregate course of that rebuilding effort.

- Lead required per building: for roof coverage Burt estimated that when cast into sheet a ton of lead could cover no more than an area of 19 square feet, and that 13 square feet was more realistic. He quoted a limited 18th-century renovation project as requiring 71 tons in total: mostly for roofing but 11 tons for rainwater goods and window work alone.[1] Allowing this for each of London's new public buildings might therefore be on the low side, but this is the figure adopted. Just 20 tons has been allowed for each of the grand houses, which is also probably low in proportion to each of the public buildings. Just 6 cwt (0.3 tons) is assumed for lead needed for middling houses and just 1 cwt allowed for minor works on small and meaner houses.

- Property mix: Earle assumed that in the early 18th century a fifth to a quarter of London households were of the middle station, which I equate here to the 'middling houses' as far as lead used in rebuilding is concerned, the gentry/upper middle class a further 3-5% and two thirds to three quarters the poorer classes.[2] To be conservative I have divided the shares of the rebuilt housing stock as 3% as 'grand', 20% as 'middling' and 77% as minor. In addition I have assumed 64 public buildings, based on the numbers given in Strype's *Survey of London*, which includes 52 livery company halls.[3] This excludes the church rebuilding programme, which took place more gradually from 1670 over the following quarter century.

- Rebuilding progress: Archer suggests 1,450 houses were built by the end of 1668, 6,000 by 1670 and 9,000 by 1673. The company halls were rebuilt between 1668 and 1673, and all public buildings completed by 1674, except for the Bridewell. The Royal Exchange reopened in 1669.[4] I have interpolated completion figures for intervening years at a smoothed rate (shown in italics).

The calculations in Table A3.3 crudely assume that houses were rebuilt in fixed proportions each year, meaning that an average of 0.7 tons per property per year. This figure is applied to the rate of annual house construction to project annual demand, including that needed for public buildings. Note from the last column in the first part of Table A3.3 that the vast majority of lead was used for the public buildings and the grand houses. A larger amount of lead for each of these and a higher number of properties would make a significant difference to demand. For example, if the 'grand' houses accounted for just more one more percentage point of the total, ie. to 4%, and still needed only 20 tons each, a further 1,800 tons of lead would have been needed on top of the 11,600 assumed in the table.

Taken together, these various assumptions conservatively project annual demand for lead from London's builders at nearly 2,000 tons in most years from 1669. There is unfortunately no opportunity to validate this with North-eastern coastal port book data between 1666 and 1673, but in the latter year, as shown in Table A3.5 below, coastal shipments, presumably mostly to London, added up to 1,250 tons. This is not greatly different to the projected sum of 1,600 tons for 1673 in Table A3.3.

Table A3.3 Estimated lead required to rebuild London

	Buildings		Lead per building (tons)	Lead (tons)
Public buildings	64		75.0	4,800
Housing				
Grand	270	3%	20.0	5,400
Middling	1,800	20%	0.3	540
Minor	6,930	77%	0.05	347
Total	9,000	100%	0.7	11,087

[1] Burt, 'Lead Production', *op cit*, pp.259-60.
[2] Earle, *op cit*, pp.80-1.
[3] Quoted in W.G.Bell, *The Great fire of London in 1666*, (1920, Folio Soc. Edn 2003), p.148.
[4] I. Archer, 'Facing up to catastrophe: The Great Fire of London', *Oxford History*, (Mich. 2016), p.4. Available from https://www.history.ox.ac.uk/facing-catastrophe-great-fire-london.

	Houses rebuilt		Public buildings		Lead demand
	Cumulative	Annually	Cumulative	annually	(tons)
1667	*300*	300			210
1668	1,450	1,150	*4*	4	1,103
1669	*3,500*	2,050	*11*	7	1,957
1670	6,000	2,500	*21*	10	2,496
1671	*7,000*	1,000	*36*	15	1,824
1672	*8,000*	1,000	*52*	16	1,900
1673	9,000	1,000	*64*	12	1,600

Between 1670 and 1698 55 churches were built under Sir Christopher Wren's direction. Taking the approximate start and completion dates for each of them and assuming each required 50 tons of lead in the final year of construction, the annualised demand for lead in five yearly periods rose to 160 tons per year in the late 1680s (see Table A3.4.) This excludes St. Paul's Cathedral, the construction of which started in 1675 and was only completed in 1711. It probably required between 800 and 1,000 tons of lead alone. 390 tons was stripped and recast on the dome during renovation in the 1960s. Taking the proportions of the entire cathedral and allowing the rates of coverage estimated by Burt, the rest of the roof will have needed some 300 tons and 200 tons for the leadwork to the windows, adding up to around 900 tons in total, without considering any ornamentation.

Table A3.4 lead required in the rebuilding of London churches, 1670-99 (excluding St. Paul's cathedral)

	Tons/year		Tons/year
1670-4	30	1685-9	160
1675-9	120	1690-4	50
1680-4	140	1695-9	40

3.2.4 Lead shipments from the North-east

Quantifying the progress of the regional lead industry in the 17th century depends very heavily upon the customs records reported to the Exchequer in the annual port books. Their principal features and limitations are set out in Appendix 1.2. In short, they are probably quite reliable on the number of sailings, but were prone to under-recording cargo volumes. It is encouraging that where lead shipments can be compared between merchants' letters and port books, the number of pieces was usually accurately recorded in the latter, but there was still scope for weight to be incorrectly reported. In 1674 Ralph Grey was asked by an overseas correspondent to send 'of the haviest Leed; to save wt we can in Coustome', and a few years later Michael Blackett was complaining that a customs officer had 'been cunning, and pickt out 8 of the greatest pcs and soe have Calculated weight of all the Rest.' [1]

While this mattered in overseas trade because of the customs duty levied, the weight of lead shipped along the coast to internal destinations might also be subject to error. As shown in Appendix 1.2 there were concerns that vessels declaring for the coast might easily slip over the North Sea instead. There is evidence from the 1690s that this might have led to some *over*-reporting of the weight of lead shipped coastally in the port books. The average weight of lead pieces shipped overseas from Newcastle in 1696 was 10.2 stones, while it was 11 stones in coastal cargoes. Although at first sight this might indicate marginal under-reporting of overseas cargo to save on customs charges, closer inspection shows that between the 74 coastal shipments there was

[1] R.Gray to Wm Peacock, 17 Jan 1674, NRO 753/J, MB to Giles Wakeman in Yarmouth, 6 May 1679.

hardly any variation between piece weights at all, with the vast majority being given as 11 stones. Overseas cargoes show the greater variation one might expect of a natural distribution. We are left to surmise that customs officers counted the coastally bound lead pieces and simply assigned them a high standard weight to reduce the temptation to merchants to sell them overseas instead. The 879 tons of lead recorded as shipped coastally from Newcastle in 1696 might therefore be slightly overstated. In most years the weight only is shown for coastal shipments, so the average piece weight cannot be calculated. However, the comparison can be made for Newcastle shipments in 1666, when there was scarcely any variation between piece sizes shipped overseas and coastally.

Table A3.5 Lead shipments from the north-east 1639-1725 (tons)

	Newcastle			Sunderland			Stockton		
	Coastal	Overseas	Total	Coastal	Overseas	Total	Coastal	Overseas	Total
1639	*26*	*131*	*150*		3		6	34	40
1640		6			15				
1652	2	*50*	*52*						
1655	26	*400*							
1661		474							
1666	286	679	965		2		279	192	471
1673	270	1,109	1,379	418	3	421	566	270	836
1674	163	1,147	1,310	340	20	360	396	538	934
1675		1,572			1			731	
1676	43	1,913	1,956	225	278	503	303	901	1,204
1679	48	1,168	1,216	11	504	515	672	819	1,491
1686	947	1,663	2,610	108	290	398	834	988	1,822
1694		2,093			16			2,065	
1695		2,434						2,119	
1696	879	1,186	2,065				1,957	981	2,938
1703	1,280			6					
1706			*2,410						*2,955
1712	554			4			2,713		
1720	1,550	565	2,115		4	4	1,566	645	2,211
1726			*1,836						*2,327

The data shown for calendar years actually ran from Christmas in the year before, but traffic was so limited in the final week of the year that this makes no practical difference. *1706 and 1726 data is taken from Burt's 'Lead production', Appendix 1, p.267. He adjusted from fothers to tons, but in the light of the findings that for customs purposes the fother was measured as a ton, Burt's figures have been –conservatively - adjusted back using the 21 cwt fother at Newcastle and 22cwt fother at Stockton.

Some lead must have been consumed locally. With the growth of Newcastle in the second half of the 17th century, not least with the construction of grand public buildings such as the new Guildhall and Exchange in the 1650s, a rising amount of lead must have been used for building purposes. But with a population, adding Gateshead, of around 20,000 by 1700,[1] even if a quarter of the housing stock had been built or rebuilt over the previous 40 years to high enough standards to require 6 cwt of lead each (the amount allowed for 'middling' houses in London) this would have required no more than 10 tons of lead per year. Doubtless there were other small scale uses. Pewter tableware was increasingly common. It was made for local use in Newcastle, but probably required little metal in total, let alone lead, which typically comprised no more than 15% of the alloy.[2] Red lead, the compound used in glassware, was probably derived from imported litharge until the repeal of the

[1] E.A.Wrigley, *Early English Censuses*, (2011), Table A2.6; P.Rushton, 'Gateshead 1550-1700: independence against all the odds?', in Newton and Pollard, *op cit*, p.313.

[2] Thomas Rowland of Northumberland had been working as a pewterer in Newcastle for several years before 1690: NRO ZGI/Do.

Mines Royal Act in the 1690s.[1] Consequently, it is likely that the vast majority of regional production was sold outside the region and carried away by sea. Table A3.5 summarises the annual totals recorded in the coastal and overseas port books, fothers being converted to imperial tons at the rate of 20cwt as mentioned in section 3.1.

Figures in italics for some of the early years are guesstimates. For 1639 we have the figures for Stockton (40 tons in total) and for Newcastle exports (99 tons) but the latter is probably an underestimate because one in three pages of the original record is now illegible. The export volume has therefore been increased by a third in compensation. Coastal shipments were less than a fifth of exports from Stockton and a similar proportion has been assumed for Newcastle and the total rounded down to 150 tons. These added guesses leave the regional total at under 200 tons. Given that Gray made no mention of lead amongst Newcastle's exports ten years later it would be surprising if the actual total had been any higher.[2] Only 6 tons of lead was recorded as exported from Newcastle in 1640, when the summer was disrupted by the Scottish occupation of the town. It is, however, reasonable to suppose that the figure was higher by 1655. Although we have only the coastal port book, which recorded 26 tons, the Sound toll records show 34 tons coming eastwards from Newcastle in that year. In the 1660s Newcastle's shipments through the Sound accounted for 7% or less of total exports, the majority going to Amsterdam instead. On this basis Newcastle exports might have been in the region of 400 tons in 1655. It would imply a large increase on pre-civil war levels of production, but it was five years into Haselrig's rapacious ownership of the Weardale mines and we have also seen examples of Newcastle merchants moving into lead mining during the 1650s. Allowing for Stockton, regional production of 500-600 tons of lead in the mid-1650s does not seem fanciful.

3.2.5 Blackett lead shipments

With the inclusion in the port books of the name of the merchant responsible for overseas cargoes the level of the Blackett family's lead exports can be tracked from 1661 and this is summarised in Table A3.6 below. There are also occasional glimpses of which merchants were responsible for domestic shipments, but only in 1679, 1696, 1703 and 1712 is this comprehensive enough to allow any assessment of scale to be made. For those years the data is included in Table A3.6. Blackett's percentage share of the coastal trade is shown only in the years where all merchants or bondsmen are named.

Table A3.6 Blackett lead trade from Newcastle (tons)

	Coastal			Overseas			
	Total	Blackett	%	Total	Blackett	%	Blackett trading names used (Overseas)
1655	26	12.5		*400*			
1661				474	53	11%	WB, EB (14 tons), B and Company
1666	286			679	20	3%	WB (14 of 48 merchant entries illegible)
1673	270	1.3		1,109	624	56%	WB
1674	163			1,147	181	16%	WB, WB& Co, MB & Co, Wm Leck
1675				1,572	1,209	77%	WB, WB& Co, MB, MB & Co, W&CB, EB
1676	43			1,913	1,520	79%	WB, WB& Co, MB, W&CB, EB
1679	48			1,168	685	59%	WB, EB
1686	947	27		1,663	161	10%	WB
1693							
1695				2,434	193	8%	WB
1696	879	-	-	1,186	-		
1703	1,280	125	10%				
1705							
1712	554	-	-				

Coastal and overseas

[1] Red lead was being imported into Newcastle as late as 1702-3: P.D.Wright, 'Shipping on the Tyne: The growth and Diversification of Seaborne Trade in the Eighteenth Century', in Green and Crosbie, *op cit*, Table 7:5, p.170.
[2] Gray, *Chorographia, op cit*, pp.80-90.

	Total	Blackett		
1726	1,836	811	44%	Approx. Blackett lead sales in year vs total Ncl outbound lead shipments

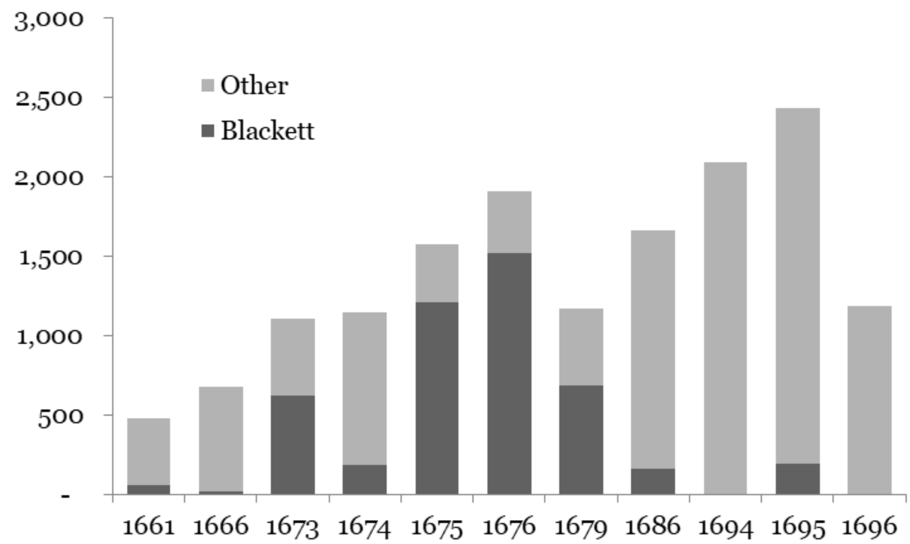
The notes column indicates the variety of trading names used by family members, using initials to save space (William, Edward, Michael, Christopher). William Leck was a shipmaster who regularly carried Blackett cargo and it is assumed here that the 26 tons of lead he carried as 'merchant' in 2 consignments in 1674 were for Blackett. As discussed in chapter 10 it seems highly likely that the clear sequence of different trading names used in 1675 and 1676 was linked to a desire to separate the sale of lead mined and smelted before and after his marriage to Margaret Rogers, rather than because the family members were competing with each other.

Figure A3.1 depicts the changing share of Newcastle's lead export trade controlled by Blackett. The position in 1674 is anomalous and many of the shipments were carried in a wide variety of different names. Blackett's share was still larger than that of any other merchant, but at face value it would seem that he – and other lead producers - chose to sell much of their lead in Newcastle rather than carry it overseas at their own risk in the last year of the third Anglo-Dutch War (even though this was far less obviously the case in 1673.) In the 1680s and 1690s it appears that William II changed to selling lead to local merchants rather than directly into distant markets.

3.2.6 Blackett lead production

This brings us to the question of whether we can rely upon the share of trade to indicate share of production and to what extent. Blackett evidently sometimes sold some of his exported lead to or through other merchants, as in 1674 and also in 1666, when, despite several years of building up his Allendale mines, he exported less lead in his own name than in 1661.

Figure A3.1 Blackett share of Newcastle lead exports, 1661-96



For the early 1660s a very rough estimate of Blackett's production under his first Allendale lease can be arrived at by considering the amounts we know he was prepared to pay to obtain it (£1,400 in 1660, and a further £420 in 1665), and the number of years in which he had to earn it back (9 and 4 ½ respectively).[1] It seems reasonable to assume that Blackett was a rational actor and a competent analyst. Suppose he was prepared to

[1] NRO 324/W3/18/3

take a 10% annual return on capital in the early years in order to gain a strategic foothold in the promising Allenheads area. This would have meant achieving the targets shown in Table A3.7 below within the 9 years and 4½ years of the two sub-lease terms 1660-9 and 1665-9. Sections 3.3 and 3.4 below give price and cost estimates. From this it would have been a reasonable projection for Blackett to assume he could make £1.30 profit per ton of lead. This figure is simply divided into the 'capital + earnings target' column and annualised, giving the amount of lead needed to achieve that: c. 225 tons on average, and then c.325 tons between 1665-9. His decision to extend his interest in 1665 surely indicates that his initial commitment was already paying off.

Table A3.7 Blackett lead production needed to recover lease purchase costs

	Capital outlay	Return sought /yr	Capital + earnings target	Profit/ton	Lead smelted/yr (tons)	Lead mined/yr (tons)
1660-9	£1,400	10%	£2,660	£1.30	225-230	430-440
1665-9	£420	10%	£609	£1.30	100-105	190-200
					325-335	620-640
1667+	£3,000	20%	£16,800	£1.30	550	1,050

Applying the same logic to the amount he agreed to pay Fenwick to renew the lease for 23 years in 1667, but this time doubling his investment return target, would have meant smelting 550 tons. The amount of ore to be mined to support this, assuming a smelting yield of 52.5% (5 bings to the fother; see section 3.4.3 below) would have been just over a thousand tons. This is a hypothetical exercise, which imposes a retrospective thought process on William Blackett, but its parameters give a rough idea of the kind of scale needed for these big decisions to pay off. They are also significantly higher than the amount he is known to have exported in 1666.

However, an examination of the activity reported by Michael Blackett in letters to his father is consistent with the quantities of lead being exported by Blackett in the peak years of 1675-6. They do not give complete coverage and there must be some doubts as to the reliability of Michael's notes and reports, although searching follow-up questions must have provided a constant incentive – to both Michael and the local agents - to be as thorough as possible. Time periods are not stated, but the dates strongly suggest each records a month's activity. The data on lead smelted that can be lifted from them is given in Table A3.8. The number of pieces in each fother is not made clear, but 16 seems a reasonable assumption given that the number never rose above 15. Fothers and pieces are converted into tons at the Newcastle rate of 21cwt/fother and rounded to the nearest ton.

Table A3.8 Blackett lead production 1675-8

	Dukesfield Mill			Plankey Mill			Total
	fothers	pieces	tons	fothers	pieces	tons	tons
1675 Oct 9	102		107	29	15	31	139
1675 Nov 6	117		123	38	11	41	163
1676 Feb 26	103		108	45	4	48	156
1677 Jan 27	38	10	41	11	14	12	53
1677 Feb 24	3	5	3	22	4	23	27
1677 Mar 24	55	7	58	14	4	15	73
1677 Apr 21	33		35	15	9	16	51
1677 May 19	71	11	75	23	7	25	100
1678 Feb 23	68		71	18	1	19	90
1678 Mar 23	60		63	31		33	96
1678 Apr 20	66	7	70	28	15	30	100

1678 May 18	74	2	78	29	15	31	109
1678 Jun 15	78	8	82	25	1	26	109
1678 Dec 14	118		124	24	4	25	149

If the production rate over the autumn/winter of 1675-6 of about 150 tons per month was sustained for 11 months, allowing one month for maintenance and hearth rebuilding, some 1,600-1,650 tons of lead would have been produced, which is not far off the 1,520 tons Blackett exported in 1676 and he might also have had a share of the small quantity of lead shipped out to domestic ports. The average for January to May 1677 was markedly lower at just over 60 tons, (though this probably included a 'maintenance month' at Dukesfield in February), but back up to 100 tons in May. It is unfortunate that the summer months are missing. Between February and June of 1678 average production was back up to 100 tons and higher still in December. This could mean that Blackett produced in 1678-9 more than the 685 tons exported in his name in 1679.

The detailed accounts kept by Edward Blackett allow the recovery of production estimates of lead smelted from ore mined at Fallowfield in the 1680s and 1690s, as shown in Table A3.9. Plankey Mill was used until March 1682, working through the last of the previous season's ore. Birkey Burn mill came into production that June. A boom followed over the next few years, which might have extended beyond 1686, but there is a gap in the records until late 1691. By then lead production was lower and the separate evidence of sales recorded from 1694 suggests a continued decline. There is little reason to believe that the sales records are incomplete for those years, but the 59 tons recorded in the ledgers of Newcastle merchant and alderman Matthew White in 1698 might only account for a proportion of Blackett's Fallowfield lead. Nevertheless it appears that the best days of the mine were over, at least until major further investment was undertaken in the 1760s.[1]

Unfortunately, no records survive at all from which corresponding estimates can be made for lead produced by Edward's brother William in Allendale and Weardale during the last decades of the 17th century. A slight hint that the Allendale mines remained highly productive can be wrung out of a claim that 'in the time of peace when these Lead-Mines did flourish' the contribution of half a day's wages a month by each miner to pay for a curate to preach at Allenheads and Coalcleugh raised between £70 and £80 per year.[2] If this meant 6d/month, it would take 233 miners to raise £70 in a year, which was more than the estimated headcount at work there in the heady mid-1670s, when around 140-180 miners and washers were raising 800-1,000 tons of lead ore per year (see Table A3.14 below). Even allowing for some exaggeration, production in Allendale must have been far higher than in Fallowfield by the turn of the century.

Table A3.9 Edward Blackett's lead production 1680-99

	fothers	tons	source	Notes
1681	174	183	NRO ZBL 273/15	Lead smelted in year from Oct 1680
1682	143	150	/15	Ditto Oct 1681
1683	290	304	/15	Ditto Oct 1682
1684	355	373	/15	Ditto Oct 1683
1685	440	462	/15	Ditto Oct 1684
1686	364	382	/15	Ditto Oct 1685
1692	243	256	NRO ZBL 273/13	Calendar year
1693	208	218	/13	Calendar year
1694	176	185	NRO ZBL 273/3,5	Lead sold by EB and Robt Fenwick
1695	118	124	/3,7	Ditto
1696	193	203	/7	Lead sold
1697	28	29	/7	Lead sold
1698	56	59	NRO ZRI 38/1	Lead sold by Matthew White

[1] Fairbairn, *op cit*, pp. 61-4
[2] Ritschel, *Charities, op cit*, p.17. This probably means the late 1690s.

The survival of sales ledgers at the very end of the period under study provides a proxy measure for lead production, assuming that sales roughly matched production in any one year. This was unlikely in reality, although over the course of a few years production and sales would balance.

Table A3.10 Blackett lead, silver and litharge sales and production 1724-37

		Lead		Silver	Litharge	Source
	tons	Price £/ton	Sales (rounded)	Oz	tons	
1724	1,240	13.0	£16,100	2,150	43	NRO 672 E/1C/1
1725	1,000	13.4	£13,500	2,850	70	E/1C/1
1726	870	13.9	£12,000	4,500	20	E/1C/1
1727	950	13.7	£12,750	4,900	102	NRO 672 E/1B/1
1728	1,100	14.4	£15,950	4,550	24	E/1B/1
1729	690	15.6	£10,750	4,580	64	NRO 672 E/1B/2
1729	1,100					E/1B/2
1730	1,370	14.2	£17,000	6,250	92	E/1B/2
1731	1,350	13.2	£17,600	6,680	80	E/1B/2
1732	1,500	13.2	£20,000	5,800	33	E/1B/2
1733	1,600	13.9	£19,500	6,400	3	E/1B/2
1734	1,770	11.9	£16,000	6,250	90	E/1B/2
1735	2,000	12.5	£20,900	5,750	81	E/1B/2
1736	1,550	12.7	£16,750	6,650	89	E/1B/2
1737	2,000	12.3	£18,500	3,400	63	E/1B/2

For 1724-March 1727 sales volume and value has been taken from merchant accounts documented in a sales ledger (NRO 672/E/1C/1). For April 1727 to 1729 similar data has been taken from the general ledger in 672/E/1B/1. Lead tonnage figures in Table A3.10 to 1729 are for sales rather than production, since the latter is unknown, but from the line break onwards, including the second figure given for 1729, tonnage figures record production.[1] Average price achieved and sales value therefore does not always marry up exactly with production, given variations in unsold stockpiles from year to year.

With the construction of a silver refinery at Blaydon in about 1722, the sales ledger also records silver and litharge sales. Although shown only as sales made, it appears each cake was sold to local and London dealers and goldsmiths as soon as it was available so production is likely to have closely tracked sales. Silver output appears to have ramped up from 1724 onwards, and peaked at 6,680 ounces by 1731, treble the production seven years earlier. Silver and litharge are both produced from the refining process, but trends in litharge sales bear little resemblance to those for silver. If silver was refined at the rate of –say- 7 oz/ton of common lead (at which rate 6,000 ounces was refined from 850 tons of lead), the absolute volume of litharge left behind must have been far higher than the tonnages sold each year. The vast majority of litharge must therefore have been reduced back to lead in the 1720s and 1730s. For the Blacketts the object of refining was to obtain silver.

3.3 Lead prices in the 17th century

Figure 7.5 draws together data from various sources into price series for lead ore in Derbyshire and smelted lead in London and Newcastle. The sources and treatment of this data are set out here.

3.3.1 Derbyshire ore.

[1] The detailed returns of ore and lead production from 1729 onwards have been tabulated in spreadsheet format, and can be downloaded from Dukesfield Documents/Documents and Sources/Northumberland Archives/Allendale Estate Papers.

This was typically sold in Wirksworth and other mining centres in the Peak District to smelters from further east in the Chesterfield area. Prices were collated from various sources into a time series by Wood as part of his work on Peak District society in the early modern period, supplemented with a few additional prices drawn from research by Slack.[1] They were quoted in shillings per 'load', a measure that Kiernan suggests was roughly equivalent to 5 cwt.[2] To give a rudimentary basis for comparison with the price of lead, an assumption is needed regarding the yield of lead at the smelting stage. Here it is assumed that with ore hearth smelting having been established in Derbyshire from the 1570s, experienced workers could achieve a 60% yield, which would have been impressive in the 17th century. This would equate to just over 6.5 loads of 5 cwt per ton of lead and 6.5 is the conversion factor used here to give the values shown in Figure 7.5, but if smelting yield was lower, a higher quantity could easily have been required. Consequently, the price series computed here for Derbyshire ore per ton of lead is likely to have been on the low side.

To obtain a general idea of the additional costs of carriage and smelting it is assumed that ore was carried 15 miles from the point of purchase in the Peak District to smelting mills at the rate of 8d/ton of ore/mile observed in the North Pennines, that smelting cost £1/ton (see section 3.4.3 below) and lead carriage a further 15 miles from mill to navigable water, also at 8d/ton/mile. This adds up to £2.30 per ton, and still excludes the cost of barge transport from Stockwith or Bawtry along the Rivers Idle and Trent to Hull. Extrapolating the Derbyshire ore prices (an average of £9.20 per ton between 1668-73) in this way gives a figure of £11.50/ton as the cost of lead in these years at the point of transhipment to the barge.

3.3.2 London lead prices

The London data was taken by Beveridge from records of the Royal Household's Office of Works and expressed in shillings per cwt for pig lead (converted in some cases from fothers at the London rate of 19.5 cwt). Most of the prices quoted therefore concern the purchase of lead for building purposes at London (until 1639), Greenwich (1665-7) and Hampton Court (1669-70) and typically excluded the cost of lifting and weighing from the ship and carriage from the quayside.[3] With Greenwich being slightly downstream from London and Hampton Court several miles upstream, this might have been expected to be reflected in noticeable price variations, but this is not the case. He noted that for many years only a single price quotation is available. Beveridge's data is converted into £/ton in Figure 7.5. There are significant gaps in the record, particularly after 1640, other than for a few years in the late-1660s. However, the volume and value of lead exports by the East India Company from 1660, presumably mainly from London, indicate high prices throughout the 1660s.[4] Blanchard depicted a continuous 17th-century price series for lead in London, but gave no provenance so it is not re-used here. For what it is worth, his data resembles Beveridge's up to a point, but was about £1/ton lower in the 1630s and then roughly level at this price until the late 1650s.[5]

It would be illuminating to compare London prices to those achieved in the principal European markets, particularly in Amsterdam, but no reliable data is available, and it would in any case be subject to vagaries of measurement, unknown port charges, local duty rates and currency exchange rates.

3.3.3 Newcastle lead prices

This limited range has been taken from a variety of sources, some of them only partial fragments to which further assumptions have been applied to arrive at price estimates. In 1599/1600 the Newcastle merchants company agreed to buy lead at £7 10s-£7 13s 4d (£7.50 - £7.67)/fother from George Bowes. We have no further price datapoints before the mid-1660s other than three indirect measures, dating from 1657, 1661 and

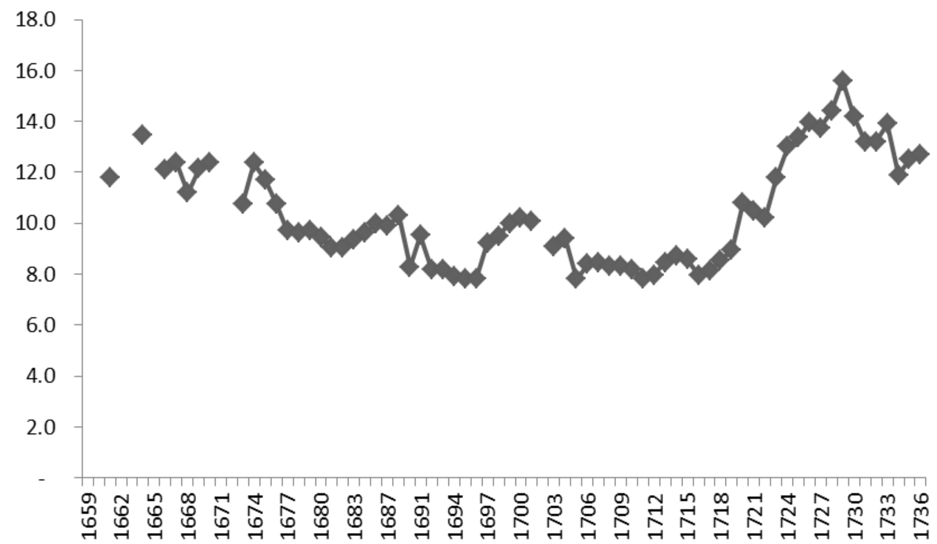
[1] Wood, *Social Conflict, op cit*, Figure 3.3, p.75; Slack, *op cit*: ore prices for 1629, 1635, (p.32), 1644 (p.38), 1655 (p.52), 1660 (p. 56), 1681 (p.60).
[2] Kiernan, *op cit*, 1989, p.ix.
[3] Beveridge, *Prices and wages, op cit*, pp.486-7.
[4] K.N.Chaudhuri, *The Trading World of Asia and the English East India Company: 1660-1760*, (1978), Appendix 5, Statistical Tables, Table C.7, pp. 517-8.
[5] I.Blanchard, *Russia's Age of Silver*, (1989), Figure 2.5, p.46.

1664. Since these were the years in which the North Pennines industry started to develop in earnest, it is nevertheless worth examining them.

- December 1657: £9 15s was the price Sir William Bowes agreed to pay for each fother of lead smelted at Mickleton in Teesdale.[1] The location suggests that the natural outlet for the lead was Stockton, 27 miles away, where the fother weighed 22 cwt, rather than Newcastle (38 miles away, 21 cwt). At 8d (3.3p)/ton/mile, (see section 3.4.2 below) lead carriage would have cost 18 shillings (90p). It is unclear what level of profit Bowes might have expected, but a 20% mark-up on costs (equivalent to a gross margin of 16.7% gross margin) seems a reasonable aspiration. This would price a ton of lead at £11.70.
- 1661: Basire and Wharton agreed 40s (£2)/bing as the purchase price of the Rector of Stanhope's Weardale duty ore.[2] The tithe was equivalent to a duty rate of 10%. The bishop's lot was paid as a flat rate of £60/year; we do not know how much production it was levied on, and is ignored here. Assuming Wharton achieved an efficient 58% yield when smelting the ore at his Wolsingham mill (an average of 8 miles from the Weardale mines), carried lead thence 17 miles to Newcastle, (all at 8d/ton/mile) and expected a 20% mark-up on costs, the implied Newcastle price was £14.20/ton. As a cross-check, in 1666, the rector sold his duty ore at 34s (£1.70)/bing when the Newcastle price was £12/fother. Pro rata this would have implied a price of £14.60/ton in 1661. The lower price is used here, despite the optimistic assumption regarding smelting yield and the removal of lot ore costs.
- 1664: Radcliffe sold his Alston Moor duty ore at 37s (£1.85)/bing to George Bacon and partners. This was more remote from Newcastle, being 17 miles from Red Lead Mill and the same distance again to Newcastle, so carriage costs would have been higher than for Wharton. The duty ore rate was 20%. If the same carriage cost rate, smelting yield and margin expectations are held the implied Newcastle price was £14.93/ton. Had Radcliffe set his duty ore sale price based on Newcastle lead prices in the manner used by the Rector of Stanhope just two years later the inferred Newcastle price was £14.15. Once more, the lower rate is used here.

These are heroic assumptions but if nothing else the reality of geography and transport costs mean that the lead price could not have been lower than, say, £11.50/ton at Stockton in the late 1650s or £14 in Newcastle in the early 1660s for those agreements to have made any sense. The trend of the Derbyshire lead ore price series bears some comparison with Newcastle lead prices in the later 17th century and also appears consistent with those high early 1660s prices. If there was any correlation between price trends in the earlier period, Newcastle might have seen rising prices from the 1640s onwards. This would certainly be consistent with the evidence of an increase in lead mining activity and investment in the North Pennines after the civil war.

Figure A3.2 Newcastle/Stockton lead price trend 1660-1736



[1] DCRO: D/St/B2/1-69.
[2] TNA E 134/19Chas2/East33.

From 1666 a greater number of direct price quotations can be gathered, supplemented from the 1670s with actual sale prices, according to a few surviving merchant letters and accounts. The number of observations, sources and quoted/actual selling prices/ton are shown in Table A3.11, and shown graphically in Figure A3.2. This reveals the slow secular decline in prices from the 1670s with temporary rallies and then a marked increase from around 1720, which has yet to be explained.

Table A3.11 Newcastle/Stockton lead price per ton 1666-1736

	£/ton	Obs	Sources
1666	12.1	3	Davenport, pp.164, 181; Blackburn
1668	11.2	2	Marescoe, p.260
1669	12.1	2	Marescoe, pp.280,308
1670	12.4	1	Cosin letters
1673	10.8	2	Grey letters: NRO 753/J
1674	12.4	8	Grey letters
1675	11.7	9	MBL and Grey letters
1676	10.8	10	MBL and Grey letters
1677	9.7	5	MBL
1678	9.6	6	MBL
1679	9.7	3	MBL
1680	9.4	3	MBL
1681	9.0	3	MBL
1682	9.0	2	MBL and Swale (Stockton)
1683	9.3	1	Swale accounts/letters
1684	9.6	1	Swale accounts/letters
1685	10.0	1	Swale accounts/letters
1687	9.9	3	Swale accounts/letters
1688	10.3	1	Swale accounts/letters
1690	8.3	1	E.Blackett accts NRO ZBL 273/2
1691	9.5	1	E.Blackett accts ZBL 273/2
1692	8.2	1	ZBL 273/13
1693	8.2	1	E.Blackett accts ZBL 273/5
1694	7.9	6	E.Blackett accts ZBL 273/3-5
1695	7.8	3	E.Blackett accts ZBL 273/7
1696	7.8	3	ZBL 273/7
1697	9.2	1	ZBL 273/7
1698	9.5	4	ZBL 273/7, M.White ledger ZRI 38/1
1699	10.0	5	ZBL 273/7, ZRI 38/1, Grinton sales
1700	10.2	3	Grinton sales
1701	10.1	2	Grinton sales
1703	9.1	3	Grinton sales
1704	9.4	2	Grinton sales
1705	7.8	2	Grinton sales
1706	8.4	5	LLC Minutes
1707	8.4	6	LLC Minutes
1708	8.3	2	LLC Minutes
1709	8.3	2	ZBL 273/9
1710	8.2	1	E.Bl ltrs ZBL 189
1711	7.8	9	Rchmd, ZBL 273/9, 260/2; CM/2/684
1712	8.0	17	E.Bl accts ZBL 273/9
1713	8.5	6	CM/2/684
1714	8.7	10	E.Bl ltrs ZBL 190; CM/2/684
1715	8.6	12	CM/2/684
1716	8.0	6	CM/2/684
1717	8.1	12	White ledger ZRI 38/1; CM/2/684
1718	8.5	8	Rchmd; CM/2/684
1719	8.9	2	CM/2/684
1720	10.8	5	LLC Minutes; CM/2/684
1721	10.5	2	LLC Minutes; CM/2/684
1722	10.2	1	CM/2/684
1723	11.8	24	Blackett sales, NRO 672/E/1C/1
1724	13.0	66	Blackett sales, NRO 672/E/1C/1
1725	13.4	72	Blackett sales, NRO 672/E/1C/1
1726	13.9	79	Blackett sales, NRO 672/E/1C/1
1727	13.7	78	NRO 672/E/1B/1, Apr-Dec
1728	14.4	73	NRO 672/E/1B/1, Jan-Dec
1729	15.6	43	NRO 672/E/1B/2
1730	14.2	*40*	NRO 672/E/1B/2
1731	13.2	*40*	NRO 672/E/1B/2
1732	13.2	*40*	NRO 672/E/1B/2
1733	13.9	*40*	NRO 672/E/1B/2
1734	11.9	*40*	NRO 672/E/1B/2
1735	12.5	47	NRO 672/E/1B/2
1736	12.7	*40*	NRO 672/E/1B/2

Sources quoted where not already expanded in the 'Abbreviations' section of the book: Blackburn, 'Mining without laws', *op cit*, p.70; Cosin letters: Ornsby, *op cit*, pp.253-4; Davenport: M.Harvey and B.Pask (eds), *The Letters of George Davenport, 1651-1677*, SS 215 (2011); Marescoe: Roseveare, *op cit*; Rchmd: Richmond letters, NRO 673/2, 1728-32; Swale: Ashcroft, *op cit*. It is assumed that most of the prices that can be derived from accounts of Swale, steward to Lord Wharton, relate to lead sold at Stockton rather than Newcastle. Grinton: Marriot's accounts for sales from these mines in Swaledale, and also sold at Stockton: TNA LRRO 3/85; LLC Minutes: sales or quotation given in the London Lead Co's minute books held at the NEIMME (NRO 3410/LLC/1-5), extracted by D.McAnelly; E.Bl ltrs/accts: Edward Blackett's letters & accounts: at NRO under refs shown; CM/2/684: Swaledale lead sales for Ld Powlett, via Stockton - at TWAM.

The price series has therefore been derived from a wide variety of sources, but their reliability is probably equally varied. Where multiple observations are available for a single year the crude average of each price quotation and/or sale is quoted. The 1680s data from the accounts kept by Robert Swale for Lord Wharton probably refer mainly to prices at Stockton, as do the Grinton and Swaledale accounts for 1698-1705 and 1711-27 respectively. These have been adjusted for the greater weight of the Stockton fother. For several years between 1711 and 1727 it is possible to compare Newcastle and Stockton prices, and they invariably closely tracked each other. They are weighted together here based on the relative number of observations taken from each port.

3.4 Costs

The concerns expressed regarding the cost of coal mining in Appendix 2 apply to the even more poorly documented lead industry during the 17th century as far as accounts are concerned. The need to smelt the mineral makes the cost structure more complicated than for coal, partly because of the direct cost of smelting and the secondary effects of smelting yield on the cost of ore in the end product. We have to rely overwhelmingly on data extracted from Michael Blackett's reports to his father in the 1670s and on the patchily detailed accounts kept by his elder brother Edward for Fallowfield in the 1680s and 1690s, supplemented with some fleeting observations from elsewhere. Both sets of Blackett numbers enable the main stages to be analysed separately and this is how they are tackled in this section.

3.4.1 Mining

Doubtless following his father's instructions, Michael's 15 reports for various dates between October 1675 and December 1678 typically indicate the sums expended at the monthly 'pays' under four geographic headings: 'the Heads', Fallowfield, Planky and 'at mill' (ie. Dukesfield). This means mining costs are captured under the first two headings and smelting at the last two, for there was no smelting in the Fallowfield area until the 1680s. This opens the possibility of establishing the unit cost of mining. 'Pay' meant all direct monthly expenses rather than miners' pay alone for there are occasional other references to supplies being purchased too, which typically comprised timber, candles, rope, sieves and other ore washing/dressing tools. In common with other accounts of the period we can assume that the accounts were reported on a cash basis and that capital spending was not distinguished from other outgoings. Monitoring cashflow was certainly important to William Blackett.

The amount of ore delivered to each of the mills was itemised by source. Fallowfield ore came from the single mine there, albeit extracted from multiple shafts and levels, whereas management at 'the Heads' covered a much wider area. Allenheads was by far the most important location, accounting for 938 tons of the 1,600 reported in total, with Greengill and Redgroves in Nentdale (340 tons) and Coalcleugh, Welhope and Bates Hill in the West Allen (230 tons) accounting for the rest. Small parcels of ore were also noted as carried to the mills on occasion from Rookhope in Weardale, Dufton and Lunehead (to the west of the Tees) and Jeffrey's Grove near Hunstanworth (105 tons in total). This was probably ore bought in rather than mined by Blackett and, since such purchases might have been settled elsewhere, it is assumed here that their cost is not included in the 'Heads' or Fallowfield expenditure.

The big drawback is that Michael did not provide a direct account of the bings of ore mined during each reporting period, only the amount carried to the mills, and – especially in the winter months - the latter cannot be expected to indicate the amount of production. By the same token, late spring months, when the roads had opened and there were stockpiles to shift from the mines, the amount of ore carried was probably higher than the rate at which it was being mined. However, we have 15 separate observations covering all seasons with the exception of July and August. The crude cost per ton of ore is therefore shown for groups of months in Table A3.12: October 1675 to February 1676, January-May 1677 and January-June 1678. The December 1678 figure appears anomalous and perhaps covers either two months of spending, or additional one-off costs that are not otherwise explained further in Michael's accompanying letter. The ore bought in small parcels from other mines is excluded from the calculations. This gives an overall cost of £2.26 per ton across the period as a whole, with Fallowfield emerging as distinctly cheaper than Allenheads and its surrounding area. The Fallowfield accounts allow some cross-checking of these conclusions.

Edward's account book for the Fallowfield mines commences on 16th May 1680, the date of his father's death. It has clearly been written up neatly – and mostly in his own hand - from journals or waste books that are now lost. Entitled 'An account of what Fallowfield Lead mines hath cost me since the 16 of May [1680]' the opening list of monthly expenditure spread over three pages appears to be comprehensive.[1] However, while this gives an unbroken monthly sequence of mining related expenditure running for six and half years, the subsidiary detail is selective, for the expenditure does not sum to the grand total. That detail includes the direct cost and produce of various mining bargains with named lead partners at various shafts, the cost and produce of washing waste ore and ore won at day rates rather than bargains. Since the monthly quantity of ore carried away for smelting is given, a reasonably secure view of total production is available and it reconciles with the amounts mined and washed accounted for alongside the direct cost detail.

Table A3.12 Blackett mining expenses and ore carried 1675-8

	'The Heads'			Fallowfield			All
	Pay £	Tons Ore carried	£/ton	Pay £	Tons Ore carried	£/ton	£/ton
1675 Oct 9	282.7	228.1	1.56	104.4	83.0	1.01	
1675 Nov 6	259.0	180.8		96.5	110.6		
1676 Feb 26	244.5	95.0		97.0	102.0		
1677 Jan 27	220.0	41.6	2.66	75.6	21.8	2.58	
1677 Feb 24	165.3	32.9		69.8	19.4		
1677 Mar 24	186.9	46.7		72.6	15.8		
1677 Apr 21	201.0	91.9		85.1	36.7		
1677 May 19	190.8	148.9		80.8	55.3		
1678 Jan 26	266.1	35.6	3.05	80.0	27.1	1.99	
1678 Feb 23	219.5	54.5		112.0	24.8		
1678 Mar 23	267.0	123.3		121.6	60.4		
1678 Apr 20	251.8	94.2		96.7	73.3		
1678 May 18	275.0	94.4		116.7	61.6		
1678 Jun 15	286.4	111.7		116.4	75.3		
1678 Dec 14	481.9	126.2		174.8	67.9		
Total	3,798.0	1,505.8	2.52	1,500.0	835.0	1.80	2.26

One important adjustment has been made to the raw figures. Between February 1683 and March 1685 just over half of the ore was obtained at day wages rather than through bargains, but the associated wages are not included in the sub-total of direct costs. However, although the day rates are known, the number of miners involved is not. A proxy measure of the cost per bing of ore has been used instead, set at the level of ten shillings (50p), the approximate rate observed for the bargains under which the other half of production was mined. Table A3.13 summarises this adjusted split of costs by year. The 'other' column isolates the indirect expenditure. A further snapshot is available for 1692, although less detailed.

In overall terms, the £2.29 it cost to raise a ton of lead ore at Fallowfield in the 1680s is not greatly different to the £1.99 calculated for the first half of 1678 (Table A3.12) and close to the 1670s level from 1684. However, it was noticeably higher before then, overwhelmingly because of the level of indirect expenditure. It is also noticeable that ore production was much lower than in the late 1670s. Annualised production of around 180 tons in 1680 was much lower than the totals carried from Fallowfield for smelting between 1675-8. Perhaps what can be glimpsed here is the exhaustion of accessible veins exploited since the start of Blackett's lease in 1668 and the need for a further investment programme in deepening shafts and driving drainage levels in the early 1680s. This bore fruit in the form of higher production once again from 1683 and at lower unit cost per ton of ore, although the lower production of 1692 suggests that the benefits were dwindling by then. Now this could mean that, while the data from Fallowfield in the 1680s apparently validates Michael Blackett's reports

[1] NRO ZBL 273/15. Separate summary accounts for smelting are also included in the volume, as used in section 3.4.3 below. 1692: NRO ZBL 273/14. All references to Birkey Burn in the 1690s are drawn from this ledger unless otherwise stated.

of cost in the previous decade, those earlier years were flattered by the absence of heavy capital expenditure. Yet his reports also chronicle progress with driving levels in both Fallowfield and Allenheads, so investment continued and was captured in the expenditure reports. With this in mind it seems more likely that the high unit cost of lead ore in the early 1680s at Fallowfield was the consequence of low production rather than high expenditure. Total spending in the full year from May 1680 to May 1681 was just under £900. It was around £920 in 1677, based on the average in the first five months, and £1,250 in 1678. Economies of scale had therefore been lost in 1680/1, but were regained with increased production by 1683.

Table A3.13 Fallowfield lead mine 1680-86, 1692

	Ore delivered (tons)	Expenditure £				Cost/ton £	
		Total	Direct	Other	% of total	All	Direct
Total 1680-6	3,722	8,541	4,754	3,787	44	2.29	1.28
1680 (May-Dec)	76	552	114	438	79	7.26	1.50
1681	239	804	325	479	60	3.36	1.36
1682	301	1,249	572	677	54	4.15	1.90
1683	666	1,607	1,000	607	38	2.41	1.50
1684	780	1,533	1,072	461	30	1.97	1.37
1685	1,072	1,552	830	722	47	1.45	0.77
1686	588	1,243	841	402	32	2.11	1.43
1692	396	861				2.17	

Overall, though, given that there were years of low and high production between 1680 and 1686, the calculated total of £2.29/ton probably gives a reasonable guide to the cost of lead mining at Fallowfield, and suggests somewhere under half of it (calculated here at 44%) was accounted for by new investment, what was often referred to as 'dead work' on new shafts and levels, maintenance, repair, drainage and overheads, and the rest the direct cost of mining and washing ore. A similar figure, 42%, is observed from analysis of expenditure accounts from Settlingstones, north of Haydon Bridge, in 1688-9, when the mines were being re-opened and investment was needed.[1] On the other hand, at the Grinton mine in Swaledale between 1697 and 1706, detailed accounts show that capital outlays and maintenance accounted for just 20% of total mining expenditure.[2] It was probably at a advanced more stage of operation and it seems logical that the proportion of outgoings accounted for by capital spending should decrease once a mine is opened up. We see this in the projections of Colonel George Liddell in Nentdale in 1737, although he seems to have been naively optimistic regarding how far the capital share would fall. His calculations imply that the 'dead charge' would be 65% of spending in the first two years, fall dramatically to 15% in the next three and then below 10% in the final 16 years of a 21 year lease.[3]

The direct costs might well have included supplies of candles, rope and tools. In 18th and 19th century bargains these were typically the responsibility of the miner and this was the case at Hunstanworth in the 1680s. Two decades earlier, when lead was mined there at daily wage rates, candles and pick shafts cost around 5% of wages.[4] At Settlingstones, to the north of Haydon Bridge, in the 1680s supplies such as candles

[1] Accounts submitted to William Ramsay indicate capital spending of £400 in the two calendar years of 1668-9, out of a total of £953, equating to £6.90 for each of the 139 tons raised during the same period. In the second year the operating cost was £3.30/ton, still significantly higher than at Fallowfield: TWA DF.HUG/43/1-12.
[2] Grinton accounts: TNA LRRO 3/85. I am grateful to Tim Gates for his transcripts of these.
[3] TNA ADM 79/35.
[4] NRO ZPA 18.

and rope cost about 9% of wages.[1] It is therefore likely the great majority of the direct cost of lead mining was physical labour. This, coupled with the detail given on bargains at Fallowfield can be interrogated to derive an approximate estimate for labour productivity in lead mining there. Between July 1680 and December 1681, 300 tons of ore were mined by five different partnerships at a range of rates and at a total cost of £433. If we assume that in the absence of bargains miners would expect remuneration of 12.2d (5.1p)/day (11d (4.6p) plus a 10% allowance for candles etc.) and that the working year consisted of 270 days (6 days per week for 45 weeks) then it would have required some 8,500 days of work to mine and wash this much lead ore ready for smelting (£433/ 5.1p per day). This equates to around 9.5 tons of ore per miner per year (300 tons/ (8,500 days/270 days)). The absence of any separate payment for washing this ore means it must have been included in the scope of the bargains. This is slightly higher than rough calculations from the information in Michael Blackett's reports (see Table A3.14) although we rely here upon ore delivered from the mines over winter-early summer periods rather than direct records of production. Headcount is derived from the paybills based on known daily rates for miners and washer and their proportions in Hunstanworth in the 1660s and after allowing for the cost of supplies. It is unlikely that the actual number of miners and washers varied by as much from year to year as shown here. The higher levels in 1678 might well reflect greater levels of overtime by a smaller total headcount.

Table A3.14 Lead miners – Allendale and Fallowfield, 1677-81

	Allendale			Fallowfield		
	Ore delivered/ month	Miners and washers	Tons/ person/ year	Ore delivered/ month	Miners and washers	Tons/ person/ year
1677 Jan-May	72	140	6.2	30	55	6.5
1678 Jan-Jun	86	180	5.7	55	75	8.8
1680-1						9.5

Fallowfield was probably one of the more productive lead mines in the region and clearly moreso than Allenheads and Coalcleugh, but even here the stark contrast between coal and lead is clear, since Hatcher estimated annual labour productivity of between 175-200 tons of coal. Lead ore was hard to win and therefore cost a great deal more than coal to extract, firstly from the bedrock and then from the lumps hauled to the surface. It would have stayed underground in the absence of economically viable uses for it. Taking a crude average of Fallowfield and Allendale of, say, 7 tons/head in the mid-1670s, Blackett must have had around 360 miners and washers at work then, plus those engaged on 'dead work' – perhaps another 50-60, if this is allowed at some 20% of the total cash outgoings as discussed above.

The key remaining element of mining cost was the dues owed to the owners of rights. This tended to vary between 10-20% of the ore mined. Few owners appear to have gone to the trouble of physically collecting their share from remote and often widespread mines, although the Radcliffes frequently took this approach to the fifth share they inserted in their Alston Moor leases. This approach or the alternative of selling the ore back to the miner kept the cost of mining rights in direct proportion to production. The Bishop of Durham, on the other hand, commuted his 10% lott ore rights (later one ninth) in Weardale to an annual lump sum that created an incentive for mining leaseholders to increase production and thereby dilute the cost until such time as the sum was renegotiated, normally after a new bishop was appointed to the see. In 1669 William Blackett I compounded with the Fenwicks who took a single lump sum in respect of Allendale and Fallowfield that in practice greatly reduced the burden of rights to Blackett when he subsequently ramped up the amount of ore mined as described in chapter 8.

[1] TWA DF.HUG/43/1-11, DF.COT CM/1/66-79. Here too, candles were at the cost of the miner when working under bargain arrangements.

3.4.2 Carriage

The cost of carrying ore and lead by packhorse or (probably fairly infrequently in the 17th century) by cart cannot be isolated within Michael Blackett's reports but the amounts paid for known quantities between specific locations in the Fallowfield accounts permit the calculation of rates per ton per mile. This shows quite clearly that in 1680 and 1681 ore was carried the ten miles from Fallowfield to Plankey Mill for 7d /ton/mile in summer and 8din winter, when the ways were less tractable but clearly often still open (2.9-3.3p/ton/mile). These rates are found elsewhere in the 1680s and 1690s.[1] They are all for journeys between mines and mills out in the country, and probably dependant wholly on packhorses carrying 2 cwt on each journey, but there are several signs of cheaper rates for carriage of smelted lead to the navigable reaches of the Tyne. This possibly reflected the use of carts on some of the journeys but also the greater opportunities for the return carriage of supplies from the town. A single observation by Michael Blackett regarding an agreed carriage rate for 1677 suggests a rate of 6d/ton/mile (2.5p) between Plankey Mill and Blaydon. 156 tons of lead was carried from Plankey to Blaydon staiths for 5.1d (2.1p)/ton/mile between November 1680 and December 1681, and just under 1,500 tons from Birkey Burn Smelt mill near Acomb to Newburn between 1682 and 1686 at 5.9d (2.5p)/ton/mile.[2] The rate scarcely varied from summer to winter. Given the distances between mines, mills and staiths, a burden of 2 cwt of carriage per packhorse, and an assumed 5-10 horses per carrier (which also allows for care and preparation of horses, their gear, packs and ore-sacks), ore and lead carriage provided seasonal work for around 30-50 people in the mid-1670s.

3.4.3 Smelting

The principal elements of the cost of smelting lead were labour and fuel, but the yield of lead from ore had a very important bearing on the overall cost of a ton of lead and this too needs to be considered. It is one of the reasons why skilled smelters were highly prized and the rapid increase in the scale of the North-eastern industry in the decades after 1650 will have placed a further premium on obtaining and developing such scarce skills in the face of rising demand for their services.

Smelters pay

As such it is reasonable to expect that pay rates for experienced and capable smelters rose in the Restoration period. They were typically paid at a piece rate per fother, and 6s (30p) per fother was the going rate for smelting Sir Edward Blackett's lead in the early 1680s. At Blackhall Mill in Hexhamshire in 1691 smelters were paid 7s6d (37.5p) per fother.[3] Translating this into average weekly pay depends upon the amount of lead that could be produced by each smelter in a year. A few mid-18th century remarks on the amount of ore processed at a hearth by two men extrapolate to between 60 and 85 tons per year per smelter, which would mean average pay of eight to twelve shillings (40-60p) per week, higher than that typically obtained by miners.[4] It is fairly safe to assume rates were lower in the 1650s and 1660s but no information is available from then. Slag hearth work was remunerated at twice or more the piece rate for 'first' smelting, reflecting some combination of the greater effort and skill needed, and the much lower yield of lead from each shift. At Birkey Burn in 1691-2 slag lead was paid for at 14s8d (73.3p)/piece compared to the 6s paid for the produce of the ore hearth. At these rates Blackett probably employed about 20 smelters in the mid-1670s.

Fuel

---

[1] Fallowfield to Plankey, 1680-1: NRO ZBL 273/15; Alston Moor (probably the productive Greengill mine in Nentdale, where Edward Blackett's brother William still held the lease) to Plankey Mill,1680-1: ZBL273/14-15; Settlingstones to Blackhall.

[2] 1677: MB to WB 19 May 1677. A Mr Carnaby tendered 14s to lead the Plankey lead, which probably meant for a fother, and almost certainly to the Blaydon staiths, which converts to 6d (2.5p)/ton/mile for a 21 cwt fother over 27 miles; 1680-6: NRO ZBL 273/12. The Birkey Burn to Newburn charge, all on the north bank of the Tyne appears to have included a small wayleave and staithroom charge.

[3] TWA Cotesworth papers CM/1/90.

[4] Nenthead in 1737: TNA ADM 79/35; Langley 1774, Visitation report: TNA ADM 79/57.

Before the 1690s, the principal fuel used for ore-hearth smelting was chopwood, typically coppiced in winter months then dried in kilns. From the 1690s peat was increasingly common and there is evidence that coal was also used from the 1690s where it was available within viable transport range.

- We have little to go on regarding the ratio of fuel to lead quantity in smelting, but for chopwood a few independent measures are in the range of a ton of fuel to a ton of lead. Around seventeen sacks of chopwood were delivered to Plankey and Dukesfield for each fother of lead smelted in 1677-8 according to Michael Blackett's reports and it seems from elsewhere that a sack typically contained a hundredweight of dried wood. At Blackhall Mill in 1691 just under a ton of wood was consumed in smelting a ton of lead, although this was an inefficient mill. In 1702 a trial at Birkey Burn mill consumed just 13 cwt of chopwood to smelt a fother of lead.[1] A sack of chopwood cost 8d (3.3p) at Dukesfield and Plankey in the 1670s and at Birkey Burn in the early 1690s, so if we allow 15 cwt of fuel per ton of lead, taking a crude average of the slightly different isolated notices available, this would mean fuel costs of 10s (50p) per fother of lead. This is more than the cost of the skilled labour required so it is no wonder that greater fuel efficiency was sought.

- The only measure of the amount of peat required is a 1737 estimate from Nenthead that three cartloads of peat would smelt a fother of lead. Cart capacity is unstated, but to carry peat cut from the deposits cladding the fells above Nenthead they could surely not have been more elaborate than the simple single-axled one-horse vehicles used to carry lead pieces. The latter could manage 10 cwt of cargo of lead, so three cartloads of peat might well have exceeded a ton and it is possible to imagine that the calorific value of peat was lower than that of chopwood. Its cost, however, was estimated at 3s-5s6d (15-27.5p), which suggests a significant saving compared to wood fuel. Alongside the advantages of savings in transport cost opened up by locating smelt mills closer to upland mines this made it worth the effort to experiment with changes in the techniques needed at the ore-hearth to make use of peat fuel from the hills (see chapter 14).

- Coal fuel appears to have been an even more efficient heat source. In 1691-2 at Birkey Burn 221 tons of lead was smelted using a mixture of a quarter ton each of chopwood and coal for every ton of lead. In 1693/4 coal comprised 80% of the fuel and the total required for each ton of lead was 0.46 tons. Since upwards of 12 cwt (0.6 tons) of coal were needed when it was the sole fuel, the superior calorific value of coal is clear, perhaps 50% higher. And at Birkey Burn it could be delivered from the adjacent Oakwood pit for 4d (1.7p) per horseload, which was probably 2 cwt – the weight of lead a horse could carry. Thus, a 50/50 mix of coal and wood cost around 2s6d (12½p), a dramatic saving compared to wood fuel alone. The problems with the use of coal were two-fold. Firstly, coal's usually high sulphur content was thought to affect the quality of the smelted lead. In the 18th century this was addressed through the development of reverberatory furnaces where the coal was kept physically separate from the ore, but it is quite clear from the Birkey Burn fuel purchase and smelting accounts that the problem had been overcome. The mention of 'cinders' used at Plankey's slag hearth in a smelting trial in 1680/1 is suggestive of coking coal in simple ovens first to reduce the sulphur content and this might therefore already have been in use instead of charcoal to obtain the greater heat needed to smelt lead slags.[2] It is plausible that experience at the slag hearths from at least 1680 was applied to the increasing use of coal in primary smelting in the 1690s at Sir Edward Blackett's works. The other constraint on the widespread use of coal was the cost of transport. Oakwood coal could be carried to the adjacent Birkey Burn hearth for next to nothing, incentive enough to find ways to exploit it. Elsewhere in North Pennines lead country, far from Tyneside's

[1] MBL; TWA CM 1/90. The same ratio for chopwood was quoted in O.Rackham, *Woodlands*, (2010), p.168. Birkey Burn trial: quoted in Hughes, thesis, *op cit*, p.74.

[2] NRO ZBL 273/15. All references to the Plankey trials of 1680/1 are taken from this source unless stated otherwise below, and likewise to ZBL 273/14 for the Birkey Burn smelting accounts of the 1690s. This appears to have attracted external interest: experienced Swaledale men were at Birkey Burn conducting smelting trials in 1702.

productive seams, good quality coal was rarely available close enough to be a serious source of fuel supply, unlike peat, which came to dominate lead smelting in the region through most of the next century.[1]

Table A3.15 summarises the discussion above into a rough set of costings for the three major sources of fuel used in ore-hearth smelting, ie. the first smelting of the ore and not subsequent slag smelting. This can only be of illustrative value given the lack of data and the unit cost of fuel was greatly dependent upon location, only being pressed into service where it was cheap enough.

Table A3.15 Approximate ore-hearth lead smelting fuel costs, late 17th century

	Fuel weight / ton of lead	Cost /ton of fuel £	Cost of fuel /ton of lead £
Chopwood	0.75	0.7	0.5
Peat	1.50	0.2	0.3
Coal	0.50	0.2	0.1

Lead yield.

Once again we must rely principally upon the Fallowfield accounts and summary of smelting trials for estimates of the efficiency of smelting. Contemporaries usually expressed yield as the number of bings of ore required to produce a fother of lead. The five bings/fothers used in a cost-benefit analysis comparing smelting mill sites at Whitfield and Ryton in 1706 translates to a yield of 52.5% (ie. 21 cwt: 1 x 21 cwt fother)/ (40cwt: 5 x 8cwt bings).[2] This was probably taken as a reasonable going rate for the time, but was better than that achieved at Blackhall Mill in 1691, where only 38% of the weight of ore was converted into pieces of lead. It indicates very poor washing of the ore and/or such incompetence by the contract smelter, if not outright fraud, that it is hardly surprising that a direct lease of the mill was taken by the mining consortium a year later.[3] Edward Blackett's mills were generally more efficient. In the year after September 1680 182 tons of lead was obtained at a yield of 62% of the weight of ore delivered, although this might have been flattered either by any existing stock of ore remaining at the mill at the start of Sir Edward's tenure that summer, or by purchases from Alston Moor (used in the trials there during this period), or both. Performance at Birkey Burn from when it opened in June 1682 to December 1686 resulted in 580 tons of lead being smelted at a yield of 50%. The accounts appear to lend themselves to a further such calculation for 1691/2, but the opening stock of ore on hand at the mill and timing of deliveries is unclear. As far as the 1670s are concerned, the uncertainty caused by knowing only when ore was delivered to Plankey and Dukesfield rather than smelted makes it difficult to assess yields. Assuming, however, that in the late spring/early summer months deliveries might have roughly matched the rate at which ore was consumed at the hearths, the figures for May 1677 and April-June 1678, when 420 tons of lead were smelted at the two mills, indicate a yield of 56%, with Plankey apparently performing better than Dukesfield. Ore quality and how thoroughly it was washed at the mine could make a noticeable difference to yield. The objective of the Plankey Mill trials in 1680 or 1681 appears to have been to compare the relative quality of lead ore from Fallowfield (53% yield at the ore hearth) and Alston Moor (a mere 33%).

Smelting the slags from the ore hearth made an important contribution to yields, and it is likely that William Blackett was an early adopter of the slag hearth, for they were present in both Dukesfield and Plankey by 1676. An indication of the contribution they could make to production can be distilled from the carefully recorded trials at Plankey in 1680/1 and in the detailed Birkey Burn accounts of the early 1690s. Across the separate small-scale trials at Plankey, the yield from the first smelting at the ore hearth was 53%, but after second and third firings of the slags this rose to 66%, adding a fifth to the lead obtained. At Birkey Burn in 1691-2 221 tons

[1] However, small supplies were probably obtained for Dukesfield from Kilnpit Hill and Espershields, 5 miles away, from at least the early 1720s: executorship accounts: NRO 11603/Box 16, 672/E/1C/1, f58.
[2] Raistrick and Jennings, *op cit*, p.120
[3] TWA CM/1/90, NRO ZRI/20/17

of lead was delivered from the ore hearth but a further 16%, 35 tons, was obtained from two further stages of slag smelting.

Depreciation

A further element of the cost of smelting was the fabric and maintenance of the mill, its equipment and the associated river works and mill race vital to the supply of waterpower to the bellows. Smelting mills were typically humble buildings, which could probably be erected for less than £100 together with ore and fuel storage outbuildings. The inventory of equipment at Birkey Burn mill in November 1691, with its three hearths, added up to just £75 and this included some new iron hearthstones ready for installation. In the 18th century the concept of a 'mill room' charge to cover contributions to the depreciation of the fixed capital was an accepted part of the charge levied on batches of work undertaken for outsiders.[1] If £300 is allowed for a two hearth mill, depreciated over 4 years, spreading the annual charge of £75 over 200 tons of lead gives a figure of 37.5p per ton. This is probably too high, for the figure suggested for 'mill room' at Blackhall in 1765 was 12.5p, by which time it is also possible that prices of machinery and labour were higher.[32]

3.4.4 Miscellaneous

A few other minor charges were incurred by producers once their lead pieces reached the navigable reaches of the Tyne. Edward Blackett paid ½d (0.2p) per piece of lead for carriage by keel or wherry from Blaydon down to Newcastle in the 1690s, that – taking 15 pieces to the ton - works out at just 3p/ton. Once on a boat carriage was cheap, but the loading, unloading, weighing at the town scales and carriage to storage cellars was cumbersome and more costly, and came to £28.60 for 135 tons in 1692, 21p/ton of lead. The staiths owned by the Blacketts at Blaydon were probably worth some £15-20 a year in rent avoided, and this might be a reasonable measure of the cost of keeping them properly maintained. Likewise, the cellars in Newcastle were already part of the family estate, but might otherwise have cost £20-30 per year to rent.

3.4.5 Summary

The detail from previous sections is brought together here, along with some further allowances, to give an approximate estimate of the unit cost of a ton of lead under the following **scenarios**:

1. 1665-6: production by William Blackett from Allendale in the first year of the Dukesfield mill, assuming 250 tons of lead, smelted down from 450 tons of ore mined, an amount hypothesised based on the lease cost and extension he obtained from Pearson between 1660-9 (see section 3.2.6 above);
2. 1675-6: production by William Blackett from Allendale, Fallowfield, Alston Moor etc. and smelted at Dukesfield and Plankey Mills, based on the 1,500 tons of lead shown in Michael's reports, smelted at 5 bings to the fother (52.5% yield);
3. 1675-6, as scenario 2, but with smelting yield at 61% based on production uplift expected from use of slag hearth;
4. 1692, showing the cost of lead mined at Fallowfield and smelted at Birkey Burn. Direct costs derived from Sir Edward Blackett's accounts and other costs per assumptions given below.
5. 1734-6: Sir Walter Blackett's lead mined in Weardale and Allendale and smelted at Dukesfield, Allenheads and Rookhope, derived from the accounts kept by Joseph Richmond.

[1] Proposed, for example, to Lancelot Allgood in respect of Blackhall Mill in July 1765: NRO ZAL 56/1, DD

Table A3.16 Unit cost of Blackett lead 1660s-1730s

	1	2	3	4	5
	1665-6	1675-6	1675-6	1692	1734-6
Lead production (tons)	250	1,500	1,500	256	1,770
Per ton of ore (£)					
Mining and duty	3.35	2.72	2.72	2.05	2.98
Ore carriage	0.40	0.40	0.40	0.04	
Smelting yield	52.5%	52.5%	61.0%	61.0%	52.5%
Direct cost £/ton of lead					
Mining and duty	6.39	5.18	4.46	3.37	5.68
Ore carriage	0.76	0.76	0.66	0.06	
Smelting	0.80	0.80	1.03	0.62	1.91
Lead carriage	0.45	0.51	0.51	0.35	
River carriage/weighing	0.25	0.25	0.25	0.25	
Management £/ton	0.40	0.12	0.12	0.39	
Depreciation £/ton					
Mines and drainage	0.89	0.61	0.61	1.39	0.13
Mills and staiths	0.36	0.16	0.16	0.40	
Lease and goodwill	0.62	0.12	0.12	-	
Total cost £/ton	10.92	8.52	7.92	6.83	7.72

Notes and assumptions:

1. Mining costs per ton of ore. Scenario 1: the higher rate of £2.55 for Allendale alone is used, as the cheaper Fallowfield mine had yet to be acquired, and uplifted by 10% to add contingency for any missed costs, a hint of which was possibly observed in discussing the difference between the 1670s and 1680s accounts above. Scenarios 2/3: The cost of ore shown in Table A3.12 (£2.26) rounded up by 15% for contingency. Scenario 5: taken from actual accounts.
2. Duty or royalty per ton of ore. Scenario 1: Under the original Allendale lease duty was to be paid on all lead at the rate of 1/6, which added an extra 54p per ton of ore mined. Scenarios 2/3: 10p is included to cover the duty payments on Alston Moor (assuming a fifth of £5/ton - 40s/bing was charged in the 1660s - and that this ore was 10% of total production, according to Michael Blackett's reports). No duty was owed on Allendale or Fallowfield ore as this was bought out as part of the 1667-9 lease terms. Scenario 4: there is no sign in Edward's accounts that he paid any duty to his brother William II as owner of the Fallowfield mining rights so while its omission flatters the mine's cost base, it is unrealistic to add a notional provision. A 10% duty rate on ore would have increased the cost/ton of lead by perhaps 3.5%.
3. Ore carriage per ton of ore is calculated from the unit rates in section 3.4.2 above and the distance between mining and smelting locations weighted by the amounts carried between each. Scenarios 1-3: 12 miles ; 4: Scenario 4: Fallowfield to Birkey Burn 1 mile; Scenario 5: Weardale to Allenheads & Rookhope, Allendale to Dukesfield, weighted by relative volume. Scenario 5: actual costs are bundled with smelting and lead carriage.
4. The above three elements are divided by the smelting yield to give the equivalent the cost per ton of lead.
5. Smelting yield: Scenario 1 assumes same yield as Scenario 2. Scenarios 4 and 5 calculated from the respective accounts used.
6. Smelting: labour and fuel as discussed in section 3.4.3. Scenario 3 cost (incl use of slag hearth) based on additional cost from Birkey Burn accounts. Scenario 4: actuals in year from accounts, and cheaper because of inclusion of coal, a far cheaper fuel source. Scenario 5: includes ore and lead carriage and wherry charges from Blaydon to Newcastle.
7. Lead carriage: as in section 3.4.2, 6d/ton/mile. Scenario 1: 18 miles from Dukesfield to Blaydon; Scenarios 2 and 3 = 20.4 miles from Dukesfield and Plankey weighed by production shares; 4: Birkey Burn to Blaydon = 17.5 miles, cost derived from actual accounts for 1692; 5: 21.2 miles average from Dukesfield, Allenheads and Rookhope weighted by production shares
8. River carriage and weighing, as in section 3.4.4.
9. Management. Scenario 1: a mines agent, mill agent, staithman and book-keeper are assumed at between £20 and £35 per year. Scenarios 2/3: 3 mine agents (2 covering Allendale/Alston Moor, 1 at Fallowfield), an agent at each of the 2 mills, 1 staithman and 1 book-keeper. Scenario 4: 1 agent each for mines, mill, staiths and book-keeper at £25 each.
10. Depreciation is derived from the capital estimates and depreciation schedule set out in Table A3.19 below for Scenarios 1-4. For Scenario 5 depreciation see note 9 to that table. Lease costs: Scenario 1: it is assumed in section 3.5 below that £670 of the £1,820 paid to Pearson by Blackett is attributed to mining assets such as shafts and drainage equipment. The remaining £1,150 therefore constitutes residual lease cost and goodwill (ie. an inducement given by

Blackett to acquire the lease) spread over the remaining term in amounts reflecting the two dates at which the sub-leases were taken: 1660 and 1665. Scenarios 2 and 3: the £4,050 of the new lease is spread over 22 years. Scenario 4: the mining rights had by then been bought by William Blackett II. Scenario 5: the £900 paid to the Bishop of Durham in 1732 to renew the leases was expensed in that year's accounts.

It is possible that some costs have been double-counted here, for as we saw in section 3.4.1 above some of the costs of mining as reported in the cash-based reports and accounts included ongoing maintenance, renewal and extension of shafts, levels, engines and mills. Yet these are also provided for within the notional unit depreciation charge shown in Table A3.16. Scenario 3 covers the large scale and mature business in the mid-1670s. If such charges ran at the 20% observed at Grinton between 1697 and 1706, then around £1,000 of annual mining cash outgoings could be classed as capital, which is slightly more than the additional £950 or so calculated as a depreciation charge in Table A3.16 (63p x 1,500 tons). On this basis it would all have been double counted. Removing the depreciation charge (other than for lease costs) lowers costs by 10% in Scenario 1, 7% in Scenario 3, and 12% in Scenario 4. However, a more cautious view is taken here. While some of the assets depreciated might already have been accounted for as capital outgoings within cash expenditure, an additional depreciation allowance provides a mechanism to recognise the use of assets paid for before the time in which we have any accounting data. This is important if those missing years included significant amounts of start-up investment, as illustrated by the 40%+ share of costs accounted for by capital expenditure observed at Fallowfield and Settlingstones in section 3.4.1.

Overall, the value of economies of scale is clear. Management, depreciation and lease costs are estimated at £1.87/ton in Scenario 1 (1665-6), or a 25% burden on the direct costs per ton of lead. In Scenario 3 (1675-6), with production six times higher, they cost just 92p/ton, half as much despite more mining and smelting assets being deployed, additional managers and a higher lease cost, and were only a 12% overhead on direct costs, despite lower mining costs because of the inclusion of Fallowfield. The same is seen in reverse in Sir Edward's lead business in 1692. Management and depreciation cost £1.45/ton, a 40% burden on the exceptionally low direct cost.

3.5 Capital and profitability

3.5.1 Profit margin

As for coal this section covers the return on sales (profitability) and the return on capital assets employed. In Table A3.17 the output, price and cost estimates developed earlier are combined to indicate overall profitability.

Table A3.17 Blackett lead profitability 1660s-1730s

	1	2	3	4	5
	1665-6	1675-6	1675-6	1692	1734-6
Lead production (tons)	250	1,500	1,500	256	1,770
Selling price per ton	£12.06	£11.19	£11.19	£8.20	£12.14
Cost per ton	£10.92	£8.52	£7.92	£6.83	£7.72
Profit margin per ton	£1.14	£2.67	£3.28	£1.37	£4.64
Revenue	£3,015	£16,791	£16,791	£2,100	£17,832*
Cost of sales	£2,731	£12,785	£11,877	£1,748	£13,656
Profit	£284	£4,005	£4,914	£352	£4,176
	9%	24%	29%	17%	23%

As before, this is probably conservative to the extent that much of the depreciation allowance might double count an element of direct mining and smelting costs in Table A3.16. If just half of this charge is removed, it would be sufficient to raise the profit margin to 21% under Scenario 1 and 30% in Scenario 4. The economies of scale enjoyed under Scenarios 2 and 3 leave the calculations largely insensitive to any such double counting. Revenue in 1734-6 (asterisked) is from actual sales rather than the value of all lead produced. These were years in which sales fell short of production, which depressed profitability. Had all lead been sold at the prevailing market price the margin would have been 38% instead of 23%. However, annual profits between 1734-6 were boosted by £2,000 from litharge and silver produced at Blaydon refinery, taking the overall margin to just over 30% of revenue in those years.

Table A3.18 Profitability of the coastal lead trade, 1669-70

£ per ton of lead	insured	uninsured	Notes and assumptions
London price	14.50	14.50	From section 3.3/ Figure 7.5
Costs	14.04	13.10	
Purchase cost	12.00	12.00	Table A3.8, rounded down
Newcastle port dues	0.20	0.20	4s allowed for town dues and lading
Freight	0.50	0.50	Avg from various Blackett and Grey letters
London port dues	0.40	0.40	Based on port charges levied on coal
Insurance	0.94	-	Assumed at 6.5% of cargo value (Marescoe)
Profit	0.46	1.40	
	3.2%	10%	

Beyond these snapshots of the returns on producing lead and delivering it to Newcastle it is worth considering how they compare to the returns on trading it. This was important to William I as it is clear he was still deeply engaged in the overseas and (probably) coastal trade in lead in the 1670s, and of course had mercantile roots. Unfortunately the complete absence of any reliable sale price and exchange rate data for the major European outlets of Amsterdam and Hamburg make this impossible. However, the London market was important in its own right, and the relative ease with which merchants could direct their cargoes between London and the principal overseas ports implies that major differences would have been competed away over time. We do have some price information from London, as discussed in section 3.3 above. Table A3.18 illustrates the potential returns in 1669-70, years for which we have London prices, taking into account the approximate freight and other charges.

This portrays the coastal lead trade as highly unattractive. Any variation in the actual port and freight charges from those assumed here are unlikely to have had a material impact, as they were relatively low compared to the lead price. Insurance premiums must have weighed heavily enough to tempt merchants into taking their chances with the sea, but a 10% return hardly rewarded such risk-taking. The key element here is clearly the difference between prices and this might represent a year in which they were particularly squeezed, despite the demand for lead to rebuild London. However, even if an extra £1.50 was available to a merchant on arrival in London with an insured cargo, the rate of profit on revenue would still only have been 11.5%. It appears that production rather than trade was a far more attractive proposition, and also offered the potential to reap economies of scale. This was clear from the last section and is also evident in turning to estimate the returns on Blackett's invested capital.

3.5.2 Return on assets

.1 Fixed asset infrastructure

As with the coal industry the best hope of estimating the stock of fixed capital deployed by Blackett in his lead business lies in forming a reasonable view of the number and cost of the physical assets in use at different dates. The shafts, levels, engines and surface equipment needed for lead mines were similar in nature to those found in collieries, although there were differences that have a bearing upon capital economics. In particular the lower volume of material extracted from lead mines must have meant that the practical lifespan of shafts and levels was longer. In addition to the access shafts from the surface, the larger lead mines required, over time, a lattice-work of underground sumps and levels in order to pursue orebodies. These often descended in sinuous mineral veins rather than sedimentary layers, unless found in rich and productive 'flats' within limestone bedrock. In all cases, these works are costed at the same rate as access shafts for simplicity's sake. The cost of sinking and lining shafts was not greatly different between coal and lead mines – and for simplicity's sake the same rates are applied here as in Table A2.7 - but a five year life is assumed here rather than just three.

Unfortunately, we have no equivalent analysis of the industry to compare with the work on the economic history of coal mining to act as a cross-check. But we do have Michael Blackett's reports, written when his father's business was at its peak, and they give clues to both the extent of his mining and smelting infrastructure and some relevant costings. These, the availability of details for Edward's Fallowfield mines in the 1680s/90s and Richmond's accounts for the early 1730s help substantiate the number of assets shown in Table A3.19 for the years which match Scenarios 3, 4 and 5 in the previous section. For Scenario 1 an educated guess has been made.

Table A3.19 Blackett lead fixed asset estimates

	cost	Deprec (yrs)	1 1665-6		3 1675-6		4 1692		5 1734-6	
			No	£2,308	No	£8,881	No	£2,565	No	£13,560
Working shafts	£80	5	4	£320	12	£960	5	£400	4	£640
Sumps etc	£80	5	2	£160	12	£960	4	£320	8	£680
Levels	£250	8	1	£250	6	£1,500	3	£750	4	£1,000
Drainage shafts	£80	7	1	£80	3	£240	1	£80	3	£250
Drainage equpmt	£80	4	1	£80	3	£240	1	£80	3	£250
Mohope		5								£500
Weardale		5								£6,000
Mine horses	£7	8	24	£168	72	£504	30	£210	80	£840
Headgear	£30	4	4	£120	12	£600	5	£150	4	£200
Misc		4		£60		£200		£100		£400
Smelt mills	250	5	1	£250	2	£500	1	£250	3	£800
hearths	£25	2	2	£50	8	£200	3	£75	12	£400
Staiths		10		£150		£400		£150		£600
Lease remaining				£620		£2,577		-		£1,000

Notes and assumptions:

1. Number of shafts, sumps and levels.
   a. Scenario 1: by inference from a named shaft in the 1660 sub-lease from Pearson to Blackett (NRO 324/W.3/18/3) there were at least two present by then. 4 are assumed at Allenheads and Coalcleugh by five years later, Pearson's level ditto and a drainage shaft and associated equipment. Sumps and underground levels are allowed for in a 2:1 ratio on working shafts given early stage of development.
   b. Scenario 3: the same number of working shafts at Allenheads and Coalcleugh, 3 at Greengill and 5 at Fallowfield, based on mentions in MB's reports. A drainage shaft is assumed at each of Greengill, Allenheads and Coalcleugh, and 6 levels (2 Allenheads, 1 Coalcelugh, 2 Fallowfield, all inferred from MB reports, and 1 added as contingency). Sumps allowed for in a 1:1 ratio to working shafts, given greater maturity of the mines by then.
   c. Scenario 4: 5 named working shafts at Fallowfield, 3 levels and a drainage shaft has been allowed for. Sumps also allowed at 1:1.
   d. Scenario 5: this is difficult to estimate. Allenheads and Coalcleugh had been at work to a greater or lesser extent for 70 years or more so it is likely that some early shafts and short levels had passed out of use, and perhaps an equivalent number of new but deeper shafts (4) sunk to reach more distant lodes. The Haugh and Shieldridge levels were still in use but presumably needed only ongoing maintenance, the construction cost

having been fully written down years before. An additional 4 new levels are allowed for. A single engine was mentioned at Coalcleugh in 1729, but two are also allowed for at Allenheads.[1] Sumps are added at a 1:2 ratio as workings spread further underground.

e. Scenario 5 Mohope and Weardale are estimated as separate line items. **Mohope** was opened up in 1732, and a level was mentioned in the spring of 1733. Accounts survive from the beginning and they show it was won very cheaply: the entire capital outlay cannot have been higher than £500 in 1732-5 and possibly lower, amounting to no more than 20% of all costs, with each ton of ore costing under £2. This is instructive when considering **Weardale**. Although a large number of groves were mentioned in 17th-century court depositions, it is likely that only a fraction were at work at any one time. In 1732 25 out of 89 were said to be presently wrought. Of these it appears that just 12 were worked directly by Blackett, two by the Blackett/Bacon partnership and the others still sub-let. At least 3 of the in-hand 12 were also hushed, and such surface work will have required little infrastructure beyond a temporary dam.[2] Based on the production statistics (c.780 tons of ore/yr 1729-31) and allowing for some of this to have been duty ore from the sub-lease, and from the hushes, (100 tons in total?) average annual production from each underground mine was probably no more than 60 tons, an amount that might be worked by 7-9 men. They were therefore still small, possibly worked in from the valley sides to minimise sinking and drainage costs and probably had little recent capital behind them. If each is allowed £500 (the same as the maximum at Mohope, which produced much more lead but was newer and therefore probably had easier access to the ore) this adds to £6,000 in total. If spread over 5 years (£1,200/yr) this represents 40% of Weardale mining costs of c.£3,000/year so is probably at the high end of estimates. This figure would therefore probably also allow for the capital needed to maintain the partnership mines, which added only a small amount (c.100 tons) to Weardale production.

2. Sinking and lining shafts. Shaft depth (120 ft) and construction costs allowed as in Appendix 2.5 on the assumption that any variation in geology and labour rates are insufficiently known to make further speculation worthwhile. However, while coal mining shafts are written down over just 3 years because of the volume of material removed greater longevity is assumed for lead mines, and a 5 year depreciation period is used here for both working and drainage shafts. In Scenario 5 the shafts are priced at £160 each in Allenheads and Coalcleugh to allow for greater depth.
3. Driving levels. In his reports MB gave several indications of the rate of progress with driving levels at Allenheads and Fallowfield, where 3 yards was a good week's work in April 1678. Allocating 3 men to the work at a shilling (5p) per day plus a 20% allowance for supplies of candles, tools and barrows, two yards/week works out at just over 10s (50p). Rough measurement of the actual levels as shown on modern maps indicates an average length of 400 yards can be used for modelling purposes. A single 60ft air shaft is allowed for each at a cost of £50. Total cost = £250, ie slightly higher than a 10s/yard rate quoted in Derbyshire in 1659 (Slack, 'Lead miners heyday', p.42) and which also seems to have been the rule applied by Daniel Wren in viewing tack prospects for the Greenwich Hospital in Nentdale in 1735 (TNA ADM 66/105, 29 Sept 1735). Levels are assumed to be written down over eight years, as drainage levels are deemed likely to be of productive value for longer periods than working shafts.
4. Drainage equipment, mine headgear and horses: costs, ratios and depreciation as for coal mines (Table A2.7)
5. Miscellaneous allowance for additional equipment, tools and buildings arbitrarily allowed as shown in the table.
6. Smelt mills. Scenario 1: Dukesfield (2 hearths assumed); Scenario 3: Dukesfield (6 hearths) and Plankey Mill (2 hearths) per MB reports; Scenario 4: Birkey Burn (3 hearths) per EB accounts; Scenario 5: 3 mills: Dukesfield, Allenheads and Rookhope. As discussed in section 3.4.3 above £250 is allowed for each mill to cover the cost of construction, mill race, wheel, bellows etc. and a further £25 for each hearth. The mill and its furniture are depreciated over 5 years and two years are allowed for each hearth. They were subject to annual maintenance but it is unclear that all the stones needed annual replacement.
7. Staiths: allowed for as shown in the Table, based on rough rates discussed in Appendix 2, and a ten year life.
8. Lease remaining: the values shown are calculated based on the amount of the lease terms (and in Scenario 1 the goodwill implied in the Pearson-Blackett agreement) remaining in the years modelled. Scenario 5: £900 was paid and fully expensed in 1732 to renew the various Weardale leases, and this is rounded up here to £1,000.
9. Scenario 5 depreciation. This is treated differently to the modelling approach used for Scenarios 1-4. All expenditure, including capital outlays, is accounted for from 1729, which makes it possible to estimate whether such outlays were higher in the early years during which output was expanding compared to 1734-6. To do this it is assumed that the underlying direct costs from 1729 onwards were based on 80% of the mining and smelting units costs observed in 1734-6 (excluding Weardale dues), years in which they ran at a lower rate than between 1729-31, and therefore might be thought to approximate to the Blacketts' underlying basic cost of mining and smelting lead. Subtracting this estimate of direct costs from total outgoings indicates that the balance, which is presumed to be largely capital spending, was £1,209/yr higher than in 1734-6. Since this was presumably still giving benefit 5 years later, a depreciation charge of a fifth of that amount, £237/year, is added to the cash outgoings in 1734-6.

As a very rough cross-check on these capital estimates, depreciation as a share of total costs under the first 4 scenarios should be within the ranges noted from a few surviving accounts and summarised in section 3.4.5.

[1] Coalcleugh engine: JR to LA, 24 Mar 1729: NRO 673/2.

[2] Mohope level: JR to WB, 15 Apr 1733. Weardale mines at work: Whitfield to Bishop Chandler, c. April 1632: DCRO D/Bo/F/117-38.

(20-40%); Calculations for our scenarios drawn from Table A3.16 are as follows: Scenario 1: 17%, Scenario 3: 11%, Scenario 4: 26%. These are generally at the low end, but when the risk that some depreciation is double-counted is recalled, it is more likely that estimates of fixed capital stock are slightly overestimated than underestimated. Although it was only a small mine working what was in all probability a newly discovered vein, the low capital needs of opening up Mohope in the early 1730s also point in this direction.

.2 Working capital

The principles used to model the working capital requirement for coal (Appendix 2.5.3) have been adopted for lead: that wages represented the majority of outgoings, were paid no more than a month in arrears (which is certainly clear from Michael's reports in 1675-8) and that receipts were delayed by both the logistics of transport journey times and credit periods extended to buyers. The very different geography of lead compared to coal and the markets favoured by Blackett affect the estimate of the time lag between expenditure and receipt of cash.

The transport challenge was described in chapters 7 and 8. Mines were up to a dozen miles away across remote country and high fell land from the mills and the mills between eighteen and 27 miles from the navigable reaches of the Tyne. The vast majority of lead was then shipped out along the coast or across the North Sea. It is inevitable that stocks of ore built up at mines, and stocks of smelted lead at the mills, staging points *en route* to Blaydon or in Newcastle's lead cellars. If transport was impossible for three or four months of the year, it is easy to conceive that nine months could elapse between ore being hewn in Allenheads and the lead smelted from it being sold on the Amsterdam Exchange. However, the evidence of Michael Blackett's reports is that ore and lead often were often moved during winter months. Over 350 tons of ore was carried from the mines to Dukesfield and Plankey in January, February, November and December 1678 and wood fuel too. The same months saw 100 tons of lead carried to Blaydon from the mills. In each case it was roughly equivalent to the ways being open for nine months of the year instead of eight. This could have had the effect of removing two months elapsed time from the point of mining to the point of sale, but in Table A3.20 this is modelled more cautiously, as not all winters would have been benign enough to allow it.

Table A3.20 Elapsed times for working capital cover 1675-6

		Inland transport operating for		Notes
Months to final delivery	Inventory cost £	8 months	9 months	
Transport				
Weighted total:		7.3	6.1	
Lead carried	1,141	2.0	2.0	time lead in cellars and on ship to destination
Lead smelted	1,540	4.5	3.5	above + time stockpiled at mill or in carriage to Ncl
Ore carried	983	7.0	5.5	above + time ore waiting at mill & being smelted
Ore mined	6,534	9.0	7.5	above + time stockpiled at mine or in carriage to mill
Sales credit		1.5	1.5	
Transport and sales		8.8	7.6	
Less				
Cost arrears		1.2	1.2	1 month for pay and 2 months for supplies
Net months		7.6	6.4	

The elapsed times between stages is weighted based on the cost embodied in inventory at each stage of the process, taken from the modelled cost breakdown for 1675-6 set out in section 3.4 above. Although mining accounted for the majority of cost, some was incurred at later stages of the process, so the weighted elapsed transport time under the '9 month' scenario is not 7.5 months, but 6.1 months.

Sales credit was customarily extended for three months but, as described in chapter 9, Blackett took advantage of generous credit terms in Amsterdam to sell for cash. Nevertheless, 1.5 months is conservatively used here to allow for sales in other markets on normal terms. It is assumed that the discount offered for cash sales in Amsterdam was at the prevailing local interest rate of 4% and the pro rata effect of this was to reduce revenue by 0.5%, and this factored price is used in Table A3.17 for the 1675-6 scenarios.

On these assumptions the business had to carry working capital to cover an average gap of 6.4 months between expenditure and receipt. In calculating working capital needs for 1665-6, the same transport elapsed time and pay arrears are assumed but two months sales credit, on the grounds that the Amsterdam market was not being as fully exploited by Blackett as a decade earlier. For 1692, the much closer proximity of Fallowfield to the Birkey Burn mill and the shorter distance from the mill to the Tyne is assumed to have reduced transport lead times by a further 1.5 months, but Edward Blackett sold all his lead to Newcastle merchants on 3 months credit terms. The total therefore remained at 6.4 net months.

Based on these figures working capital is calculated based on the percentage of total annual operating expenditure ('cost base' in Table A3.21) to be covered while awaiting receipt of payment. It could be argued that the allowance should be made based on the ultimate value of the lead to be paid for, rather than the cost represented by the inventory at different process stages, but it was cost that mattered from a cashflow perspective. Payment of mining royalties is excluded from this calculation on the grounds that it was probably settled annually in arrears, but half of the calculated depreciation allowance is included, to allow for new investment omitted from operating costs, and half of the management charge. For simplicity's sake, any seasonal variation in working capital demand is ignored. While the peak in any one year was probably higher, there will also have been seasons when it was lower.

Table A3.21 Working capital requirement – Blackett lead

	1	3	4	5
	1665-6	1675-6	1692	1734-6
Net months credit	6.9	6.4	6.4	5.5
As % of year	57.5%	53.3%	53.3%	45.8%
Cost base	£2,109	£10,869	£1,468	£13,419
Working capital	£1,213	£5,797	£783	£6,150

For Scenario 5 (1734-6), an estimate can be derived from the cost embodied in the average stock of ore and lead at various locations between mines and quayside accounted for at each year's end in the summary journals (£9,100). This includes the increasing amount of unsold lead remarked on earlier. However, the pays now took place annually at the calendar year-end very little of the new year-end stock had to be financed by the business in the preceding months. However, lead newly arrived at Blaydon might be assumed to take a further 3 months to sell and 3 subsequent months to be paid for. Weighting this together with additional time for stock further back into the hills gives an annualised £6,150 of working capital requirement, which was the equivalent of 5.5 net months credit.

.3 Rate of return

As with the similar projection given in Appendix 2 for coal, it is dangerous to assume that the calculated rate of return on capital employed at different stages in the Blackett lead business can be of anything other than illustrative value. The conservative approach taken with regard to the intermediate calculations might mean that the figures indicated in Table A3.22 err on the low side, but even as shown they indicate an exceptionally profitable state of affairs in the mid-1670s. It is highly likely that the return on capital in Blackett's lead business was well above 30% in 1675-6, thanks to efficient operations, a sustained high price of lead and the enjoyment of economies of scale in the use of fixed assets, lease and management costs. Edward's Fallowfield business, on the other hand, was hampered by operating on a much smaller scale due to lower production and separation from his younger brother's Weardale/Allendale/Dukesfield concern, despite the low cost of mining at Fallowfield.

Table A3.22 Blackett – capital employed in lead, 1660s-1730s

	1		3		4		5	
	1665-6		1675-6		1692		1734-6	
Lead produced (tons)	*250*		1,500		256		1,770	
Revenue	£3,015		£16,791		£2,100		£17,832	
Profit	£284		£4,914		£352		£4,176	
Profit %	9%		29%		17%		23%	
Capital employed	£3,521		£14,678		£3,348		£19,710	
Fixed assets	£2,308	66%	£8,881	61%	£2,565	77%	£13,560	69%
Working capital	£1,213	34%	£5,797	39%	£783	23%	£6,150	31%
Return on capital	8%		33%		11%		21%	

For Scenario 5, (1734-6) it should be noted that while the profitability and the return on capital for lead alone are calculated to have been 23% and 21% respectively (depressed by the unsold lead noted above), the overall performance of the business was greatly enhanced by the refining of around a half of the common lead from the smelting mills for silver and litharge. Average total revenue including refinery products for those 3 years was £20,600 and profit £6,300, giving a margin of just over 30%. The capital cost of the refinery in 1722-4 had been £700. On the assumption this asset value was maintained thereafter and a net three months are allowed for sales and payment for silver and litharge, the refinery and its products added £1,350 to the overall stock of capital, making the return on capital employed 30% on the business as a whole.

.4 Profit estimates 1660s/70s.

The assumptions developed regarding prices, unit costs (of production and fixed capital assets) and pace of expansion can be further put to use to give an approximate sense of the performance of William Blackett I's lead business from the early 1660s to the eve of his death (Table A3.23). Returns were probably high in the early 1660s when the lead price was high, but by the end of the decade significant additional investment probably meant Blackett had had to draw on reserves or short-term lending from elsewhere to fund payments to Fenwick for the new lease and for expanding smelting capacity at Dukesfield. The big money was made in the 1670s. The projected accumulated profits are those calculated to be left after the further assumption that Blackett withdrew £150 for his own use annually by the end of the 1660s, rising to £500/year by the late 1670s.

Table A3.23 Indicative Blackett lead income and profit 1660s-70s

Annual average	1661-4	1665-9	1670-4	1675-9
Lead produced (tons)	180	340	875	1,380
Revenue	£2,450	£3,950	£10,300	£14,100
Costs	£1,850	£3,300	£6,800	£10,400
Profit	£600	£650	£3,500	£3,700
Profit %	24%	16%	34%	26%
Accumulated by period end	£600	-£2,100	£12,500	£29,000

3.6 Blackett and London Lead Company business performance 1738-50

3.6.1 Blackett.

Annual summaries of lead mining, smelting and refining quantities, costs and revenue have survived in large ledger volumes from 1729 onwards.[1] They were evidently drawn up from detailed quarterly returns from the various mines and mills. The loss of the latter means that the analysis of costs between various types of current and capital expenditure is not possible, but the overall course of business performance can be reconstructed. Hughes' tabulation is accessible but incomplete for, while litharge sales are included silver is not, nor the refinery costs involved in their production and the annual profit or loss is adjusted by alterations in the level of stock held. Stock clearly had value but, under the approach taken here, outlined in section 3.5.2, it is regarded as inventory at different process stages and unsold final goods, which therefore needs to be financed by working capital until sold and revenue obtained. To overcome these drawbacks the original data on mining, smelting, carriage and refining charges, all of which include local management costs, but not those of the Newcastle office, have been reconstituted to give a revised figure for cash expenditure between 1728 and 1750. This is deducted from revenue from sales of lead, litharge and silver to give a simple measure of profitability. Movements in stock levels are excluded but can be identified to assess working capital needs.

Using this data, Figure A3.3 charts revenue and costs between 1729 and 1750, showing a rapid rise in 1730 and a marked fall in the 1740s as a further recession affected the northern lead trade before recovering in the 1750s. It is noticeable that costs were also reduced significantly in the 1740s so that despite the drastic reduction in revenue the business did not record any meaningful losses and then recovered briskly towards the end of that decade and restored profits to a high level in 1750 and thereafter.

As noted in section 3.5.3 above, silver and litharge made a noticeable difference to the overall performance of the lead business, raising the profit margin from 23% on lead alone in 1734-6 to 30% in total. Analysed on its own, therefore, the refinery business made a very high profit margin, although this depends on how the accounts are constructed. The direct costs of the refinery were labour and the cost of supplies, principally bone ashes and fuel. However, the value of common lead lost in the process must also be set against the refinery revenue and this could easily double the cost of refining. Nevertheless profitability remained high, as shown in Table A3.24. Note that this cannot be compared directly with the corresponding data in Tables A3.17 and A3.22 above, for the additional depreciation allowance included earlier is excluded here. Profitability might be slightly overstated as a result.

[1] NRO 672/E/1B/2-8 covering the years 1729-1840. Volume 1B/1 has more limited data, focused on lead sales and some cost data for 1727-8. The data is available in tabulated form in Hughes, thesis, *op cit*, vol 2, section 2, Tables 9-14 and 17, pp. 19-33, 39-41 and in greater detail in a spreadsheet covering the period 1728-1800 compiled by Ian Hancock which can be downloaded from Dukesfield Documents: https://www.dukesfield.org.uk/research/dukesfield-documents/archive-sources/ northumberland-archives/allendale-estate-papers/.

Figure A3.3 Blackett lead business profitability, 1729-50

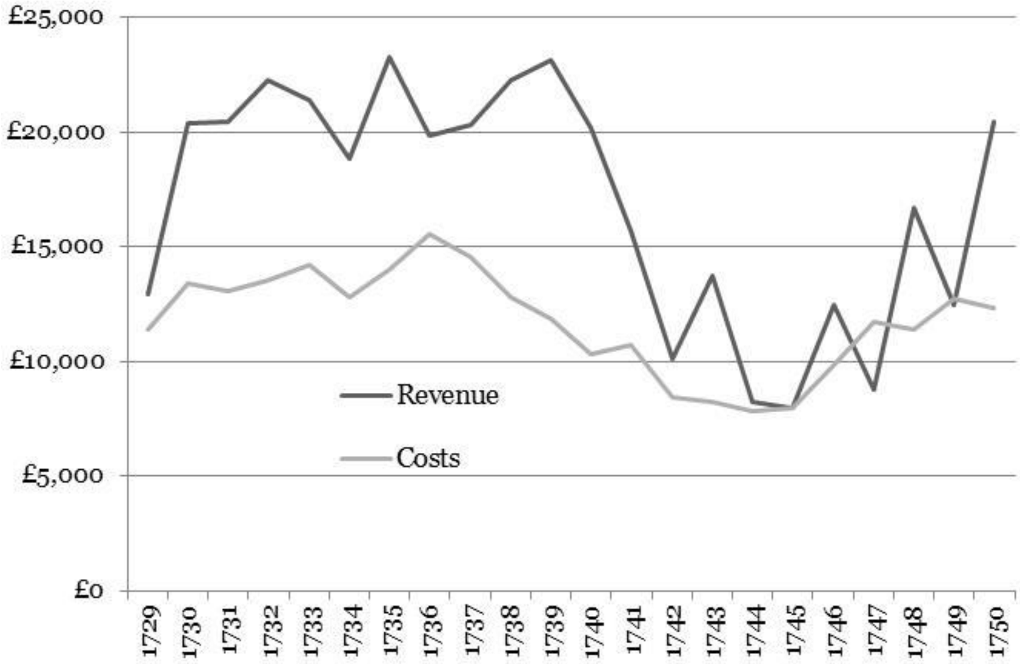


Table A3.24. Blackett lead profitability 1734-6

	Lead	Silver and litharge	Total
Revenue	£17,832	£2,804	£20,636
Costs	£13,560	£692	£14,252
Direct		*£326*	
Value of lead lost		*£366*	
Profit	£4,176	£2,112	£6,288
Profit %	23%	75%	30%

This begs an obvious question. If the return on refining lead was so high, why was only roughly a half of Blackett common lead sent to the refinery? The LLC typically refined the vast majority of its lead. There is no clear answer. Diverting lead to the refinery instead of for immediate sale probably added a month or two to the elapsed time between production and obtaining payment, thereby adding to working capital strain, although the return would still appear to have been worth it. Perhaps there was no spare capacity available at Blaydon, although if the economics were so compelling the lack of further extension, construction, recruitment and training is odd. At present the likeliest explanation, given the great care taken to refine only the most silver-rich lead, is that poorer quality lead cost disproportionately so much more to refine that it was not worthwhile.

3.6.2 London Lead Company.

The chance survival of the LLC's cost accounts for its north Pennines operations between the late 1730s and 1765 make it possible to reconstruct approximate summaries, but they were not kept or presented in a structured fashion.[1] Nevertheless figures can be extracted showing the cost and quantity of lead ore mined in certain years, carriage, smelting and refining volumes and costs, and this exercise has been carried out for the calendar years 1738 and 1750, before and after the 1740s recession. Detail of charges noted for the various mines and mills indicate that 'dead work' is included. As such it appears that the cash based accounts mix capital and operating spending, as was common practice. The LLC refinery accounts appear not to account for lead lost in the refining process, so an allowance has been made for this based on the level observed for the Blackett business.

It is important to note that since the records cover costs only, actual revenue can only be imputed based upon the volume of lead, silver and litharge produced, using the prices observed for the Blackett business in the corresponding years. This seems a reasonable assumption given the national market into which lead was sold and that both companies sent their North Pennines lead to Newcastle. The summary results presented in Table A3.25 indicate the scale of the LLC's expansion during the 1740s, despite the fall in prices during that decade. It was during that decade that Colonel George Liddell gave up his mining rights on Alston Moor and the LLC took a general lease of its mines instead. By 1750 the LLC was operating four smelting mills, at Nenthead, Jeffreys, Whitfield and Acton, and refining lead at the last three locations. All Nenthead common lead was sent on to Jeffreys Mill upstream from Blanchland for refining. The LLC always refined a much higher proportion of their common lead than the Blacketts but this fell slightly between the two dates shown, and this largely explains the reduced share of total revenue accounted for by silver in 1750. All the LLC mills grew busier, but Acton grew twice as fast as Jeffreys and Whitfield. In 1738 it accounted for a third of the LLC's lead sent to Newcastle and for half of the total in 1750.

Table A3.25 London Lead Company in North Pennines, 1738-50

	1738		1750	
Production				
Ore mined (tons)	620		2,800	
Lead smelted	380		1,880	
Silver (oz)	6,800		14,700	
Revenue	£5,594		£22,349	
Lead and litharge	*£3,654*	*65%*	*£18,298*	*82%*
Silver	*£1,940*	*35%*	*£4,051*	*18%*
Costs	£6,116		£22,589	
Profit/loss	-£522		-£240	
%	-9%		-1%	

3.6.3 Comparative performance.

The LLC's financial performance can be compared in each of these years with that achieved by the Blackett company, and is summarised in Table A3.26. In each of these years, the Blacketts made a handsome profit amounting to around 40% of revenue. This is flattered in each year by the sale of old stock, so underlying profitability was probably closer to 30%. However, in 1738 the LLC operated at a loss of nearly 10% and matters were not much improved 12 years later. Their operations had grown greatly in size but the company was probably still trading at a loss.

[1] From a later copy of these papers in the hands of Pete Jackson of the Nenthead Mines Conservation Society.

Table A3.26 Lead profitability 1738 and 1750 (rounded): Blackett and LLC

	Blackett			LLC		
	Revenue	Net income	Margin	Revenue	Net income	Margin
1738	£22,250	£9,400	42%	£5,600	-£500	-9%
1750	£20,500	£8,100	40%	£22,300	-£250	-1%

Table A3.27 shows approximate unit cost measures in lead production in the two businesses in 1738 and 1750. This analysis excludes silver production. The difference in profitability is primarily explained by the LLC's much higher cost of mining. In 1738 each ton of ore cost them £6.10 to mine, far more than the £3.50 achieved by the Blacketts. The largest single element of this is the requirement on the LLC to pay duty ore, usually at the rate of one fifth, without which the unit cost would have been £4.88/ton. This was still higher than for the Blacketts, who also had mining rights to pay in Weardale, without which their unit mining cost would have been £3.20. The LLC were evidently faced with working more difficult veins on Alston Moor and in the Derwent Valley, which could have loaded their investment costs, particularly as they embarked upon such a major regional expansion. Assuming mining rights affected each company in the same proportion in 1750, their underlying ore mining costs were much closer to each other by 1750. The smelting yields used to convert this to the cost of ore within each ton of lead were more variable and we cannot be confident they accurately capture the true yield, for one year's lead output is likely to have been fed to an unknown extent by ore delivered to the mill in the year before. Nevertheless, it seems that the LLC smelted more inefficiently than the Blacketts in both 1738 and 1750. Carriage costs were also slightly higher for the LLC had greater distances between mines and mills (11.8 miles in 1738, vs. 7.8 miles for the Blacketts, each weighted by the amount of ore delivered) and from mills to Tyneside (21.7 miles vs 21.2 miles in those years).

Table A3.27 Unit costs of principal elements of the cost of a ton of lead, Blackett and LLC, 1738, 1750

	1738		1750	
	Blackett	LLC	Blackett	LLC
Mining £/ton of ore	3.5	6.1	4.3	5.4
Smelting yield	56%	61%	62%	57%
£/ton of lead	**8.6**	**13.6**	**9.6**	**12.5**
Mining	6.2	9.9	6.9	9.5
Carriage	0.9	1.0	0.8	1.1
Smelting	1.6	2.6	1.8	2.0

3.7 North Pennines lead smelt mills

Figure 9.4 shows the proliferation of lead smelting mills in the North Pennines during the 17th century. Those presently known are listed in Table A3.28, with summary evidence for the earliest known date at which they were at work.

Table A3.28 North Pennine smelting mills in the 17th and early 18th centuries

Mill	Nat Grid ref	Dates	Notes	Sources
Dukesfield, Hexhamshire	NY 942580	1665/6 - 1835	Blackett bought site 1665	NRO 324/W.3/18/3
Red Lead Mill, Hexhamshire	NY 932574	1650s – by 1750	Bacon had woodland there 1650s	Ritschel, (1780), p.49
Blackhall, Hexhamshire	NY 932584	1629 – c.1780	Butler took lease of site 1629	NRO SANT/DEE/1/38/111a
Dalton, Hexhamshire	NY 919581	By 1676 – c.1700?	Deeds	Private collection
Hathery Haugh, Hexhamshr	NY 904568	fl 1700	Listed in rates assessment	NRO ZAL/D/78/6
Fallowfield	NY 936674	c.1650s	Mentioned in case notes	NRO 2762/X17
Birkey Burn, Acomb	NY 943659	1682 – 1760s	E.Blackett accounts	NRO ZBL 273/15
Woodhall, nr Haydon Bridge	NY 859645	1679- by 1721	Lease from Radcliffe to Jackson	TNA ADM 75/68
Plankey, Allendale	NY 796625	1673- c.1690	E.Blackett marriage settlements	NRO ZBL 261/1-2
Whitfield, Allendale	NY 800588	By 1699 – by 1811	Mentioned in Blagill lease	TNA ADM 75/68
Bishopsfieldhaugh, Allen	NY 826571	Poss 1648-1680?	Built by Pearson for mining lease	NRO 324/W3/18/3
Allen, Allendale	NY 832566	c. 1680s – 1896		NRO ZAL 56/1-3
Allenheads	NY 850464	c.1690s-1870	Poss after Carrshield decision	Finch, (2014), p.255
Smithy Haugh, Derwent	NZ 055488	1668 – by 1805		DCRO D/X 1361/1
Acton High Mill, Derwent	NY 981533	Late 17th C? –	Present by 1710	Fairbairn, (2000), pp.119-20
Feldon, Derwent	NZ 001485	1660s? - 1800+	Licence to build in 1662	DCRO D/X 654/37
Boltshope, Derwent	NY 951474	c.1700- c.1870		Fairbairn, (2000), 123
Jeffries, Derwent	NY 955480	1713-c.1821		*Ibid*, p.125
Stanhope Hope, Stanhope	NY 986413	1677 – late 18th C?	Lease to Wharton	NRO ZWN A/1 f336
Bollihope, S.Weardale	NZ 016352	By 1667 – aft 1842	Lease from Bishop to C.Wall	Fairbairn, (1996), 135
Burtreeford, Weardale	Unknown	1585-90s?	Grant to Emerson/Bowes 1585	DUL WEC.12
Burtreeford, Weardale	Unknown	1724-46	Geo Mowbray/Blackett	NRO 673/2, 672/E/1B/3
Wolsingham, Weardale	NZ 089366	By 1647 - ?	Poss c.1632 by Wharton	Kirby, SS (1971), p.170
Rookhope (Rispey)	NY 909428	1690s?- 1740	Poss built by Blackett after 1692	T. Gledhill, *pers comm*, 2013
Blackton, Teesdale	NY 989248	By 1614 - ?	Prob site of Lady Bowes Mill	DCRO D/Bo/A 945
Mickleton, Teesdale	NY 964245	By 1657 - ?	Bowes agreement with Nicholson	DCRO D/St/B2
Cockfield, Gaunless/Teesdale	NZ 134250	Late 1680s - ?	Vane deed in Cornwall RO	CY 1196/8
Blagill, Nentdale	NY 7378475	1699 – c.1789	Lease Radcliffe to Errington	TNA ADM 75/68
Nenthead	NY 784433	1736-1896	George Liddle papers	TNA ADM 79/35

The Blackton or Eggleston mill was owned by Lady Bowes, whose previous husband Sir Godfrey Foljambe, had a Derbyshire lead business and an ore hearth smelt mill near Chesterfield by 1580: Kiernan, *op cit*, pp.210-1.

Appendix 4 Blackett wealth estimates

Estimates of the material progress of the successive Blacketts provide some quantitative perspective alongside the largely narrative account of their careers and the development of the family business covered by this book. They can only be ever estimates given the varying source documentation available and the dates they cover, which do not fall neatly in line with key milestones, principally the deaths of the three Sir Williams. There are, broadly, two approaches to valuation: historic cost and market value. This appendix focuses on market valuations, for this was the basis upon which bequests and – crucially – mortgages can be assessed. The final section on asset allocation compares these with estimates of historic cost, which is explained further there.

4.1 William Blackett I - 1680

The wealth William Blackett had amassed by the time of his death is estimated mainly based on attempting to quantify his real assets by placing values on the capital employed in the business and laid out in land and secured loans. Since his will included some specific financial bequests, it can provide a limited amount of validation.

4.1.1 Asset valuation.

This is based on the known property and business interests held by Blackett at the time of his death. Most of his property was purchased just a few years before his death, and where the actual cost is known this is used, on the assumption that land value had not changed in the intervening years. Table A4.1 sets out the sources and specific assumptions associated with valuing each estate. Land was generally valued by multiplying the gross rental yield by a 'number of years purchase' that is thought to have been between 16-18 years in the late 17th century. In 1679 Sir William was negotiating to buy Killhope and Wellhope in Weardale at 16 year's purchase, but ended up paying nearer 20 years annual rental.[1] 17 years is used here where estimates are derived rental values, unless specifically stated otherwise. The Allen Valleys property consisted mainly of cottages rather than land. It is conservatively valued at just 12.5 years rental, for later valuations tended to use lower multiples for cottages than for land, often no more than 10 years.

It is particularly difficult to value the lead and coal businesses, but there are a few hints elsewhere that a multiple of annual profits was used, but reflecting the risk and volatility, a much lower figure applied than that used for land – ten times, rather than 16-18.[2] 10 year's purchase equates to a return of 10%, which seems low given the risk involved. The approach taken here is to use a multiple of 7, implying a 14.3% return, but also to add 90% of the value of estimated working capital on the assumption that this was stock that would eventually be sold or outstanding sums owed that would ultimately be collected. The 10% deduction allows for stock losses or degradation (coal did not store well) or bad trade debts.

We know of three secured loans: to Fenwick, Brandling and son-in-law Robert Mitford. Perhaps there were others now lost to us because they never led to lawsuits. Capital employed in the lead and coal businesses is derived from the estimates of fixed assets and working capital in Appendix 3 and 2 respectively. Working capital will have comprised of inventory – unsold ore, lead and coal - and receivables that formed part of Blackett's estate at the time of his death. Ten of the originally 21-23 years of the 1667 Allendale and Fallowfield lead lease obtained from Fenwick for a total of £4,050 in 1667-9 were still to run in 1680. On the assumption that its residual value reduced on a 'straight line' basis, the remaining term was worth £1,840 in 1680. Similar considerations might apply in respect of residual value in Blackett's share of the coal mining leases at Stella and Whorlton Moor (to 1685), and for lead at Greengill on Alston Moor (to 1692) but these are

[1] Clay, *op cit*, p.250; MB to John Theobald, 28 Jan 1679; MB to WB, 5 Apr 1679.

[2] In 1676 Blackett was in correspondence with a London merchant concerned about a proposal to settle coal mines upon a suitor to his daughter valued at 10 times their annual value (ie. profits) but that they were a much less certain thing than lands: Wm Rollinson to WB, 9 and 18 March, 6 April 1676: NRO ZBL 193. Richmond valued collieries at 10x annual income in the 1730s.

not included here. It is also worth noting the wealth he had already distributed to his children, mainly during the 1670s, estimated here at around £19,000.

Table A4.1 William Blackett I's assets at death

			Source/ notes
Total	£69,000		*Rising to £87,830 including earlier disposals*
Land	£19,000		28% of total
Winlaton		£9,860	Cost in 1674: NRO ZWN A/1 f320-3 + undiscounted £1,666 payable at deaths of Selby heirs. Some of this (c.£1,000?) will represent value ascribed to coal mining rights.
Woodcroft		£1,600	Cost £1,584 in 1676: ZWN A/1 f317, and rounded here.
Dukesfield		£1,530	Farmland let for £104 in 1711 per JW rental (section 4.2 below), and set at a lower rate here of £90/year assume at 17 years purchase.
Killhope/Wellhope		£1,600	Cost in 1679: MB to WB, 2, 5 Apr 1679.
Greyfriars		£2,700	Assume worth £150 /year (ie. over 3 times rental value of Tyne bridge house – see below) and at 18 years purchase given location in central Newcastle
Tyne Bridge House		£975	£40/year in 1711 and other property on The Close, valued at £25/year in 1711, all @ 15 years
Allen Valleys		£750	Allenheads, Coalcleugh and Wolfcleugh tenements let for £83/year in 1718 but assume just £60 in 1680 at 12.5 years purchase: Brumell to Ord 14 Apr 1719, NRO 324/W3/18/1.
Secured loans	£7,000		10%
Mitford		£2,500	In 1674: NRO 324/W3/19.
Fenwick		£2,000	In 1674: NRO 2762/E/X16.
Brandling		£2,500	In 1676/7: NRO 324/ M1/1-2.
Lead business	£31,600		46%
Underlying business		£28,000	7x net annual income, which by 1680 was probably around £4,000.
Working capital		£3,600	90% of £4,000 working capital (roughly pro rata with that estimated in 1675-6 (Appendix 3.5.2.2) allowing for lower production by 1680
Coal business	£11,400		17%
Underlying business		£8,400	7x net annual income, which by 1680 was around £1,200 (Appendix 2)
Working capital		£3,000	90% of £3,300 working capital (assumed at 33% of revenue - Appendix 2.5.).
Earlier disposals	£18,830		
Edward		£9,430	Estd £7,830 cost of 'Westwater' estate purchases 1672-6 (NRO ZBL 1/58-94) settled by marriage + Fallowfield lands and cottages, let at £106/year in 1685: NRO ZBL 273/10, at 15 years = £1,600 (rounded).
Michael		£6,000	Under marriage settlement, per WB will 1680.
Christian		£1,400	£1,000 per 1669 marriage settlement: R.Welford, 'Local Muniments', *AA* 3rd ser, V, (1909), pp. 115-6, augmented in 1674 with £400: NRO 324/W3/19.
Elizabeth		£1,000	Assume 1664 marriage settlement same as Christian's, augmented by 1680 will (see below).
Isabella		£1,000	Assume same as sisters, augmented by 1680 will.

Other assets can also be presumed but are missing from this list. Nothing is allowed here for the value of his residual trading business, yet Blackett shipped 15,000 tons of coal in 1679. Neither is there any provision for the value of any ship shares he held, nor of his personal effects – the household stuff, plate, jewels, coach and horses mentioned in his will - or cash at hand, all of which could together easily have been worth thousands. Unfortunately, his will is not accompanied by an inventory that would give further detail on these personal effects, loans extended, net book debts and the residual value of his leases.

As such, the total as calculated here might underestimate his wealth at death, but against it is possible that some of his recent purchases were supported by mortgages or other loans perhaps unknown to us because they were later paid off. The only one explicitly mentioned in his will was £1,666 13s4d owed to the Selby heirs at Winlaton on their death, included in the asset value of Winlaton but not deducted from the gross assets in view of the lack of any valuation for trade, shipping shares and personal effects.

On balance, the headline figure in Table A4.1 of £69,000 probably gives a rough idea of William I's wealth at death. Earlier disposals will have added some £18-19,000 to this figure. If these are included, a fuller measure of the wealth he had generated by the time of his death was around £88,000.

4.1.2 Will provisions.

William Blackett I's original will of March 1680 is amongst the many miscellaneous Allendale Estate boxes in the Northumberland Archives at Woodhorn (NRO 2762 Box C74), and the Durham probate court copy is at DPR1/1/1680/B16. A transcript of the abstract found amongst the Trevelyan papers, also at Woodhorn (NRO ZWN A/1/315) is available in Dukesfield Documents. A financial summary is given in Table A4.2.

His specific lump-sum bequests add up to around £6,000, and ongoing annuities of just over £2,000/year. His daughters, son-in-laws and their offspring benefited to the tune of £3,000 outright and £160/year, although in the case of Christian Mitford this was to come out of the loan security offered by her husband Robert in 1674. He also left £100 each to Edward and Michael's wives and Edward's two young daughters. Extended kinship ties were reflected in the £20 per year left to brother-in-law Matthew Kirkley, suggesting some mixture of gratitude over decades working closely with each other in Newcastle and hope for continued co-operation with Blackett's sons. His deceased brothers' children were to receive £120 between them, although the £50 for Edward's three children was to be paid from money owed to Blackett by Edward's Dutch widow and eldest son. Two of his Kirkley cousins, sisters Anne Simpson and Alice Butler, were given £10 and £5 respectively and £10 was bequeathed to Margaret's 'sister Maddison', originally Jane Cock. Several friends, the 'worthy' and the 'trusty', were left 5 guinea tokens and each servant £1.

There were other bequests with financial implications but of unstated value, especially those left to William II: most of the land, lead and coal business (other than Fallowfield), and personal estate. However, this was expected to generate funds to pay the other bequests, most importantly the £500 'estate of inheritance' of oldest brother Edward (included in the £2,000 given above). Placing an overall value on the implications of William I's will is difficult but the simplistic approach taken here and summarised in the lower part of Table A4.2, is as follows. The annuities can be divided into three categories.

1. Life annuities: these added up to £1,030/year, to Dame Margaret, son Michael, daughter Elizabeth and brother-in-law Matthew Kirkley. In addition to the sum granted to each of them, the calculation of a present value in 1680 requires a discount rate (assumed here at 6%, the then legal rate of interest) and estimated duration, ie. lifespan. At the time this was probably based on no more than William I's hunches regarding each individual, if even that, although the London-based mathematician John Graunt had published systematic observations related to age-specific mortality in 1662. Rough estimates here are derived from the age-specific partial life tables given in work on population history by the Cambridge

Table A4.2 William Blackett I's will – cost of main provisions

	Income	Capital	Source/ notes
Widow Margaret			
Newcastle property	£50		Hathericks Mill, Stables etc on The Close – assume £50/year
Winlaton	£300		To be produced from Winlaton, managed by William
Personal estate	£100		+ her own personal effects at time of marriage
Edward			
Estate of inheritance	£500		Assuming 18 years purchase needed to buy £500/year
Fallowfield			Assume 40% of lead fixed assets and residual lease term
Michael	£400		To be produced from Winlaton, managed by William
William II			
Lead business			Assume 60% of fixed assets, and all stocks/working capital
Coal business			As given in Table A4.1.
North'd & Weardale	£280		Based on 1711 rentals for Dukesfield, Woodcroft, Allenheads, Killhope
Greyfriars, Tyne Bridge	£178		Estimated rental value as above, less £12/year to charities
Residue of estate			After discharging debts and legacies, as executor
Elizabeth Davison			
For children's education	£160		Annually for ten years
Lump sum		£1,000	At husband's death or to children as she wills it
Christian Mitford	£60		Though charged to security for £2,500 loan to husband
Matthew Kirkley	£20		
Charity	£12		
Specific provisions			
Funeral		£1,000	
Sons/daughters-in-law		£900	
Grandchildren		£2,500	Mitford £1,000 to be forgiven from previous loans
Nephews/nieces		£250	
Sarah Rogers		£200	One of widow Margaret's daughters. Mary was not mentioned.
Miscellaneous		£111	
Specific provisions		£5,961	
Fallowfield lead - Edward		£11,500	Assume 40% of lead business value
Recurring commitments	£2,000		Excluding Christian's £60 (see above)
Life annuities	£1,030	£11,000	Estimated present value given ages and 6% discount rate
Perpetual annuities	£512	£9,250	For Edward and charities- assume at 18 years purchase
Funded income	£458	£9,000	William – est'd gross rent from known properties (incl Greyfriars)
Total		**£47,100**	

Group.[1] The ten year provision for the education of Elizabeth's children is discounted in the same way, and included in the rounded sub-total of £11,000.

[1] P.Kreager: 'New Light on Graunt', *Population Studies*, (1988); E. Wrigley, R.Davies, J.Oeppen and R.Schofield, *English Population History from Family Reconstitution 1580-1837*, (1997), Figure 6.16, p.287.

2. Perpetual annuities: principally Edward's £500 'estate of inheritance', and also the £12/year to the parish charities. Since these were explicitly tied to landed property they can be valued at the prevailing yield on land, ie. the '18 years purchase' used above.

3. Funded income: the actual annual income from estates given to William II, less the charities provision from Tyne Bridge House.

These categories add up to about £30,000. To this must be added the £6,000 of specific bequests, and the Fallowfield fixed lead assets also given to Edward. Taking the latter at 40% of the overall lead business, which might be too generous, since Appendix 3 shows that Fallowfield production was much lower by the early 1680s, this would be about £4,000. This gives a total commitment under William I's will of just over £47,000. To the extent that this can be compared to the asset view in section 4.1 above, the remainder of about £22,000 would effectively become part of William II's inheritance. The implied incentive in the will was that the better William II could drive the business the higher his personal return would be.

4.2 William Blackett II - 1705

To estimate William II's wealth at his death we rely heavily upon a 1711 rental in John Wilkinson's hand (see Table A4.3). It was probably drawn up at the time William III came of age. Although dating to six years after William II's death it is unlikely that the gross rental income it documents had changed greatly in the intervening years.[1] Indeed, the note attached to the first three entries – for Hexham, Weldon and Wallington - forecasting increases because of recent improvements suggests that the amounts shown had been at the stated levels in the recent past. Wallington had, however, apparently already been 'improved' since its purchase in 1690, when its rents grossed £950, but it is assumed here that the impressive 25% rise to £1,184 by 1711 had been achieved in the lifetime of William II as he sought better cover for the £2,000 annuity to the Fenwicks.[2] The same consideration applies to Hexham, part of that same 1689 purchase from the Fenwicks. A rental of 1682 showed income of £529 from Hexham, to which might be added £150 for the adjacent Anick Grange lands (assessed at £176 in 1723), adding to a rounded £700/year.[3] The 1711 figure included Gunnerton and Fenwick, possibly worth around £400-450, without which Hexham and Anick Grange would have accounted for £770-820. Although the gross rental value of Kenton in 1689 is unknown, it was presumably significantly less than the £530 stated for 1711, for otherwise the estate would have cost much more than £6,000.[4] As with Wallington and Hexham, the increase to the rent level shown in 1711 is assumed to have been achieved in William II's lifetime.

The rents shown have been extrapolated to an estimated value in the fourth column of Table A4.3 (not included in the original document), on the assumption that land values had increased from 16-18 to 20 years' purchase, and rounded down to the nearest £1,000. Although some of the estates might have been assigned inflated values through this arithmetical exercise there are probably some underestimates. Short Thorns in Weardale is valued based on the rental income alone, making no allowance for the substantial agent's dwelling of New House. Likewise, the Wallington valuation does not include the Hall. A notional rent is not given in the rental for Greyfriars and its value is given here at £5,000, to reflect major improvements to the mansion in the 1680s or 1690s. The total has itself been rounded down to £78,500. This might represent the upper end of a range that starts at £72,000 – roughly equivalent to 19 years purchase, to give a more conservative view of the increase in land value – but, as with William I, personal effects are excluded, so £78,500 is used here.

The rental lists but does not value the coal and lead businesses. The same valuation approach is used as for William I: 7x annual profits and 90% of estimated working capital. Profits were much lower in 1705 than in 1680 (perhaps £1,200/year from lead - £1/ton on 1,200 tons - and perhaps just £500 from coal – see Figure

[1] Filed with the 1737 estate survey: NRO 11603/Box 8.
[2] Rental of Wallington, Feb 1751: NRO 11603/Box 16.
[3] Miscellaneous Hexham manor documents NRO 11603/Box 5 or 16.
[4] At the 16-18 years rental value suggested by Clay, *op cit*, p.250 Kenton was worth around £350/year in 1689.

15.1) extrapolated to a total of £10,920 for the lead business and just £6,200 for coal. Added to the land valuation of £78,500 this gives a gross total of £95,600.

From the gross total two deductions must be made: £15,350 for known debts and £19,500 as the approximate present value of outstanding liabilities to William II's step-mother Lady Margaret and to Lady Fenwick in respect of the Wallington/Hexham estate. As far as the latter are concerned, the discount rate was now 5% rather than 6% and it is possible that William II or his advisers were aware of the sophisticated advances in life expectancy calculation developed by the astronomer and scientist Edmond Halley in the 1690s, one of the uses of which was explicitly to value annuities. Halley's adjusted life tables have been used here to estimate the present value of those annuities.[1]

Table A4.3 1711 Blackett estate rental

	Steward	rent	[Estd value]
			£78,500
Rents will be more, some of the lands being lately advanced:			
Hexham, Aynwick Grange, Gunnerton, Fenwick	Mr. Carr	£1,220	£24,000
Weldon	Mr. Carr	£255	£5,000
Wallington, Cambo, Rothley &c	Mr. Carnaby	£1,184	£23,000
Buildings Repairs Sesses and Taxes and Steward charges to be deducted. Loss by bad tenants to be considered:			
Kenton	Robt Todd	£530	£10,000
Winlaton (1/4 share)	Jno Robinson	£214	£4,000
Woodcroft	Mr Featherston	£74	£1,500
Steel [Hexhamshire]	Mr Featherston	£27.5	£500
Dukesfield & Slaley	Mr Featherston	£104	£2,000
Allenheads, Coalcleugh, Killhope, Welhope & c	Mr Mowbray	£148	£2,500
Short Thorns in Weardale [New House]	Cuth Peart	£15	£300
In Rookhope	Mr Featherston		
In ditto	Mr Featherston		
Sidgate lands [Newcastle]	'My Lady'	£20	£400
House land [sic] in Newcastle			
In Pilgrim St			*[£5,000]*
Tyne Bridge end – Jona Jeffreyson &c		£40	£1,300
Coach cellar in The Close – Alderman Atkinson		£11	incl
Cellar & Lofts at foot of Long Stairs – ditto		£5	in
House and Stable at foot of Tuttle [Tuthill] Stairs	untenanted	£9	above
Lead mynes – Allenheads, Coalcleugh, Weardale			
Kenton Colliery, ½ freehold, ½ leasehold			
Bpp & Dean & Chapter Colliery ½ [Heworth/Gateshead]			
Winlaton Colliery ¼ part			

[1] Bellhouse, *op cit*, p.830. Given the widening market in financial products it would be surprising if this innovation was not adopted in subsequent decades. One or two examples of such valuations which can be shown to be faithful to the use of Halley's tables appear amongst the Blackett papers. Wilkinson valued Dame Julia Blackett's £800 annuity at £8,000 in his 1711 rental, which is reasonably close to the £8,600 which can be computed using Halley's rates adjusted for the reduction in the interest rate from 6% to 5%.

Stella Grand lease colliery 1/12 part

This leaves a net sum of about £61,000.[1] The assessment of his father's will in section 4.1 above implies that William II was left around £21,500, although this was based on projected rather than actual annuity values. Adjusting these for the actual out-turn probably saved about £1,500, which effectively fell back into William II's inheritance as the residuary legatee, taking his total sum to about £23,000. This means he increased his inheritance by a factor of 2.6 in 25 years, although a small amount of the growth (possibly £3-4,000) might reasonably be ascribed to the presumed increase in land valuation multiples on the land bequeathed by his father. While an impressive sum, his estate was encumbered with future liabilities of nearly £40,000 in lump sum provisions and with the annuity bestowed on Lady Julia. This is valued at £9,700 on the same principles as the existing annuities. Deducting the estimated present value of these bequests, £11,000 was left to his son William III, significantly less than William II's own inheritance 25 years earlier.

4.3 William Blackett III - 1728

Soon after the death of William Blackett III Joseph Richmond drew up an inventory of the estate from which a snapshot of assets and liabilities can be drawn.[2] These are summarised in Table A4.4 below. The most significant omission is any valuation of the land, lead and coal mining assets. These omissions are remedied as follows.

1. Land. Rentals of the landed property are available for 1723 and 1737. The former was drawn up to document the security given for the mortgage obtained from Thomas Guy.[3] It does not cover the entire estate, Winlaton being the most obvious and most material absence, but its gross rental was £214 in 1718.[4] Adding this in gives a gross total rent of £5,600 for 1723. Since it was submitted in support of a mortgage application it might have been overestimated. Even so, the equivalent gross sum in a detailed rental drawn up by Richmond in 1737 (see section 4.4 below) was £6,350. It is impossible to say how much of the increase over the intervening 14 years took place before William III's death in 1728, but it is reasonable to suppose, given Richmond's hard-driving approach elsewhere, that he acted vigorously in this area from 1728 onwards. On a *pro rata* basis, the gross rental income in 1728 would have been about £5,860. In the early 1730s Richmond was valuing most of the land at 25 years purchase and, even with most of the housing valued at just ten years, the weighted average was 24.5 years. Combining these two sums gives a valuation of the land at £143,000 in 1728. £5,000 is added for Greyfriars, as in 1705.

2. The lead business was far more profitable by the late 1720s thanks to the revival in the lead price. To judge from the returns achieved by the early 1730s (see Appendix 3.6.1) a reasonable estimate of annual profits in 1727-9 would be about £2,500. Using the multiple of 7 once again this values the business at £17,500. Richmond's inventory allows a snapshot to be extracted of the working capital balance as of 1st January 1729. The outstanding balance of ore, lead, litharge and silver stocks and sales was around £9,200. Against this, however, the long overdue pays to the mills and mines added up to £11,400. Consequently, what was effectively a forced interest-free loan from the miners meant that the working capital balance was effectively a negative £2,200. No additional working capital allowance is included in the valuation.

3. Coal mining assets are assumed to have been 'distressed' given the parlous state of the business, but the mining rights owned at Kenton and Winlaton and the residual term of the Heworth/ Gateshead leases had some market value. In 1737 they were let for £790/year and the same sum is used here at '7 years purchase', or £5,530, and £900 is allowed for the value of working capital.

[1] In early 1706 John Ord was owed £2,800, £1,000 was still owed on the Kenton mortgage and £9,600 to his Davison relations, some of which might have been inherited from William I. A further £1,950 was lent by Ord in June 1706 to cover 'a debt due by Judgm.t from Sr Wm Blackett Barr.t Due to Mrs Mary Ann Barr': John Ord in account with John Wilkinson 20th June 1706: NRO 324/W.3/18/1.
[2] 1728 estate valuation: NRO 11603/Box 16.
[3] LMA H09/GY/A/8/1 Guys Hospital Minutes.
[4] 1718 rental sent by Thos Brumell to John Ord, 14 Apr 1719: NRO 324 W3/18/1.

The inventory lists other assets of around £7,000, giving an overall gross total of £172,000. The debts that offset this are divided in Table A4.4 between those already outstanding and those valuing future liabilities.

- Present debts. The £77,000 Guy's mortgage was the most important of these, but other outstanding liabilities, bonds, unpaid bills in Newcastle and London, including for William III's ostentatious funeral, added a further £7,600. Further invoices and other accounts totalling £3,300 turned up over the next few years and this has been added to the total in Table A4.4.

- Existing liabilities: an annuity owed to Blackett's cousin Robert Mitford (£400) has been given a present value on the same basis as before (£5,130). Two of William III's sisters remained unmarried at the time of his death, Barbara and Isabella, to whom £6,000 dowries would be owed at some point, under the terms of William II's will. In the meantime they were to continue receiving their £200/year annuities, but they are disregarded here as a counterweight to the possibly onerous liability ascribed to the widow and cousin's annuities.

The total liabilities as calculated here add up to around £105,000. Of this figure £61,500 (59% of the total) dated back to the time of William II or his will bequests. The balance of £43,500 was of William III's own making. The net balance of his estate was perhaps just under £74,000, only half of the amount asserted by Walter Calverley in 1729.[1] In section 4.2 above the projected share of William II's assets left to his son and heir was £11,000. However, this residual sum came after the deduction of about £29,000 for the then present value of existing and future annuities. The largest single constituent of this total was just under £18,000 in respect of Lady Fenwick's £2,000/year from Wallington. At the age of 54 in 1705 she might be presumed to have a further 12 years to live. In fact she died just three years later. In hindsight the actual 1705 value of the 3 annuities can be set at £16,750. On this basis the residual estate that devolved to William III was £23,000. His net worth can therefore be said to have risen by up to £51,000 in 23 years, slightly more than tripling.

Table A4.4 Summary of William III's net assets in 1728

Land	£148,000	See text
Lead	£17,500	
Coal	£6,400	
Other assets	£7,000	Incl household goods (£2,785), unpaid Barbara Villiers dowry (£1,267), miscellaneous loans and bonds (£3,000).
	£179,000	
Existing debts	£88,000	Guy's mortgage (£77,000), unpaid bills and bonds
Future liabilities	£17,200	Present value of existing annuities and dowries for two unmarried sisters
Net balance	£73,800	rounded down

Before revising our opinion of him, however, the increase in land multiples needs to be taken into account. This was a windfall brought about by changes in economic conditions nationally. The value of William III's land in 1728 was roughly double that at the time of his father's death (allowing for the purchase of Ryal by William III). Like-for-like rental income had been increased by around 40%, which largely relied upon active management by the agents. Had the rents been left unchanged, the increase in the valuation ratio – from (say) 20 to 25 years – would have raised the overall land value by 25% alone, worth perhaps £20,000 to the headline valuation. A similar case can be made that the dramatic recovery in the lead market in the 1720s

[1] In his petition to the Lord Chancellor to be given leave to marry Elizabeth Ord/Blackett, Calverley claimed that the estate was worth £150,000 above encumbrances: NRO ZWN C1/1/19. As can be seen in Table A4.4, the £150,000 is more likely to have been the gross value of the landed estate alone.

lifted the value of the lead business, adding perhaps £7,000 to a market valuation of its assets between 1705 and 1728 largely thanks to external factors. Without these two elements of luck, William III's net wealth at the time of his death would have been closer to £47,000 than the £73,800 calculated above, an increase of £22,000 – about double what he had started with. This was actually less than the fruits of the work of his agents to increase like-for-like rents by around £30,000 alone – the 40% increase noted above.

A much higher share of William III's estate passed into the hands of his nephew and successor, Walter Calverley, than had been the case in the previous two generations. While William II had inherited roughly a quarter of his father's net assets in 1680 (including earlier disposals) and William III about 30% of William II's, Walter was left with nearly 90% of William III's, about £67,000. An immediate bequest of £500 to Lady Barbara and an annuity that can be valued at around £6,500 were the only material financial provisions in William III's will that did not devolve to Walter.

Table A4.5 Blackett wealth in 1737

	Gross Rent	Yrs	Value	Notes
Total	£7,742			
Wallington & Sweethope	£2,186	25	£56,600	£2,000 added to capital value to reflect additional work on Wallington Hall in 1730s
Fallowlees	£80	25	£2,000	
Ryal, Ingoe & Kearsley	£382	25	£9,550	
Hexham & Anick Grainge	£1,296	25	£32,400	
Fenwick	£460	25	£11,500	
Gunnerton	£190	25	£4,750	
Welton	£340	25	£8,500	
Kenton	£527	25	£13,100	
Winlaton (1/4)	£266	21	£5,500	
Dukesfield	£191	25	£4,800	
Allenheads, Coalcleugh	£135		£2,500	Assume same value as 1728-9
Killhope & Wellhope	£76	17	£1,300	
Woodcroft	£80	25	£2,000	
Weardale -other	£79	22	£1,700	Short Thorns, Wolsingham, Redburn, Lintzgarth
Newcastle	£46	28	£6,280	Rental excl Greyfriars (£5,000 added)
West Ord, Lucker, Ilderton	£619	25	£15,000	Elizabeth Orde/Blackett's estate
Land, total			£177,500	Rounded
Personal effects?			£3,000	Based on 1729 inventory value
Lead			£23,900	£4,200 profits x 7, as before, + 90% of w/c
Coal	£790	10	£5,500	See section 4.3 above
			£210,000	Rounded
Existing debts			£79,000	Wm Blackett's unpaid bills had been settled
Future liabilities			£16,800	Mitford's annuity ceased in 1734, and Barbara Villiers' can be valued at £5,800. £1,000 of Barbara's dowry was paid. Isabella remained unmarried until the 1740s.
Net balance			£114,000	Rounded

4.4 Walter Blackett's net worth - 1737

Joseph Richmond compiled another detailed estate survey in 1737, which has survived amongst miscellaneous Allendale Estate documents and recently deposited at the Northumberland Archives in Woodhorn.[1] It therefore provides the basis for a measure of Walter Blackett's wealth at the closing point of this book and is summarised in Table A4.5 below. The gross rental income is scaled based on valuation multiples given in an undated single sheet found within the 1737 ledger, possibly dating from 1734-5, shown in the column 'Yrs'. Notes regarding specific line items are given in the last column.

To compare the value of land on a like-for-like basis between 1728 and 1737 the £15,000 ascribed to the West Ord estate near Berwick-upon-Tweed must be removed, together with the £2,000 arbitrarily estimated as the value of Wallington house improvements in the 1730s. This leaves £160,500, which compares to the £148,000 estimated at the death of William III. Since the valuation multiple is assumed to have been unchanged between these two dates, the 8.5% improvement is explained by increases in gross rental values, as discussed in section 4.3. The lead business is valued more highly in 1737 because of higher profitability and the outstanding debt burden was reduced by about £10,000. Taken together and adding back in the West Ord estate, a net balance of £114,000 is calculated as Walter Blackett's net wealth, (or £99,500 without the Ord estate) a marked improvement thanks primarily to the enhancement of his estate and lead business through the work of Joseph Richmond and the agents.

4.5 Asset structure 1680-1728

The previous sections show a marked rise in net wealth in the hands of Walter and his antecedents between the death of William I and the mid-1730s, less than 60 years later. Landed assets account for the vast majority of the increase. The gross market valuation of land and other property rose from about £19,000 in 1680 to nearly £80,000 in 1705 –and this after the distribution of some assets to William II's siblings - to £148,000 just 23 years later - and to £178,000 within a decade. This asset class accounted for just under a quarter of William I's gross assets at his death to four-fifths or so of his grandson's less than half a century later, mostly because of the major property purchases by William II after 1689. The Blacketts apparently retreated to the land having made their money in trade and industry, conforming to the stereotype.

Table A4.6 Blackett gross asset distribution 1680-1728

	1680				1705			
	Mkt Value	%	Hist Cost	%	Mkt Value	%	Hist Cost	%
Land	£19,000	28%	£19,000	37%	£78,800	82%	£58,300	63%
Lead	£31,600	46%	£15,140	30%	£11,000	11%	£16,750	18%
Coal	£11,400	17%	£9,650	19%	£6,200	7%	£17,600	19%
Other	£7,000	10%	£7,000	14%	-	-	-	-
	£69,000		£50,800		£96,000		£92,650	

	1728				1737			
	Mkt Value	%	Hist Cost	%	Mkt Value	%	Hist Cost	%
Land	£148,000	83%	£67,750	73%	£178,000	81%	£83,250	75%
Lead	£17,500	10%	£11,600	13%	£34,000	15%	£19,000	17%
Coal	£6,400	3%	£6,100	7%	£5,500	3%	£5,500	5%
Other	£7,000	4%	£7,000	8%	£3,000	1%	£3,000	3%
	£179,000		£92,450		£220,500		£110,750	

[1] NRO 11603/Box 8.

However, a few other considerations must be borne in mind.

Firstly, the proportionate share of assets of different classes is greatly affected by market valuations. Land appreciated greatly in value during this period, whereas the lead and coal trades were volatile and often precarious. The effects of this can be seen in Table A4.6 above, which compares market valuations with an estimate of the book value of the assets at each date based on their historic cost. The approach here is to use the actual or (more usually) estimated asset purchase prices, deducting depreciation based on the time elapsed between purchase and valuation date, but adding in the cost of replacement investment. For example, the estimated investment in coal mining shafts and waggonways at the valuation date will derive from the initial cost less a deduction for depreciation but adding in the cost of adding new shafts and levels as work continues. The assets are estimated based on the calculations undertaken in Appendices 2 and 3. Where mining rights were owned they are assumed to have fully depreciated over 30 years.

Land is assumed not to depreciate, so is shown at the original purchase cost. Where rents rose other than through the impact of rising demand for agricultural produce alone it is assumed further investment has taken place, such as for enclosure, hedging, draining and farm building. An allowance has been added on the assumption that such investment generated a return of 10-12%, as suggested by Clay.[1] The historic cost basis is helpful when considering how overall investment has been allocated between different types: the lead and coal businesses and landed property and is the correct approach to be used to calculate returns on capital as discussed in appendices 2 and 3.

Table A4.6 shows significant differences between historic cost and market valuations. The general appreciation in land valuations is seen in the higher share of landed assets under the latter approach compared to the former. The volatility of lead and coal business valuations is seen in their relatively buoyant market value in 1680 and 1737 compared to the historic cost of the underlying assets and the opposite in the intervening years, especially in 1705, when William II was struggling with poor lead and coal markets. In that year their business value dragged his overall valuation below the gross historic cost of the assets and the comparison would have been far worse but for the rise in land values. There was still a marked rise in the share of assets accounted for by land owned by the generations that succeeded William I, but not to the dominant share (80%+) based on market valuation.

Secondly, the forgoing analysis is based on gross asset distribution, ignoring any borrowings. In practice many of the property purchases were backed by mortgages or other loans, either directly or indirectly, and deducting these from the gross landed assets might give a more realistic view. William II's gross assets shown in table A4.3 are reduced from £72,000 by £6,000: at Kenton £1,000 remained unpaid and it is assumed that about half of the £9,600 owed to his Davison cousins supported purchases of land such as at Fallowlees. By the time of William III's death a great swathe of his estate provided the security for the Guy's mortgage of £77,000 and the Ryal estate supported Lady Barbara's annuity. The £148,000 of gross assets must therefore be reduced by £86,000, leaving a net figure of £62,000. It might be more logical to ascribe some of the loans to the industrial assets (and there *were* other borrowings) but only land was certain enough, to paraphrase Nicholas Barbon, to provide secure collateral.[2] On this basis, land will have represented a smaller proportion of net assets at the dates shown, particularly in 1728.

Thirdly it must be remembered that the return on land was typically low, particularly as yields fell with the trend in interest rates. Furthermore land valuations were taken from gross rents. The net sum could be 20% lower after deductions for repairs, uncollectable arrears, land taxes and agents' salaries. A rough estimate for 1680 is that net rent contributed around £750 to William I's income in the year he died, a net return of about 4%. The equivalent in 1728 was probably little different after further deductions of the Guy's interest payments

[1] Clay, *op cit*, p.250. For Kenton, so close to Newcastle, it is assumed that half of the rent rise seen between 1690 and 1705 was based on increased demand and land investment is assumed to have supported the other half of the rise.

[2] The economist quoted in 1690: Turner, Beckett and Afton, *Agricultural Rent, op cit*, p.217.

(£3,465) and Lady Barbara's £450 annuity. Conversely, profits from lead represented much higher returns on the assets employed in 1680, 1728 and 1737 and contributed a large share of income, as did coal too in 1680. But they were much more volatile compared to the relative stability of land rent, so the purchase of land was a rational hedge against too much variation. It did not necessarily reflect a flight from industry, but a rational buffer or hedge against commercial volatility.

Appendix 5 The Wallington Portraits

Despite the inscriptions added to the portraits of many members of the Blackett family at Wallington Hall their true identification remains highly problematic. There is only minor variation in the writing style and colouring of the inscriptions, and one, on the portrait said to be of Anne, the youngest daughter of William II, includes her date of death, 1783. It is quite possible that they were all added only after 1791 when Sir John Trevelyan, later the 5th baronet, was given the estate on his marriage, by his father, 4th baronet Sir John, who had inherited Wallington from his uncle Sir Walter Blackett in 1777. The 4th baronet does not seem to have had much interest in Wallington. By contrast, the 5th baronet and his wife Maria loved the place, and Maria was the favourite daughter of Dame Jane Wilson, one of nature's intrepid collectors and classifiers.[1] The inscriptions were certainly present by the mid-1820s, when Hodgson described Wallington.[2] If they date from the 1780s or 1790s, to help Wallington's new owner identify his ancestors, no household members or living relations could possibly have recognised those shown in the earlier portraits. Sir John, 4th baronet, was born in 1735, the son of Julia Calverley, Walter's sister. He grew up at Nettlecombe in Somerset but possibly met some of his Blackett great-aunts, the daughters of William Blackett II, off and on since his childhood. This might give us some confidence regarding the inscriptions of their portraits, but even here there are problems.

Diana, the wife of Sir William Wentworth is portrayed both at Wallington (Fig 1) and Bywell Hall near Stocksfield in Northumberland (Fig 2). The Bywell portrait has descended through generations of her Wentworth and Beaumont family, so it is reasonable to suppose that this identification is accurate. However, it is not at all clear that they are of the same lady, although the varying artists' styles might be at work.

Diana Blackett 1702-42 Fig 1 Wallington Fig 2 Bywell Hall

Even within Wallington Hall, inscriptions on separate portraits purporting to be of Julia Blackett (1685-1736), Sir Walter's mother and the grandmother of Sir John Trevelyan, 4th bart, show strikingly different sitters (see Figures 3 and 4). Another portrait of Julia Calverley, nee Blackett remains at Esholt Hall (Fig 5), her home for

[1] Hugh Dixon, the National Trust's northeast regional curator until 2011, *pers comm.*
[2] J.Hodgson, *Hist Northumberland, op cit*, pp.275-6.

the last thirty years of her life after marrying in early 1707. It shows a far closer resemblance to the sitter in Fig 4 than Fig 3. The identification of Fig 3 with Julia Blackett/Calverley consequently seems highly suspect.

Julia Blackett 1685-1736: Fig 3 Fig 4 Both at Wallington Fig 5 Esholt Hall

If such doubts accompany the given identification of the Blackett daughters in their portraits, women who mostly died within living memory if the inscriptions date from the 1780s or 1790s, those given on the earlier portraits must be regarded with much greater scepticism. For these, in the absence of clear evidence of sittings and definite artist attribution –in most cases- we are left with speculating based on inference.

The portrait claimed to be of William I (Fig 6), and said to have been painted by John Riley (d.1691), is one of a pair with Fig.8 given the similarity of the frames. Since he is shown in armour it is possible that the portrait was commissioned after he was created a baronet by King Charles II in December 1673. His sons Edward and William II were of course also knights by the mid-1680s. However, the figure portrayed appears very similar to the man in another –unidentified- portrait (Fig 7), also one of a pair, with another lady (Fig 9). William II was married only once. Edward was married three times, but since he had his own house at Newby in Yorkshire and later descendants, it seems unlikely that two separate portraits of him with two of his wives would have come to Wallington. William I appears more likely to have been the sitter. Since, according to Edward Blackett, his mother (Elizabeth nee Kirkley) was afflicted with '*a great dizziness … trembling and shakeing*' for '*some time*' before her death in April 1674 -only 4 months after her husband received his baronetcy- it seems more plausible that William's second wife Margaret Rogers is portrayed in Fig 8.[1] If the pair of portraits was created at around the time of their marriage in 1675, to adorn Greyfriars, purchased at around the same time by Blackett, he would have been 54 and she 44, which seems plausible. This could leave Fig 9 to be identified as Elizabeth Kirkley alongside her husband depicted at an earlier date – perhaps wrapped in red to signify his elevation of the ranks of the Newcastle aldermen in 1665 (when he would have been 44 and she 48). Hodgson reported in 1827 that the man depicted was 'supposed' to be the first Sir William.[2] It is difficult to attach any certainty to these identifications, but they are arguably more credible than other hypotheses.

[1] Edwd Blackett to John Wilkinson, 29 March 1711: NRO ZBL 189.
[2] Hodgson, *op cit*, p.275.

Fig 6 William Blackett I? Fig 7

Fig 8 Margaret Rogers? Fig 9 Elizabeth Kirkley?

The National Trust's notes on the portraits shown in Figs 6 and 8 speculates that they might show Sir Edward Blackett, who inherited his father William's baronetcy in 1680, and his second wife Mary nee Yorke. However, a comparison between these and the portraits of Edward (in his descendant's collection), and –especially- of Mary Yorke (likewise), Figs 10 and 11 respectively, suggests that this is unlikely. William Blackett I therefore appears more likely to have been the sitter in Fig 6.

Fig 10 Edward Blackett

Fig 11 Mary Yorke

Slightly greater certainty accompanies the identification of Figs 12 and 13 as William II and his wife Julia Conyers. Although the present oval frames were probably of a later date, they do seem to represent a married couple. The wig style could well imply a late 17th or very early 18th-century date, which would be consistent with the likely ages of William and Julia as depicted.

Fig 12 William Blackett II?

Fig 13 Julia Conyers?

Fig 14 Julia Conyers?

The lady in Fig 13 is identified as Barbara Villiers, who married William III in 1725. She was, however, just 19 at the time, and only 22 when her husband died three years later, and even the later age seems improbably young for the lady shown in Fig 13. Another portrait at Wallington shows clearly the same lady (Fig 14) and identifies her as Julia Conyers instead. Although we cannot rely upon this inscription any more than for the others, it is perhaps worth noting a similarity between her features and those of Julia Blackett/ Calverley as shown in the Esholt portrait (Fig 5). This supports a suggestion that the lady in Figs 13-14 was Julia Calverley's mother, Julia nee Conyers. If so, then Fig 12 surely depicts William Blackett II.

A resemblance can be seen with the figure described as William I (Figs 6-7), although 'William II' had a slightly fuller face. The likeness shown in a miniature (Fig 15) is also similar, and once again the 17th-century wig style could mean this was William II. The style in Fig 16, on the other hand, might suggest a date of the 1710s or later, in which case the facial similarity would perhaps identify the sitter as the second William's son, William III, (1690-1728). This identification would also fit reasonably with the attribution of the portrait to Enoch Seeman the younger, born in Gdansk c.1694, who would have been only 11 years old at the time William II died.

Fig 15 William II?

Fig 16 William III?

What of the individual portrayed in flamboyant style in Fig 17? The inscription identifies him as William II, but his features perhaps have more in common with those shown in Figs 6 and 7, thought to show William I.

Fig 17

Fig 18 Possibly Matthew Kirkley?

The inscription on Fig 18 identifies the sitter as Michael Blackett (1652-83) but this seems an entirely speculative addition a century or more after Michael's death, and unconvincing. It is difficult to believe that Michael, a Newcastle alderman like his younger brother William II, would have appeared without a wig and finery commensurate with his status. The style is in any case perhaps more suggestive of the Civil War/ Commonwealth period than the Restoration years. Perhaps it was of John Rogers (c.1621-71), Margaret Rogers' first husband prior to her marriage to William I, one of Haselrig's fellow military officers who came to Newcastle in the 1640s. Any such portrait could have been brought by Margaret to Greyfriars, but it would surely also have left with her when she later moved to London. Another possibility is that it shows Matthew Kirkley (1616-91), William I's brother-in-law and fellow merchant. The Kirkleys were cousins of the Bonners who dominated Presbyterian Newcastle following the Civil War, and Matthew was one of Corporation's common councillors at the time. Ostentation was frowned upon. He married in 1648; the portrait could perhaps date from around this time. The childless Matthew remained close to his Blackett brother-in-law and nephews. William II (1657-1705) was one of his executors in the 1690s.[1] By his will Matthew left his pictures to Ann Simpson, a Kirkley cousin, but it remains possible that William II was subsequently able to obtain his uncle's portrait from Ann as a memento to display in Greyfriars or Wallington.

There is at least little question over the identification of the full length portrait of Sir Walter Blackett by Joshua Reynolds (Fig 20). It is more curious that none of the portraits at Wallington clearly identify a single work as being of his wife of thirty years, the tragic Elizabeth Ord (1711-59), daughter of William III, and the key to Walter's inheritance of the Blackett business and estates. However there is a good case to be made that it is Elizabeth portrayed in the left hand portrait of the pair in Fig 19.

[1] DPR1/1/1691/K5

Fig 19. Sir Walter Blackett and possibly Lady Elizabeth, *nee* Ord

These portraits appear as if they have always hung together at Wallington but that of Sir Walter was in fact an auction purchase by the National Trust in the West country in recent decades. At some point prior to this it might therefore have been in the Trevelyan estate at Nettlecombe, a logical home for a portrait of the man who left Wallington to his Trevelyan relatives. The frames are highly suggestive of it being the missing half of a pair, now reunited, and an early- to mid-18th century date is thought reasonable by Hugh Dixon. The inscription attached beneath the lady's portrait (in the same hand as that responsible for the inscriptions on most of the other Wallington portraits) suggests the sitter was Elizabeth Blackett (1735-52), the only child of Sir Walter and Lady Elizabeth. It seems odd that the daughter would be paired with her father while her mother was still alive, and perhaps much more likely, therefore, that it depicts her mother instead in the early years of her marriage. The elder Elizabeth was 24 at the birth of her daughter, and Walter was 28, ages that could both be consistent with those of the sitters, in a pair of frames from the 1730s.

Fig 20 Sir Walter Blackett

Figure credits

1 Diana Blackett, attributed to Philippe Mercier, Wallington Hall collection. ©National Trust Images
2 Diana Blackett, Lady Wentworth, Bywell Hall. Collection of Viscount Allendale, Bywell Hall, reproduced by permission.
3 Unknown, probably a daughter of Sir William Blackett II, Wallington Hall collection. ©National Trust Images
4 Probably Julia Blackett, Lady Calverley (1683-1736), Wallington Hall collection. ©National Trust Images
5 Julia Blackett, Lady Calverley. Esholt Hall, Bradford
6 Probably William Blackett 1621-80, Wallington Hall, attributed to John Riley and John Closterman. ©National Trust Images
7 Possibly William Blackett 1621-80, Wallington Hall. ©National Trust Images
8 Possibly Margaret Rogers, 1631-1710, Wallington Hall, attributed to John Riley and John Closterman. ©National Trust Images
9 Possibly Elizabeth Kirkley, 1617-74, Wallington Hall. ©National Trust Images
10 Sir Edward Blackett, second baronet, 1649-1718. Reproduced by permission of Sir Hugh Blackett
11 Mary Yorke, later Lady Blackett, 1657-96. Reproduced by permission from a private collection
12 Probably William Blackett, 1657-1705, Wallington Hall. ©National Trust Images
13 Probably Julia Conyers, Lady Blackett, Wallington Hall. ©National Trust Images
14 Probably Julia Conyers, Lady Blackett, Wallington Hall. ©National Trust Images
15 Probably William Blackett, 1657-1705, by Peter Cross (1645-1724), Wallington Hall collection ©National Trust Images/Brenda Norrish
16 Possibly William Blackett, 1690-1728, attributed to Enoch Seeman the younger (c.1694 Gdansk – poss London 1744), Wallington Hall. ©National Trust Images
17 Possibly William Blackett, 1621-80, possibly by L. Schuneman, Wallington Hall collection. ©National Trust Images
18 Possibly Matthew Kirkley, 1616-91, Wallington Hall. ©National Trust Images
19 Walter Blackett, 1707 – 77, and possibly his wife Elizabeth, 1711-59, Wallington Hall. Greg Finch
20 Walter Calverley/Blackett, by Sir Joshua Reynolds, Wallington Hall collection. ©National Trust Images/Derrick E. Witty

Appendix 6 Family trees

Table A6.1 Blacketts of Hamsterley

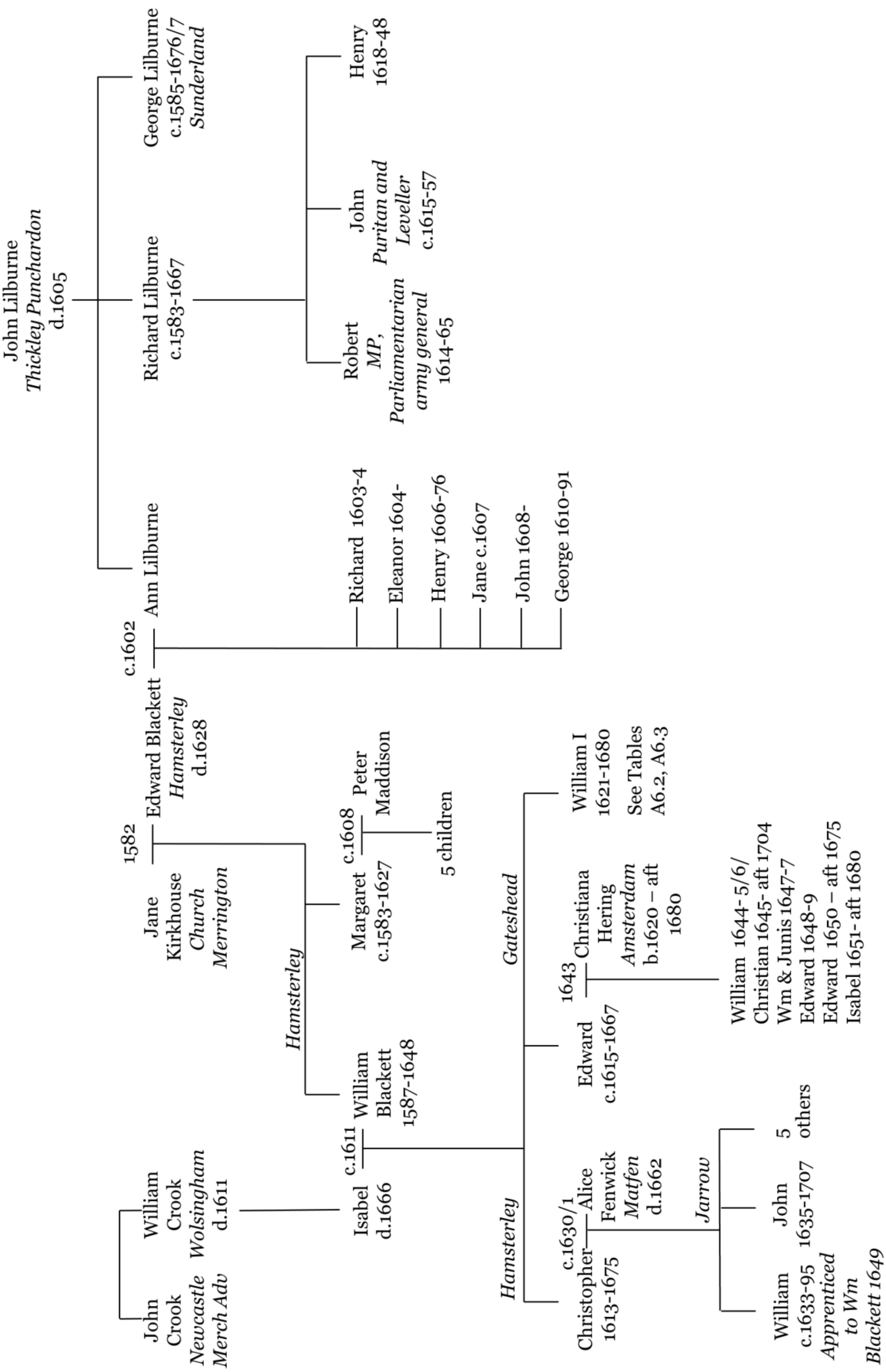


Table A6.2 Chapmans and Kirkleys of Newcastle

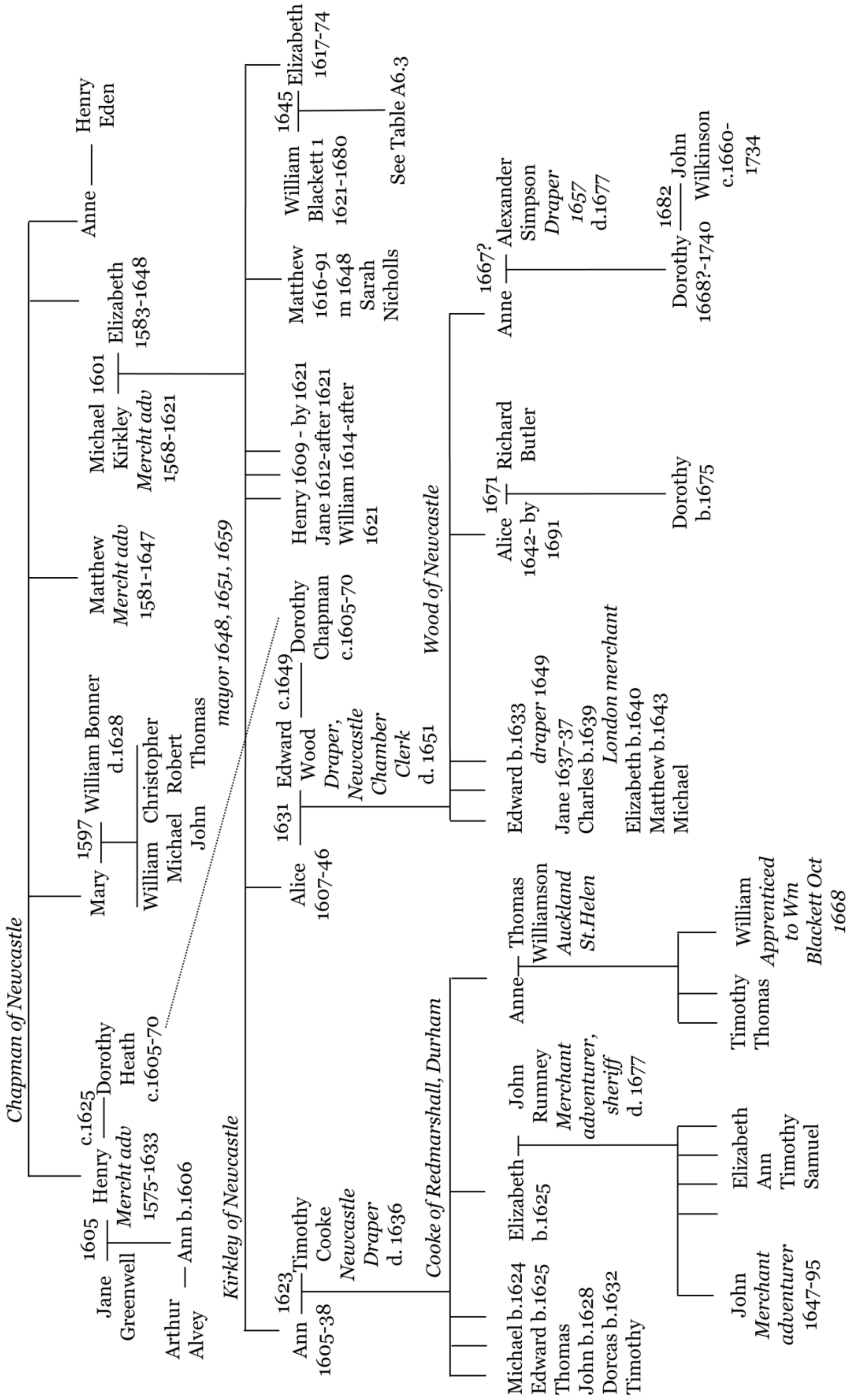
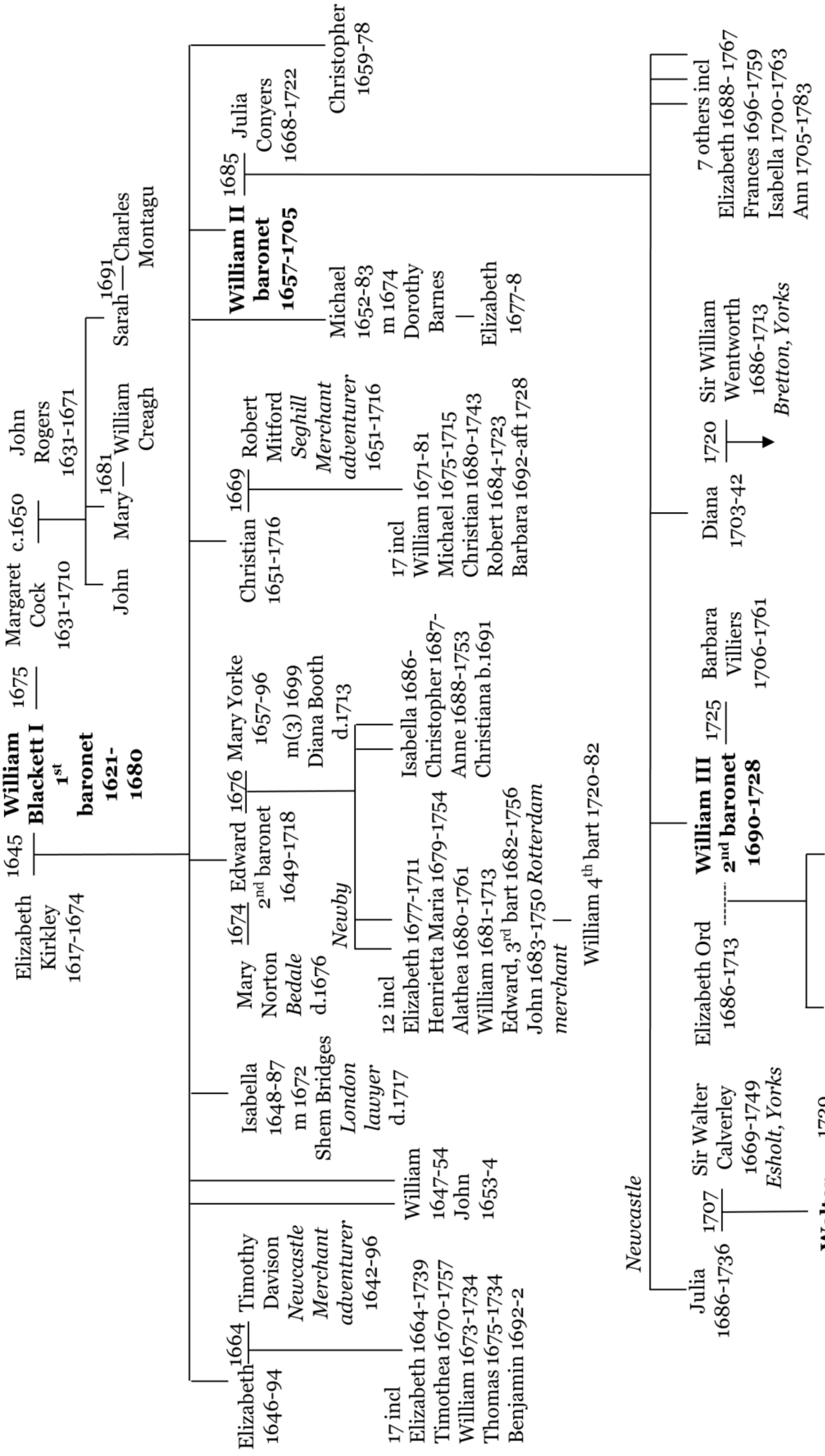


Table A6.3 Blacketts of Newcastle



Sources

General: The details given in Tables A6.1-3 are drawn from various sources including www.theblacketts.com, MA Records-1, 2, *Hostmen*. Most parish register material has been extracted from www.familysearch.org

Table A6.1 Blacketts of Hamsterley

Parish registers of baptisms, marriages and burials: St.Andrew Auckland, Hamsterley

Wills &/or inventories. DPR1/1/: 1611/C12 William CROOKE, yeoman, Wolsingham; 1628/B5/1-4, Edward Blackett, yeoman, Hamsterley; 1631/F3/1-3, Thomas Fenwick, W.Matfen; 1675/B21 Christopher Blackett, gent, Hamsterley; 1667/B9 Edward Blackett, merchant, Newcastle; 1676/L3 George Lilburne, Sunderland.

Amsterdam, archive 5001, DTB 459, p.295. Stadsarchief Amsterdam, DTB 137, pp.70, 78, 80, 84, 88; Durham Cath. Library SUR/3,5,22 Notes on Blackett family; NRO ZBK/B/1/2, 10 Bargain & sale of Hoppyland, County Durham Jan 29 Ch II, 1678-9; TNA DURH 3/186 Inquisition Post Mortem, Edward Blackett, 1628.

Hodgson, *Hist Northum, pt II*, vol I, p.258; Barry Coward, 'Lilburne, Robert (bap. 1614, d. 1665)', Andrew Sharp, 'Lilburne, John (1615?–1657)', *Oxford Dictionary of National Biography*, (2004).

Table A6.2 Chapmans and Kirkleys of Newcastle

Parish registers of baptisms, marriages and burials: St.Nicholas, Newcastle; All Saints, Newcastle; St. Andrew, Newcastle; Auckland St.Helen.

Wills &/or inventories. DPR1/1/: 1620/K2 Michael Kirkley, merchant, Newcastle; 1632/C4/1-8 Henry Chapman, alderman, Newcastle; 1636/C9/1 Timothy Cooke, draper, Newcastle; 1670/W18 Dorothy Wood, widow, Newcastle; 1691/K5 Matthew Kirkley; 1733/W21/1 John Wilkinson, merchant, Newcastle; 3/1638/B295 probate bond over will of Anne Cooke nee Kirkley. TNA PROB/11: 215/681 Elizabeth Kirkley, widow proved 1651; 216/426 Edward Wood proved 1651.

DUL Beamish deeds/80 12 July 1623; /101 6 Jul 1636, letters & papers 1623-1932/473; TNA E 134/11Chas1/Mich16 Warren & Jermy vs Kirkley 1637.

Welford, *History Newcastle & Gateshead* Vol III pp.237, 250.

Table A6.3 Blacketts of Newcastle

Parish registers of baptisms, marriages and burials: St.Nicholas, Newcastle; St. Andrew, Newcastle.

Wills &/or inventories. DPR1/1/: 1696/D4 Timothy Davison, Newcastle; 1714/M6 Robert Midford, Segill; 1716/M9 Christian Mitford, Newcastle. NRO 2762/Box C74: William Blackett of Newcastle, 1680 . TNA PROB 11/518: Dame Margaret Blackett of Westminster, 1711.

DUL Beamish deeds/124, 199, 201-2, 214, 281; NRO ZBL 194; 2762/E/Deeds/C61 marriage settlements.

Foster, *Alumni Oxoniensis*, Robert Mitford matric 1664; R.Welford, 'Local Muniments', *AA* 3rd ser, V, (1909), pp. 115-6.

Bibliography

Manuscript Sources

Northumberland Archives (NRO)

Allendale Estate

672/E/1A/1	Cash book 1722-7
672/E/1B/1-8	Account ledgers, 1727-1813
672/E/1C/1	Sales ledger, 1723-7
672/E/1E/1-3	Office copy correspondence, 1754-76
2762/Box C74	Miscellaneous – William Blackett's will, 1679
2762/E/DEEDS/C61	Miscellaneous Deeds
2762/E/X16	Deeds and associated case papers
11603/Box 5	Blackett estate records
11603/Box 8	Blackett estate survey, 1737
11603/Box 16	Blackett Executorship accounts, 1729
11619	Blackett estate Kenton account book, 1692

Blackett of Matfen

ZBL 1/58-96	Deeds – Westwater estate
ZBL 2/9	John Mowbray to William Blackett, 1674
ZBL 35/3	Galba's 'bond for life', 1727
ZBL 84/10	Fallowfield mine report - J.Armstrong, 1734
ZBL 189-91	Edward Blackett copy letters, 1709-15
ZBL 192-95	Miscellaneous family letters and accounts, 17^{th}-early 18^{th} century
ZBL 260/2	Miscellaneous letters, 1694-1844
ZBL 261/1, 10	Family marriage settlements and wills
ZBL 264/1	Parliamentary and civic affairs 1674-19
ZBL 273/1-18	Rent, estate and household accounts, 1636-1717

Blackett-Ord

324/M.2/1-2	Blackett vs Brandling case papers, 1675-84
324/O.1/45	John Ord's accounts and balance sheet, 1721
324/W.1/28	Whitfield manor boundary depositions
324/W.3/18/3	Blackett mortgage papers and deeds schedules
324/W.3/19	Miscellaneous papers - John Wilkinson

Other

673/2	Joseph Richmond's office correspondence, 1728-34 (copy of BL Add. Ms 27,420)
753 Box 1/J	Grey – Grey and Briggs lead accounts, 1672-77
	Grey – Margaret and Ralph Grey's letterbook, 1674-79
3410/For/1/5/56	Kenton colliery survey, 1732 (held at NEIMME)
EP 13/1-4	Newcastle St. Andrew's parish registers
EP 86/1	Newcastle St. Nicholas' parish register
SANT/DEE/1/35/26	Butler/Hunstanworth & Blackhall
ZAL 56/1-3	Allgood – Allendale lead accounts
ZAL 57/12	Allgood – George Allgood - Blackett correspondence
ZBK/B/1/2	Blackett of Wylam – Hoppyland deeds, 1618
ZBK/B/1/5	Blackett of Wylam - apprenticeship deed, 1652
ZBK/B/1/10	Blackett of Wylam – Hoppyland deeds, 1678-79

ZCK 14/1	Cookson – Radcliffe rental, 1669
ZCO I.15, 23a-d	Cookson – Blaydon deeds
ZCO IV.47/1-30	Cookson – Stella colliery accounts
ZCO VIII.1	Cookson – Stella colliery correspondence
ZGI/Do	Gibson –abstract of title – Dotland
ZMD 147/7	Miscellaneous documents – Fallowfield, 1629
ZPA/7/3	Parlour – Hunstanworth deeds, 1687
ZPA/18	Parlour – Hunstanworth mine accounts, 1663-1721
ZRI/21/11, 17	Ridley - lead mining leases
ZWN A/1	Trevelyan of Wallington – deeds and settlements
ZWN C1/1/4, 16-19	Trevelyan of Wallington – Ord vs Blackett case papers

The National Archives

Admiralty Papers

ADM 66/105	Greenwich Hospital – Northern Receivers letters, 1735-7
ADM 75/68-9	Radcliffe – Alston Moor mining leases, 17th century
ADM 79/35	George Liddell's lead mining notebook , 1735
ADM 79/57	Greenwich Hospital – Visitation report Langley, 1774

Chancery Court cases (pleadings)

C 5/31/41	Errington vs Fenwick, 1657, bill and answer
C 5/451/105	Blackett vs Norton, 1679, bill and answer
C 6/228/10	Blackett vs Norton, 1676, bill and answer
C 6/385/95	Brownell vs. Gray, 1680, bill and answers
C 7/520/10	Chesman et al vs Blackett, 1669, bill and answers
C 8/55/189	Cooke vs Bishop of Durham, 1639, bill and answers
C 10/133/84	Milburne vs Blackett & Rogers 1677, answer only
C 10/346/10	Burleigh vs Armstrong, 1693, bill and answers
C 10/411/17	Blackett vs Radcliffe, 1685, bill and answer
C 10/477/47	Clark vs Blackett, 1668, bill only
C 10/483/192	Milburne vs Blackett and Rogers, 1680, bill only
C 10/67/53	Fawdon vs Blackett, 1662, bill and answer
C 11/1466/10	Blackett vs Robinson, 1727, bill and answers

Exchequer Court cases (depositions except where shown)

E 134/11Chas1/Mich16	Warren and Jermyn vs Kirkley, 1636
E 134/12Chas1/East1	Warren and Jermyn vs Kirkley, 1637
E 134/17&18Chas2/Hil6	Tulley vs Briggs, Grey *et al*, 1666
E 134/19Chas2/East33	Basire vs Wharton, 1667
E 112/395/120 32Chas2	Wharton vs Blackett, 1680-1, bill and answer
E 134/32Chas2/Mich18	Wharton vs Blackett, 1680-1
E 134/36Chas2/Mich47	Wharton vs Blackett, 1684-5
E 134/2Jas2/Mich42	Crewe vs Wharton, 1686
E 134/2W&M/Trin15	Blackett vs Tempest, 1690

Other

DURH 3/186	Inquisitions Post Mortem - George Blackett, 1628

E 179/158/101, 104, 110	Hearth Tax assessments – Newcastle and Northumberland
E 179/254/18	Hearth Tax assessments – Northumberland
E 190/192-224	Exchequer Port Books – Newcastle. (See Appendix Table A1.1 for
FEC 1/501/D2	Forfeited Estates – Radcliffe, 1717
LLRO 3/85	Land Registry - Grinton in Swaledale accounts, 1698-1705
PROB 11	Prerogative Court of Canterbury wills
SP 34/3/67	Blackett to Nottingham, 1703
SP 44/104	Nottingham Letter Book, 1704

Tyne and Wear Archives

<u>Cotesworth papers</u>

DF.COT/CA/19/36	Rookhope mining lease, 1695
DF.COT/CK/1/27	Ramsay mining lease, 1690s
DF.COT/CK/2/325-462	Gateshead Fell coal accounts, 1693-1711
DF.COT/CK/3/47	Annual coal shipments from Newcastle
DF.COT/CM/1/66-89	Miscellaneous leases and accounts
DF.COT/CM/1/90	Blackhall Mill lease , 1691-2
DF.COT/CM/2/684	Swaledale lead accounts for Lord Powlett, 1711-27

<u>Newcastle Corporation records</u>

MD.NC/1/1	Order Book, 1636-50
MD.NC/1/3	Order Book, 1656-1723
MD.NC/2/1	Calendar, 1645-50
MD.NC/2/2	Calendar, 1650-59
MD.NC/2/3	Calendar, 1699-1718
MD.NC/FN/1/1/13-15	Chamberlain's accounts, 1635-36

DF.HUG/43/1-12	Settlingstones mines accounts, 1680s
GU.MA/3/3	Merchant Adventurers - Company Order Book, 1639-75
GU.TH/109/3	Trinity House accounts

Durham University Library Archives and Special Collections

DPR1/1	Durham Probate Registry, original wills and associated documents.
DPR1/3	Durham Probate Registry, probate bonds
Add.MS 1623/3	Miscellaneous Correspondence – 1698
Add.MS 1930	Bishop Cosin's Survey, 1662
CCB/B/182/121	Durham Bishopric and Palatinate – correspondence
CCB/D/1981	Durham Dean and Chapter Estates – Weardale
DCD/E/Ba	Dean and Chapter - Miscellaneous surveys - Cowpen
DCD/K/LP5/6-95	Dean and Chapter – coal accounts – Heworth
DCD/MAN/5/29	Dean and Chapter – manorial records – Muggleswick
DDR/EJ/PRC/2/1637/1	Durham Consistory Court/ probate causes – Blackett vs Fenwick
BRA/1041/1-3	Orde family deeds and related papers
SHA/Deeds/ 488	Shafto/Beamish Estate deeds and papers
GBV/76	Gibson maps and plans – Blaydon village 1817
TUR (1958)25	Turton papers - Middleton St. George deeds - 1631

Archives of the Duke of Northumberland at Alnwick Castle

Sy: C.X.2.a (1-2)	Mine and quarries in Northumberland – coal – Whorlton/Newburn
Sy: C.X.3.a	Mine and quarries in Northumberland – lead – Hawden field
Sy: M.VI.13.d	Whorlton mining leases
Sy: Q.VI.128 1655	Correspondence – Hawden field
Sy: Q.VI.80, 93	Correspondence – Newburn
Sy: R.IV.1.b	Petition regarding Corbridge bridge, n.d., c.1667

British Library

Add. Ms 27,420	Blackett office copy letter book
Add. Ms 27,421	Blackett funerals - orders of procession
Add. Ms 47,218	Walter Calverley's diary

Bodleian Library, Oxford

MS Lister 37	Martin Lister letters
MS Tanner 56	Tanner correspondence

Cambridge University Library Special Collections

MS.Add .91	Michael Blackett letter book 1675 – 77
Dd 7/26	Michael Blackett letter book 1677 – 83

Durham County Record Office

D/Bo/F/117-38	Durham Bishopric stray papers
D/St/B2/1-69	Bowes deeds and accounts
D/X 1361/1-2	Wharton deeds – Stanhopehope and Derwent Mills
EP/Ga.SM 4/1	Gateshead Churchwardens Accounts 1626-40

London Metropolitan Archives

H09/GY/A/8/1	Guys Hospital - Minutes
H09/GY/D/88	Guys Hospital - Blackett accounts

Riksarchivet Sweden

756/1/B 11/3	Court papers Blackett and Clavering, 1660-4
E2499	Momma-Reenstierna, 1669-70

Miscellaneous Archives

Derbyshire RO	D7676/ Bag C/3295
Durham Cathedral Library	SUR/3,5,22 Conyers-Surtees
National Records Scotland	RH15/102/6/2 Standsfield papers, 1680
Newcastle University Special	Misc. MSS. 85, Montagu
North Yorks RO	ZBO V LR7 Wharton, 1670s
Stadsarchief Amsterdam	5001, 5075/3607/113247, notarial records; DTB 137, 459
University College Oxford	UC:AR2/MS1/11 Register, 1705-6
University of Manchester, John Rylands Library	MS 899 Clayton papers
Wallington Hall	Charles Montagu to WB, 1699
West Yorks Archives	DB16/C7/9L, n.d [1729]

Printed Primary Sources

An Act for the Rebuilding of the City of London (18-19 Chas II, 8), *Statutes of the Realm: volume 5: 1628-80,* (1819)

Anon, 'Miscellanea. extracts from Newcastle Custom House books', *PSAN*, 3rd ser., 3, (1909)

Anon, 'Eve of revolution' in *Rare Tracts*, Volume IV

Ashcroft, M.Y., (ed), *Documents Relating to the Swaledale estates of Lord Wharton in the 16th and 17th centuries*, (1984)

Atkinson, D.H., *Ralph Thoresby, the topographer; his town and times*, (1885)

Atkinson, J.A., Flynn, B. and others (eds) *Darlington Wills and Inventories 1600-1625,* SS 201, (1993).

Banson, W., *The Merchant's Penman*, (1702)

An Arithmetical Exercise, (1709)

Bennett, J.A., (ed), *The Manuscripts of S.H.Le Fleming Esq. of Rydal Hall*, RCHMC 12th report, Appendix, Part VII, (1890)

Beveridge, W., *Prices and wages in England from the Twelfth to the Nineteenth Century,* 2nd edition, (1965)

Bourne, H., *History of Newcastle,* (1736)

Boyle, J.R. and Dendy, F.W., (eds), *Extracts from the Records of the Merchant Adventurers of Newcastle-upon-Tyne*, SS 93, (1895)

Bray, W., (ed), *The diary of John Evelyn, Volume 2, 1665-1706* (1901)

Briggs et al, (eds), *Sunderland Wills and Inventories*, SS 214, (2010).

Browell, M., Diary for 1688 in Richardson, *Rare Tract*s, Vol 1.

Buckley, W., (ed), *Memoirs of Thomas, Earl of Ailesbury*, (1890)

Burton, J., (ed), *Autobiography of the Rev Dr Alexander Carlyle*, 2nd edition, (1860)

Calendar of State Papers Domestic: Charles I, 1638-9, Charles II, 1660-1, 1665-6, 1666-7, 1673-5, 1683-4, 1684-5, Addenda 1660-85

Calendar of Treasury Books: 1672-5, 1676-9, 1685-9

Cary, J., 'An essay on the State of England in relation to its trade..', (1695), quoted in `, J., and Cooper, S., *Seventeenth Century Economic Documents*, (1972)

Dafforne, R., *The Merchant's Mirror*, (1636)

de Rochefort, A., *Le voyageur d'Europe…,* Vol III, (1672).

Defoe, D., *The Compleat Tradesman*, (1726)

Dendy, F.W., (ed),), *Extracts From the Records of the Merchant Adventurers of Newcastle-Upon-Tyne*, SS 101, (1899)

(ed) *Extracts from the records of the Company of Hostmen of Newcastle-upon-Tyne*, SS 105, (1901)

'Extracts from Privy Seal Dockets', *AA*, 2 ser, 24, (1903)

Doble, C.E., (ed), *Remarks and Collections of Thomas Hearne*, Vol I 1705-1707, Oxford Historical Society, (1885)

Dodds, M., *Extracts from the Newcastle-upon-Tyne Council Minute Book 1639-56*, (1920)

www.dukesfield.org.uk/documents - Dukesfield Documents online transcript archive

Dunn, M., *An Historical, Geological, and Descriptive View of the Coal Trade of England*, (1844)

Ellis, J.M., (ed), *The Letters of Henry Liddell to William Cotesworth*, SS 197, (1987)

Fenwick, J., (ed), 'Extracts from the Accounts of the Steward of Sir Francis Radclyffe, Bart', *AA*, 2nd ser., 2, (1858) Fewster, J., (ed), *The Keelmen of Newcastle-upon-Tyne 1638-1852*, SS 225, (2021)

Finch, G., (ed), *A Pack of Idle Sparks*, (2013)

Flinn, M.W., (ed) *The Law Book of the Crowley Ironworks*, SS 167, (1957)

Foster, J., (ed) *London marriage licences, 1521-1869*, (1887)

(ed), *Alumni Oxoniensis, 1715-1886*, (1888)

(ed), *Pedigrees recorded at the Visitations of the county palatine of Durham,* (1887).

Fraser, C., (ed), *Durham Quarter Session Rolls 1471-1625*, SS 199, (1991).

The Accounts of the Chamberlains of Newcastle-upon-Tyne 1508-11, (1987)

Gardiner, R., *Englands Grievance Discovered in relation to the Coal Trade,* (1655).

Gray, W., *Chorographia, or A Survey of Newcastle upon Tyne 1649*, (6th edition 1883).

Green, A., Parkinson, E., Spufford, M. (eds), *Durham Hearth Tax Lady Day 1666*, (2006)

Hainsworth, D.R., (ed), *Commercial papers of Sir Christopher Lowther 1611-1644*, SS 189, (1977)

The Correspondence of Sir John Lowther of Whitehaven, 1693-98, (1983)

Harvey, M., and Pask, B., (eds), *The Letters of George Davenport, 1651-1677*, SS 215 (2011)

Hodgson, J.C., 'Some forgotten epitaphs and monumental inscriptions in Hexham Priory church', *PSAN*, 2nd ser., 8, (1897)

(ed), *Wills and Inventories from the Registry at Durham Vol III*, SS 112, (1906)

(ed), *Six North Country Diaries*, SS 118, (1910)

(ed), 'Radcliffe papers', *PSAN* 3rd ser, Vol 7, (1915-6)

Hunter, J., (ed), *The Diary of Ralph Thoresby*, (1830)

Hutton Wood, (ed), *Collection of Decrees in Tithe Causes…* , (1798)

Jackson, C., (ed), *Yorkshire Diaries and Autobiographies of the Seventeenth and Eighteenth Centuries*, SS 77, (1886)

James, G., (ed), *Letters Illustrative of the Reign of William III*, Vol 2, (1841)

Journal of the House of Commons, 1660-67, 1693-97

Kimber, E., and Johnson, R., *The Baronetage of England*, vol 2, (1771)

Kip, J., *Brittania Illustrata,* (1707)

London, W., *A Catalogue of the most vendible Books in England*, (1658)

Longstaffe, W.H.D., (ed), *Memoirs of the life of Ambrose Barnes,* SS 50, (1867)

'Francis Radcliffe, First Earl of Derwentwater', *AA*, 2nd ser.. 1, (1857)

Luttrell, N., *A brief historical relation of state affairs, from Sept. 1678 to Apr. 1714*, (1857)

Newcastle Courant: 7-9 January 1715/6, 12 Jan 1723, 31 Oct 1724, 9 Oct 1725, 14 May 1726, 24 Sep 1726, 9 Dec 1727, 12 Oct 1728

North, R., *The life of the Rt Hon Francis North*, (1746)

Oliver, T., *Actual Survey of Newcastle upon Tyne* , (1830)

Ornsby, G., (ed), *The Correspondence of John Cosin, Vol 2*, SS 55, (1872)

Palmes, W., *Life of Mrs. Dorothy Lawson, of St. Anthony's, near Newcastle-upon-Tyne*, (1851)

Patten, R., *The History of the Rebellion in the year 1715,* (1746 edn)

Primatt, S., *The City and Country Purchaser and Builder*, (c.1667)

Raithby, J., (ed), *Statutes of the Realm: Volume 5, 1628-80*, (1819)

Richardson, M.A., 'Obsequies of Certain of the family of Blackett of Newcastle' in *Reprints of Rare*

Tracts, Vol 1, (1847).

Ritschel, G., *An account of certain Charities…in Tynedale*, (1713)

Scotland, Scandinavia and Northern European Biographical Database (SSNE): https://www.st-andrews.ac.uk/ history/ssne

Sellers, M., (ed), *The Acts and Ordinances of the Eastland Company*, (1906)

Sopwith, T., *A historical and descriptive account of All Saints' Church in Newcastle upon Tyne*, (1826)

Sound Toll project http://www.soundtoll.nl/index.php/en/over-het-project/sonttol-registers

Stringer, M., *English and Welsh mines and minerals discovered*, (1699)

Taylor, J., *Journey to Edenborough,* ed. Wm Cowan, (1903)

Vernon, J., *The Compleat Countinghouse*, (1678)

Welford, R., 'Local Muniments', *AA,* 2nd ser., 23, (1902)

(ed), *Records of the Committees for compounding, with delinquent royalists in Durham and Northumberland during the civil war, 1643-1660,* SS 111, (1905)

'Local Muniments', *AA* 3 ser, V, (1909)

'Newcastle householders in 1665. Assesssment of Hearth or Chimney Tax', *AA*, 3rd ser., 7, (1911)

Wood, H.M., (ed), *Wills and Inventories from the Registry at Durham, Part IV,* SS 142, (1929, reprinted 1968)

(ed), *Durham Protestations,* SS 135, (1922)

Secondary Sources

Anderson, R. *et al*, *A History of Blaydon*, (1975)

Andrews, J.H.,'Two Problems in the Interpretation of the Port Books', *EconHR,* 9.1, (1956)

Anon, 'Exhibition of Silver Plate of Newcastle Manufacture', *AA*, 2nd ser., 21, (1899)

Archer, I., 'Facing up to catastrophe: The Great Fire of London', *Oxford History*, (Mich. 2016)

Arkell, T., 'The probate process' in T.Arkell, N.Evans, N. Goose, (eds), *When Death do us part: Understanding and Interpreting the Probate Records of Early Modern England*, (2000)

Åström, S.E., *From Cloth to Iron,* (1963)

Baxter, N., 'The Missing Family Portrait', *Journal of the Northumberland and Durham Family History Society*, Vol 10, (1985)

Bell, W.G., *The Great fire of London in 1666*, (1920, Folio Soc. Edn 2003)

Bellhouse, D.R., 'A new look at Halley's life table', *Journal Royal Statistical Society*, (2011)

Bennett, G., Clavering, E., and Rounding, A., *A Fighting Trade. Rail Transport in Tyne Coal 1600-1800*, (1989)

Blackburn, A., 'Mining Without Laws: Origins and Practices of the Weardale Moormasters', *Bulletin of the Peak District Mines Historical Society*, 12.3, (1994)

Blackett-Ord, M., *ODNB*

Blanchard, I., *Russia's Age of Silver*, (1989)

Bradshaw, F., 'Sir William Blackett', *PSAN*, 3rd ser., 3, (1907)

Brand, J., *History and Antiquities of Newcastle* (1789)

Brassley, P., 'Northumberland and Durham', in J.Thirsk (ed), *The Agrarian History of England and Wales, Vol V.I, 1640-1715 Regional Farming Systems,* (1984)

Agricultural Economy in Northumberland and Durham 1640-1750, (1985) Broadberry, S., Campbell, B., Klein, A., Overton, M., and van Leeuwen, B., *British Economic Growth 1270-1870*, (2015)

Brook, F., 'Fallowfield', *Industrial Archaeology,* (1967)

Brooks, C., 'Apprenticeship, Social Mobility and the Middling Sort, 1550-1800' in J.Barry & C.Brooks (eds), *The Middling Sort of People: Culture, Society and Politics in England, 1550-1800* (1994).

Brown, A.T., *Rural Society and Economic Change in County Durham, Recession and Recovery, c.1400-16140*, (2015).

Burn, A., 'Work and Society in Newcastle upon Tyne, c. 1600-1710', University of Durham, Ph.D thesis, (2014).

'Seasonal work and welfare in an early industrial town: Newcastle upon Tyne, 1600–1700', *Continuity and Change* 32/2, (2017)

'Work before Play: The Occupational Structure of Newcastle-upon-Tyne, 1600-1710' in A.Green and B.Crosbie (eds), *Economy and Culture in North-East England 1500-1800,* (2018)

Burt, R., 'Lead Production in England and Wales, 1700-1770', *EconHR*, 22, (1969).

'The transformation of the nonferrous metals industries in the seventeenth and eighteenth centuries', *EconHR*, 48, (1995)

Carlton, R., 'A Third Season of Fieldwork on the site of Dukesfield Smeltmills, Hexhamshire', unpublished report, (2015): https://www.dukesfield.org.uk/ research/ archaeological-reports/

Chartres, J.A., 'The Marketing of Agricultural Produce', in J.Thirsk (ed), *The Agrarian History of England and Wales, Vol V.II, 1640-1715,* (1985)

Chaudhuri, K.N., *The Trading World of Asia and the English East India Company: 1660-1760*, (1978)

Child, M.S., 'Prelude to Revolution: The Structure of Politics in County Durham, 1678-88', unpublished University of Maryland Ph.D thesis, (1972)

Clavering, E., and Rounding, A., 'Early Tyneside Industrialism: The lower Derwent and Blaydon Burn Valleys 1550-1700', *AA*, 5th ser, Vol 23, (1995)

Clay, C., 'Landlords and Estate Management in England' in Thirsk, *Agrarian History*, (1985) *op cit*

corbettsbookshop.omeka.net/

Corfield, P.J., 'Norwich on the cusp -from second city to regional capital', in C.Rawcliffe and R.Wilson (eds), *Norwich since 1550*, (2004).

Coward, B., *The Stuart Age, England 1603-1714,* (1994)

'Lilburne, Robert (*bap.* 1614, *d.* 1665)', *ODNB*

Craster, H.H.E., *Earsdon and Horton*, History of Northumberland, 9, (1909)

Corbridge, History of Northumberland, 10, (1914)

Crawhall, T., 'An account of Instruments formerly used for the Purpose of Blasting', *AA*, 1st ser., 1, (1822)

Crossley, D., & Kiernan, D., 'The Lead smelting-mills of Derbyshire', *Derbyshire Archaeological Journal*, Vol 112, (1992)

Cruikshanks, E., 'Henry Liddell' in *HistParl,* 1690-1715

'Blackett, Sir Wm (1690-1728)' in *HistParl,* 1690-1715, 1715-54.

'John Trenchard', *HistParl,* 1715-54.

Cruikshanks, E., and Harrison, R., 'Constituencies, Newcastle', *HistParl, 1690-1715*

'Blackett, Sir Edward', in *HistParl*, *1690-1715*.

'Blackett, Sir William', *HistParl*, 1690-1715.

Davis, R., *The Trade and Shipping of Hull 1500-1700*, (1964) Dickinson, G., *Allendale and Whitfield; Historical Notices of the two parishes*, 2nd edition (1903)

Dodds, M.H., *Ovingham, Stamfordham and Ponteland,* History of Northumberland, 12, (1926)

Heddon on the Wall, Newburn, Long Benton and Wallsend, History of Northumberland, 13, (1930)

Simonburn, Rothbury, Alwinton, History of Northumberland, 15, (1940)

Earle, P., *The Making of the English Middle Class*, (1989)

Edwards, E.R., and Ferris, J.P., 'O'Brien, Henry, Lord Ibrackan (c.1642-78)', *HistParl,* 1660-1690

Edwards, J.R., *A History of Financial Accounting*, (2014)

Edwards, J.R., Hammersley, G., and Newell, E., 'Cost Accounting At Keswick, England, C. 1598-1615: The German Connection', *The Accounting Historian's Journal*, (1990).

Ehrman, J., *The Navy In The War Of William-III*, (1953)

Ellis, J.M., 'A Study of the Business Fortunes of William Cotesworth, c.1668-1726', unpublished Oxford D.Phil thesis, 1975

'The Decline and Fall of the Tyneside Salt Industry, 1660-1790.A Re-examination', *EconHR*, 33.1, (1980).

'A Bold Adventurer: The Business Fortunes of William Cotesworth, c.1668-1726', *Northern History*, (1981).

'Cartels in the coal industry on Tyneside, 1699-1750', *Northern History*, 34, (1998)

Fairbairn, R.A., 'Plankey Mill – 17th century lead Smelting Mill', *British Mining*, Vol 59, (1997)

Allendale, Tynedale and Derwent Lead Mines, British Mining Monographs, Vol 65, (2000)

Fewster, J.M., *The Keelmen of Tyneside. Labour Organisation and Conflict in the North-East Coal Industry, 1600-1830*, (2011)

Finch, G., 'The Carrshield lead mill dispute of 1694', *AA*, 5th ser., 44, (2014)

'William Blackett, Dukesfield, and the 17th century lead industry', *HH*, 25, (2015)

'Allenheads Transformed', *HH*, 29, (2019)

'The North Pennines lead industry in the seventeenth century', *Proceedings of the National Association of Mine Historical Organisations conference 2015*, (2020)

Flinn, M.W., *Men of Iron* (1962).

Forbes, I., *Images of Industry*, (2015).

'Charles Paulet, Weardale's forgotten mining entrepreneur and the origin of Weardale's partnership mines', *Friends of Killhope Newsletter*, 90, (2017)

'Elizabeth Ord: a woman of the 18th century', *HH*, 28 (2018)

'George Mowbray and Burtreeford Smelt Mill', *Friends of Killhope newsletter*, (2020)

Forbes, I., Young, B., Crossley, C., and Hehir, L., *Lead Mining Landscape of the North Pennines Area of Outstanding Natural Beauty*, (2003)

Forster, W., *A Treatise on a Section of the Strata*, (1821)

Fraser, R., Jamfrey C. and Vaughan, J., 'Excavation on the Site of the Mansion House, Newcastle, 1990', *AA*, 5th ser., 23, (1995)

Gelderblom, O., Jonker, J., and Kool, C., 'Direct finance in the Dutch Golden Age', *EconHR,* 69, (2016)

Gibson, W.W., 'The Manor of Winlaton', *AA*, 4th ser., 23, (1945)

Gill, M.C., and Harvey, W.S., 'Weights and Measures used in the lead industry', *Northern Mine Research Society Memoirs*, 61, (1998)

Gleeson-White, J., *Double Entry. How the Merchants of Venice created modern Finance* (2011).

Gooch, L., *The Desperate Faction?* (2001)

Grassby, R., 'The personal wealth of the business community of Seventeenth-century England', *EconHR,* 23, (1970)

The business community of seventeenth-century England, (1995)

Graves, C.P., 'Building a New Jerusalem: The Meaning of a Group of Merchant Houses in Seventeenth-Century Newcastle upon Tyne, England', *International Journal of Historical Archaeology*, Vol. 13, No. 4 (2009)

Green, I., *Humanism and Protestantism in Early Modern English Education*, (2009)

Greenhall, M.R., 'The Evolution of the British Economy: Anglo-Scottish Trade and Political Union, an Inter-Regional Perspective, 1580-1750', Durham Ph.D thesis, (2011)

Hainsworth, D.R., *Stewards, Lords and people. The estate steward and his world in later Stuart England*, (1992)

Halcrow, E.M., Harbottle, B., Slipper, J., 'Merchant Charities of Newcastle-upon-Tyne', *AA* 4th ser., 30, (1952)

Hammersley, G., 'The Charcoal Iron Industry and its Fuel', *EconHR*, 26, (1973)

Hampson, G., 'Blackett, Sir William (1657-1705)', *HistParl,* 1660-90.

'Blackett, William (c.1620-80)', *HistParl* 1660-90.

'Carr, Sir Ralph (1634-1710)' in *HistParl,* 1660-90.

'Newcastle-upon-Tyne' in *HistParl,* 1660-90.

Hancock, T.W., 'Pennant Melangell: its parochial history and antiquities', *Collections Historical & Archaeological relating to Montgomeryshire and its borders*, XII, (1879)

Harris, R., 'Government and the economy, 1688-1850' in R.Floud and P.Johnson (eds), *The Cambridge Economic History of Modern Britain* (Cambridge, 2004)

Harrison, C.J., 'Grain Price Analysis and Harvest Qualities, 1465-1634', *Agric History Review*, 19, (1971)

Harrison, G., *History of Yorkshire*, Vol 1, (1885)

Hatcher, J., *The History of the British Coal Industry*, Vol 1 (1993)

Hayton, D., Cruickshanks, E., and Handley, S., (eds), *History of Parliament: the House of Commons, 1690-1715* (2002)

Hayton, D., 'William Thompson, c.1676-1739)' in *HistParl,* 1690-1715.

Healy, S., 'The Tyneside Lobby on the Thames: Politics and Economic Issues, c.1580-1630' in D.Newton and A.Pollard (eds), *Newcastle and Gateshead before 1700*, (2009).

'Constituencies, Newcastle', *HistParl, 1604-29*

Helms, M., and Hampson, G., 'Anderson, Sir Francis (1614-79)' in *HistParl,* 1660-90.

Henning, B.D., (ed) *History of Parliament: the House of Commons, 1660-1690* (1983)

Heyes, W.F., 'A History of Mining in Teesdale in the 16th and 17th Centuries', *British Mining*, 90, (2010)

Hibbert, C., and Weinreb, B., *The London Encyclopedia*, (2010)

Hinds, A.B., *Hexhamshire Part 1*, History of Northumberland, 3, (1896)

Hodgson, J., *History of Northumberland, Pt 2, Vol 1*, (1827)

Hodgson, J.C., *Hexhamshire Part 2*, History of Northumberland, 4, (1897)

Bywell St.Peter, Bywell St.Andrew, Slaley, History of Northumberland, 6, (1902)

Hodgson, R.I., Coalmining, Population And Enclosure In The Seasale Colliery Districts Of Durham (Northern Durham), 1551-1810, A Study In Historical Geography, unpublished thesis, Durham University, (1989)

Hopkins, P., 'Sir John Fenwick c.1644-97', *ODNB*.

Hoppitt, J., A *Land of Liberty? England 1689-1727,* (2000) Horwitz, H., *Revolution Politicks, The career of Daniel Finch, Second Earl of Nottingham, 1647-1730*, (1968)

Houpt-Varner, L., 'Maintaining Moral Integrity: The Cultural and Economic Relationships of Quakers in North-East England, 1653-1700' in Green and Crosbie, *Economy and Culture , op cit*

Howell, R., *Newcastle-upon-Tyne and the Puritan Revolution,* (1967)

Monopoly on the Tyne, (1978)

Hughes, E.T., *North Country Life in the Eighteenth Century*, (1952)

Hughes, M., 'Lead, Land and Coal as sources of Landlord Income in Northumberland between 1700 and 1850', unpublished Durham D.Phil thesis, (1963)

Hunter-Blair, C.H., 'Members of Parliament for Northumberland and Newcastle-upon-Tyne, 1559-1831', *AA*, 4th ser., 23, (1945);

Hussey, D., *Coastal and River Trade in pre-Industrial England*, *Bristol and its region, 1680-1730*, (2000)

Jackson, G., *The British Whaling Trade*, (2005)

Jones, A., 'Johannes Kip (1652-1721) and the Gloucestershire engravings', *The Local Historian*, 50, (2020)

Jones, D.W., 'The "Hallage" Receipts of the London Cloth Markets, 1562-c.1720', *EconHR*, 25, (1972)

Kennedy, P., *The Rise and Fall of British Sea Mastery*, (1976)

Kiernan, D., *The Derbyshire Lead Industry in the Sixteenth Century,* (1989)

King, P., 'The production and consumption of bar iron in early modern England and Wales', *EconHR,* 58.1, (2005)

Kirtley, A., Longbottom, P., and Blackett, M., *A History of the Blacketts* (2013).

Kreager, P., 'New Light on Graunt', *Population Studies*, (1988)

Kussmaul, A., *A general view of the rural economy of England, 1538-1840*, (1990)

Levine, D., and Wrightson, K., *The Making of an Industrial Society*, *Whickham 1560-1765,* (1991).

Mackenzie, E., *Historical Account of Newcastle-Upon-Tyne Including the Borough of Gateshead* (1827)

Mains, B., and Tuck, A., (eds), *Royal Grammar School, Newcastle upon Tyne: a history of the school in its community*, (1985)

Matthew, H.C.G., and Harrison, *B. (*eds), *Oxford Dictionary of National Biography,* (2004)

Meikle, M., 'The Scottish Covenanters and the Borough of Sunderland 1639-1647. A Hidden Axis of the British Civil Wars', *Northern History*, 54:2, (2017)

Meikle, M., and Newman, C., *Sunderland and its origins, monks to mariners*, (2007)

Miller, J., 'The Crown and the Borough Charters in the Reign of Charles II', *English Historical Review*, 100, (1985)

Millington, J.T., and Chapman, S.D., (eds), *Four Centuries of Machine Knitting: Commemorating William Lee's Invention of the Stocking Frame in 1589,* (1989)

Mokyr, J., *A Culture of Growth: The Origins of the Modern Economy*, (2018)

The Enlightened Economy, (2009)

Müller, L., *The Merchant Houses of Stockholm, c.1640-1800*, (1998)

'Britain and Sweden: the changing pattern of commodity exchange 1650-1680' in P. Salmon & T. Barrow (eds), *Britain and the Baltic*, (2003)

Namier, L. 'Blackett, Sir Walter, 2nd Bt. (1707-77)', in *HistParl,* 1754-90.

Nef, J.U., *The Rise of the British Coal Industry* (1932)

Newman, P.R., *Royalist Officers in England and Wales, 1642-1660: A Biographical Dictionary*, (1981)

Oldroyd, D., *Estates, Enterprise and Investment at the Dawn of the Industrial Revolution: Estate*

Management and Accounting in the North-East of England, c.1700-1780, (2007)

Page (ed), W., *A History of the County of York North Riding, Volume 1*, (1914)

Pears, R. and Atherton, B., 'Anderson Place, Newcastle upon Tyne', *AA*, 5th ser., 44, (2015)

Pevsner, N., *The Buildings of England, County Durham*, (1953)

Pollard, S., *The Genesis of Modern Management*, (1965)

Porter, S., 'The great fire of London', *Oxford Dictionary of National Biography*, (2014), http://www.oxforddnb.com/view/theme/95647.

Purdue, A.W., *The Ship That Came Home,* (2004)

Newcastle The Biography, (2011)

R.R.Sedgwick, 'William Thompson', *HistParl* 1715-54

Rackham, O., *Woodlands*, (2010)

Raistrick, A., *Quakers in Science and Industry*, (1950)

Raistrick, A., and Jennings, B., *A History of Lead Mining in the Pennines*, (1965)

Richardson, J., *The Gentleman's Steward*, (1730)

Ridley, M., *A History of the Merchant Adventurers of Newcastle-upon Tyne*, (1998)

Roberts, M., 'The staircase from Anderson Place, Newcastle-upon-Tyne', *English Heritage Historical Review*, vol 1, (2006)

Roseveare, H., (ed), *Markets and Merchants of the Late Seventeenth Century*, (1991)

Rowland, K.M., 'Sir William Thompson', *William and Mary Quarterly*, Vol 3, (1894)

Rushton, P., 'Gateshead 1550-1700: independence against all the odds?', in Newton and Pollard, *op cit*,

S.Carter & K.Gibson, 'Printed Music in the Provinces', *The Library*, (2017)

Schama, S., *A History of Britain, The British Wars 1603-1776,* (2001)

Sedgwick, R., *History of Parliament: the House of Commons, 1715-1754* (1970)

Serdiville, R. and Sadler, J., *The Great Siege of Newcastle 1644*, (2011)

Sharp, A., 'Lilburne, John (1615?–1657)', *ODNB*.

Smith, A., *An Inquiry into the Nature and Causes of the Wealth of Nations*, (1776)

Smith, P., 'A house by Sir Christopher Wren? The second Newby Hall and its gardens', *The Georgian Group Journal*, (2008)

Stephens, W.B., *Seventeenth-century Exeter, A Study of Industrial and Commercial Development*, 1625-1688, (1958)

The seventeenth-century customs service surveyed: William Culliford's investigation of the Western Ports 1682-84, (2012)

Straker, J., *Memoirs of the Public Life of Sir Walter Blackett of Wallington*, (1819).

Surtees, R., *The History and Antiquities of the County Palatine of Durham*, Volumes 1, (1816), 2, (1820), 3 (1823)

Taylor, T.J., *The Archaeology of the Coal Trade*, (1852, repr 1971)

Terry, C.S., 'The Visit of Charles I to Newcastle in 1633, 1639, 1641, 1646-7, with some notes on contemporary Local history', *AA*, 2nd ser., 21, 1899.

www.theblacketts.com – maintained by A.Kirtley

Thirsk, J., 'Industries in the Countryside' in F. J. Fisher (ed.), *Essays in the Economic and Social History of Tudor and Stuart England* (1961)

Thomlinson, W.W., *Denton Hall and its associations*, (1894)

'Chopwell Woods', *AA*, 2 ser, 19, (1898) Thrush, A., and Ferris, J.P., (eds) *History of Parliament: the House of Commons,* 1604-1629 (2010)

Trevelyan, C., *Wallington, Its History and Treasures*, (1930).

Turnbull, L., *Railways Before George Stephenson*, (2012)

Turner, M., Beckett, J., Afton, B., *Agricultural rent in England, 1690-1914*, (1997)

Welford, R., *History of Newcastle and Gateshead Vol 2 Sixteenth Century*, (1885)

History of Newcastle and Gateshead, Vol 3 *Seventeenth Century*, (1887)

Men of Mark 'Twixt Tyne and Tweed, (1895)

Wilson, J.F., *British business history, 1720-1994*, (1995)

Wood, A., *The Politics of Social Conflict, The Peak Country, 1520-1770*, (1999)

Wright, P.D., *Life on the Tyne: Water Trades on the Lower River Tyne in the Seventeenth and Eighteenth Centuries, a Reappraisal*, (2014)

'Shipping on the Tyne: The growth and Diversification of Seaborne Trade in the Eighteenth Century', in Green and Crosbie, *Economy and Culture, op cit*

'The Ballast Trade: An Economic Driver In Seventeenth And Eighteenth century Newcastle Upon Tyne', *Northern History*, (2020).

Wrightson, K., *Ralph Tailor's Summer: A Scrivener, His City and the Plague*, (2011)

Wrigley, E.A., *Early English Censuses*, (2011)

Wrigley, E.A, Davies, R., Oeppen, J., and Schofield, R., *English Population History from Family Reconstitution 1580-1837*, (1997)

Zyns, H., *England and the Baltic in the Elizabethan era*, (1972)