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I am submitting herewith a dissertation written by James Larry Smith entitled "Historical Geography of the Southern Charcoal Iron Industry, 1800-1860." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Geography.

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We have read this dissertation
and recommend its acceptance:

Accepted for the Council:

Vice Chancellor
Graduate Studies and Research

HISTORICAL GEOGRAPHY OF THE SOUTHERN CHARCOAL IRON INDUSTRY, 1800-1860

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

James Larry Smith

August 1982

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DEDICATION

This dissertation is dedicated to Diane Young Smith, whose extraordinary devotion, loving encouragement and assistance made this study possible.

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ABSTRACT

The purposes of this study are to show the changes in the pattern of pig iron production and to determine the role that competition in the iron trade and depletion of timber played in the demise of the southern charcoal iron industry. The study also examines the changing pattern of iron ore and charcoal consumption, size and economic components of the iron plantation, and labor necessary to conduct the industry. The compatibility of the industry and the agricultural regime is demonstrated, and markets for pig iron are identified. These topics are systematically discussed by iron district, including the (1) Virginia, (2) Western, (3) Hanging Rock, and (4) Upland South districts.

The dominant method employed is historical, covering the period from 1800 to 1860. However, a temporal transition into the postbellum period is employed for the Hanging Rock and Upland South districts. The basic sources of data are manuscript records of families engaged in the industry and the manuscript and published censuses. Maps, graphs, and tables are used extensively to give order to the manuscript data.

Pig iron production of the southern iron districts, accounting for 29% of the nation's output in 1840, represented a declining share of U.S. production during the 1840's. The causes and periods of decline differ for each iron district; however, competition in the iron trade was the overriding factor. The primary and secondary data overwhelmingly support the hypothesis that the demise could be largely explained by the inability of ironmasters to compete for markets.

Another cause commonly given for the industry's demise is the depletion of timber. This study, however, presents data to support the hypothesis that depletion of timber was a cause for the failure of furnaces at specific sites, but it was not a principal factor in the regional demise during the antebellum era.

Finally, the study concludes that the success of the southern charcoal iron industry was partly explained by its compatibility with the agricultural regime. In addition to coordinating iron making and farming, ironmasters were engaged in an interchange with the farmer and planter, giving rise to agricultural settlement and development.

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CHAPTER I

INTRODUCTION

Statement of the Problem

During the early years of settlement in this country, the iron industry played a significant role in rural and urban development. The industry supplied agriculture with necessary tools and implements, provided materials for the military, and contributed to the later growth of a modern urban-industrial society. The impact of the charcoal iron industry on the character of areas may not be readily perceivable today, but was of far greater significance than is commonly thought.

The details of the operation of most southern and western manufacturing enterprises are imprecisely and incompletely known.[1] The lack of understanding of the southern charcoal iron industry is not surprising, since its contribution appears insignificant upon cursory examination. However, the charcoal iron industry played an important role in southern economic development. Southern ironmasters produced a substantial proportion of the nation's iron, partially equipped the yeoman farmer and planter with bar iron, tools, and hollowware, provided employment for surplus slaves, and created a market for agricultural

---

[1]Fred Bateman, James D. Foust, and Thomas J. Weiss, "Large-Scale Manufacturing in the South and West, 1850-1860," Business History Review 45 (Spring, 1971), p. 2.

commodities. Thus, a thorough study of the 19th century southern iron industry is badly needed.[2]

This dissertation examines the southern charcoal iron industry and the role it played in the process of settlement and development. It places the southern iron industry into the broader framework of the development of the country's iron industry and presents some needed revisions concerning the importance of southern industry.

The study examines the resource base, i.e. the changing pattern of iron ore and charcoal consumption, the size and economic components of the iron plantation as an occupance type, and the labor necessary to conduct the business. The compatibility of the iron industry and the agricultural regime is also demonstrated, and the markets for pig iron are identified. These topics are systematically discussed for each iron district, illuminating the variable character of the southern iron districts.

The objectives of this study are: (1) to show the changes in pattern of iron production and discuss elements which fostered the change in pattern, and (2) to identify the intraregional contrasts that contributed to the distinctive character of the iron producing districts.

In addition to the objectives, the data were thoroughly examined in order to test the following hypotheses: (1) the depletion of timber for

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[2]Charles B. Dew, Ironmaker to the Confederacy, Joseph R. Anderson and the Tredegar Iron Works (New Haven and London: Yale University Press, 1966), p. 332.

charcoal shut some local ironworks down, but it did not cause the demise of the charcoal iron industry on a regional scale; (2) the existence of the southern charcoal iron industry is partially explained by the compatibility between the agricultural regime and the iron industry; and (3) the changing patterns of iron production, particularly the demise, are partly explained by the inability of the ironmasters to compete for markets.

A complete treatment of the rise and decline of the southern charcoal iron industry is beyond the scope of this study, because the industry was in operation over a broad area from early in the colonial period to the present century. The period covered here is from 1800 to 1860, and the region is that generally recognized as the South. As part of the national expansion, iron making developed in four iron districts or subregions, each the subject of a subsequent chapter. These were: (1) the Virginia Iron District, with a concentration in the Great Valley; (2) the Western Iron District, with a concentration in the Cumberland and Tennessee valleys; (3) the Hanging Rock Iron District of southeastern Ohio and northeastern Kentucky, including an outlier in Bath County and Red River area in east-central Kentucky;[3] and (4) the Upland South Iron District, comprising eastern Tennessee, western North and South Carolina, and northern Georgia and Alabama (Figure 1).

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[3]The Red River Iron District and Bath County are only peripherally discussed under the Hanging Rock Iron District, with the other outliers in central Kentucky included with the Western Iron District.

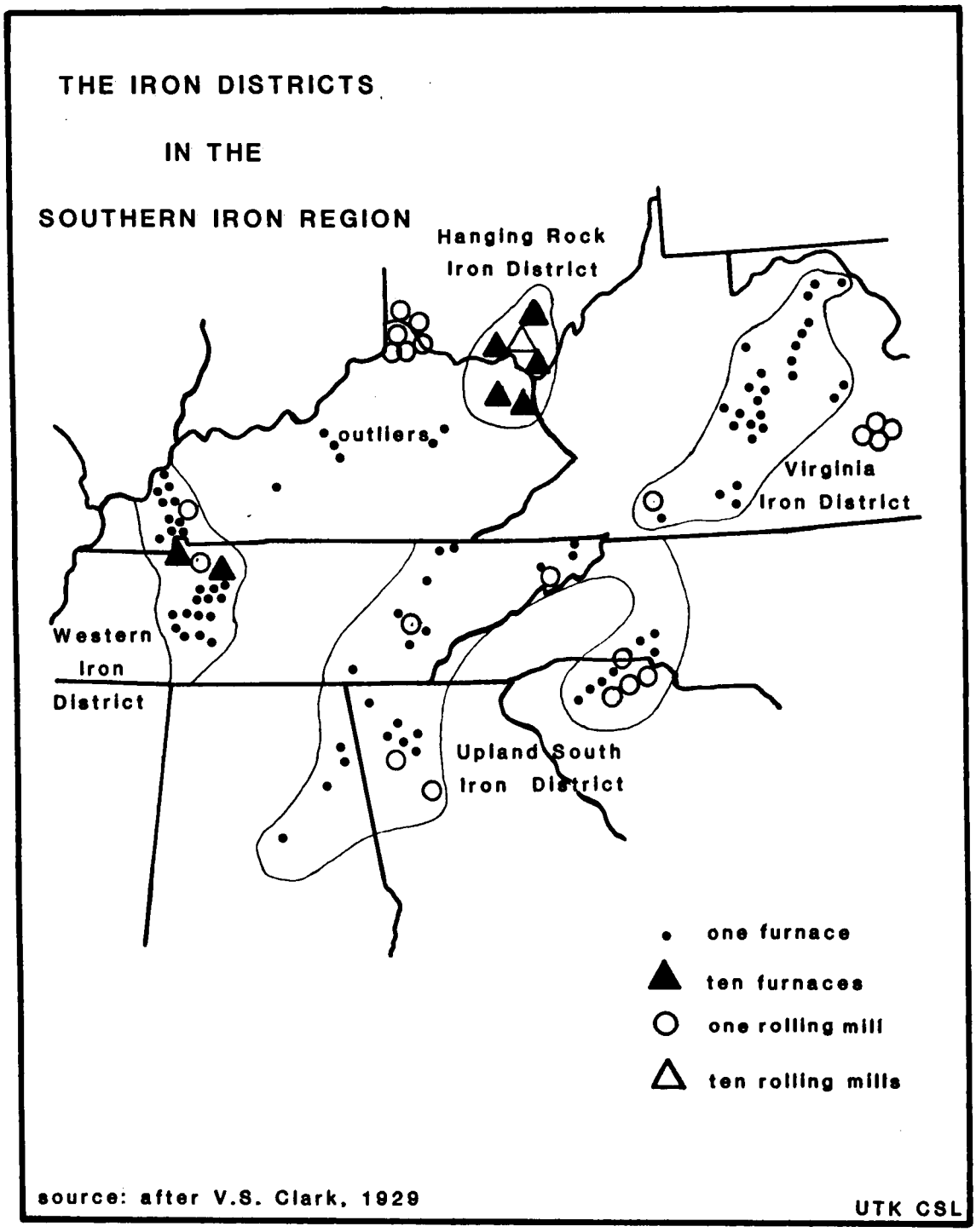

Figure 1. The Iron Districts in the Southern Iron Region.

The Southern Iron Region Defined

The major criterion employed to differentiate the southern iron districts from their northern counterparts is the persistence of pig iron made with charcoal fuel.[4] The balance of pig iron made with mineral fuels in the southern iron districts did not exceed that made with charcoal until 1877 (Figure 2). In contrast, as early as 1854, the first year the American Iron and Steel Association collected statistics, pig iron made with anthracite fuel amounted to over 46% of the total output of the United States, and including pig iron made with bituminous coal and coke, mineral fuels accounted for over 53% of the production in 1854.[5] A year later, pig iron made with anthracite coal alone exceeded that produced with charcoal fuel.

The northern boundary of the Southern Iron Region follows the Virginia state line to the Ohio River, excluding the northern panhandle of present-day West Virginia (Figure 1). The boundary then follows the Ohio River, except in the state of Ohio, where the region extends northward to include the Ohio section of the Hanging Rock Iron District. Thus, the Southern Iron Region includes southern Ohio, Kentucky, Tennessee, Alabama, Georgia, North Carolina, South Carolina, and Virginia, excluding the northern panhandle of the present state of West Virginia.

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[4] James M. Swank, Annual Report of the Secretary of the American Iron and Steel Association (Philadelphia: AISA, 1881), pp. 44-45.

[5] Swank, p. 60.

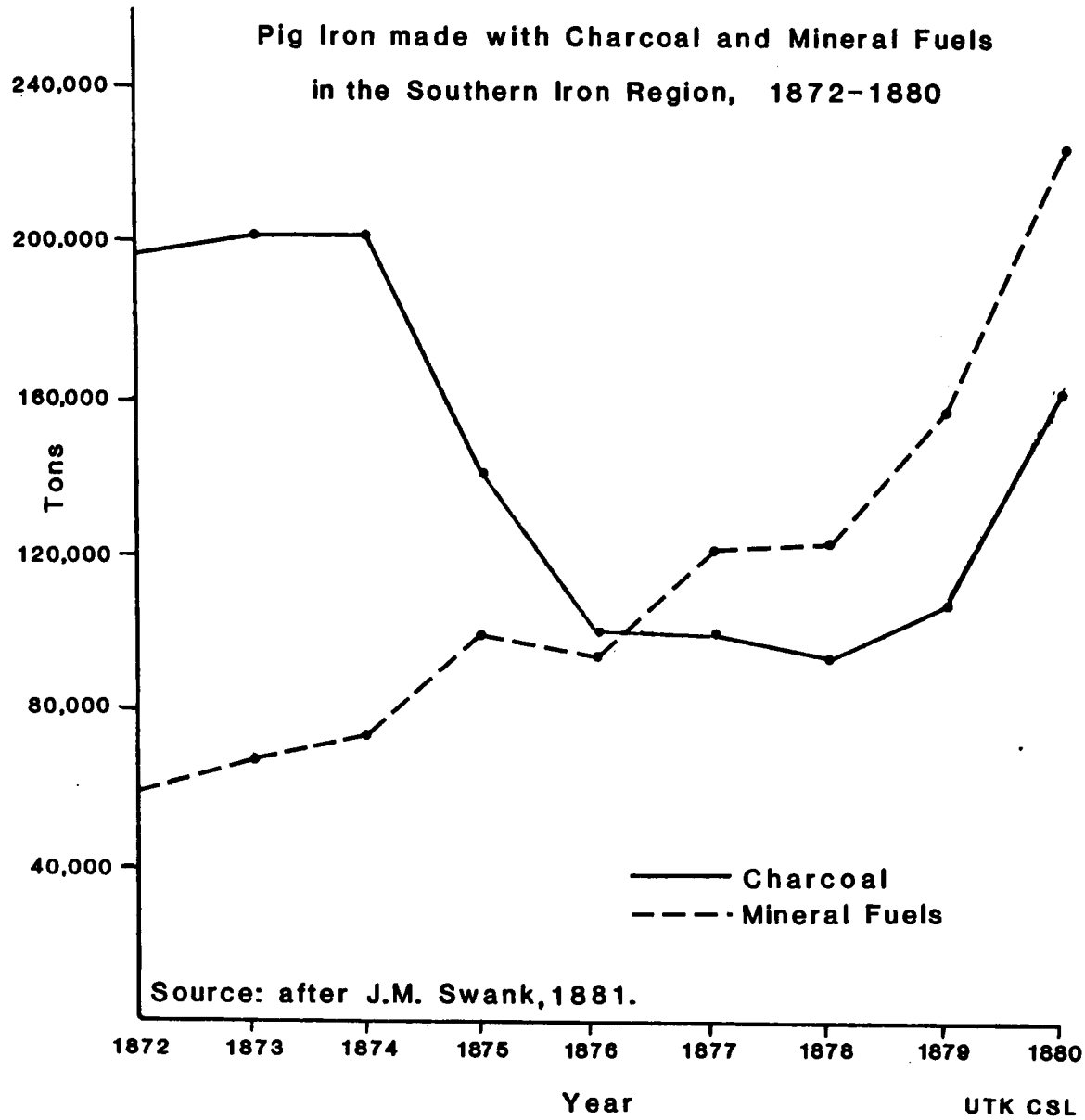

Figure 2. Pig Iron Made with Charcoal and Mineral Fuels in the Southern Iron Region, 1872-1880.

During the antebellum period, Wheeling, Virginia, was an iron using center rather than an area of pig iron production. Moreover, present-day West Virginia had only a small output of charcoal pig iron, and the portion of its iron industry located in the vicinity of the Monongahela River was more closely associated with the southwestern Pennsylvania region. As a consequence, this area is only peripherally treated under the Virginia Iron District.

The states of Mississippi and Florida had no pig iron production during the period of this study. Areas west of the Mississippi River that may be properly considered as part of the South by some authors either had a negligible production of pig iron or have been adequately covered by other researchers.[6] The iron industry of Maryland showed both northern and southern characteristics, but 19th century commentators included Maryland with the eastern Pennsylvania Iron District.[7] The adoption of innovations in Maryland was also more closely akin to eastern Pennsylvania. Thus, Maryland is excluded from consideration with the Southern Iron Region.

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[6]Arthur B. Cozzens, "The Iron Industry of Missouri," The Missouri Historical Review 35 (July, 1941), pp. 509-538; Arthur Cozzens, "The Iron Industry of Missouri," The Missouri Historical Review 36 (October, 1941), pp. 48-60; James D. Norris, Frontier Iron: The Maramec Iron Works, 1826-1876 (Madison: The State Historical Society of Wisconsin, 1964).

[7]John P. Lesley, The Iron Manufacturer's Guide to the Furnaces, Forges, and Rolling Mills of the United States (New York: John Wiley, 1859), pp. 748-749.

Methods and Procedures

The dominant method employed in this study is historical. The study covers the period from 1800 to 1860, although a temporal transition into the postbellum era is appropriately employed in the chapters on the Hanging Rock and Upland South iron districts. The geographic change through time is treated by both the cross-sectional and vertical approaches. A comparison of cross-sections reveals change, and explanation of change focuses on the processes involved in creating the spatial changes.[8]

Extensive use of maps, graphs, and tables gives order to a seemingly unmanageable volume of manuscript data. Graduated circles portray the distribution of iron production, while the pattern of iron sales is shown by schematic flow maps. When data were incomplete or missing, means were calculated for the phenomenon under investigation, and other information was drawn together for the purpose of making inferences. Finally, as intraregional variations became apparent, the comparative method was used to emphasize the varying character of areas.

Data Sources: Problems and Advantages

The two basic sources of data used in this study are manuscript collections of the various families engaged in the iron business and the

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[8]John Richard Moravek, "The Iron Industry as a Geographic Force in the Adirondack-Champlain Region of New York State, 1800-1971" (unpublished Ph.D. dissertation, The University of Tennessee, Knoxville, 1976), p. 11.

published and manuscript censuses. The writer conducted extensive research in manuscript materials, and the study was largely written from the information provided by these furnace and forge records.

Most of the statistical data used are those of the published and manuscript censuses. The 1810 statistics are taken from Tench Coxe, and data on the Hanging Rock District for 1832 are from the McLane Report.[9] Since the collection of manufacturing data for 1810 was an afterthought, the main purpose of the census being to collect population statistics, these data must be judged accordingly.[10] Statistics on manufacturing were gathered in 1830, but it was not until subsequent years that the scope and content of the censuses were greatly expanded. The census of 1840 is generally acknowledged to be unsatisfactory, and it contains the least reliable data for the antebellum period.[11] The basic procedures formulated for the 1850 census were also used in 1860 and 1870. Microfilm copies or the original schedules of the manuscript censuses for 1820, 1850, 1860, and 1870 are available at Duke University, the University of Kentucky, The University of Tennessee, and the State libraries of Alabama, Virginia, and Ohio. Of the original manuscript census schedules, Georgia is no longer available, while those for Tennessee and Ohio are incomplete for 1860.[12]

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[9]Tench Coxe, A Statement of the Arts and Manufactures of the United States of America, for the Year 1810 (Philadelphia: A. Cornman, 1814); United States Treasury Department. Documents Relative to the Manufactures in the United States (Washington, D.C.: D. Green, 1833); the latter source is hereafter referred to as the McLane report.

[10]Peter Temin, Iron and Steel in Nineteenth Century America: An Economic Inquiry (Cambridge: M.I.T. Press, 1964), p. 234.

[11]Temin, pp. 235-236.

[12]Bateman, Foust, and Weiss, p. 2.

The reasonably consistent format established in 1850 makes possible a comprehensive and systematic subregional comparison of iron making. The advantage of the manuscript censuses is that they provide data unavailable in the published censuses. Data on the production of iron by firm and county are largely taken from these manuscript schedules, as was information on raw materials consumed and type of power and machinery used. A bonus in using both the published and manuscript censuses is that comparison allows a determination of their reliability. Moreover, with an increasing knowledge of the iron industry, one learns to evaluate the competency of the census marshals, and consequently to judge the reliability of the data. In cases where numerical entries were suspect, this writer through simple calculations of the statistical data was able to infer what was presumably correct. Finally, the clerical errors made during the tabulation of manuscript data can be detected in the published censuses.

To supplement the 1850 and 1860 censuses, J. P. Lesley's Iron Manufacturer's Guide to the Furnaces, Forges, and Rolling Mills of the United States is extensively used for the middle 1850's. His production data for the mid-1850's have been generally found to be satisfactory, although they may not contain a complete listing of ironworks.[13] Nonetheless, the Guide is one of the most complete sources available.

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[13]Robert William Fogel, Railroads and American Economic Growth: Essays in Econometric History (Baltimore: The John Hopkins Press, 1964), p. 158.

The manuscript data used in this study are from a variety of sources, and they vary in reliability.[14] While problems and difficulties in using family papers and census data are formidable, they are not unsolvable. The American Iron and Steel Association production statistics were collected by calendar year, while the census year began June 1st and ended May 31st, and when both sets of data are used for consecutive years, it creates an over- or underestimate.[15] Moreover, the census statistics for 1810, 1840, 1850, and 1860 are in gross tons of 2,240 pounds, but those for 1870, 1880, and 1890 use the net ton of 2,000 pounds, which makes the transition period of this study more difficult to handle.[16] Unfortunately, complete sets of data for individual furnaces cannot be compiled over the course of time from the censuses, because ownership and partnership changes were so frequent and periods of furnace operation very sporadic. Fortunately, the data can be used on a county basis, but using the county as a statistical unit creates the additional problem of county boundary changes.[17] Finally, the coverage of family papers, business records, and other manuscript

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[14]Temin, pp. 233-245; Fogel, pp. 151-167.

[15]Temin, p. 243.

[16]James Moore Swank, History of the Manufacture of Iron in All Ages, and Particularly in the United States from Colonial Times to 1891 (2nd ed., Philadelphia: The AISA, 1892), p. 511.

[17]The base maps used in this study are those prepared by Birdsall and Florin supplemented by the USDA series; Stephen S. Birdsall and John W. Florin, A Series of County Outline Maps of the Southeastern United States for the Period 1790-1860 (Chapel Hill: UNC Department of Geography Map Study Number 2, 1973).

data is often incomplete over time and space.[18] When the temporal coverage of a particular group of family papers is limited, the manuscript censuses and J. P. Lesley's data are used to supplement them.

A purposeful search for the scattered manuscript collections was made. Family papers and other documents were extensively researched at the State libraries of Alabama, North Carolina, Ohio, Tennessee, Virginia, and West Virginia, the University of Virginia, the Virginia Historical Society in Richmond, Duke University, the Southern Historical Collection at the University of North Carolina, West Virginia University, The University of Tennessee, the University of Kentucky, the Filson Historical Society of Louisville, the Cincinnati public library, the Cincinnati Historical Society library, Ohio Historical Center in Columbus, Ohio University, and the Marietta College library in Marietta, Ohio.

These family papers and business records give a relatively good coverage for the Virginia and Hanging Rock iron districts, adequate for the Upland South District, and poor coverage for the Western Iron District. Fortunately, when manuscript records are weak for a particular topic in one chapter, they are strong in another.

Review of Literature

Despite the importance of the charcoal iron industry in settlement and development of this country, historical geographers have not yet

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[18] Alan R. H. Baker, John D. Hamshere, and John Langton, editors, Geographical Interpretations of Historical Sources (New York: Barnes and Noble, Inc., 1970), p. 15.

systematically researched it. This apparent neglect is especially true in regard to the southern charcoal iron industry. Only a few geographers have employed the historical approach in analyzing the charcoal iron industry, including Warren, Pounds, Roepke, DeVorsey, McManis, Kury, Muntz, Cozzens, Gillenwater, Moravek, Johnson, and Baber.[19] Their regional emphasis has been on the development of the industry in Great Britain, France, and the United States.

The regional studies in Great Britain and France offer some major findings and methodology which have been emulated in other regional

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[19]F. T. Baber, "The Historical Geography of the Iron Industry of the Forest of Dean," Geography 27 (1942), pp. 54-62; Norman J. G. Pounds, "Historical Geography of the Iron and Steel Industry of France," Annals, Association of American Geographers 47 (March, 1957), pp. 3-14; B. L. C. Johnson, "The Charcoal Iron Industry in the Early Eighteenth Century," Geographical Journal 117 (1951), pp. 167-177; Louis DeVorsey, Jr., "The Growth and Distribution of Iron Manufacturing in New Jersey, 1780-1860" (unpublished M.A. thesis, Indiana University, 1954); Mack Henry Gillenwater, "The Development of the Iron Industry in the Ashland, Kentucky, Area of the Hanging Rock Iron Region: A Study in Historical Geography" (unpublished M.A. thesis, Marshall University, 1958); Alfred P. Muntz, "Forest and Iron: The Charcoal Iron Industry," Geografiska Annaler 42 (1960), pp. 315-23; Howard G. Roepke, "Changes in the Distribution of the Iron and Steel Industry of Great Britain, 1720-1951" (unpublished Ph.D. dissertation, Northwestern, 1953); Theodore W. Kury, "Historical Geography of the Iron Industry in the New York-New Jersey Highlands: 1700-1900" (unpublished Ph.D. dissertation, Louisiana State, 1968); Howard G. Roepke, Movements of the British Iron and Steel Industry, 1720 to 1951 (Urbana: University of Illinois Press, 1956); Kenneth Warren, The American Steel Industry 1850-1870: A Geographical Interpretation (Oxford: Clarendon Press, 1973); Douglas R. McManis, "English Evaluation of North American Iron During the Late Sixteenth and Early Seventeenth Centuries," The Professional Geographer 21 (March, 1969), pp. 93-96; John Richard Moravek, "The Iron Industry as a Geographic Force in the Adirondack-Champlain Region of New York State, 1800-1971" (unpublished Ph.D. dissertation, The University of Tennessee, Knoxville, 1976); Arthur B. Cozzens, "The Iron Industry of Missouri," The Missouri Historical Review 35 (July, 1941), pp. 509-538; Arthur Cozzens, "The Iron Industry of Missouri," The Missouri Historical Review 36 (October, 1941), pp 48-60.

studies. F. T. Baber and Norman Pounds stressed that political, technological, and raw material developments were paramount in fostering changes in the pattern of iron production.

Baber presents a chronological treatment of the Forest Dean region between the Norman conquest and the early 1900's, his focus, however, is on the 17th and 18th centuries. He found that a decision by the government to release a plentiful supply of timber enabled Forest Dean ironmasters to cling to charcoal technology through 1800, while in contrast to Forest Dean, iron making in Kent and Sussex exhausted the timber supply between the 13th and 18th centuries. Baber concluded that during the 18th century it was the general shortage of raw materials that inevitably gave rise to a spate of invention which was directed toward replacing charcoal and waterpower with coal and steam power.[20] Unfortunately, the emphasis given to the depletion of timber and the resultant technological changes ignores other developments, such as the changing pattern of demand, which fostered changes in the pattern of iron production.

Pounds' study of the iron industry of France deals with a broader area, and his focus is on the regional patterns between 1789 and 1955. During the 18th century the major characteristic in the pattern of iron production was its wide distribution, and before 1840 the paramount factor in location was charcoal fuel. Pounds concluded that after 1860 a change in the French iron industry slowly came about, because of a

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[20]Baber, pp. 58-60.

repeal of a regulation requiring a license to begin an ironworks, the extension of the railway system creating a national market, the introduction of technological advances, and a tariff reduction causing the extinction of some lesser ironworking centers.[21]

B. L. C. Johnson departs from the approach taken by Pounds and Baber. His major source of data was family papers, which enabled him to show the relationship between the smelting industry and the market, particularly the demand generated by the forge. His research is essentially an economic geography of the patterns of production and iron trade in England and Wales between 1688 and 1717. Johnson concluded that while shortages of timber did occasionally occur, by and large it seems that furnaces and forges were well supplied with charcoal resources at the regional scale, a hypothesis under consideration in this dissertation.[22] This finding is contrary to that proposed by Baber and others. In a subsequent article, Johnson demonstrated the powerful influence that the Foley partnerships, which controlled about half the region's pig and bar iron production, had on the pattern of production and trade.[23]

A number of monographs, books, and articles treat the regional development of the iron and steel industry of the United States, and these studies provide background information for this study. Historians

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[21]Pounds, pp. 3-6.

[22]Johnson, pp. 167-177.

[23]B. L. C. Johnson, "The Foley Partnerships: The Iron Industry at the End of the Charcoal Era," in Geographical Interpretation of Historical Sources, ed. by Alan R. H. Baker and others (New York: Barnes and Noble, Inc., 1970), pp. 173-191.

and economists have been the most noteworthy contributors. Kenneth Warren's geographical interpretation and Peter Temin's economic inquiry are the best studies of the American iron and steel industry. Temin's book, Iron and Steel in Nineteenth-Century America: An Economic Inquiry, is the first to use the tools of modern economic analysis to explain the nature of the growth of the iron and steel industry,[24] and it provides invaluable background information for students of American economic development. However, it takes only an occasional and incomplete glance at the development of the southern iron districts.

Warren, in The American Steel Industry 1850-1870: A Geographical Interpretation, covers, at a broad scale of time and space, the development of a complex industrial organization. At his scale of investigation he was unable to make extensive use of manuscript collections of the early ironmasters, and depended mainly on published primary and secondary sources. He gives a balanced treatment of ways in which resources, markets, entrepreneurs, organization, technology, and governmental policy resulted in changes in the patterns of iron production. His major focus was on spatial change, and his aim was to account for the present pattern and to provide a case study of locational change in a major manufacturing industry.[25] Warren states that to accomplish these objectives he neglected two major lines of inquiry, the landscape-shaping and region-forming consequences of growth and change in a basic

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[24]Temin, jacket cover.

[25]Warren, p. viii.

industry and the comparison and contrast of the American pattern with that of other countries.[26]

In his treatment of the iron industry during the antebellum era, Warren quotes only two works by geographers, an article by Langdon White and a doctoral dissertation by Allan Rodgers.[27] However, a number of regional studies were available to Warren, including those by Kury, Muntz, Wacker, and Cozzens. Without the benefit of regional studies at various scales to develop basic understandings of the charcoal iron industry, Warren made some important errors. He mistakenly states that the supply of charcoal for a blast furnace might annually require the produce of 2,000 to 5,000 acres of woodland, a figure perhaps ten times too large.[28] In a discussion of the southeastern Ohio area, Warren states that the ". . . prospects seemed very bright for a time in the Hanging Rock district of the Scioto Valley of Ohio and Adams and Greenup County, Kentucky."[29] In fact, however, Adams County, Ohio, is located west of the Hanging Rock District proper, and the location of the furnaces was east of the Scioto Valley. Moreover, Warren assumes that Lesley's Iron Manufacturer's Guide . . . was a complete listing of furnaces, and he dates the maps as if the data were enumerated in 1859. Lesley's inquiry, however, took place between 1854 and 1857, reflecting the status of furnaces, forges, and rolling mills between these dates. While these errors do not harm the overall value of his study, they do

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[26]Warren, p. vii.

[27]Warren, pp. 1-87.

[28]Warren, p. 11.

[29]Warren, p. 52.

point to the need for other studies at the space and time scale of this dissertation.

Geographers have given some attention to charcoal iron regions, but none has focused on the entire Southern Iron Region. Arthur Cozzens gives a fairly complete treatment of the iron industry of Missouri from its origin to the 20th century. The purpose of Kury's study of the New York-New Jersey Highlands was to examine landscape change and evaluate a pioneer activity.[30] He refutes the commonly held generalization that following the demise of the region's iron industry there was subsequent agricultural settlement, i.e. there was no iron maker-farmer sequence in settlement. Instead, the abandonment of a manufactory led to the general depopulation of the surrounding lands.[31] His work details the size, functional components, trade, labor, and resources of the iron plantation. He does not emphasize the consumption of resources, and devotes minimal effort to demonstrating regional variations. Finally, while Kury mentions the trade relationship between the furnace and farm, he does not give a quantitative estimate of the impact that iron making had on agriculture. While these latter inquiries were not the major objective of Kury's work, he alludes to them in a general way, using qualitative data.

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[30]Theodore W. Kury, "Historical Geography of the Iron Industry in the New York-New Jersey Highlands: 1700-1900" (unpublished Ph.D. dissertation, Louisiana State University, 1968; Kury's dissertation is partly published in a series of articles in Pioneer America.

[31]Theodore W. Kury, "Early Settlement in the Highlands: An Iron Maker-Farmer Sequence?," Pioneer America 2 (January, 1970), pp. 7 and 12-13.

Muntz and Wacker have also treated the New York-New Jersey Highlands region. The primary focus by Muntz is the iron industry's role in alteration of natural vegetation in the New Jersey Highland, and Wacker's findings are similar to those of Kury. Finally, Kohn demonstrates that numerical change in population in the Katahdin, Maine, area during the last half of the 19th century and the first part of the 20th century was largely due to fluctuations in the iron industry.[32]

Louis DeVorsey's study, "The Growth and Distribution of Iron Manufacturing in New Jersey, 1780-1860," deals largely with the 19th century, but includes a retrospective discussion of the colonial period.[33] He uses three cross-sections, 1783, 1832, and 1857, with the latter covering the anthracite era. While changes in the pattern of iron production are discussed, they are not emphasized, since each cross-section is treated separately. Gillenwater's study focuses on the Ashland, Kentucky, area, which is only a small part of the Hanging Rock Iron District.[34] Both studies are based on standard sources for their region, as manuscript collections did not serve as a major source of data.

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[32]Moravek, p. 5-6.

[33]Louis DeVorsey, Jr., "The Growth and Distribution of Iron Manufacturing in New Jersey, 1780-1860" (unpublished M.A. thesis, Indiana University, 1954).

[34]Mack Henry Gillenwater, "The Development of the Iron Industry in the Ashland, Kentucky, Area of the Hanging Rock Iron Region: A Study in Historical Geography" (unpublished M.A. thesis, Marshall University, 1958).

One of the most thorough regional treatments of the iron industry is Moravek's study of the Adirondack-Champlain region. His chief objectives were to determine the nature and extent of the impact of the iron industry of the region through time and to provide a historical geography. His major sources of data were primary and secondary materials, but heavy emphasis was given to newspapers and state and U.S. censuses. Manuscript collections, i.e. family papers, did not serve as a major source in his research.[35]

Presently the history and geography of the southern charcoal iron region can be only partially pieced together from monographs and articles. Sources too numerous to cite here provide a substantial body of information and give valuable insight into the history of the subregions, with each source being appropriately used in the text of this dissertation. Lester J. Cappon's work was particularly helpful on all the iron districts.[36] The sources most helpful on the Virginia District are those written by Charles B. Dew, Samuel S. Bradford, Kathleen Bruce, and Francis R. Holland, Jr.[37] Ethel Armes' work on the

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[35]John R. Moravek, "The Iron Industry as a Geographic Force in the Adirondack-Champlain Region of New York State, 1800-1971" (unpublished Ph.D. dissertation, The University of Tennessee, Knoxville, 1976).

[36]Lester J. Cappon, "History of the Southern Iron Industry to the Close of the Civil War," unpublished manuscript, University of Virginia Manuscript Section; Lester J. Cappon, "Trend of the Southern Iron Industry Under the Plantation System," Journal of Economic and Business History 2 (1929-1930), pp. 353-381.

[37]Dew, Ironmaker to the Confederacy; Samuel S. Bradford, "The Ante-Bellum Charcoal-Iron Industry of Virginia" (unpublished Ph.D. dissertation, Columbia University, 1958); Samuel S. Bradford, "The Negro Ironworker in Ante Bellum Virginia," Journal of Southern History 25 (May, 1959), pp. 194-206; Kathleen Bruce, Virginia Iron Manufacture in

Alabama iron industry, E. M. Lander's article on South Carolina and Cappon's study on North Carolina were the most helpful sources on the Upland South District.[38] The basic sources on the Hanging Rock Iron District were those written by Wilbur Stout, Vernon D. Keeler, and F. H. Rowe.[39] Unfortunately, few primary and secondary sources exist for the Western Iron District.

These iron districts are discussed in subsequent chapters. But first, to assist the reader in understanding the Southern Iron Region and placing it in the broader context of the nation's industry, processes of iron manufacture, trends in iron production, and the changing patterns are discussed in the next chapter.

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the Slave Era (New York: The Century Company, 1930); Kathleen Bruce, "Slave Labor in the Virginia Iron Industry," William and Mary Quarterly 6 (October, 1926), pp. 289-302; Francis R. Holland, Jr., "Three Virginia Iron Companies, 1825-1865" (unpublished M.A. thesis, University of Texas, 1958).

[38]Ethel Armes, The Story of Coal and Iron in Alabama (Birmingham, Alabama: The Book-Keepers Press, 1972); Ernest M. Lander, Jr., "The Iron Industry in Ante-Bellum South Carolina," Journal of Southern History 20 (August, 1954), pp. 337-355; Lester J. Cappon, "Iron-Making--A Forgotten Industry of North Carolina," North Carolina Historical Review 9 (October, 1932), pp. 331-348.

[39]V. D. Keeler, "An Economic History of the Jackson County Iron Industry," The Ohio Archaeological and Historical Quarterly 42 (April, 1933), pp. 133-237; Wilbur Stout, "The Charcoal Iron Industry of the Hanging Rock District--Its Influence on the Early Development of the Ohio Valley," Ohio Archaeological and Historical Quarterly 42 (January, 1933), pp. 72-104; Frank H. Rowe, History of the Iron and Steel Industry in Scioto County, Ohio (Columbus: Ohio State Archaeological and History Society, Volume 10, 1938).

CHAPTER II

THE RISE AND CHANGING PATTERN OF THE IRON INDUSTRY, 1620-1858

Processes of Iron Manufacture

Iron ore was converted into bar iron by one of two processes. In the direct process the ore was heated in a bloomery forge until a lump of impure iron called a bloom was formed. Alternate reheating and hammering refined the bloom into wrought or bar iron of various shapes. The bloomery forge was located in relatively isolated areas, and it produced a small quantity of iron for the local market.

In the indirect process two separate stages were required to make bar iron; the blast furnace made pig iron from the ore, and the refinery forge and/or rolling mill fabricated the pig into bar iron. In addition to being cast into pigs, the ironmaster could also cast the molten metal into a variety of hollowware and castings.

Market Structure and Stages of Development of the Blast Furnace

Trans-Appalachian pioneers brought bar iron with them, because it was essential for frontier life. Work animals had to be shod, wagons repaired, and farm implements and tools fashioned.[1] Household items

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[1]H. H. Chapman, The Iron and Steel Industries of the South (Birmingham: University of Alabama Press, 1953), p. 98; James Bowron, "The History of the Iron and Steel Industry in the South," Yearbook of the American Iron and Steel Institute (New York: AISI, 1914), pp. 466-468.

such as pots, kettles, skillets, and other castings and hollowware were also in demand. However, the difficulties of transporting iron products made it necessary for blast furnaces and forges to supply local markets with local manufactures.[2] These early iron making enterprises in the Southern Iron Region were designed to meet the diversified needs of the local, isolated areas struggling to develop and maintain an agrarian economy.[3]

During the first quarter of the 19th century, the blast furnaces in the Southern Iron Region sold their castings and hollowware directly to the consumer and merchant and their pig iron largely to the rural forge. The development of the foundry and rolling mill in urban areas created additional markets for pig iron, and these urban manufacturers began to produce a range of ironware similar to that of the rural furnace and forge.

The traditional method of refining pig into bar iron was to reheat and hammer it at the forge to remove the carbon. This could also be accomplished by puddling and rolling it at the rolling mill. A low wall in a reverberatory furnace separated the iron from the fuel in the puddling process, and the labor involved stirring or puddling the iron through ports in the wall of the furnace. Higher temperatures were obtained in puddling, and it was soon discovered that iron could be

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[2]Bowron, p. 467; Arthur Lippincott, A History of Manufacturing in the Ohio Valley to the Year 1860 (New York: Knickerbocker Press, 1914), p. 194.

[3]Chapman, p. 99.

rolled instead of hammered into bar iron.[4] As a result, the rolling mill gradually replaced the rural forge. The other major urban market was the foundry, which recast pig iron into stoves and other castings.

The pattern of production and consumption of the primary and secondary iron manufactures changed during the course of time. Three stages in the changing pattern can be identified, but they cannot be dated with any great precision.[5] In the first stage (to the 1830's) the blast furnace produced pig iron, castings, and hollowware, including skillets, pots, kettles, dutch ovens, tools, implements, and other household utensils, while the forges made bar iron of various descriptions for the artisan and craftsman. The blast furnace supplied the forge with pig iron, and the castings and hollowware were sold locally to merchants and farmers. Iron products sold outside the local area were generally secondary manufactures, such as bar iron, blooms, castings, and nails, which sold for much higher prices than pig iron.

The second stage overlapped the first and was characterized by the establishment of foundries and rolling mills in urban centers which had a close linkage to both agricultural hinterlands and urban consumers. Iron districts accessible to water and/or rail transportation produced fewer castings and hollowware for the local market and shipped more pig iron to the urban rolling mills and foundries. In addition to pig iron,

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[4]Peter Temin, Iron and Steel in Nineteenth Century America: An Economic Inquiry (Cambridge: M.I.T. Press, 1964), p. 16-19 and Chapter 5.

[5]The idea for these stages was taken from Lippincott and Cozzens. Lippincott, p. 98; Cozzens, p. 45.

some rolling mills also used bloom iron, which was fabricated from pig metal at a rural forge. The rolling mills produced a variety of iron products, including merchant bar, iron plate, boiler plate, sheet, and nails. The foundries and machine shops made engines, stoves, mill equipment, and other castings.

Between the second and third stages there were some changes in the supply and demand of crude iron. During the 1830's the demand at rolling mills was dominated by bloom iron, but by 1850, 85% of the rolled iron in Pittsburgh was made directly from pig rather than bloom iron.[6] While the consumption at rolling mills was shifting toward pig iron, wrought iron production was also experiencing a relative decline. In 1830 about 85% of the pig iron production was destined to be converted into wrought iron; by 1850, this proportion had fallen to less than half, remaining at about this proportion until the end of the Civil War.[7]

Meanwhile, the makers of iron castings were using more pig iron, and by 1856 the foundries in the U.S. were consuming nearly 42% of the

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[6]Alfred D. Chandler, Jr., "Anthracite Coal and the Beginnings of the Industrial Revolution in the United States," Business History Review 46 (Summer, 1972), pp. 160-161; Louis C. Hunter, "The Influence of the Market Upon Technique in the Iron Industry in Western Pennsylvania," The Journal of Economic and Business History 1 (February, 1929), pp. 247-251; Louis C. Hunter, "Factors in the Early Pittsburgh Iron Industry," in Facts and Factors in Economic History (Howard University Press, 1967), p. 433.

[7]Temin, pp. 26-27.

nation's pig iron production.[8] This trend was the result of various influences, including (1) the ease with which cast iron could be shaped, (2) its greater rigidity in small machine parts, (3) its greater strength in larger structural items, and (4) the changing nature of products in demand.[9] The trend of production toward castings had been reversed by 1870, however.[10] American iron makers returned to the production of wrought iron when the demand for castings decreased and when they were in a better position to compete with British wrought-iron imports.[11]

In the third stage (1830's-1850's) of the changing pattern of production and consumption, pig iron became the dominant commodity. The growing number of foundries and machine shops used greater quantities of pig iron, and the rolling mills increasingly used pig iron in place of blooms. The blast furnaces in some iron producing districts eliminated their casting and hollowware business, exclusively making pig iron for the larger standardized urban market.

A charcoal iron district could begin in any of the three stages of development. Some districts retained the characteristics of a particular stage throughout, while others progressed full circle and in their decline assumed characteristics of an earlier stage. In summary, in the

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[8]John P. Lesley, The Iron Manufacturer's Guide to the Furnaces, Forges, and Rolling Mills of the United States (New York: John Wiley, 1859), p. 761; Temin, pp. 26-27.

[9]Temin, pp. 28 and 44.

[10]Temin, p. 28.

[11]Temin, p. 29.

first stage the ironmaster produced a diversity of ironware, including castings and hollowware for the merchant and farmer and pig iron for the rural forge. In the second stage, the ironmaster made greater quantities of pig iron and fewer castings and hollowware. Finally, in the third stage, the ironmaster concentrated on the manufacture of pig iron.

The Iron Plantation

Blast furnaces throughout the Southern Iron Region operated at different scales of production. According to E. P. Douglas, by the mid-18th century there were three types of ironworks.[12] The first type was the isolated country furnace and/or forge that operated six months or less, producing up to a few hundred tons of cast or bar iron for the local population. The second type, the iron plantation, was situated close to water transportation and sold its surplus ironware in more distant markets. A third type, situated near the tidewater, was comprised of a few large plantations with more than one blast furnace, making products mainly for export. During the period of this study the first two types, the country furnace and/or forge and the iron plantation, were the most common in the Southern Iron Region.

The iron plantation originated during the colonial period in southeastern Pennsylvania and spread westward to the Monongahela

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[12]Elisha P. Douglas, The Coming of Age of American Business: Three Centuries of Enterprise 1600-1900 (Chapel Hill: UNC Press, 1971), pp. 261-264.

country, Ohio, Kentucky, and Missouri.[13] The occupance type also spread to other southern iron districts. The elements of the iron plantation were essentially those enumerated by Merle Prunty in his definition of the agricultural plantation.[14] In modified form these criteria include (1) a large landholding, (2) a distinct division of labor and management functions with management in the hands of the ironmasters, (3) a specialized industrial production, and (4) a distinctive settlement form and spatial organization reflecting centralized control by the owner.

The Blast Furnace

The owner usually constructed the blast furnace, which ranged from 25 to 40 feet in height, against a hillside, creating an upper and lower level (Figure 3). Iron ore and limestone were piled in the open on the upper level, and the charcoal and other supplies were stored in sheds. A bridge or shed connected the storage yard with the open top of the furnace, where workmen charged the furnace by depositing baskets of ore, charcoal, and limestone. At Cassandra furnace in Virginia the workmen made thirty-five charges in a 24-hour period, with each charge consisting of 14½ boxes of iron ore (790 pounds), six baskets of charcoal (15 bushels), and two boxes of limestone (134 pounds).[15] At the base of the

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[13]Arthur Cecil Bining, "The Iron Plantations of Early Pennsylvania," Pennsylvania Magazine of History and Biography 57 (April, 1933), pp. 117 and 137; Cozzens, pp. 518-519.

[14]Merle Prunty, Jr., "The Renaissance of the Southern Plantation," The Geographical Review 45 (October, 1955), p. 460.

[15]Letter, T. H. Burns to F. T. Anderson, February 2, 1852, Duke University, F. T. Anderson Papers.

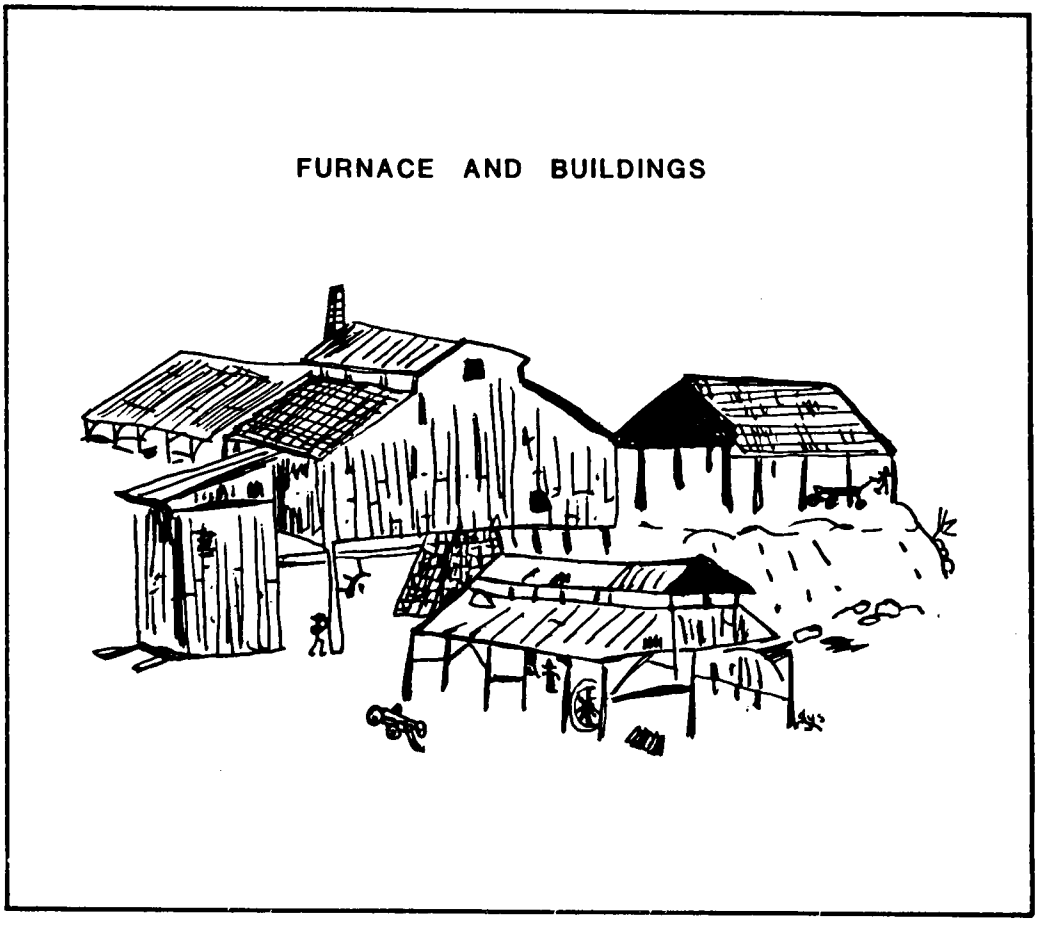

Figure 3. Furnace and Buildings.

furnace on the lower level was the casting house, where the molten metal was cast into pigs. Other buildings of the furnace community included workmen's homes, a store, school, church, and other structures which housed the machinery, equipment, and other economic components.

The blast furnace stack was square at the base, sloping inward as it rose and had an outer wall and inner lining (Figure 4).[16] The outer wall was built of hugh hand-hewn sandstone blocks, while the inner part of the stack was lined with a fine-grained sandstone or fire brick. The space between outer wall and inner lining was filled with sand and sandstone rubble which partly served as insulation.

The shape of the inner lining allowed a constant downward flow of the charge, with the widest point, known as the bosh, measuring about nine feet across.[17] Waterpower or steam power was used to force air into the molten metal by means of a tuyere or opening near the bottom of the stack. As the molten metal settled to the bottom of the furnace, it was periodically drawn off and cast into pig iron.

Forward and Backward Integration

Some blast furnaces were integrated forward; their pig iron was fabricated by the same firm's forge and/or rolling mill. Forward integration favored the location of furnaces in proximity to the secondary iron manufactures; hence, spatial clusters developed. However,

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[16] H. R. Collins and D. K. Webb, Jr., "The Hanging Rock Region of Ohio," (Columbus: The Ohio Historical Society, no date); Eliot Wigginton, ed., Foxfire 5 (Garden City, New York: Anchor Press/Doubleday, 1979), p. 78.

[17] Temin, p. 58.

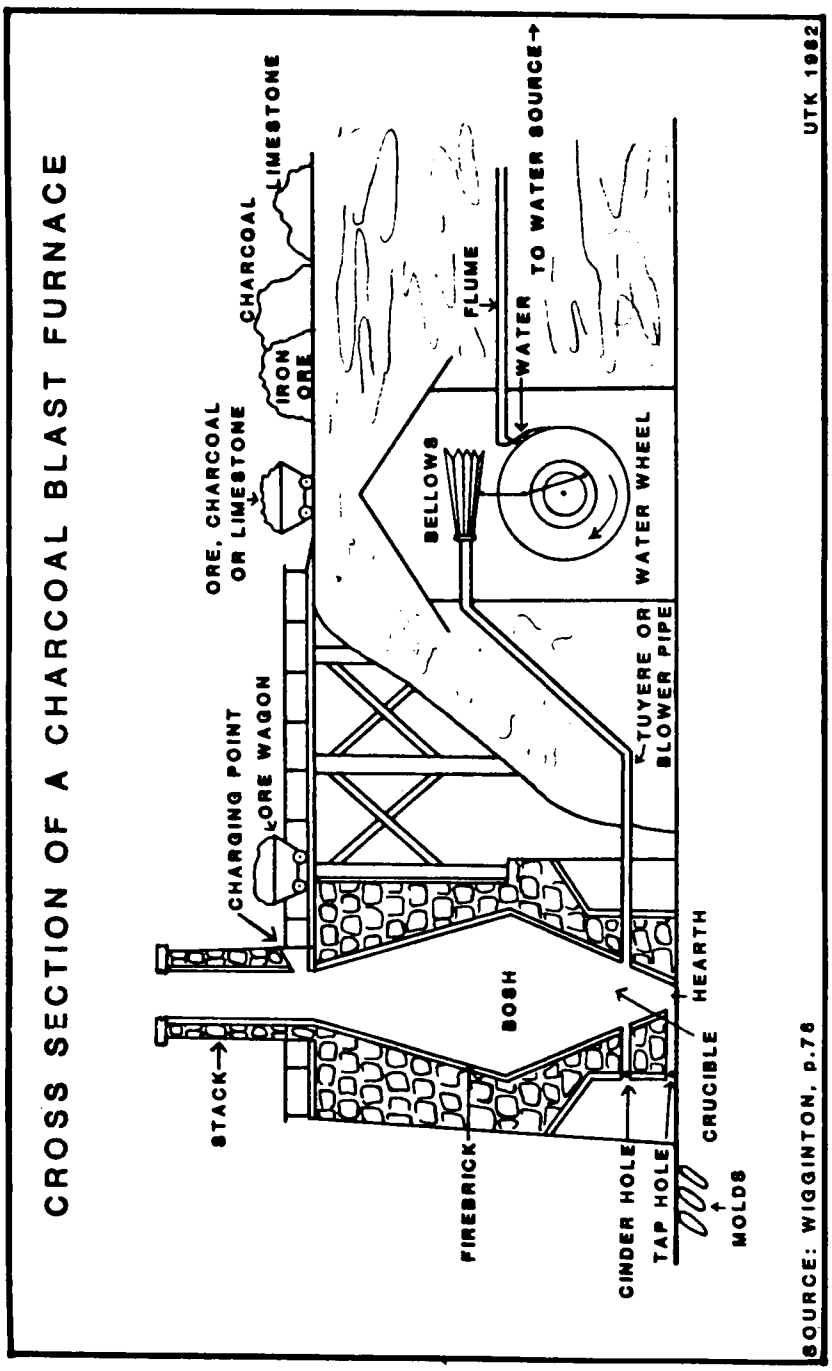

Figure 4. Cross Section of a Charcoal Blast Furnace.

the demand for charcoal fuel and inadequate waterpower at one site often encouraged areal separation of the ironworks.[18]

An integrated firm gave the ironmaster certain production, service, and trade advantages. The ironmaster was able to supply pig iron to his forge and/or rolling mill. Service linkages between the branches of manufactures, including the exchange of supplies, labor, draft animals, bar iron, machinery and other ironware to maintain the iron plantation, were beneficial as well. The ironmaster also minimized costs by transacting business for each sector of the integrated firm, including sales through commission merchants, slave hiring, and transportation of products. Finally, an integrated firm produced a greater variety of ironware, which may have led to a greater degree of success in the iron trade.

Grosse found that less than 20% of the blast furnaces in 1820 were integrated with a forge, with the data from the McLane report on western Pennsylvania suggesting about the same proportion. The firms studied for 1857 also showed approximately the same proportion.[19] In subsequent discussions concerning the southern iron districts, data are presented which suggest a spatial and temporal variation in the degree of forward integration described here.

In contrast to forward integration, iron plantations were almost universally integrated backward, i.e. the ironmaster provided his own

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[18]The other reasons for areal separation were the demand for pig iron for use in making castings and the location and shortage of capital in the charcoal iron industry; Temin, pp. 93-94.

[19]Temin, p. 94.

raw materials.[20] The large consumption of raw materials necessitated that the ironmaster administer a large landholding in order to insure a timely supply of iron ore, charcoal, and limestone. As a consequence, the blast furnaces, especially those linked with a forge and/or rolling mill, were among the largest industrial establishments with respect to capital investment, employment, and size of landholding.

Importance of the Raw Material Base as a Location Factor

The blast furnace needed to be situated close to its raw materials, and the scale of production was limited by the narrow radius from which the raw materials were assembled. When the timber supply, or less frequently the ore supply, within economic reach was exhausted, the blast furnace was dismantled.[21]

Before commencing the season's blast, it was desirable to have a sufficient quantity of raw materials assembled. A Virginia ironmaster suggested to his brother that he ought to be careful until he had a good stockpile, since ". . . it (is) a bad policy to go into blast before you are ready."[22]

An examination of the location requirements for blast furnaces indicates a temporal variation in importance of raw materials. In the

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[20]Temin, pp. 90-93.

[21]Hunter, "Factors in the Early Pittsburgh Iron Industry," p. 435.

[22]Letter, John Anderson to Dear Brother (F. T. Anderson), February, 1958 or 1859, Duke University, F. T. Anderson Papers.

charcoal era, ore deposits and forests were so widely distributed in America that, at the regional level, the location and extent of iron making were not primarily determined by the presence of raw materials.[23] Nonetheless, the major expense in iron making was the cost of procuring and assembling raw materials, which occasionally dictated success or failure of iron making at specific sites. One 19th century ironmaster suggested that the expense of manufacturing iron varied widely, depending upon the nearness of the timber supply, character of terrain where cutting and coaling took place, distance to the ore banks, expense of raising ore, percentage of iron content in the ore and its freeness from sulphur and sand, and the cost of labor.[24] In addition, waterpower sites, the extent of the local market, and the accessibility to distant markets were of paramount importance in successfully conducting the iron business.

Iron Ores in the Southern Iron Region

Iron ores of varying composition and structure were scattered throughout the Southern Iron Region (Figure 5). Magnetite ore (magnetic oxide, Fe_3O_4) contained over 72% metallic iron and occurred as veins in

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[23]Victor S. Clark, History of Manufactures of the United States, 1607-1860, Volume I (New York: McGraw-Hill, 1929), p. 328.

[24]Letter, Colonel Thomas Shanks to Joseph C. Cabell, 1845 in the Annual Report of the President to Stockholders of the James River and Kanawha Canal, December, 1845, p. 89.

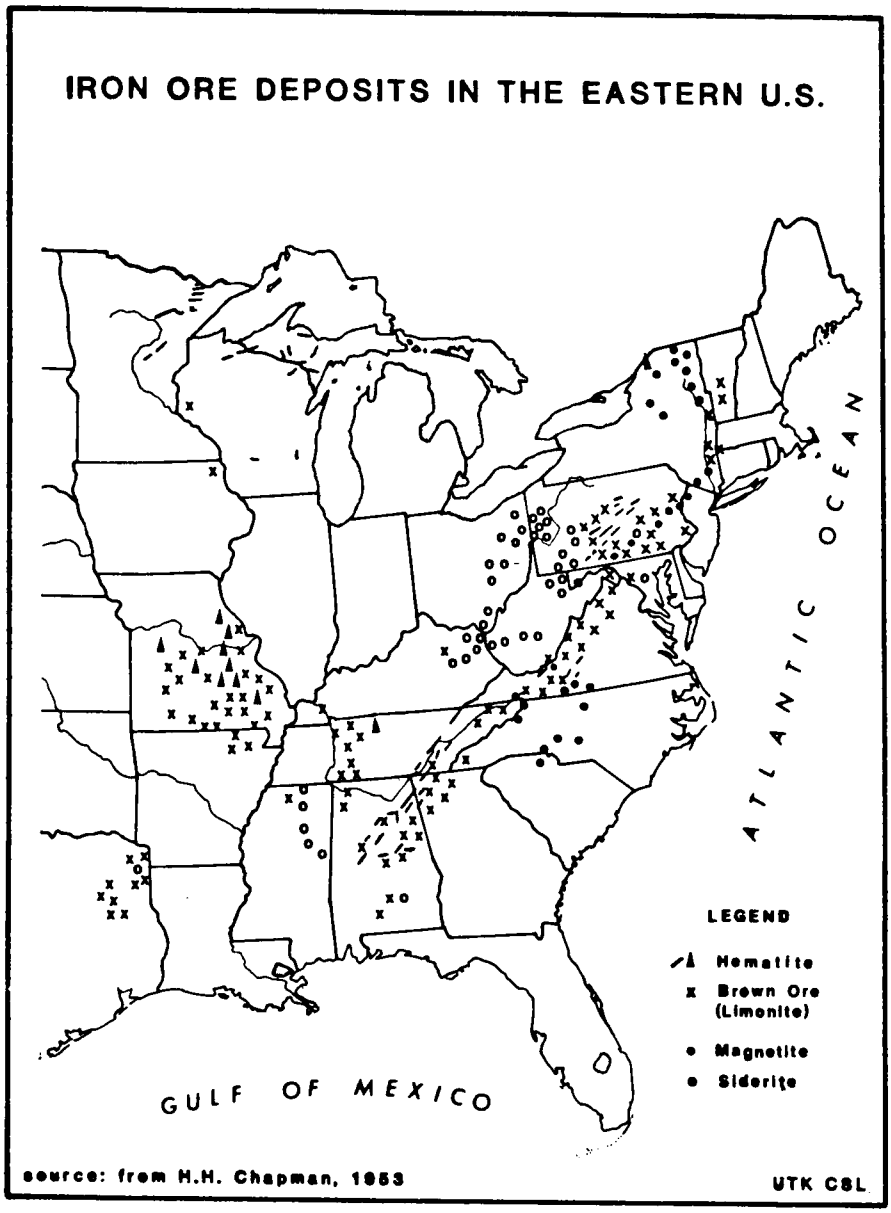

Figure 5. Iron Ore Deposits in the Eastern United States.

the crystalline rocks of the Carolina and Virginia piedmont and in the mountains of east Tennessee and northwestern North Carolina.[25]

Red hematite ores were the most striking in extent and regularity of occurrence, with an iron content that could exceed 60%, although the southern deposits rarely contained much over 40% iron. These hematite ores were primarily located along the Cumberland Plateau from Virginia to Alabama where it terminated in Red Mountain. The hematite strata were closely associated with limestone, shale, and sandstone; ore was buried beneath the associated deposits in some places and exposed above them in others.[26] Above the water table the calcium carbonate was leached out to produce a "soft ore," higher in iron content, and more easily worked than the "hard ore." The hard ore was located below the soft and was little used so long as the soft ore was plentiful.[27]

Closely related to the red ores were the limonites (brown ferric oxide, Fe_4O_3--H_2O). Limonite ore contained about 14% water in chemical combination; its metallic iron content was 60%, except in southern deposits, where it fell well below 50%. The ore, usually occurring in pockets of irregular shape and uncertain extent, was either associated with limestone or clay and chert in areas where limestone had been worn

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[25]Lester Cappon, "History of the Southern Iron Industry to the Close of the Civil War," unpublished manuscript, p. 4, University of Virginia, Cappon.

[26]Cappon, unpublished manuscript, p. 5.

[27]Cappon, unpublished manuscript, p. 5; Ernest F. Burchard, The Red Iron Ores of East Tennessee (Nashville: State of Tennessee Geological Survey Bulletin 16, 1913), p. 75.

away. Along with bog ore, the colonists worked limonite very early, and the most important and valuable deposits were scattered throughout the Appalachian ridges and valleys, along the Blue Ridge, and Unakas extending into northern Alabama (Figure 5).[28] Limonite was also exploited in central Kentucky, but its most notable 19th century development was in the Western Iron District.

A fourth class of ores consisted of the carbonates or siderites ($Fe\ CO_3$) which were relatively low in iron content, usually under 40%. Siderite, occurring in beds of varying thickness, was closely associated with coal measures of a wholly bituminous character. The most noteworthy exploitation of these ores was in the Hanging Rock Iron District.[29]

Charcoal Fuel

The charcoal iron industry was a fuel intensive industry, and supplying and processing timber into charcoal were foremost in the provision of raw materials. After curing, the wood possessing the lowest water content was the best for making charcoal, and that producing the heaviest charcoal made the most iron.[30] Hardwoods were the most desirable, because charcoal made from soft wood would not support the

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[28]Cappon, unpublished manuscript, p. 6.

[29]Cappon, unpublished manuscript, p. 6.

[30]Cappon, unpublished manuscript, p. 34; G. Troost, Fifth Geological Report (Nashville: J. George Harris, 1840), p. 37.

burden of the furnace charge as well.[31] Species of oak (red, white, black, and chestnut), maple, and ash were especially good for charcoal; but hickory, walnut, white pine, spruce, and other species were also used.[32]

Although timber was cut the year-round, it was primarily supplied during the winter season.[33] In the Virginia District, for example, nearly two-thirds of the cordwood was procured between November and April.[34] However, the pattern of woodcutting varied from time to time, depending on the type of ironworks, weather conditions, and coordination of other functions.

Charcoal hearths. The hearths were prepared in advance of the blast, and the forthcoming blast generally governed when the coaling took place. Preparation of the hearth involved clearing a circle of

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[31]Letter, Charles K. Gorgas to Uncle (William Weaver), November 29, 1857, Duke University, William Weaver Papers.

[32]Cappon, unpublished manuscript, p. 34; Troost, Fifth Report, p. 37; Letters, Charles Gorgas to William Weaver, March 24, 1859; W. W. Rex to Uncle (William Weaver), January 8, 1861, University of Virginia, Weaver-Brady Papers.

[33]Cozzens, p. 529; Wilbur Stout, "The Charcoal Industry of the Hanging Rock Iron District--Its Influence on the Early Development of the Ohio Valley," Ohio Archaeological and Historical Quarterly 42 (January, 1933), p. 85; Harold F. Round, "The Wilderness," Virginia Cavalcade 14 (Winter, 1964), p. 6; Kendall Gordon Seaton, The Rise and Growth of the Iron Industry In and About Ashland, Kentucky (Ashland, Kentucky: POAGE chapter of the D.A.R., November, 1948), p. 10.

[34]"Time and Wood Records, Buffalo Forge," 1830-43, 1831-41, University of Virginia, Weaver-Brady Papers; "Journal 1842-1847"; "Time Book, 1847-1853," University of Virginia, Graham Family Papers; "Daybook 1855-1856, Cordwood at Upper Coling," University of Virginia, Anderson Family Papers.

about 30 to 40 feet in diameter and arranging the cordwood in a conical pile about 10 to 12 feet high (Figure 6).[35] The pile was then covered with a dampened layer of leaves, dirt, charcoal dust, or clay, and ignited in a chimney-like hole in the center with air holes at the base controlling air intake.[36] Charcoal making lasted ten to fourteen days, eliminating the tar and other volatile or gas-forming constituents in the wood.[37] About six colliers, constantly supervising the coaling, could tend between three and five charcoal hearths at a time.[38]

With an average yield of 40 bushels of charcoal per cord, a charcoal hearth which generally contained 25 to 55 cords would produce between 1,000 and 2,200 bushels of fuel.[39] A hearth was used more than once when possible, because more charcoal and iron could apparently be made by depending upon one coaling operation.[40]

Charcoal hearths were usually located in thickly wooded areas convenient to wagon transportation and water.[41] Since charcoal often

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[35]Round, p. 7; Tennessee Valley Authority, "The Iron Industry in Land Between the Lakes," n.d., p. 4.

[36]Round, p. 7; Seaton, p. 16; T.V.A., p. 5.

[37]Seaton, pp. 16-17; T.V.A., p. 6.

[38]T.V.A., p. 6.

[39]Temin, p. 83; T.V.A., p. 4; "Furnace Coaling Ground" Oxford I.W. 1807-1803, Duke University, William Bolling Collection.

[40]"Daybook, Union Forge 1825-1826" December 31, 1825, Duke University, Lantz and Rinker; Letters, T. H. Burns to F. T. Anderson, June 13, 1851; W. A. Anderson to Dear Father (F. T. Anderson), February 2, 1863, University of Virginia, Anderson Family Papers.

[41]Letter, Charles Gorgas to William Weaver, April 11, 1859, University of Virginia, Weaver-Brady Papers.

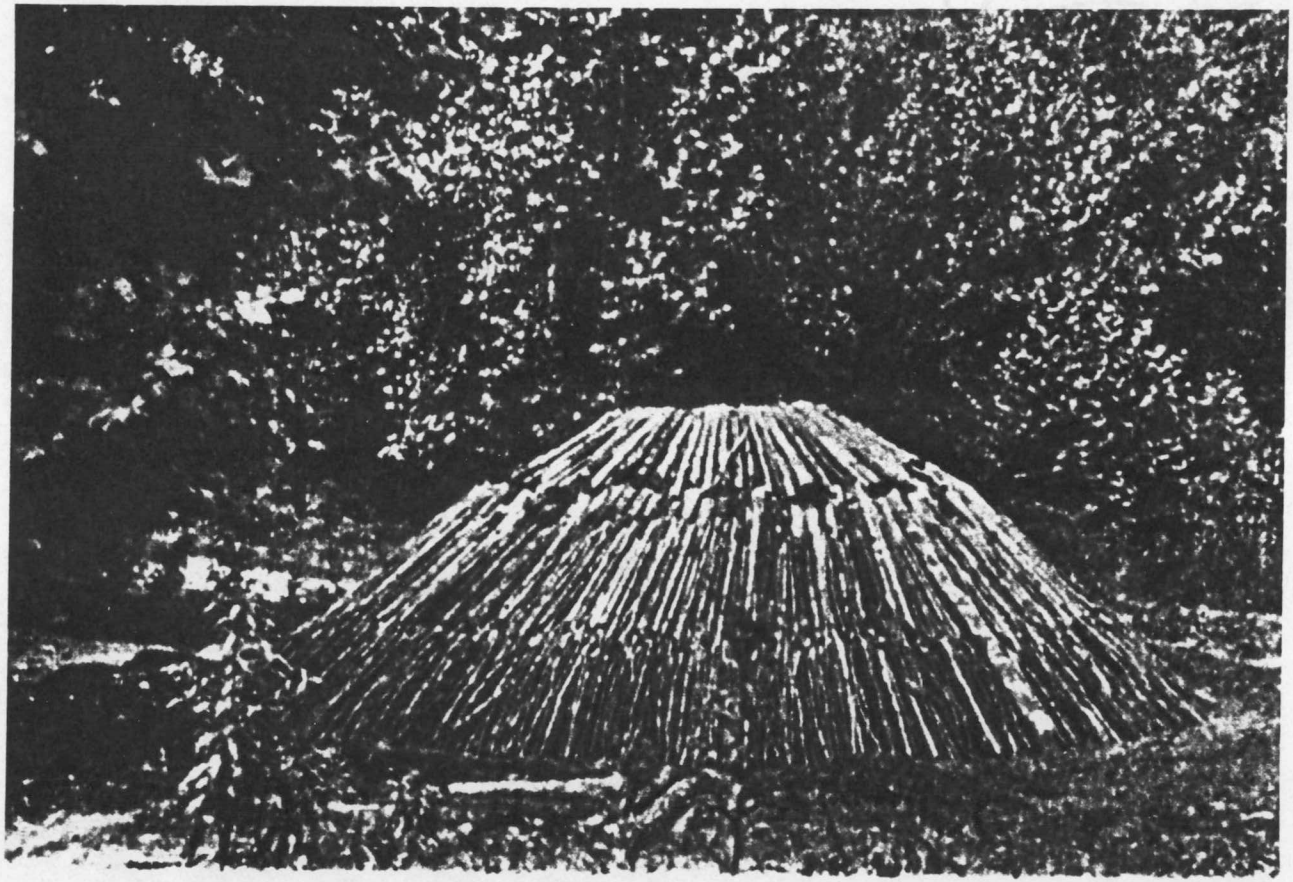

Figure 6. Charcoal Hearth in Preparation for Firing.

Source: Gillenwater, p. 54.

ignited when removed from the hearth, the nearby water source was used to extinguish it. The charcoal was then placed in baskets, loaded in wagons, and hauled to the blast furnace. Wagons in the Hanging Rock District carried from 188 to 200 bushels per load, and several wagoners were kept busy hauling fuel.[42]

It was important to haul and store charcoal with care. Good road conditions were a necessity, because rough roads pulverized the fuel making it less efficient in the blast furnace. However, the pulverized fuel was sometimes used to purify the iron ore in districts where roasting the ore was a common practice. The ironmaster also faced problems in storing and preserving charcoal, since the fuel became soft or pulverized when poorly stored over a long period of time.

Other problems included the high cost of the fuel, the seasonal character of charcoal making, the abandonment of furnaces because of timber exhaustion within economic reach of the furnace, and the small scale which these conditions compelled.[43] In addition, a conflict in land use sometimes developed, e.g., at one iron plantation, colliers set four charcoal hearths in a field that was later planted in corn, and the charcoal could not be brought out until after the harvest.[44]

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[42]"Sketch of Vesuvius Furnace," n.d., Marietta College Archives, Iron Furnaces; "Account of Several Blasts of Franklin Furnace from 1854-1857," Marietta College, Franklin Furnace; "Scrapbook 1857-1873," University of Kentucky, Means Family Papers; Stout, p. 88; Seaton, p. 10.

[43]Hunter, "The Influence of the Market," p. 264.

[44]Letter, T. H. Burns to F. T. Anderson, June 13, 1851, University of Virginia, Anderson Family Papers.

Other Location Factors: Water, Limestone, and Sand

Water, limestone, and sand complete the location requirements for the charcoal iron industry. As a rule, limestone to flux the molten metal and sand to line the molds for casting the metal were easily acquired.[45]

However, the multiple uses of water have been often neglected as a location influence. Water was an important location factor in charcoal iron making, because it provided a cooling agent, served as a means of transportation for ironware in many cases, and before the introduction of steam, supplied power.[46]

Nevertheless, the use of water and waterpower had its problems. The variability of weather and the volume of stream flow often created a water surplus or deficit which could interrupt the operation of the iron plantation. A freshet could wash out roads and power facilities, while drought produced insufficient runoff to operate the facilities. Insufficient power also created the danger of the furnace chilling, and low stream flow interrupted water transportation in some cases.[47] Finally, the competition for waterpower at the same site may have discouraged forward integration.

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[45]Limestone and sand were seldom mentioned in the manuscript collections. "The following is a list of Sands Charged to Mayburry and Weaver in Commifsioners 1-Book for Botetourt County for 1839," Duke University, William Weaver Papers.

[46]Temin, p. 84.

[47]Letter, T. H. Burns to F. T. Anderson, July 19, 1856, University of Virginia, Anderson Family Papers.

Water and steam power had three important differences. First, waterpower was available only at fixed locations, and its use generally involved transport charges on commodities and products. Second, steam power could be generated at any location, but might require transport charges on the fuel. Third, the capital costs formed a greater portion of total costs for waterpower, and the choice between water and steam was affected by interest rates. These differences increased the incentive for western industry to use steam power.[48]

There was a rapid spread of steam power in industry. The lessening of the locational constraint of charcoal fuel, the shift toward coal, and increasingly high interest rates encouraged the transition to steam power.[49] The iron industry was one of the earliest branches of industry to shift toward steam power, and in the mid-1850's 46% of the nation's blast furnaces, forges, and rolling mills used steam power wholly or in part (Table I).[50] Moreover, 53% of the charcoal blast furnaces employed steam power.

The spread of steam power occurred more rapidly in the Ohio Valley. Over three-fourths (79%) of the charcoal blast furnaces in this area used steam power wholly or in part by the mid-1850's (Table II). The ironmasters in the Hanging Rock and Western iron districts sold iron to

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[48]Peter Temin, "Steam and Water Power in the Early Nineteenth Century," Journal of Economic History 26 (June, 1966), pp. 196 and 199.

[49]Temin, "Steam and Water Power," p. 202.

[50]Louis C. Hunter, Economic History of the Ohio Valley (New York: DeCapo Press Reprint series, 1973), p. 39.

TABLE I

USE OF STEAM AND WATER POWER IN THE IRON INDUSTRY
OF THE UNITED STATES, MID-1850's

Type of Ironworks	Water	Steam	Steam and Water
Bloomeries and Forges	336	30	1
Blast Furnaces			
Charcoal	190	187	25
Coal and Coke	18	133	13
Rolling Mills	64	118	14
TOTAL	608	468	53

Source: Louis C. Hunter, Economic History of the Ohio Valley, Vol. 19 of Studies in the Economic History of the Ohio Valley, Smith College Studies in History, ed. by John C. Hildt, W. D. Gray, and H. U. Faulkner (New York: DaCapo Press, 1973), pp. 39-41.

TABLE II

USE OF STEAM AND WATER POWER IN THE IRON INDUSTRY
OF THE OHIO VALLEY, MID-1850's

Type of Ironworks	Water	Steam	Steam and Water
Bloomeries and Forges	54	11	
Blast Furnaces			
Charcoal	36	143	3
Coal and Coke	2	35	
Rolling Mills	3	54	1
TOTAL	95	243	4

Source: Louis C. Hunter, Economic History of the Ohio Valley, pp. 39-41.

foundry and machine shops in the Ohio Valley whose business was to manufacture steam engines and castings for steamboats, sugar mills, saw mills, and grist mills. The early trade with these secondary manufacturers made the equipment for steam power readily available, perhaps encouraging the ironmasters to adopt it.

The Changing Pattern of the United States Iron Industry, 1620-1858

Until approximately 1850, the abundance of wood for charcoal fuel and the lack of developed means of transport dictated a widely scattered distribution of iron making.[51] The characteristics of primary iron manufacture in the charcoal era were its wide dispersion, rural location, close relationship with agricultural development, rapidly changing pattern, and the lack of a widespread integration.

Iron ore was discovered in North Carolina in 1585, but the initial attempt at erecting an ironworks was made in 1619 by the Virginia Company at a site on Falling Creek, a tributary of the James River about seven miles below Richmond.[52] An Indian attack in March, 1622, demolished the ironworks, and no evidence is presently available to

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[51]Norman J. G. Pounds, The Geography of Iron and Steel (London: Hutchinson, 1966), p. 120.

[52]James Moore Swank, History of the Manufacture of Iron in All Ages, and Particularly in the United States from Colonial Times to 1891 (2nd Edition; Philadelphia: The AISA, 1892), p. 103; Kathleen Bruce, Virginia Iron Manufacture in the Slave Era (New York: The Century Company, 1930), pp. 4-5; R. A. Brock, "Early Iron Manufacture in Virginia, 1619-1776," Proceedings of the United States National Museum, Vol. 8 (1885), p. 78.

indicate that iron was actually produced at the works. Although the first attempt at the development of an iron industry occurred in the South, it was not until the first quarter of the 18th century that the southern industry was successfully initiated by Alexander Spotswood near Fredericksburg, Virginia.[53]

The first successful ironworks was established in New England at a site on the Saugus River near Lynn, Massachusetts, by 1645.[54] Its design was a water-powered system comprised of a furnace, a forge, storage facilities, workmen's accommodations, and a pier for the use of small boats which carried the iron products.[55] By 1647 two ironworks existed near Boston, one at Lynn and the other at Braintree.[56] By the mid to latter 17th century, the industry had expanded from Massachusetts into Rhode Island, Connecticut, and New Jersey.[57] Coincident with the distribution of population on the Atlantic seaboard and the industry's dependence upon water transportation, the iron industry for its first 50 years exhibited a coastal and riverine pattern (Figure 7).

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[53]O. F. Northington, Jr., "The Revival of the Iron Industry in Eastern Virginia as Exemplified by the History of the Catherine Furnace in Spotsylvania County," William and Mary Historical Quarterly 16 (January, 1936), p. 71; Cappon, unpublished manuscript, p. 12; Swank, pp. 105-106, 260.

[54]Swank, pp. 108-110.

[55]E. N. Hartley, Ironworks on the Saugus (Norman: University of Oklahoma Press, 1957), p. 4.

[56]Hartley, p. 3.

[57]Swank, pp. 118-119; Pounds, p. 118.

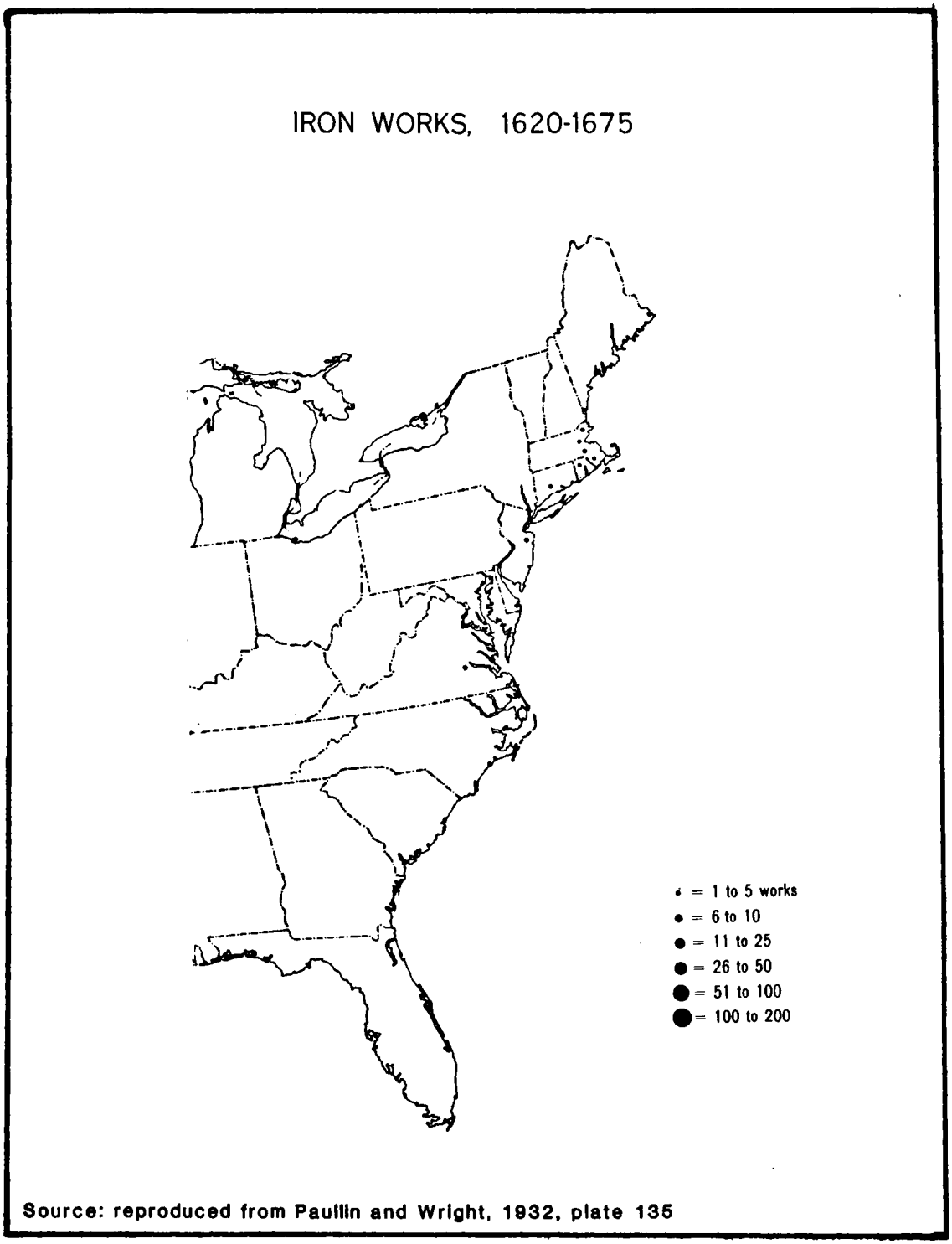

Figure 7. Iron Works, 1620-1675.

Through most of the 17th century, the New England region, especially Massachusetts, occupied a preeminent position in iron manufacturing in colonial America.[58] Bog ore, charcoal, marine shells for flux, and waterpower provided the resource base for the New England industry. One of the most important effects upon the location of the industry was the availability of iron ore. The persistence of the iron industry into the 19th century in southeastern Massachusetts was fostered by the high yields of bog ore, because when properly managed the bog ore could be made to yield on a sustaining basis.[59] Moreover, the location of the iron industry in southeastern Massachusetts was also market oriented.[60]

Toward the end of the 17th century other regions began to develop, as blast furnaces were built in New Jersey and Pennsylvania.[61] From here the industry spread south into Virginia, Maryland, and North Carolina and northward into the hills of New York during the first half of the 18th century (Figure 8).[62]

Between 1775 and 1810, the enlargement of existing iron regions and the development of new regions, which created a more widely scattered distribution, were the two major changes in the pattern (Figure 9). The

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[58]Robert G. LeBlanc, Location of Manufacturing in New England in the 19th Century (Dartmouth: Geography Publications Number 7, 1969), p. 73.

[59]LeBlanc, p. 71; Charles S. Boyer, Early Forges and Furnaces in New Jersey (Philadelphia: University of Pennsylvania Press, 1963), p. 2.

[60]LeBlanc, p. 72.

[61]Pounds, p. 118.

[62]Swank, pp. 109, 136, and 199; Pounds, p. 118.

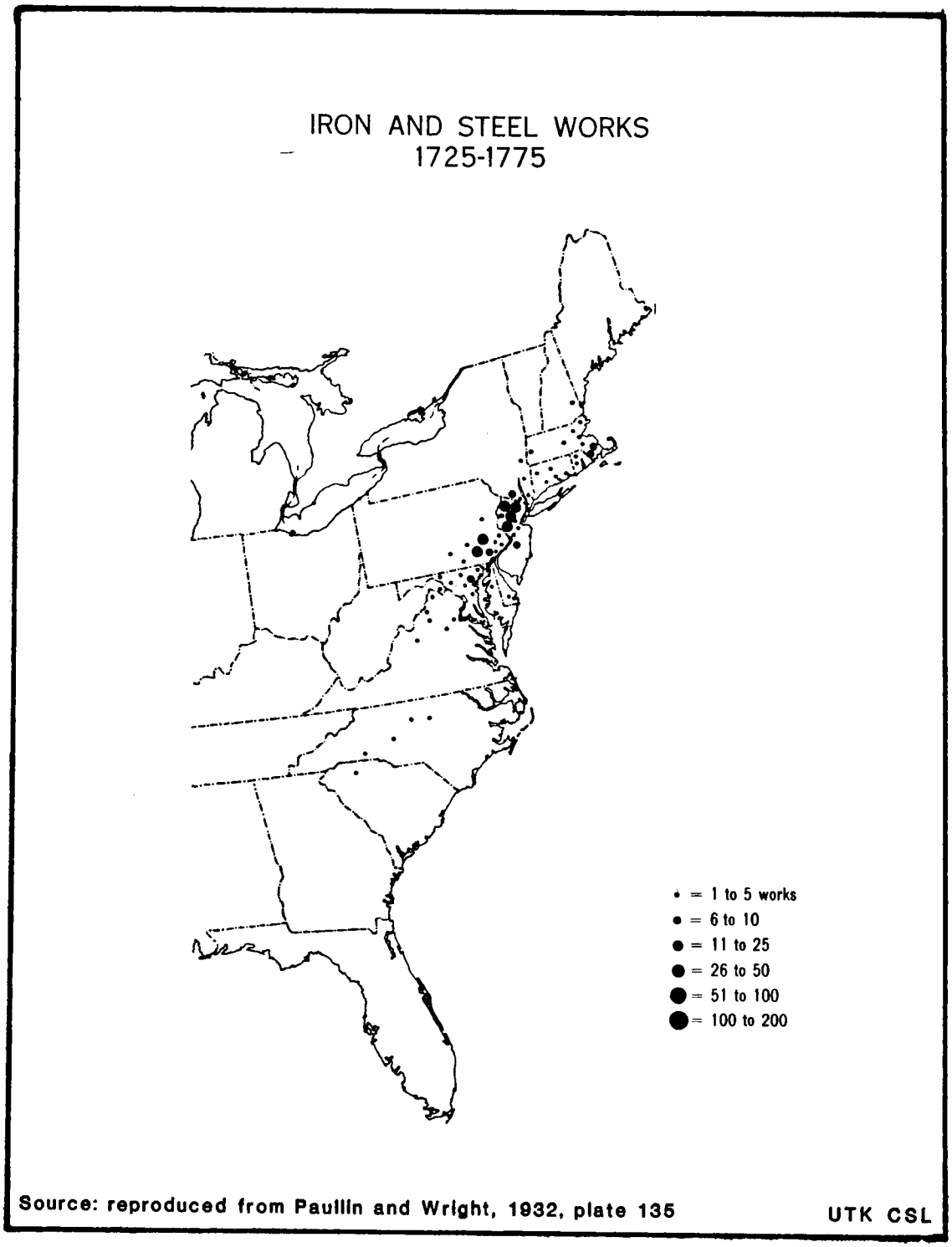

Figure 8. Iron and Steel Works, 1725-1775.

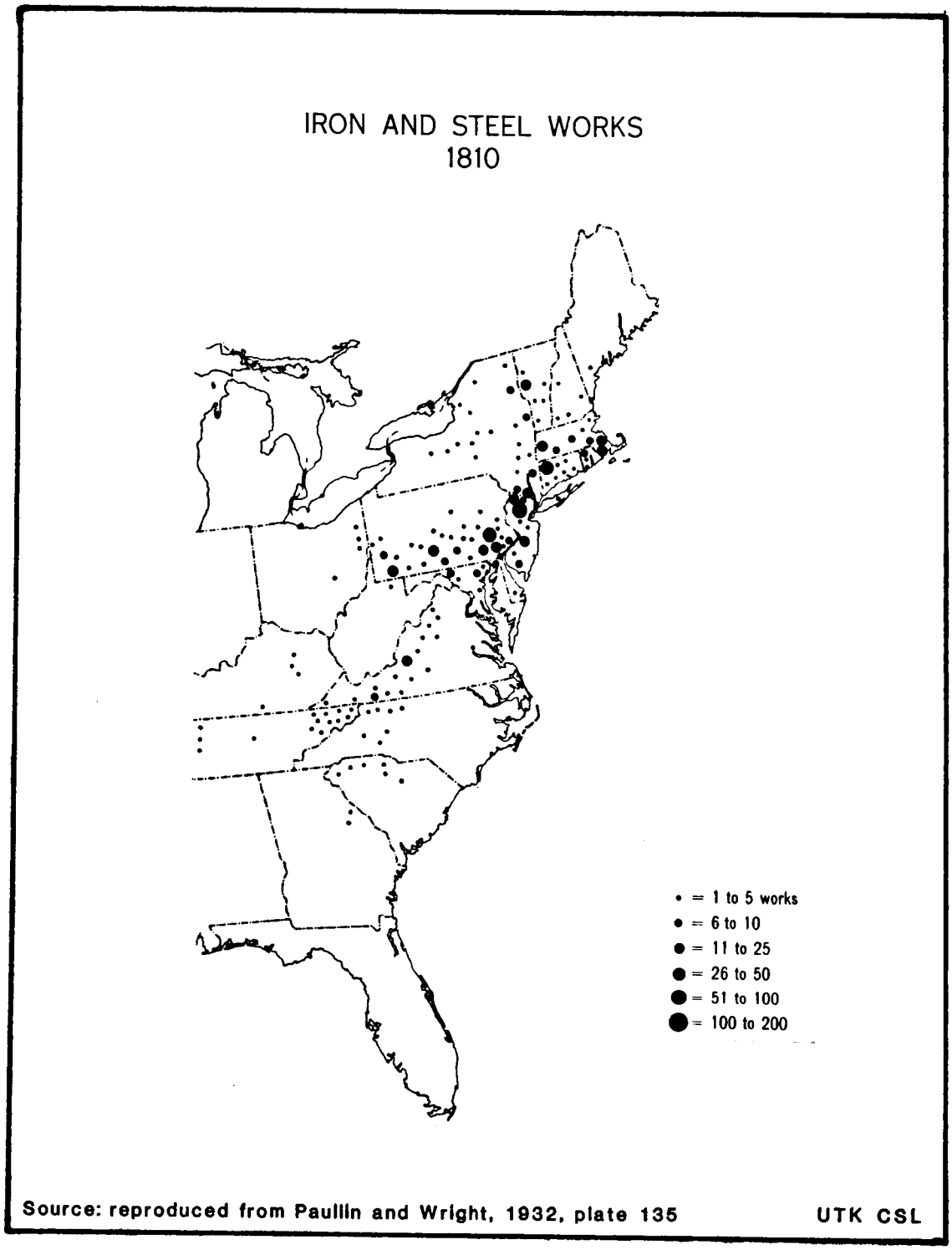

Figure 9. Iron and Steel Works, 1810.

iron industry in the brown hematite area of the Berkshires in western Massachusetts and Connecticut was greatly expanded. Massachusetts, Connecticut, and Rhode Island showed a general dispersal of ironworks, and the industry was also established in New Hampshire and western Vermont,[63] the latter forming the nucleus for the development of the New York and Vermont iron region. The iron industry grew significantly in the New York-New Jersey highlands as well. Before the end of the 18th century, an area stretching north-eastward from the Susquehanna to the Delaware rivers in Pennsylvania was dotted with furnaces and forges. Finally, the iron industry spread from a nucleus in eastern Pennsylvania into western Pennsylvania, Ohio, Virginia, the Carolinas, Tennessee, Georgia, and Kentucky.

The westward movement of the iron industry by 1810 was part of the general process of settlement. Because frontier settlements were separated by great distance and poor transportation from the older iron regions, they had to be supplied by a local industry. As a consequence, furnaces and forges were among the first industrial establishments in the newly settled areas.

Generally, the iron districts which were developed by the end of the first quarter of the 19th century were the regions that persisted through the antebellum period. There were, however, changes in magnitude of existing iron centers and a continued westward expansion. During the antebellum period American iron development was still ". . .

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[63]Swank, pp. 132-133.

a tale of local markets supplied by comparatively small furnaces, and as entry to such a trade was easy so, too, elimination was frequent."[64] Small ironworks everywhere, particularly in Pennsylvania, with poor equipment and an uneconomic labor force, began and failed over a short time span.[65] Blast furnaces were being abandoned and built in the same districts, causing a considerable change in magnitude of the regional production. Thus, the two outstanding characteristics of the mid-19th century American iron industry were its wide scatter and rapidly changing pattern (Figure 10).[66]

The most notable features of change in the pattern between 1810 and 1858 were the development of the Hanging Rock Iron District, the expansion of the Western Iron District, the continued southwestern extension of the industry from eastern Tennessee into Georgia and Alabama, the development of the Missouri Iron District, and the expansion of the iron industry along the lower Great Lakes.

By the 1850's ten iron districts were generally recognized. They were: (1) eastern Pennsylvania and Maryland, the greatest iron region in the country, with 98 anthracite furnaces, 103 charcoal furnaces, and 117 forges; (2) the Hanging Rock Iron District, containing 45 charcoal furnaces in southeastern Ohio and 17 in northeastern Kentucky; (3) northwestern Pennsylvania and northeastern Ohio; (4) the highland area extending from western Massachusetts to northern New Jersey, with

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[64]Kenneth Warren, The American Steel Industry 1850-1970: A Geographical Interpretation (Oxford: Clarendon Pres, 1973), p. 11.

[65]Warren, p. 11.

[66]Warren, p. 15.

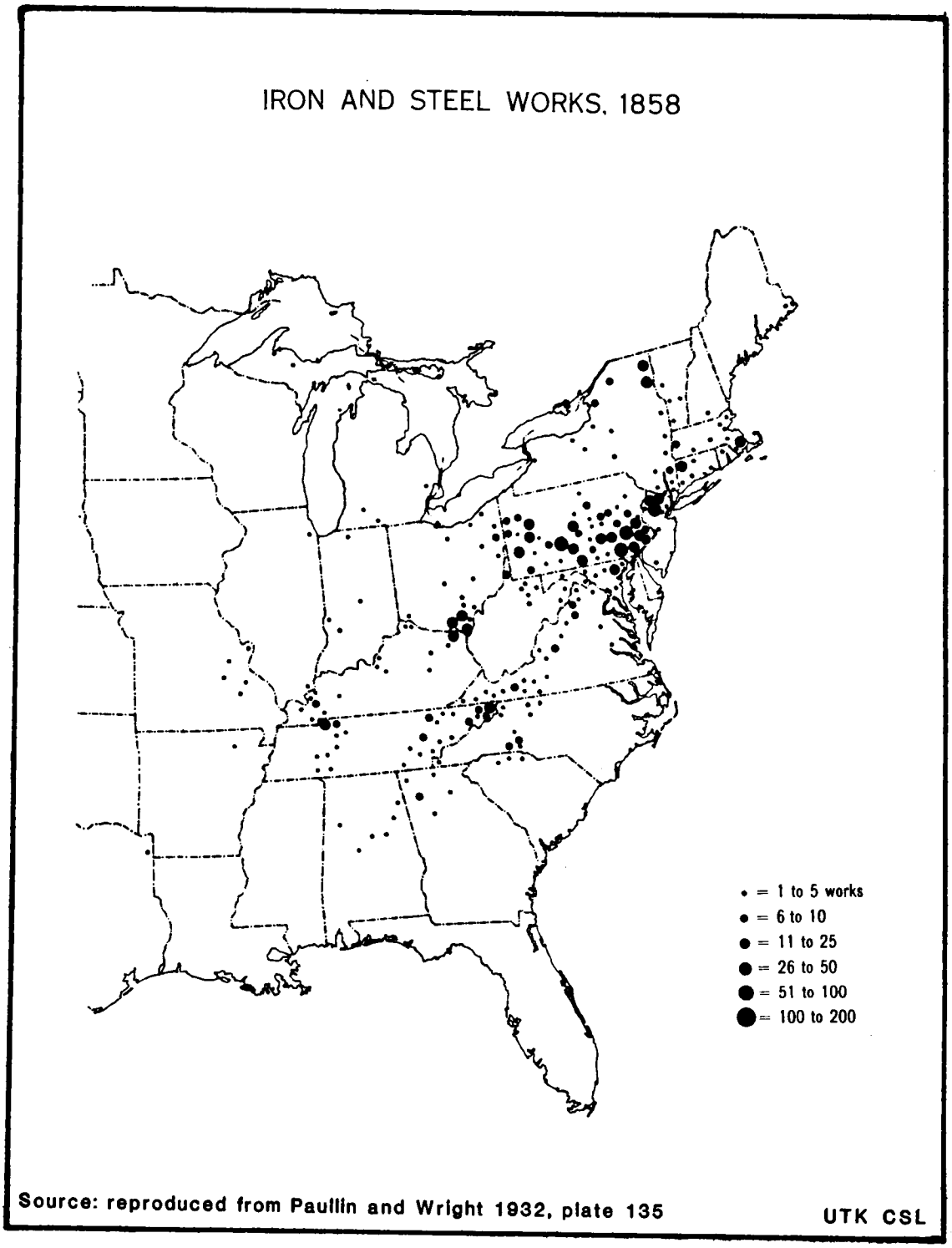

Figure 10. Iron and Steel Works, 1858.

44 charcoal furnaces, 22 anthracite furnaces, and 60 forges; (5) the Western Iron District; (6) northern New York, with 40 bloomeries and a few blast furnaces (three of which used anthracite); (7) southwestern Pennsylvania and northwestern Virginia; (8) the Upland South Iron District; and (10) middle and eastern Virginia.[67]

Iron Production in the Southern Iron Region

Mean Annual Production of Furnaces

The mean annual production of furnaces in the Southern Iron Region exceeded that in the rest of the nation through 1840 (Table III). By midcentury, however, only the furnaces in the Hanging Rock Iron District were more productive than the furnaces in the rest of the country, though the mean annual production in the Western Iron District was close to the national average.

The average production of furnaces in the Hanging Rock District was especially impressive. During the 1820's furnaces in the district were averaging between 300 and 500 tons annually, which was competitive with the most productive furnaces in the nation. In 1827, the annual production at Union furnace was as large as any furnace in the country, a quantity which was comparable to the blast furnaces in England.[68] In the early 1830's the average production of furnaces in the Ohio section of the district was 867 tons, with some expected to make 1,000 tons

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[67] Lesley, pp. 748-749.

[68] T. M. Adams, "Sketch of Hanging Rock Iron Region," University of Kentucky, Seaton Family papers; Seaton, p. 22.

TABLE III

MEAN ANNUAL PRODUCTION OF FURNACES IN THE DISTRICTS OF THE SOUTHERN IRON REGION, 1810-1870 (IN TONS)

Districts of the Southern Iron Region	1810	1840	1850	1860	1870
Virginia	385	448	764	727	957
Western Iron District		774	1,401	1,908	2,184
Hanging Rock		1,437	1,712	1,830	2,307[b]
Red River[a]		900	1,100	600	1,350
Upland South		151	305	432	920
United States		357	1,498	3,453	5,318

Sources: U.S. Bureau of the Census, published censuses and unpublished census manuscripts; Tench Coxe, pp. 9-10.

[a]Red River was primarily Estill County, Kentucky.

[b]The average for charcoal furnaces only; the stone-coal furnaces averaged 3,847 tons.

annually.[69] In 1837, Raccoon furnace in Greenup County, Kentucky, was described as the largest in the United States. In that year it ran 300 days, making 1,300 tons of metal.[70]

By 1840 blast furnaces in the Hanging Rock District were averaging 1,437 tons, an amount quadruple that of the rest of the nation (Table III). At midcentury furnaces in the district averaged 1,712 tons and during the 1850's nearly 2,000 tons.

Much of the increase in the mean annual production was due to a number of technological and management changes. These included changes in the smelting process, such as the introduction of hot blast, enlarging the capacity of new and rebuilt furnaces, extending the length of blast, applying more labor, abandoning less efficient furnaces, and improving the processing of raw materials.

A large share of the advance in the mean annual production was due to the introduction of hot blast, which involved forcing hot air into the furnace charge. The hot blast process was installed at Vesuvius furnace in the Hanging Rock District in 1837, which was one of the earliest applications of hot blast in the United States.[71] This

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[69]United States Treasury Department, Documents Relative to the Manufactures in the United States, Volume 2 (Washington, D.C.: D. Green, 1833), pp. 865-867 (hereafter cited as McLane Report).

[70]Journal of the House of Representatives of the Commonwealth of Kentucky (Frankfort: A. G. Hodges, 1837), pp. 161-162 and 485; J. Winston Coleman, Jr., "Old Kentucky Iron Furnaces," The Filson Club Historical Quarterly 31 (July, 1957), p. 236.

[71]Cozzens stated that the first hot blast in the U.S. was installed at Vesuvius furnace in 1836; Cozzens, p. 216; Temin, pp. 58-59.

innovation was the first major change in American blast furnace practices, and Overman stated that by using hard charcoal in a hot blast furnace there was a 20% fuel saving with a 50% augmentation in production.[72] When hot blast was installed, some furnaces experienced a fourfold increase in production; and, generally, hot blast furnaces had a larger per annum output than furnaces using cold blast.

Although these changes gave blast furnaces in the Southern Iron Region a larger mean annual production, by the mid-19th century blast furnaces using mineral fuels had much larger capacities. Consequently, during the 1850's the mean annual production of the nation's furnaces advanced dramatically. By 1860 the annual output of the nation's furnaces averaged 3,453 tons, an output above the average of every iron district in the Southern Iron Region (Table III).

Trend of Production in the Southern Iron Districts, A Comparative Overview

In 1810 blast furnaces in Virginia produced 92% of the southern pig iron, the state remaining the most important district until the 1830's (Figure 11 and Table IV). At that time the district began producing a smaller share of southern iron production, and during the 1850's the Virginia District experienced an absolute decline in production.

In 1840 pig iron production in the Western Iron District had nearly equaled the Virginia output, and the Hanging Rock Iron District exceeded the combined production of both the Virginia and Western iron districts.

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[72]Temin, pp. 58-59.

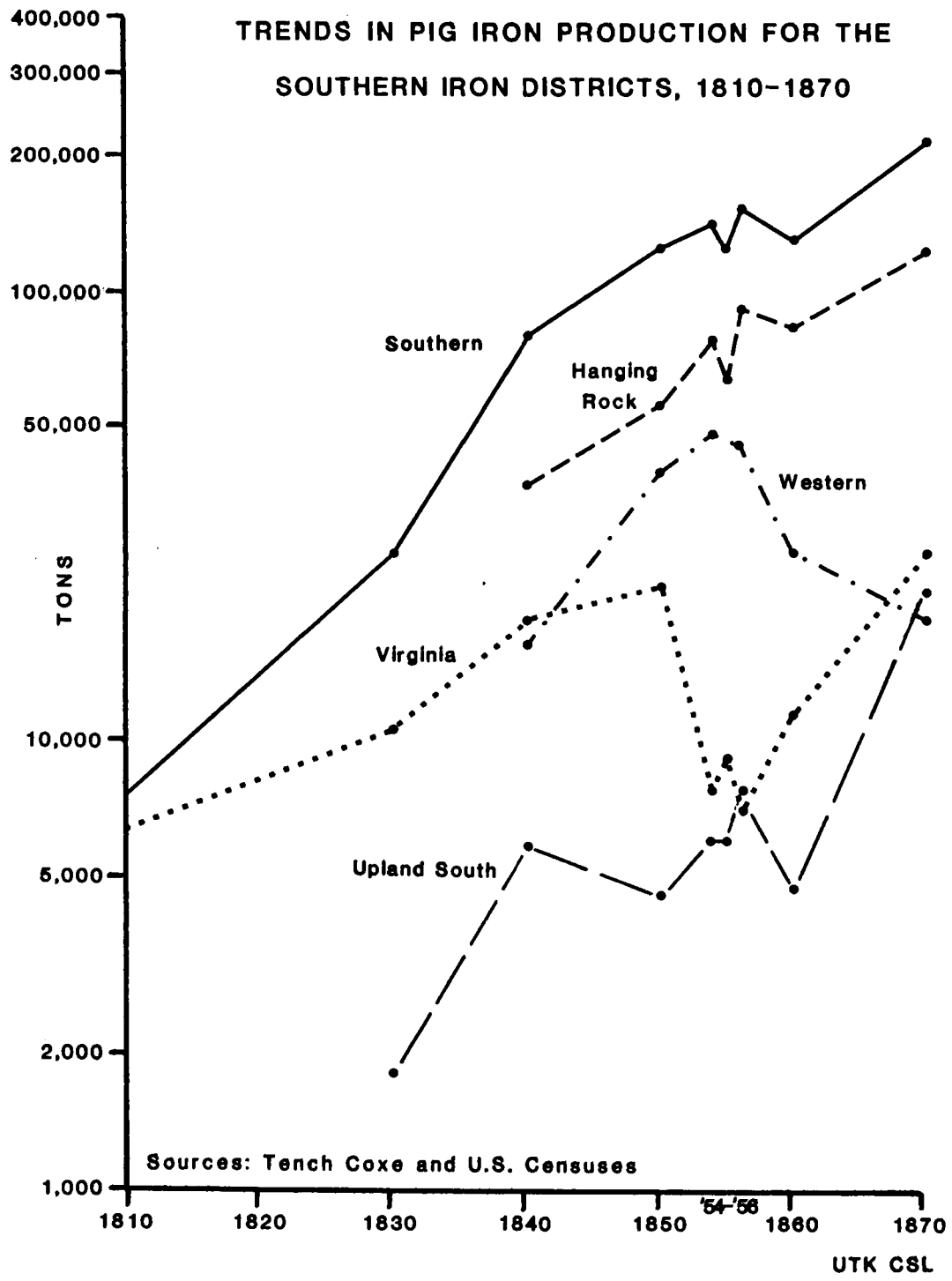

Figure 11. Trends in Pig Iron Production for the Southern Iron Districts, 1810-1870.

TABLE IV

PIG IRON PRODUCTION[1] BY STATE AND DISTRICTS OF THE SOUTHERN IRON REGION, 1810-1870
(IN TONS)

	1810	1830	1840	1850	1854	1855	1856	1857	1860	1870[h]	1880[h]
By State											
Virginia	6,930	10,500	18,811	22,163	7,810	9,268	7,197		11,646	26,883[a]	17,906
Tennessee	587	5,000	16,129[b]	30,420[c]	39,763	35,199	33,093		22,302	28,688[d]	47,873
Kentucky	4	4,500	22,606[b]	29,109[c]	35,165[e]	29,844[e]	36,563		33,471	49,295[d]	58,108
Ohio	1,187	5,000	35,236	52,658	67,370[e]	57,908[e]	87,511[f]		112,065	306,363	548,712
North Carolina		1,800	968	400	1,820[f]	1,830[f]	1,956[f]			1,422	
South Carolina			1,250							180	
Georgia			494	900	2,391	2,715	2,807		1,100	1,220	23,099
Alabama			30	522	g	g	g		1,742	6,273	62,336
By District											
Virginia	6,930	10,500	18,811	22,163	7,810	9,268	7,197		11,646	26,883[a]	17,906
Western			16,250	40,636	49,419	47,347	47,064		26,640[i]	18,866[j]	7,536
Tennessee			13,000[k]	28,336	37,183	33,683	32,162	27,050	20,390[i]	15,686[j]	5,036
Kentucky			3,250[k]	12,300	12,236	13,664	14,902	15,808	6,250	3,180[l]	2,500
Hanging Rock			37,355	56,491	79,010	64,162	92,116	96,000	84,000	126,896[l]	n
Ohio		4,300[m]	23,799	42,446	56,081	47,982	70,455		60,446	106,281[l]	
Kentucky			13,556	14,045	22,929	16,180	21,661		23,724	20,615	
Red River			2,300	1,600				1,418	600	4,050	900
Upland South		1,800	5,866	4,567	6,056	6,061	7,694		4,754	22,097	128,272
Southern Iron Region[2]	7,521	26,100	84,087	125,960	143,030	126,838	154,071		130,707	220,242	n
Percentage of the U.S. Production	14%	16%	29%	22%	205	17%	19%		13%	11%	
United States	53,909	165,000	286,903	564,755	724,833	728,873	812,917		987,559	2,052,821	3,781,021

Sources: United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860, and 1870; Lester J. Cappon, "Trend of the Southern Iron Industry under the Plantation System," Journal of Economic and Business History 2 (1929-1930), p. 379; Tench Coxe, pp. 9-11; Sixth Census 1840, p. 358; The Seventh Census, 1850, pp. 156-157; Eighth Census, 1860, p. clxxx; Ninth Census, 1870, Vol. 3, pp. 602-603; Tenth Census, 1880, Vol. 2, pp. 10-13.

[1] These data may include some castings and hollowware.

[2] The total for the Southern Iron Region equals the production of Virginia, Tennessee, Kentucky, North Carolina, South Carolina, Georgia, Alabama, and the Ohio section of the Hanging Rock District.

[a] Includes the production of West Virginia. The total production was 34,183 tons for the two states, but the 26,883 tons excludes the 7,300 tons made in Ohio County, West Virginia, which is outside the Southern Iron Region.

[b] The entry for Nelson County's one furnace was 10,000 tons, which I believe to be 1,000 tons; consequently, 22,606 tons is used in place of the reported data.

[c] The manuscript census totals 29,109 tons, while the published census gives 24,245 tons.

[d] I have used the manuscript census here. The published report gives 57,943 tons.

[e] Some inferences and estimations were made.

[f] Also includes South Carolina.

[g] Alabama is included in the data for east Tennessee.

[h] The 1870 and 1880 data includes production with mineral fuels.

[i] I have estimated the production for Dickson and Hickman counties.

[j] Partly estimated by using $56.25 per ton to calculate the tonnage from the value of pig iron.

[k] Includes 750 tons for Caldwell County and 2,500 tons for Muhlenberg, an outlier of the district.

[l] The data for the Ohio section was taken in 1869.

[m] Inference.

[n] The author was unable to separate the production for the Ohio area of the Hanging Rock District in 1880.

During the mid-1850's the Hanging Rock District ranked second only to the Pennsylvania anthracite iron region (eastern Pennsylvania and Maryland).[73] The trend of pig iron production in the Hanging Rock District was similar to that of the Southern Iron Region as a whole, and between 1840 and 1860 the district made from 46% to 64% of the southern pig iron. During the antebellum era, the district reached its zenith of production in 1857, followed by a subsequent decline through 1860. The panic of 1857 materialized too late to affect the 1857 output, but pig iron production in 1858 was reduced to one-half that of the previous year.[74]

Pig iron production in the Western Iron District rapidly increased from 16,250 to 40,636 tons between 1840 and 1850. Through the mid-1850's the district made over one-third of the southern pig iron, ranking as the fifth largest iron producing district in the United States. In spite of this success, the district experienced a relative and absolute decline in production after 1854.

The Upland South Iron District had the smallest production of any southern iron district. Iron production in the district increased rapidly after 1830, and it probably reached a zenith during the 1840's. Between 1840 and 1860 annual production was small and fluctuating. However, the revival of the charcoal iron industry in the 1860's and 1870's and the development of the mineral fuel industry made the Upland South one of the most important iron producing districts during the postbellum period.

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[73] Lesley, p. 754.

[74] Lesley, p. 754.

The Southern Iron Region's Contribution to the Nation's Iron Industry

When the growth of the Southern Iron Region is compared to that of the iron industry of the entire United States, its significance becomes apparent. The rate of growth was increasing at an accelerated rate between 1810 and 1840, a rate exceeding that of the rest of the nation (Figure 12). In 1840 the Southern Iron Region accounted for 29% of the country's pig iron (Table IV). During the late 1840's, however, the rapid rate of growth leveled off, as the region's manufacture of pig iron began to represent a decreasing proportion of the United States' production. By the mid-1850's the proportion of pig iron made in the Southern Iron Region decreased to between 17% and 20% of the nation's output. In the late 1850's the Southern Iron Region experienced a relative and absolute decline in production, and by 1860 the region produced only 130,707 tons of pig iron, or 13%, of the country's output.

Pig iron production in the Southern Iron Region increased from 130,707 to 220,242 tons between 1860 and 1870; but despite the absolute increase, the region experienced a relative decline, accounting for only 11% of the nation's production in 1870 (Table IV). The revival of iron making following the Civil War was based on charcoal fuel, and even in 1870 about three-fourths of the iron was made with charcoal. The conversion to a mineral fuel technology was slow in the Southern Iron Region and did not gain much momentum until the 1870's, but it is estimated that by 1880 about two-thirds of some 300,000 tons were made with mineral fuels.

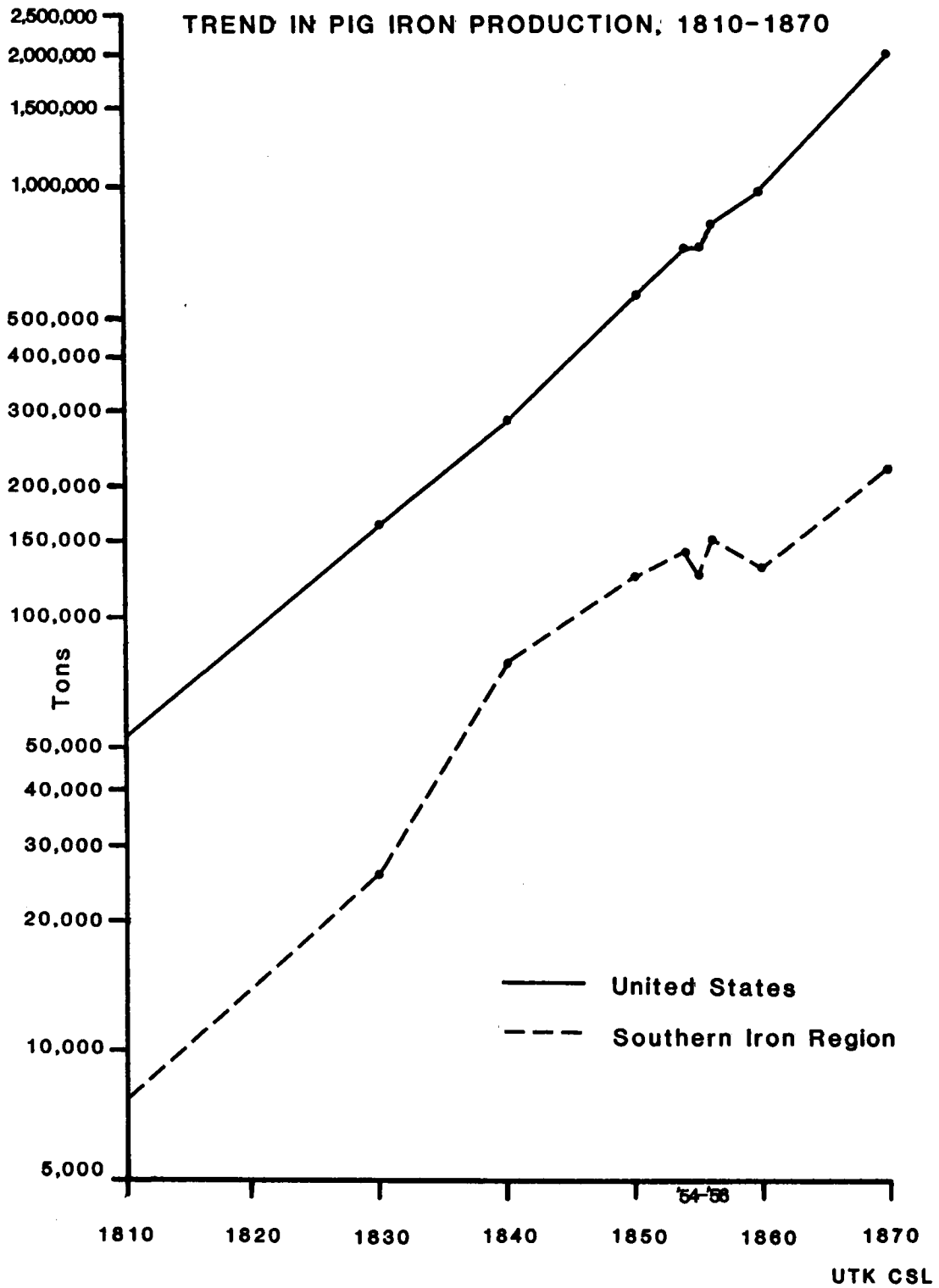

Figure 12. Trend in Pig Iron Production, 1810-1870.

The Transition from a Charcoal to Mineral Fuel Technology

Compared to its counterpart in Britain, the adoption of a mineral fuel technology was slow in America. The question of why American iron makers clung to the charcoal technology has been examined largely from a supply, demand, and/or technological point of view.

Several reasons for this delay were given by James M. Swank and Victor S. Clark. They concluded that charcoal iron making persisted because of the lack of suitable coking coal in juxtaposition to the iron districts, unsuitable varieties of bituminous coal for coking, misunderstanding of coke making, inadequate transportation to bring ore and coke together, abundance of timber for charcoal fuel, prejudice in favor of charcoal iron, and conservatism of ironmasters.[75] Among these reasons the strongest arguments were that charcoal was more plentiful in this country than England and that American ironmasters were opposed to the use of coke because of ignorance, irrationality, or both.[76]

In 1927 Louis C. Hunter showed conclusively that these reasons were false and proposed a new hypothesis which in part stated that the character of demand in the West was the controlling factor. During the agricultural era the demand was for a high quality merchant iron which could be easily worked by artisans, and the iron which filled this

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[75] Swank, p. 366; Clark, p. 413; Hunter, "Influence of Market," p. 255; Temin, Iron and Steel, p. 54.

[76] Peter Temin, "Reappraisals in American Economic History, A New Look at Hunter's Hypothesis About the Antebellum Iron Industry," American Economic Review 54 (May, 1964), pp. 344-345.

demand was pig and bar iron made with charcoal fuel. However, the new industrial era gave rise to a demand for low-cost, low quality coke iron which rose relative to the demand for high-cost, quality charcoal iron.[77]

Temin proposes an alternative to part of Hunter's hypothesis, stating that the cost of making pig iron with coke fell and/or its quality improved; i.e., the changes were on the side of supply rather than demand.[78] The change in supply which improved the quality of pig iron made with coke was the exploitation of the sulphur-free Connellsville coal in western Pennsylvania, and by the 1870's coke pig iron had improved so that it was interchangeable with pig iron made with anthracite coal.[79] The change in character of demand proposed by Hunter may also have helped the transition to coke fuel, but it is impossible to assess the extent to which it fostered the transition.[80]

Warren corroborates Temin's hypothesis by emphasizing the important role that transportation played in the supply of a suitable coking coal. While use of the Monongahela River stimulated the coal trade, the best coking coal lay further inland to the east so that delivery to the river still required wagon haul and transshipment. As a consequence, the development of a suitable coking coal awaited the construction of

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[77]Hunter, "The Influence of Market," pp. 265-281; Temin, "A New Look at Hunter's Hypothesis," pp. 345-346.

[78]Temin, "A New Look at Hunter's Hypothesis," pp. 345-346.

[79]Temin, "A New Look at Hunter's Hypothesis," pp. 348-349.

[80]Temin, "A New Look at Hunter's Hypothesis," p. 351.

railways into the coalfield centered on Connellsville. The Pittsburgh and Connellsville Railroad, following the Youghiogheny Valley, reached the main coal basin, five miles west of Connellsville, in 1855. The extensions and branch lines of railroads in the area improved the possibilities of assembling raw materials and improved marketing opportunities; consequently, successful coke smelting grew rapidly in the Pittsburgh area.[81]

Alfred Chandler concludes that the answers provided by Hunter and Temin are still inadequate to explain the timing and the way in which the modern iron industry developed in this country.[82] He states that Hunter and Temin said nothing about the larger market for iron in the East, which was as much industrial as agricultural and was still dependent upon a supply of iron from Europe in the 1830's.[83] Chandler contends that the opening of the anthracite coal fields in eastern Pennsylvania greatly influenced the development of large business enterprises subdivided into manufacturing and mining.[84] The great increase in iron production which followed did not come about because of a sudden new demand but because the anthracite coal operators developed the first blast furnaces to use their coal.[85] Thus, coal entrepreneurs

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[81]Warren, pp. 36-38.

[82]Chandler, p. 142.

[83]Chandler, p. 148.

[84]Chandler, p. 180.

[85]Chandler, p. 158.

were responsible for providing America with its first large supply of inexpensive iron to meet the already existing demand.[86]

The transition to mineral fuels in the Southern Iron Region is beyond the temporal focus of this study. It appears, however, that the reasons for the transition were similar to those presented by Hunter, Temin, Warren, and Chandler. Chapman concluded that, following the Civil War, three events changed the character of the southern iron industry. The first was the discovery and exploitation of large deposits of coking coal in Tennessee (Chattanooga area) and Alabama, where it was substituted for charcoal. The discovery of a superior quality coking coal in the Warrior field (later named the Pratt seam) about 1874 set the stage for the development of the Birmingham area and gave rise to the manufacture of pig iron with coke.[87] Similarly, in the Hanging Rock District, the successful initiation of the bituminous coal era was based on a coal seam nearly free of sulphur.[88] The second event was the use, in quantity, of the red hematite ore and the establishment of the industry in the Birmingham, Alabama, area. A network of railroads linking the ore and coal deposits and providing access to northern markets accelerated the development. Finally, the Bessemer

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[86]Chandler, p. 180; F. W. Taussig, "The Tariff, 1830-1860," The Quarterly Journal of Economics 2 (1887-1888), p. 328.

[87]Chapman states that there were four events, but this writer combined the discovery of coking coal and the substitution of coke for charcoal fuel; Chapman, pp. 101-102.

[88]Vernon D. Keeler, "An Economic History of Jackson County Iron Industry," Ohio Archaeological and Historical Quarterly 42 (April, 1933), pp. 183-185.

process, invented about 1857, and open-hearth process, invented about 1866, made cheaper steel production possible.

Thus, as was the case in western Pennsylvania, the successful initiation of the mineral fuel technology in the Southern Iron Region was related primarily to supply rather than demand, although the changing character of demand may have helped the transition from a charcoal to mineral fuel technology.

Regardless of the reasons, by 1880 two-thirds of the pig iron produced in the Southern Iron Region was made with mineral fuels. During the postbellum period, a new phase of iron smelting in the Southern Iron Region began with a trend toward fewer furnaces with larger capacities, large capital investments, and a large-scale exploitation of red hematite ore and coking coal.[89] The mineral fuel technology brought about large scale production, large mines, and a subdivision of labor which ended the highly personal management of the iron plantation. With the use of mineral fuels, raw materials were often assembled at optimum locations near urban markets or along major routeways, and the backward-integrated iron plantation gave way to a more modern industrial organization.

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[89]Stuart W. Maher, The Brown Iron Ores of East Tennessee (Nashville: State of Tennessee Department of Conservation Division of Geology Report No. 19, 1964), p. 5.

CHAPTER III

THE VIRGINIA IRON DISTRICT, 1800-1860

Iron Production

Throughout the 18th and early 19th centuries Virginia was the most productive district in the Southern Iron Region, accounting for as much as 92% of the region's production in 1810. Between 1810 and 1850 production rose from 6,930 to 22,163 tons, although the peak production probably occurred in the late 1840's. In the meantime, the district's relative share of total regional production declined, as it accounted for only 18% of southern pig iron production in 1850. During the 1850's the district suffered an absolute decline, and shortly before the Civil War it was responsible for only 9% of southern iron production. (See Table IV, Chapter 2, page 59.)

The Patterns and Changes in Production, 1810-1860

In 1810 pig iron production was largely concentrated in the Valley of Virginia (Figure 13). The pattern extended from Frederick County in the north to Washington County in the south, though the furnaces in Shenandoah, Augusta, and Botetourt counties were the largest producers. While forges making bar iron accounted for 23% and 29% of the output in Botetourt and Shenandoah counties respectively, pig iron was exclusively produced in Augusta County. Finally, a larger share of the output in the counties of southwestern Virginia was bar iron made directly from the ore in bloomery forges.

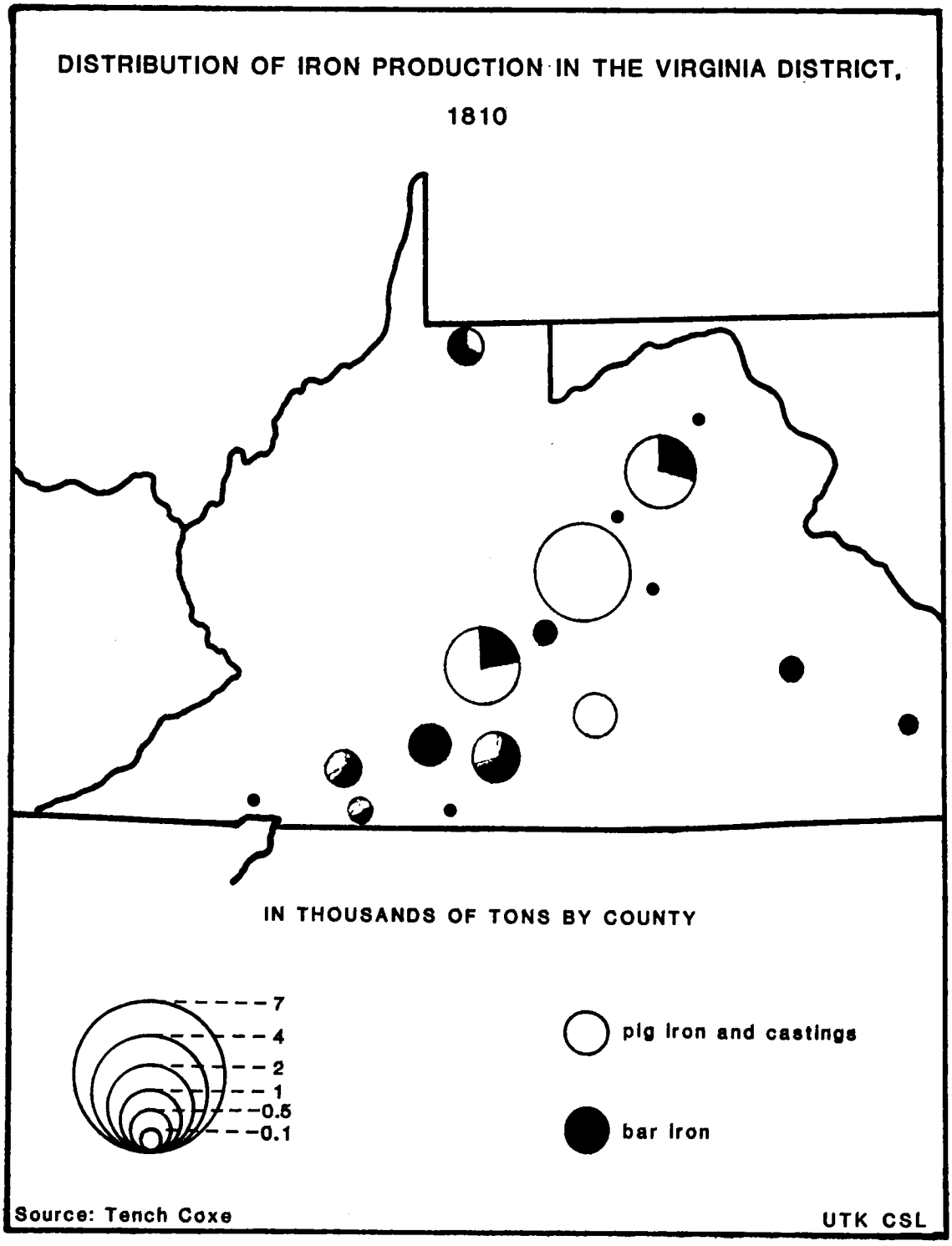

Figure 13. Distribution of Iron Production in the Virginia District, 1810.

Pig iron production increased from 6,930 tons to 18,811 tons between 1810 and 1840, and in 1840 iron making in the Virginia District had reached its maximum areal extent (Figures 14 and 15). The major change in the pattern was the general increase in pig iron production in the Great Valley, the Piedmont, and Monongalia County. Between 1840 and 1850 the iron industry of the Piedmont region and Monongalia County began to decline, but the counties in the Great Valley continued to experience a substantial increase in production (Figure 16). By midcentury bar iron accounted for a smaller share of production as ironmasters in the Great Valley directed their attention to making pig iron for the expanding urban-industrial market (Figure 17).

During the 1850's the Virginia iron industry suffered an absolute decline in production due to competition from northern iron. The decline in pig iron production was uniform throughout the Virginia District with the exception of a small increase in production in Hardy and Preston counties and the manufacture of 2,250 tons of pig iron made with mineral fuel (coke) in Loudoun County (Figure 18). In 1860 pig iron production was still concentrated in and near the Great Valley, but it was markedly reduced and the areal extent of the pattern was less widespread (Figure 19).

The Weekly, Seasonal, and Annual Pattern of Production

Until the 1830's furnaces in the district were casting from 3 to 21 tons a week, averaging about 10 to 15 tons.[1] During the 1840's the

[1]U.S. Bureau of the Census, unpublished census manuscript, "Census of Manufactures, 1820."

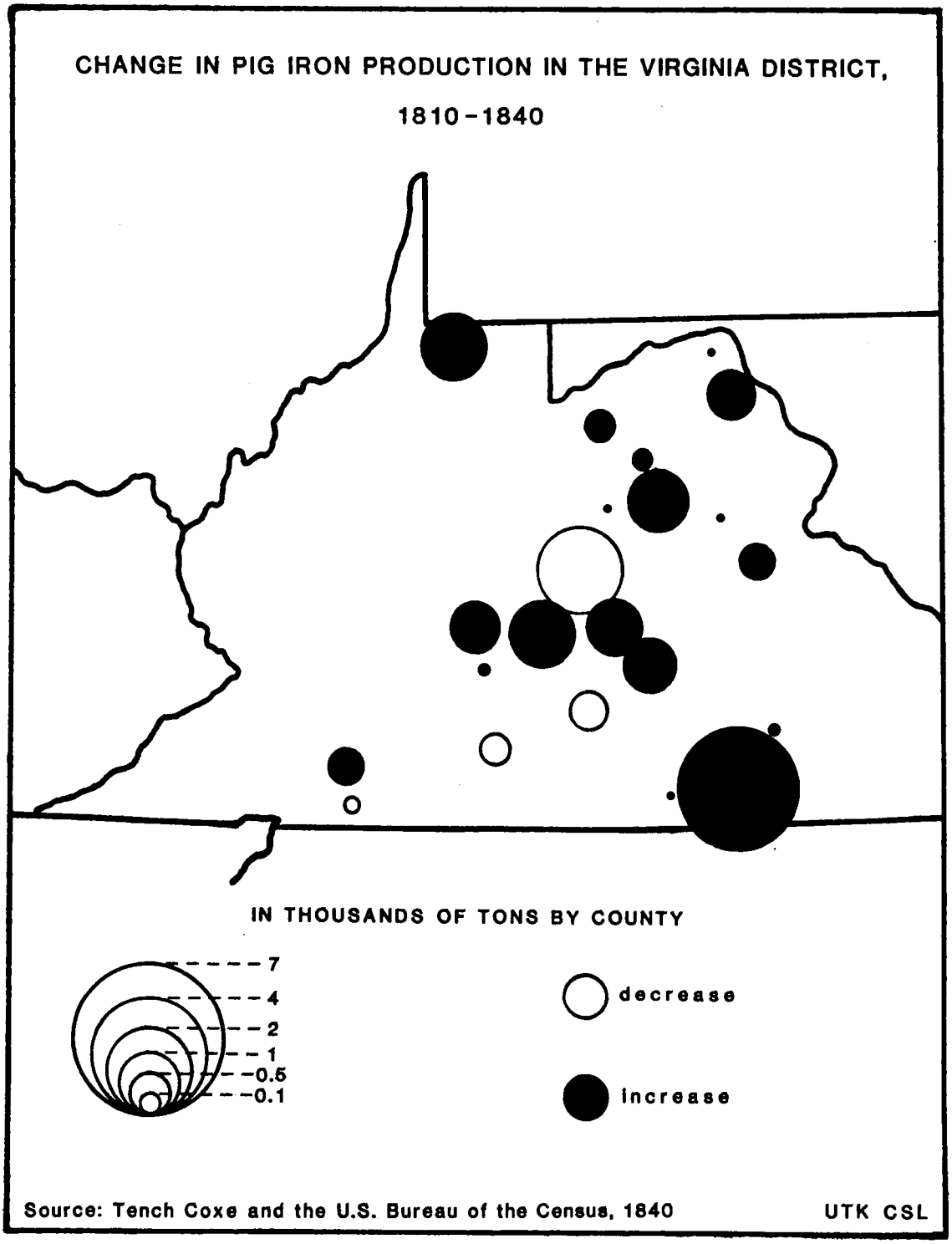

Figure 14. Change in Pig Iron Production in the Virginia District, 1810-1840.

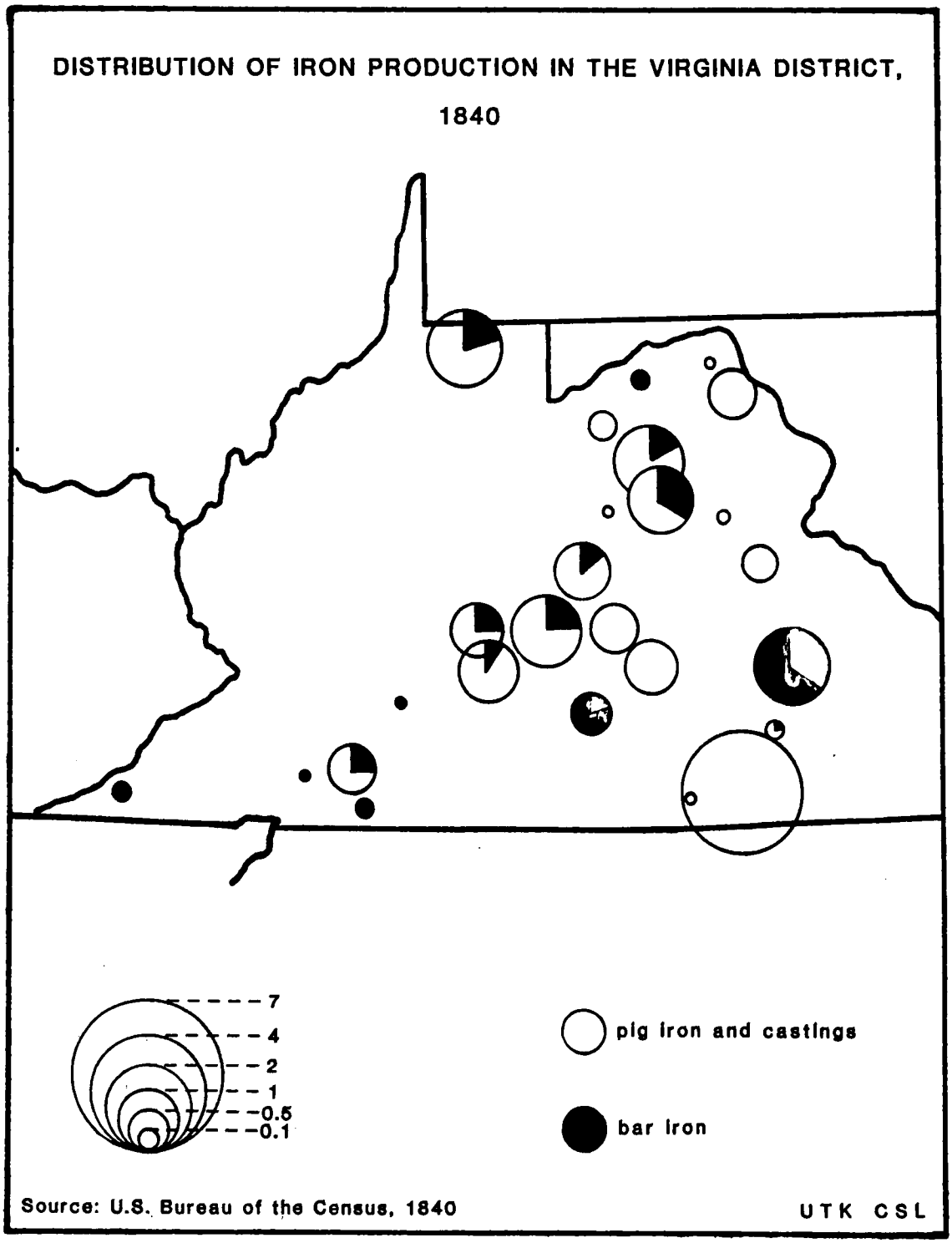

Figure 15. Distribution of Iron Production in the Virginia District, 1840.

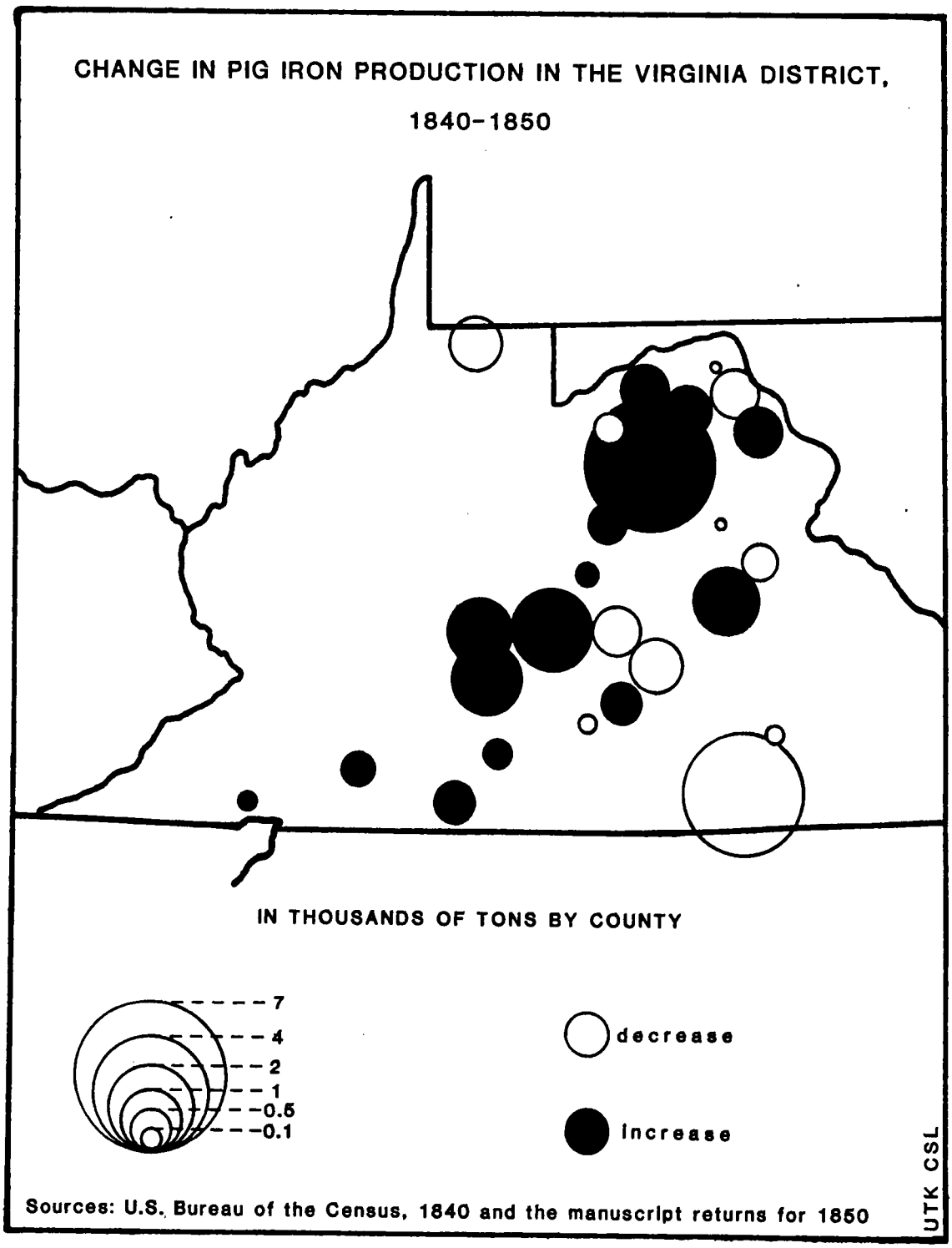

Figure 16. Change in Pig Iron Production in the Virginia District, 1840-1850.

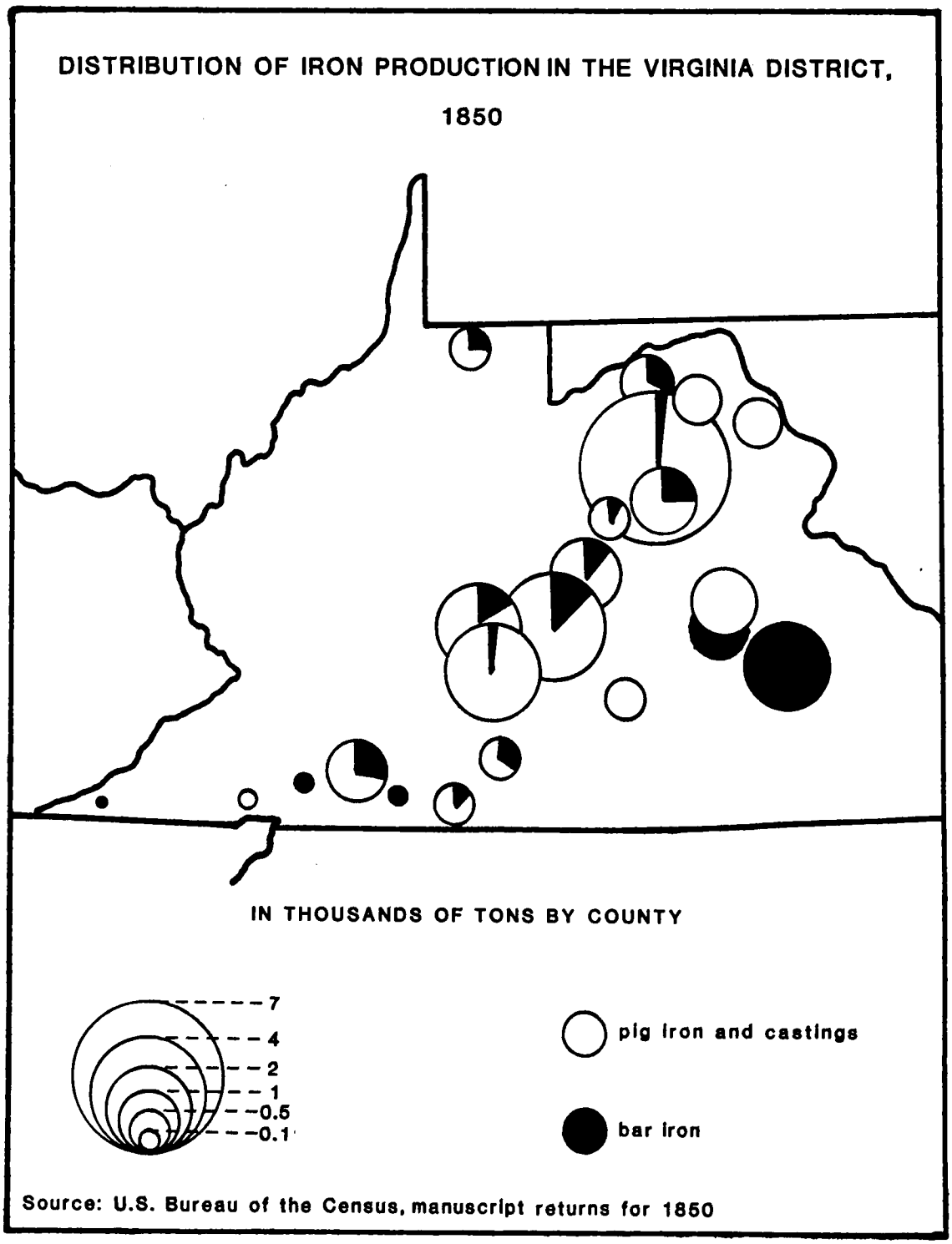

Figure 17. Distribution of Iron Production in the Virginia District, 1850.

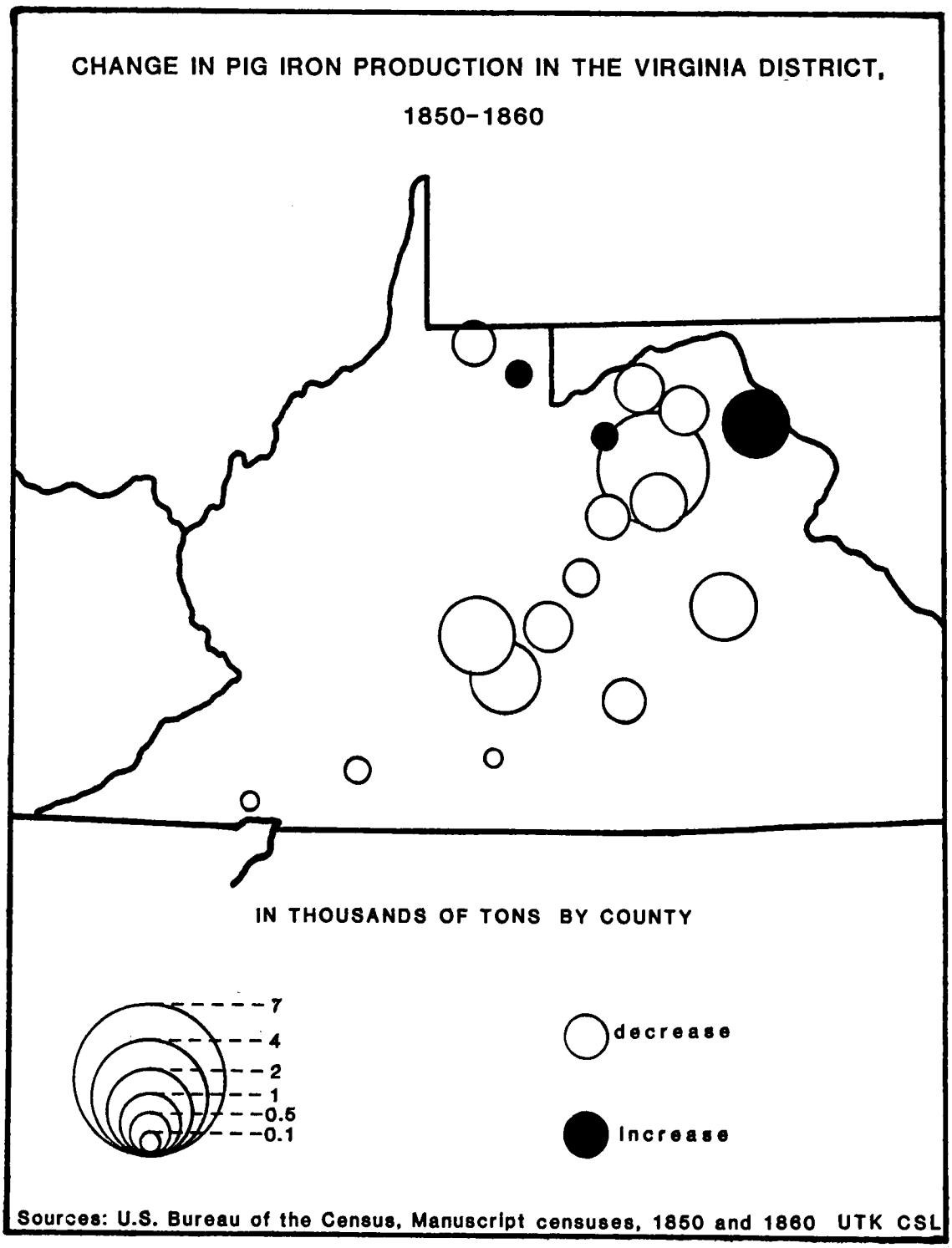

Figure 18. Change in Pig Iron Production in the Virginia District, 1850-1860.

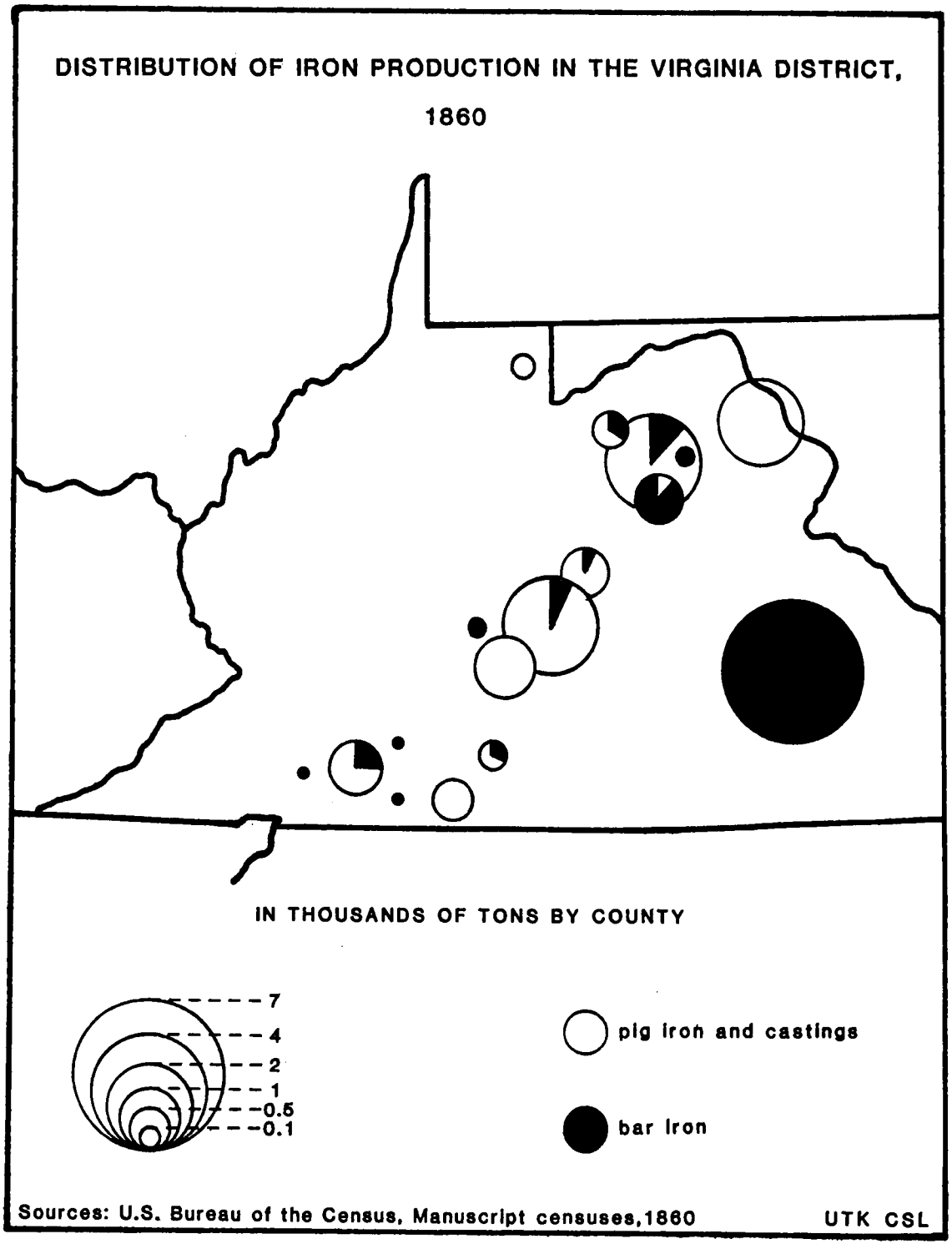

Figure 19. Distribution of Iron Production in the Virginia District, 1860.

weekly output advanced to between 30 and 50 tons, which was typical through 1860. This substantial increase in weekly production was due to a number of developments, including the failure of less efficient furnaces, a better understanding of smelting ore, greater application of labor, erection of larger furnaces with greater capacities, adoption of hot blast and steam power, and an increase in demand for pig iron.

In 1810 the mean annual production for furnaces in the Virginia District was 385 tons, which was greater than the mean annual production for the rest of the nation. (See Table III, Chapter 2, page 55.) Similar to the weekly output, the mean annual production in the district increased during the 1840's; and in 1850 and 1860, the typical furnace manufactured 764 and 727 tons, respectively.

The mean annual production was less than the weekly output suggests because most furnaces were operated only part of the year. In 1815 only two furnaces, Cloverdale in Botetourt County and Langhorn and Company in Franklin County, were in blast as long as twelve months.[2] They produced 930 and 540 tons of pig iron and castings, respectively, which was the largest annual production in the Virginia District. In other cases, furnaces were in blast nine to twelve months a year, closing only for brief periods to stockpile raw materials and make repairs to the furnace hearth and other equipment.

The majority of ironmasters, many of whom were actively engaged in agriculture, operated their furnaces for only six to nine months a

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[2]Auditor Item 86, "Returns of Salt, Lead, Iron, and Cigars, 1815," Virginia State Library.

year.[3] In these cases the blast was usually begun during the spring or sometime after mid-May, continuing until late fall or winter when the blast was stopped in order to make repairs and stockpile raw materials for the next season. Fewer workmen were needed to operate the furnace during its blast, and some laborers engaged in assembling and processing raw materials during the winter were available for other tasks in spring and summer. Thus, ironmasters skillfully coordinated the furnace operation around the availability of labor, procurement of raw materials, market demand, weather conditions, and other economic components of the iron plantation, particularly agriculture.

The Resource Base

Iron Ore

In the Virginia District, even though hematite, limonite, magnetite, and siderite ores were available, ironmasters almost exclusively smelted brown hematite ore.[4] The brown hematite ore was easily mined and smelted, yielding up to 70% or 75% iron when well screened.[5] The pig iron made from the brown hematite in the vicinity of the Great Valley was superior to the iron made in the Piedmont

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[3]Auditor Item 86, "Returns of Salt, Lead, Iron, and Cigars, 1815," Virginia State Library.

[4]John Peter Lesley, The Iron Manufacturer's Guide to the Furnaces, Forges, and Rolling Mills of the United States . . . (New York: J. Wiley, 1859), pp. 63-74, 445-446.

[5]Annual Report of the President to the Stockholders of the James River and Kanawha Canal (Richmond: Shepard and Colin, 1846), pp. 85 and 88.

(magnetic oxide and crude hematite), northwestern Virginia (siderite) and Pennsylvania, commanding an even higher selling price then the Pennsylvania iron.[6] However, the ore smelted in the Virginia District was not as highly regarded as the magnetic ore in New Jersey and northern New York.[7]

The amount and cost of ore used in making pig iron. The amount of ore used in making a ton of pig iron decreased in the course of time, and the pattern of consumption exhibited considerable spatial variation (Table V). At midcentury the furnaces in the Virginia District used 3 tons of ore at a cost of $5.58 to manufacture a ton of pig iron. The mean consumption decreased during the 1850's, requiring only 2.38 tons at a cost of $4.64 to make the same iron in 1860 (Table V).

The changing pattern of consumption was largely due to improvements in selecting, processing, and smelting ores. Some ironmasters hired experienced miners to extract and deliver ore from new deposits to improve their situation. In addition, the closing of less efficient furnaces also improved the district's ore to pig iron ratio.

Mining the ore. Mining was a fundamental segment of the backward integrated iron plantation. The mining was usually done during the winter so that miners could stockpile the ore before the blast was begun

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[6] Annual Report of the President, pp. 87-88.

[7] Annual Report of the President, p. 85.

TABLE V

CHANGE IN THE AMOUNT AND COST OF IRON ORE USED IN MAKING A TON OF PIG IRON IN THE VIRGINIA DISTRICT, 1850-1870 (IN TONS)

	1850		1860		1870	
	Amount	Cost	Amount	Cost	Amount	Cost
Virginia District	3.00	$5.58	2.38	$4.64	2.77	$5.60
Counties						
Alleghany	2.08	1.84	-	-	-	-
Amherst	-	-	-	-	2.70	-
Appomattox	2.00	-	-	-	-	-
Augusta	2.77	2.84	1.35	2.36	2.77	3.96
Botetourt	3.33	-	2.50	5.00	2.50	6.25
Campbell	-	-	-	-	4.33	8.01
Franklin	-	-	5.00	20.00	-	-
Frederick	-	-	-	-	-	-
Hampshire	2.56	3.20	2.66	-	-	-
Loudoun	4.50	10.49	2.00	1.50	-	-
Louisa	3.56	1.78	-	-	2.50	-
Monongalia	3.00	8.53	-	-	-	-
Page	2.50	2.50	5.00	10.00	3.00	-
Patrick	-	-	1.41	3.12	-	-
Preston	-	-	4.50	9.20	-	-
Pulaski	-	-	-	-	2.22	2.22
Rockbridge	2.85	4.33	2.04	6.12	-	-
Rockingham	1.66	1.66	-	-	3.00	4.98
Shenandoah	3.44	8.98	2.63	5.37	2.50	2.08
Wythe	3.00	-	4.00	2.84	2.38	2.38

Source: Calculated from the census manuscripts. U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860 and 1870.

in the spring.[8] This was necessary to prevent a "running stock" situation in which the operation of the furnace was dependent upon daily receipt of raw materials.[9]

To provide the stockpile, miners using picks and shovels raised the ore from open pits and simple shafts and tunnels.[10] They then loaded the ore into carts and wagons and transported it over relatively poor roads to the furnace, with some crude tramways possibly being used by midcentury.[11] Since wet roads made delivery difficult and uncertain, teamsters diligently hauled the ore during periods when road conditions were good.[12] Maintaining the wagon roads, constructing new roads, and caring for the draft animals were important tasks for the workmen.

In most cases the furnace was located a relatively short distance from the ore, and the road network did not need to be extensive. In

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[8]"Quantity of Ore Raised--Number of Ox Carts and Wagon Loads Freight of Each Load for the Blast 1807-1808," Duke University, William Bolling Papers; Letter, John Anderson to Dear Brother, February 3, 1858, Duke University, F. T. Anderson Papers.

[9]Letter, John Anderson to Dear Brother (F. T. Anderson), February 3, 1858, Duke University, F. T. Anderson Papers.

[10]Peter Temin, Iron and Steel in Nineteenth-Century America, An Economic Inquiry (Cambridge, Massachusetts: M.I.T. Press, 1964), p. 88; Letter, Charles K. Gorgas to Uncle (William Weaver), November 29, 1857, Duke University, William Weaver Papers.

[11]"Specifications for J. W. Green for Making a Railroad from Furnace to Ore Banks, 1861," Duke University, Sanders-Green Papers; Letter, C. K. Gorgas to Uncle, date unknown, Duke University, William Weaver Papers; "1855-1861 Time Book, Etna furnace," University of Virginia, Weaver-Brady Papers; Francis R. Holland, Jr., "Three Virginia Iron Companies, 1825-1865" (unpublished M.A. thesis, University of Texas, 1958), pp. 86-87.

[12]Letter, unknown (Buffalo forge) to William Weaver, September 25, 1830, Duke University, William Weaver Papers.

the mid-1850's the mean distance between the ore deposits and furnaces in the Virginia District was approximately 1.7 miles.[13] As in other southern districts, the low cost of Virginia ore was largely due to low transportation costs, an important factor in the success of the industry.[14]

The proposed movement of ore to coal. The backward integrated iron plantation depended upon the furnace being near the resources. During the 1840's, however, Professor W. B. Rodgers suggested that ore and limestone should be assembled at a site near fuel, power, and/or the market. Rodgers noted that this new pattern of location was being instituted in Pennsylvania, Maryland, and New York; and he suggested that the ores of Virginia should be transported to coal, either at Richmond or westward, possibly at the falls of the Kanawha River. He further recommended that coking ovens and large blast furnaces should be connected in a productive chain with rolling mills, nail factories, and foundries.[15]

In March, 1860, S. H. DeBow stated that his company's plan to transport ore to coal deposits near the market would be the best mode of operation.[16] However, the transition from a backward integrated iron

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[13]Lesley, pp. 63-74.

[14]Although Temin is referring to the postbellum period, the statement is also applicable to the antebellum era. Temin, p. 198.

[15]Letter, W. B. Rodgers in Annual Report of the Proceedings, pp. 84 and 86.

[16]Letter, S. H. DeBow to William Weaver, March 22, 1860, Duke University, William Weaver Papers.

plantation to an operation whereby raw materials were supplied by other firms was not easily accepted. For example, in 1867 Dakin and Company leased furnace property and arranged to have the iron ore supplied by other parties. When the furnace was not as successful as expected, the lessor complained that the company should have mined its own ore as in the antebellum period.[17]

Charcoal Fuel

The consumption of charcoal varied widely in the district; and, as with ore consumption, the amount necessary to manufacture a ton of pig iron decreased in the course of time. In the mid-19th century the mean consumption in the Virginia District was 219 bushels per ton, but by 1860 and 1870, the consumption had decreased to 192 and 171 bushels, respectively.[18]

The quality of ore was especially important in determining charcoal consumption since it required more fuel to smelt some ores. As a result, part of the spatial variation in fuel consumption was caused by differences in the ore at various sites. However, much of spatial variation and decrease in consumption were due to changes in selecting, processing (washing and/or screening the ore), mixing, and smelting the

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[17]"Articles of Agreement between F. T. Anderson, Lexington and Jacob Dakin of New York," Lease March 7, 1867, University of Virginia, Anderson Papers; draft of a letter to Eugene Kelly written by F. T. Anderson (inference), January 13, 1869, University of Virginia, Anderson Papers.

[18]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860 and 1870.

ores correctly.[19] A major change in smelting was the installation of hot blast and steam power, which reduced fuel consumption and augmented production, although a large portion of furnaces (about 60% in the mid-1850's) in the Virginia District continued using cold blast and waterpower.[20] Finally, since it required more charcoal (20% or more) to make pig iron with soft and pulverized fuel, part of the decrease and spatial variation in consumption may be attributed to the quality of charcoal used.[21]

The fuel supply. The depletion of wood for charcoal fuel has been widely offered as a major cause for the decline of the charcoal iron industry;[22] and it is probable that some ironmasters depleted timberland without regard to reforestation, thus causing the abandonment of selected furnaces. Nevertheless, as hypothesized in Chapter 1, depletion of timber at the regional scale was not a major cause of the demise of iron production in the Virginia District during the antebellum period.

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[19] Annual Report of the President, p. 88.

[20] Lesley, pp. 63-74.

[21] Letters, W. W. Rex to Brady, August 31, 1861 and October 8, 1861, Duke University, William Weaver Papers; Annual Report of the President, pp. 88-89.

[22] Ernest M. Lander, "The Iron Industry in Ante-Bellum South Carolina," Journal of Southern History 26 (1960), p. 354; Pierce F. Lewis, "Small Town in Pennsylvania," Annals, Association of American Geographers 62 (June, 1972), p. 339; Harold F. Round, "The Wilderness," Virginia Cavalcade 44 (Winter, 1964), p. 6; "Memos of An Agreement Entered into this Day of April, 1811 between John Thompson and William Newburn on behalf of David Rofs," Duke University, William Bolling Papers; Letter, Charles to Uncle, January 24, 1860, Duke University, William Weaver Papers.

The antebellum ironmaster, well aware of his needs, controlled a large landholding in order to provide the immense quantity of wood required for charcoal fuel. In Virginia, an acre of timber produced 30 cords, with each cord making about 40 bushels of charcoal; consequently, an acre of timber supplied about 1,200 bushels of charcoal, enough fuel for the typical furnace to manufacture 5½ tons of pig iron in 1850.[23] Since the annual production of the typical furnace was 764 tons in 1850, it follows that a minimum of 139 acres of timber was cut to provide its annual fuel needs. Since a stand of timber desirable for cordwood could regenerate in 20 to 30 years, 2,500 to 4,500 acres were thus necessary to supply fuel on a sustained basis; and the typical landholding was likely over 10,000 acres. Even excluding the cleared land, most iron plantations had the potential to provide fuel much beyond the duration of the antebellum era.[24] In addition, some ironmasters augmented their

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[23]Temin, p. 83.

[24]The following sources suggest that there was an abundant supply of wood and charcoal. While problems encountered in supplying cordwood and charcoal are occasionally mentioned, the general absence of such references in the manuscript data further indicates that wood was abundant during the decline of the Virginia iron industry. "1858-1859 Daybook," Etna furnace, January 29, 1858, University of Virginia, Weaver-Brady Papers; Letter, Jordan David and Co. to William Weaver, November 24, 1830, Duke University, William Weaver Papers; "Redwell Furnace Account Book, 1805-1816," Virginia Historical Society, Redwell furnace; Letter, A. W. Davis to Uncle, September 25, 1830, Duke University, William Weaver Papers; "Articles of Agreement between F. T. Anderson, Lexington, to Jacob Dakin, New York," 1867, University of Virginia, Anderson Papers; "1855-1861 Time Book, Etna furnace" July, 1859, University of Virginia, Weaver-Brady Papers; Letter, John Anderson to Dear Brother, February 3, 1858 or 1859, Duke University, F. T. Anderson Papers; "Oxford Iron Works Furnace Coaling Ground, 1807-1808," Duke University, William Bolling Papers; Annual Report of the President, p. 86.

fuel supply by purchasing additional woodland and/or cordwood from farmers and others.[25]

That the depletion of wood was not a major cause of the demise of the Virginia District is shown by the stable price of charcoal. If charcoal had been in short supply during the period of decline, the shortage should have been accompanied by a significant rise in cost. However, the cost of a bushel rose only from 3¢ to 3 2/3¢ between 1850 and 1860, causing the cost of fuel used in making a ton of pig metal to rise from $6.57 to $7.02.[26] In fact, two ironmasters asserted they could afford to pay as much as 5¢ a bushel and still make a profit as long as iron was selling at $30 a ton in Richmond.[27]

In spite of the fact that wood depletion at the regional scale was not a major factor in the demise, it must be pointed out that iron

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[25]"Day Book, Buffalo Forge, 1840-44," University of Virginia, Weaver-Brady Papers; Letter, Charles Gorgas to William Weaver, March 24, 1859, University of Virginia, Weaver-Brady Papers; "Memos of Bargain between John Graybill and J. H. Burns for Shanks and Anderson" in "Negro Book, 1847-49," 1847, University of Virginia, Anderson Papers; Letter, R. S. Wade to William Weaver, February 3, 1860, Duke University, William Weaver Papers; "Journal (Slave) 1842-1847," Glade Coaling, University of Virginia, Graham Family Papers; Letter, W. W. Rex to D. Brady, March 14, 1859, University of Virginia, Weaver-Brady Papers; "Ploughboy-Communication to Editor, 1842," University of Virginia, Bruce Collection; Robert D. Mitchell, Commercialism and Frontier Perspectives on the Early Shenandoah Valley (Charlottesville: University Press of Virginia, 1977), p. 205.

[26]U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850 and 1860; Temin, p. 65; Holland, p. 87; Alfred D. Chandler, Jr., "Anthracite Coal and the Beginnings of the Industrial Revolution in the United States," Business History Review 46 (Summer, 1972), p. 161; Annual Report of the President, p. 88; Letter, W. W. Rex to Daniel Brady, March 14, 1859, University of Virginia, Weaver-Brady Papers.

[27]Annual Report of the President, pp. 87-88.

making was clearly a fuel intensive industry, and supplying charcoal in advance of consumption was difficult.[28] The coaling operation suffered interruption by heavy rainfall, which saturated the coaling ground and made roads wet and impassable. Steep slopes and an increase in distance traveled over poor roads also made coaling more difficult and costly.[29] In order to stay ahead of consumption, the ironmaster sometimes had to assign a large portion of his labor force and draft animals to the coaling ground.[30]

The woodchoppers were kept busy during the winter supplying cordwood for the forthcoming coaling.[31] Soon after the first of the year the newly hired slaves and others were assigned to woodcutting chores.[32] Bondsmen were expected to cut 9 cords a week, although some

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[28]Letter, W. W. Rex to Brady, May 24, 1861, University of Virginia, Weaver-Brady Papers; Letters, W. W. Rex to Brady, November 15, 1861, August 20, 1861, August 31, 1861, and October 8, 1861, Duke University, William Weaver Papers; Letters, T. H. Burns to F. T. Anderson, February 14, 1852 and June 13, 1851, University of Virginia, Anderson Papers; Letters, W. W. Rex to Brady, August 31, 1861 and October 8, 1861, Duke University, William Weaver Papers.

[29]Annual Report of the President, p. 89.

[30]Letter, T. H. Burns to F. T. Anderson, February 14, 1852, University of Virginia, Anderson Papers.

[31]Letter, A. W. Davis to William Weaver, September 19, 1830, Duke University, William Weaver Papers.

[32]Letter, Jordan, Davis and Company to William Weaver, January 25, 1833, Duke University, William Weaver Papers; "Daybook Union Forge 1825-1826," December 30, 1826, Duke University; Lantz and Rinker, Daybooks and Ledgers; "Time and Wood Records, Buffalo Forge, 1830-1843," University of Virginia, Weaver-Brady Papers.

slaves could cut and stack as many as 18 cords.[33] To alleviate the problem of consuming raw materials as they were supplied, ironmasters employed slaves in the evenings and on Sundays and holidays. The overwork system allowed the ironmaster to produce raw materials, particularly charcoal, in excess of consumption; and the bondsmen were paid for the overtime.[34]

The Predominance of Waterpower in the Virginia District

At midcentury, 88% of the furnaces in the district were still using waterpower, but the proportion was declining (Table VI). By 1860 a little over two-thirds of the furnaces were operated by waterpower, making it the dominant mode of power during the antebellum period.

Despite the prevalence of waterpower, two technical improvements, hot blast and steam engines, were gradually introduced during the recovery from the Panic of 1837.[35] Ironmasters in the northern counties of the district, including those in Page, Shenandoah, Jefferson, Loudoun, and Spottsylvania, were probably using steam power by the late 1830's (Figure 20). They continued installing steam power in the area

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[33]One source stated that the task was 9 cords a week, which I assume was the general pattern. "Time and Wood Records 1830-43," University of Virginia, Weaver-Brady Papers; Letter, William N. Anderson to Frank, January 30, 1853, University of Virginia, Anderson Papers; Letter, Charles Pettyjohn to F. T. Anderson, April 16, 1861, University of Virginia, Anderson Papers.

[34]Letter, Charles (Gorgas) to Uncle (William Weaver), September 15, 1859, University of Virginia, Weaver-Brady Papers.

[35]Lester J. Cappon, "Lucy Selina's Charcoal Era," Virginia Cavalcade 7 (Autumn, 1957), p. 36.

TABLE VI

THE USE OF STEAM AND WATERPOWER AT BLAST FURNACES
IN THE VIRGINIA DISTRICT, 1850-1870

Year	Water	Steam	Water and Steam	Unknown
1850	22	2	3	—
1856	25[a]	10	7	—
1860	11	3	1	1
1870	6	5	2	—

Sources: Lesley, pp. 63-74; U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860, and 1870.

[a]Lesley listed 42 furnaces in operation during the mid-1850's, indicating that 17 used steam and/or steam and waterpower. This writer has assumed the rest of the furnaces were using waterpower.

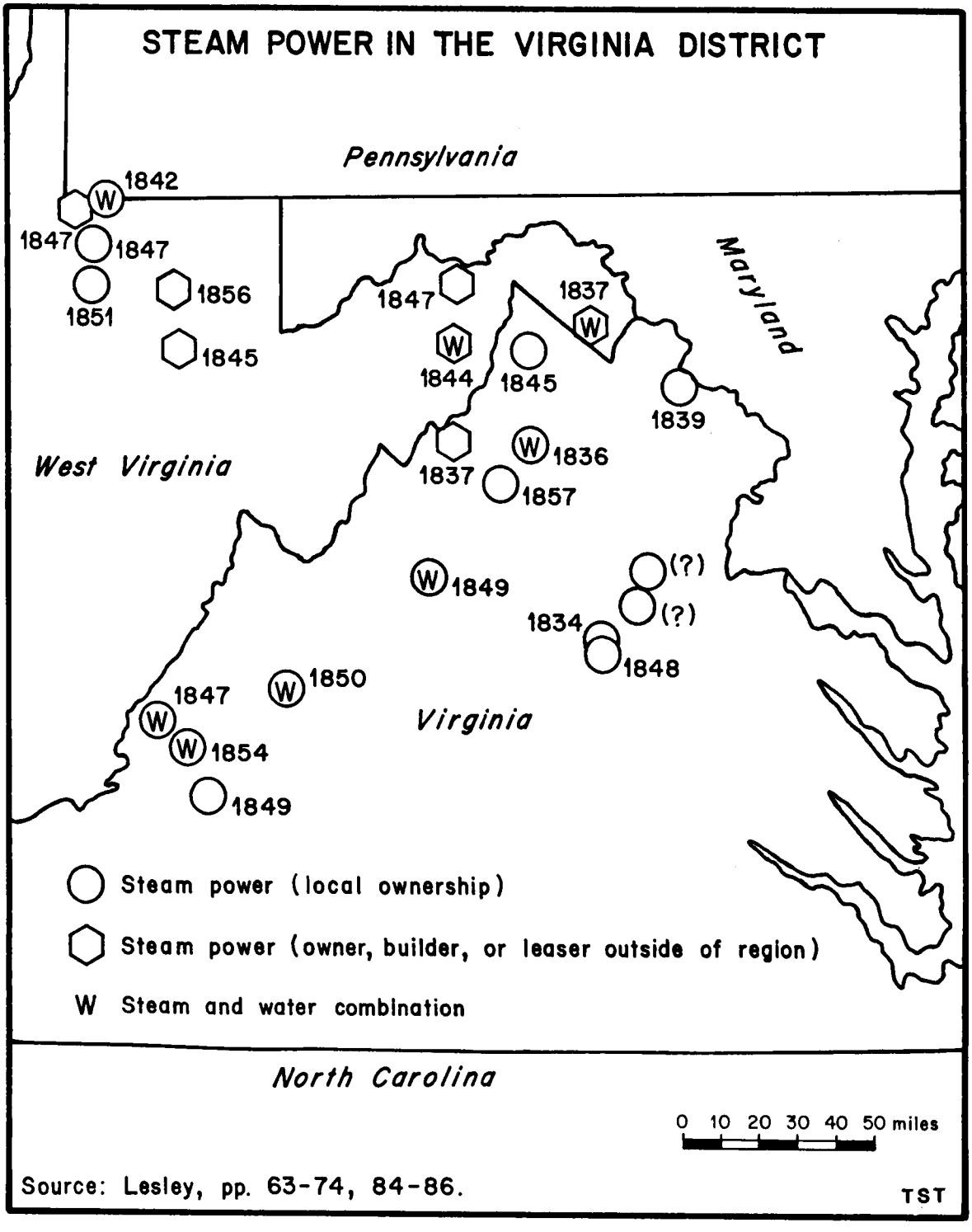

Figure 20. Steam Power in the Virginia District. Dates on map are those when furnaces were built; steam power could have been added later.

during the early 1840's; and it is significant that by 1847 about 50% of the furnaces operated by steam power were owned, leased, or built by ironmasters from the North. By the late 1840's and early 1850's, steam power had spread southward to the furnaces in Alleghany, Botetourt, and Rockbridge counties, though most of the furnaces here were using a combination of steam and waterpower.

The Iron Plantation Occupance Type, Its Form and Function

It has been commonly asserted that the South was an agrarian society resisting industrialism;[36] nonetheless, the success of the Virginia iron industry can be partially explained by its compatibility with the agricultural regime. This compatibility is illustrated by (1) entrepreneurs investing in both agriculture and iron making, conducting them on the same estate; (2) the ironmaster-planter coordinating the application of labor in order to take advantage of peak demands and seasons favoring each sector of his business; and (3) the ironmaster establishing a mutually satisfactory interchange with the yeoman farmer and planter, involving the hiring of slaves, sale of ironware, and trade for food, provisions, and fuel.

The Size and Form of the Iron Plantation

The iron plantations in the Virginia District varied in size from 5,000 to 40,000 acres, probably averaging well over 10,000 acres

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[36] Kathleen Bruce, "Economic Factors in the Manufacture of Confederate Ordnance," Part 1, Vol. 6 Army Ordnance, p. 168, University of Virginia, Anderson Papers.

(Table VII). The estates were usually irregular in shape and were comprised of either contiguous or fragmented landholdings. In some cases, fragmented land ownership gradually developed as ironmasters purchased additional land for right-of-ways, farming, or raw materials.

A brief description of two ironworks, Marlbro and Glenwood, illustrates the size and form of the typical iron plantation. Situated about twelve miles from Winchester, Marlbro ironworks consisted of a furnace, forge, saw mill, merchant mill, and farm.[37] Besides the buildings housing these functions, there were smith shops, a store house, dry goods store house, compting house, family and workmen accommodations, and a stone mansion. In addition, there were numerous stone, log, and frame outbuildings, including stables, three barns, a still house, spring house, ice house, fountain house, and many other conveniences not enumerated here. The settlement was located on a 300-acre plantation, with the buildings situated no more than 825 feet apart on a 10-acre tract; however, the whole iron plantation, including woodlands, was between 7,000 and 10,000 acres in size.

The settlement at Glenwood furnace, located about 1½ miles from the James River in Rockbridge County, was arranged in linear form along Elk Creek.[38] The estate was an irregularly shaped landholding containing

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[37]A photo copy of a document from the American Antiquity Society, Philadelphia, 1791, University of Virginia, Isaac Zane.

[38]"Basis of My Estimates of Glenwood Property in Offer I Made to W. Dakin," University of Virginia, Anderson Papers; "Prospectus, The Virginia Valley Iron and Manufacturing Company," Letter, Joseph R. Anderson to Messrs. Fitzhugh, January 17, 1866, University of Virginia, Anderson Papers; Lesley, p. 70; Letter, F. T. Anderson to Mr. Imboden, May 5, 1868, University of Virginia, Anderson Papers.

TABLE VII

SIZE OF THE IRON PLANTATIONS
IN THE VIRGINIA DISTRICT

Furnace, Firm, or Ironmaster	Size of Landholdings (in Acres)	Approximate Date
Oxford Iron Works	24,000	1811
Marlbro' Iron Works	7,000 to 10,000	1791
Weaver and Mayburry	6,415[a]	1814
Peter Saunders & Co.	25,000 to 30,000	1820
Lydia furnace	5,110	1825
Lucy Selina	40,000	1831
Edward Bryan, Jr.	10,673	1833
Greenville Furnace and Mining Co.	10,000	1837
Fredericksburg Iron and Steel Co.	5,000[b]	1836
Etna furnace	8,000	1845
Buffalo forge	5,000	1859
D.C.E. Brady	7,185[c]	1870
Catawba Iron Works	8,000 to 10,000	1846
Glenwood furnace (Estate)	25,425	1860's
David Graham	6,917	1862
Samuel F. Jordan and G. W. Jordan	3,300	1863
Virginia Valley Iron and Manufacturing Company	5,000	1866
Elizabeth furnace Iron Property	6,605	1869

Source: Compiled by author from multiple manuscript sources.

[a]Included Retreat and Etna furnaces and Union forge.

[b]Type of ironwork unknown.

[c]Successor of William Weaver's Buffalo forge.

25,425 acres, 20,000 to 21,000 of which belonged to the ironmaster. Within the estate there were farm enclaves owned or leased by other parties; and even after subtracting the arable land of these farms, the property contained enough woodland to supply fuel for more than one furnace (Figure 21).

Economic Components of the Iron Plantation

The furnace community provided a variety of jobs for the residents and often gave part-time employment to yeoman farmers and others in the tributary area. In more isolated areas, the furnace community was an important market for those trading with the ironmaster, and served as a center providing goods and services for the surrounding populace.

In addition to the furnace, a community often contained one or more ancillary activities, including a forge, rolling mill, foundry, grist mill, saw mill, lime kiln, barrel factory, general store, and farm. Some ironmasters also made liquor, sorghums, oil (flax), cloth and leather, and might process salt or cut cordwood for resale.[39] The most

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[39]United States Bureau of the Census, unpublished census manuscripts, "Census of Manufactures, 1820"; Letter, James W. Donenhower to John Whitmore, October 13, 1829, University of Virginia, Weaver-Brady Papers; "Daybook Union and Buffalo Forge 1825-1826, 1826-28"; "Time and Wood Records, Buffalo Forge, 1830-43, 1831-41"; "Time Book, Buffalo Forge, 1843-53," University of Virginia, Weaver-Brady Papers; Holland, p. 124; Letter T. H. Burns to F. T. Anderson, February 7, 1853, Duke University, F. T. Anderson Papers; Letter, T. H. Burns to Dear Sir, August 6, 1852, University of Virginia, Anderson Papers; Letter, T. H. Burns to F. T. Anderson, July 19, 1852, Duke University, F. T. Anderson Papers; Letter, Joseph R. Anderson and Company to F. T. Anderson, February 19, 1864, University of Virginia, Anderson Papers; Letter, W. W. Rex to Brady, December 21, 1861, Duke University, William Weaver Papers.

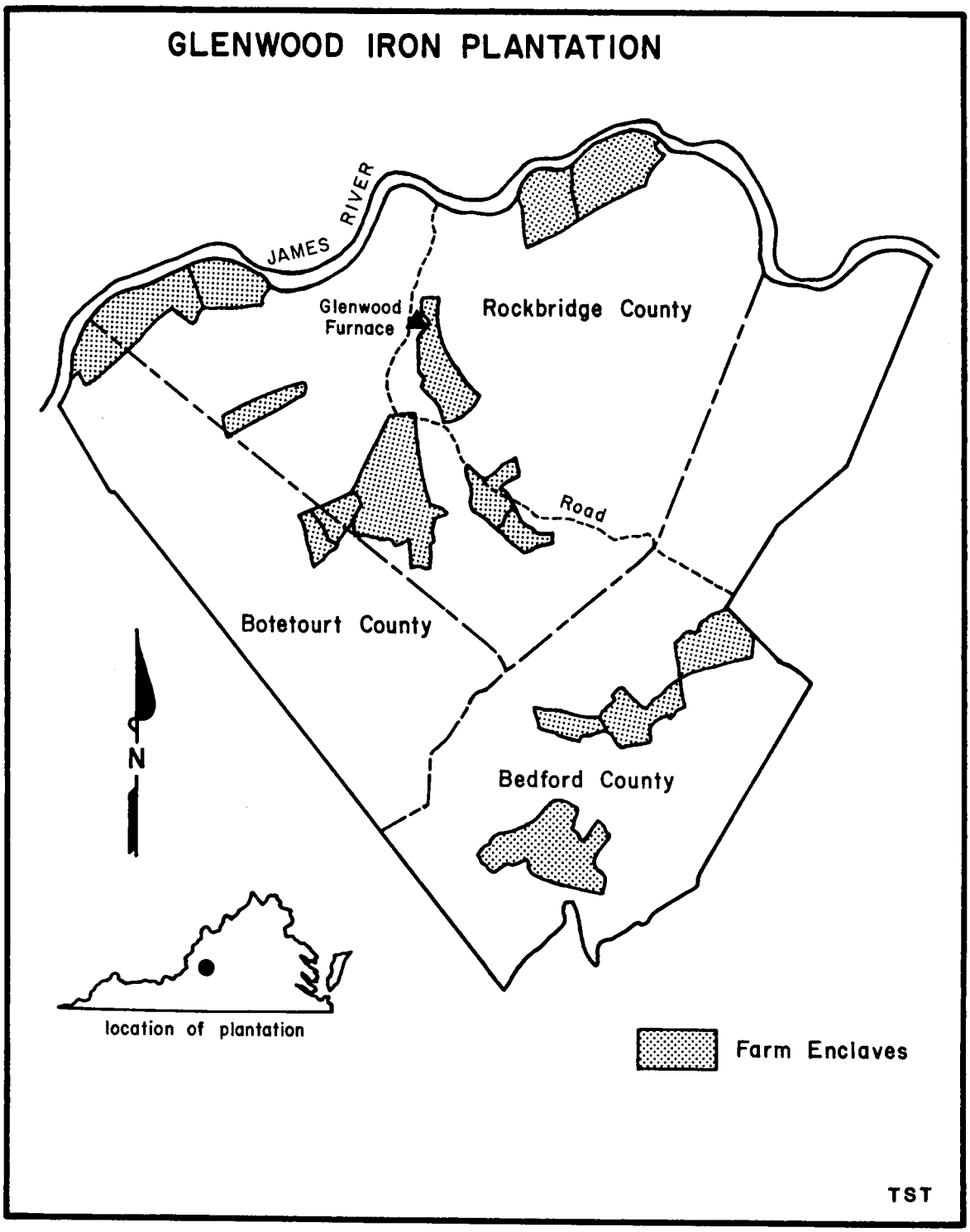

Figure 21. Glenwood Iron Plantation, ca. 1868.

common ancillary activities, however, were the operation of a general store, secondary iron manufacture, grist mill, and farm(s). The operation of a grist mill allowed the ironmaster to process his own grain and provide custom milling services for the farmer and planter, receiving a share of the grain for the service.[40]

Secondary manufacturing was relatively common, but since the forge and/or rolling mill competed with the furnace for fuel and power, they were often located at different sites.[41] Assuming that firms were linked in a productive chain when the furnace and forge were located at different sites, it is estimated that the Virginia District had a greater incidence of forward integration than indicated by Grosse's findings. Since ten or more ironmasters operated both a furnace and forge in 1815, about two-thirds of the firms apparently were vertically integrated.[42] Moreover, an estimated 40% and 30% of the firms were linked in a productive chain in 1820 and 1850, respectively, though Grosse found that in 1820 and 1857 less than 20% of the furnaces he

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[40]Cappon, "Lucy Selina's Charcoal Era," p. 34.

[41]"Day Book Union and Buffalo Forge, 1825-26, 1826-27," "1828-1830, Ledger, Bath I. W."; "Buffalo Forge 1841-44"; Letters, Charles Gorgas to Buffalo Forge, March 29, 1859; W. W. Rex to Brady, January 28, 1859; W. W. Rex to Brady, February 25, 1859; "1859 January-March Accounts from Charles to Buffalo Forge," University of Virginia, Weaver-Brady Papers; Holland, pp. 84, 86, 110-111, 114, 116-118; Cappon, "Lucy Selina," p. 34; Letter, H. T. Jordan to Frank (Ira F. Jordan), January 14, 1851, Virginia State Library, Jordan Family Papers; Hegelziah T. Jordan to Dear Frank, January 7, 1854, Virginia State Library, Jordan Family Papers; "Ledgers 1848-1852 Union Forge, Virginia," Duke University, Lantz and Rinker; Letter, W. W. Rex to Brady, November 19, 1861, Duke University, William Weaver Papers.

[42]Auditor Item 86, "Returns of Salt, Lead, Iron . . .," 1815, Virginia State Library.

studied were linked with a forge.[43] In the course of time, the incidence of forward integration in Virginia became less prevalent, mainly because of the development of secondary manufactures in urban areas, displacing the rural forge and creating a growing market for pig iron.

The ironmaster-planter, farming on the iron plantation. In addition to secondary manufactures, farming was an important component of some iron plantations. However, while some furnace owners were ironmaster-planters who were heavily engaged in farming, others were pioneer industrialists who directed their interest solely to the exploitation of mineral resources.

In an isolated, rural society iron making began as an auxiliary to agriculture in order to meet local needs with local resources.[44] An ironworks was often financially tributary to agriculture and operated only when labor in the field was so light that it could be diverted to the industry.[45] However, this arrangement changed as demand for iron increased, with the major transition probably occurring during the 1830's, but the timing cannot be stated with any exactness for broad

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[43]After a study of the manuscript census returns (with some inferences on ownership patterns made), these data were estimated with the percentages of forward integration perhaps overstated. Temin, p. 94; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry, 1850"; U.S. Bureau of the Census, unpublished census manuscripts, "Census of Manufactures," 1820.

[44]Cappon, "Lucy Selina's Charcoal Era," p. 32.

[45]Lester J. Cappon, "Trend of the Southern Iron Industry Under the Plantation System," Journal of Economic and Business History 2 (1929-1930), p. 365.

areas. About 1857, for example, the net profits from the sale of iron at Glenwood furnace were $29,800 and those from the farm $4,000 to $5,000.[46] Even though agriculture on the iron plantation was clearly financially subordinate in the late 1850's, it is difficult to measure its indirect contribution. Perhaps indicative of the relative importance of the farm is the fact that its manager was paid the same salary as the manager of the furnace.[47]

The furnace farm was as much a facet of backward integration as were mining and coaling activities. It provided all or part of the furnace community's food and provender, with the degree of involvement in farming depending upon the ironmaster's objectives.[48] In addition, some ironmasters allocated arable land to furnace hands, yeoman farmers,

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[46]Letter, F. T. Anderson to D. K. Colbourne, April 26, 1858, University of Virginia, Anderson Papers; "Dover Coal and Iron Company Property Report . . . December 13, 1865, New York," University of Virginia, Dover Iron Company.

[47]Letter, David Ross to Charles W. Beard, October 29, 1813, Virginia Historical Society, Letterbook David Ross; "Deed . . . January 26, 1833," University of Virginia, Sophia Jolly; "Estimates of Expenses of Glenwood Furnace for the Year 1859," University of Virginia, Anderson Papers; Letter, T. H. Burns to F. T. Anderson, June 13, 1851, University of Virginia, Anderson Papers.

[48]Holland, p. 130; Letters, John and Rex to William Weaver, July 28, 1856; A. W. Davis to William Weaver, October 8, 1830, Duke University, William Weaver Papers; "1863 Appraisement of Goods and Chattels of William Weaver Deceased," June 1, 1863, University of Virginia, Weaver-Brady Papers; Letter, David Ross to Thomas Hopkins, August 17, 1813, Virginia Historical Society, Letterbook David Ross; 1828-1830 Ledger, Bath I. W. loose page in the ledger, "Account of Beef Slaughter in 1828," University of Virginia, Weaver-Brady Papers; "Statement October 3, 1859," University of Virginia, Weaver-Brady Papers; Letter, Jacob Shook to William Weaver, June 9, 1854, Duke University, William Weaver Papers.

and others on a share tenancy basis to augment the food supply.[49] Ironworkers also supplemented their food supply by planting gardens and tending a few animals in the furnace community.[50]

Regardless of the ironmaster's degree of involvement in agriculture, the demand for feed and food promoted agricultural settlement and development. While cutting cordwood for fuel, the ironmaster cleared arable land in areas that under other circumstances may have been less intensively cultivated. The iron industry also fostered the development of transportation, which further encouraged agricultural development.

On the other hand, trends in agriculture also had an effect on the charcoal iron industry. Poor crop yields, high prices for commodities, and delays in receiving foodstuffs influenced the cost and production of pig iron.[51] Moreover, during periods of agricultural prosperity, agriculture competed with the industry for available workmen.

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[49]"Lease Advertisement Written Lynchburg Star," September 3, 1811, Duke University, William Bolling Papers; Letters, David Ross to Charles W. Baird, February 9, 1812, David Ross to Charles W. Baird, Virginia Historical Society, David Ross Letterbook; Letters, John Britt to Dear Sir (F. T. Anderson), August 7, 1856 and February 21, 1857, University of Virginia, Anderson Papers.

[50]Letter, T. H. Burns to F. T. Anderson, February 7, 1853, Duke University, F. T. Anderson Papers.

[51]Letters, (A. W. Davis) to William Weaver, September 25, 1830; William Weaver to (A. W. Davis), June 2, 1831; Charles to William Weaver, April 18, 1860; Letters, John Donihoe to William Weaver, October 8, 1830; A. W. Davis to William Weaver, May 28, 1831, Duke University, William Weaver Papers; Letter David Ross to George, January 27, 1812, Virginia Historical Society, Letterbook David Ross; Letter, F. T. Glasgow to Dear Uncle (F. T. Anderson), March 11, 1864, University of Virginia, Anderson Papers.

William Weaver's iron plantation, an example of agricultural practices. William Weaver was born in Pennsylvania, but he spent most of his life engaged in iron making, farming, and milling in the Great Valley of Virginia. While iron making dominated his business interests, he was considered a pioneer in scientific agriculture.[52]

Weaver purchased about 800 acres near the Blue Ridge mainly for a wood supply. After being cleared, the steeply sloping hill sides were plowed along the contours, and the land was transformed into an economical and ecological system of crop-livestock farming with reasonably good crop yields. Weaver applied lime and manure on the poorest spots, but he attributed his success in soil improvement to the exclusive use of clover and plaster.

Weaver's three-year crop rotation scheme required the labor of twelve hands and six mules for a four-month period, with the production of corn for the furnace and forge community the primary objective of the mountain farm. The average yield of the corn was 40 to 60 bushels an acre, with the harvest of 200 acres producing a minimum supply of 8,000 bushels. Furthermore, it was anticipated that ninety acres of oats would produce an additional 3,000 to 4,500 bushels of grain.

Weaver also planted 40 acres of wheat yielding an average of 36 bushels an acre for two successive years, rotating it with clover the next two years. The wheat made about 200 barrels of flour; and with the

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[52]The following discussion is based on the document addressed to Ploughboy. The Control File in the Manuscript Collection, University of Virginia, Weaver-Brady Papers; "Ploughboy Communication . . . August 29, 1842," University of Virginia, Bruce Collection.

other grain and roughage, Weaver's iron plantation was nearly self-sufficient. A commission merchant in Lynchburg summarized the ironmaster's success when he wrote that since William Weaver raised most of his feed and food and maintained most of his labor (slaves), he could "make iron for less price than any other man. . . ."[53]

The trade function of the furnace community. Many furnace communities were not nearly as self-sufficient as Weaver's, and they created a large demand for pork, grain, and other provisions. Consequently, the ironmasters developed a thriving reciprocal trade with farmers, planters, and merchants.[54] The ironmasters in the district received offers and inquiries to trade ironware for pork and grain from various quarters in Virginia, North Carolina, Tennessee, and from as far away as Kentucky, Ohio, and Indiana.[55]

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[53]He quotes a letter from Lee Rocke and Co. to William Weaver, January 8, 1859; Holland, p. 130.

[54]Letter, Glasgow to F. T. Anderson, June 18, 1858, Duke University, F. T. Anderson Papers; Letter, Henry Loving to J. R. Anderson, April 28, 1849, University of Virginia, Anderson Papers; Letter, Walker and Hill to F. T. Anderson, April 26, 1853, Duke University, F. T. Anderson Papers; Letter, Clark and Echols to F. T. Anderson, February 14, 1855, University of Virginia, Anderson Papers; Letter, Samuel S. Miller to F. T. Anderson, August 16, 1860, University of Virginia, Anderson Papers; "Daybook, Union and Buffalo Forge 1825-26, 1827-28," University of Virginia, Weaver-Brady Papers; "Daybook Bath Furnace, 1837-44," University of Virginia, Weaver-Brady Papers; "Daybook, Glenwood Furnace, 1855-56," University of Virginia, Anderson Papers; Letter, Charles to Brady, April 2, 1860, Duke University, William Weaver Papers.

[55]Letter, David Ross to William J. Dunn, January 9, 1813, Virginia Historical Society, Letterbook David Ross; Letter, J. W. Schoolfield to William Weaver, December 9, 1825, Duke University, William Weaver Papers; "Daybook, Union and Buffalo Forge, 1825-1826, 1827-28, University

Merchants and commission merchants in Virginia, who served as dealers in ironware, were also instrumental in supplying the furnace community with a variety of goods and provisions.[56] The trade with these merchants took place in Lexington, Staunton, Charlottesville, Fredericksburg, and other places, but Lynchburg and Richmond dominated the trade. In all places, the merchants subtracted the ironmaster's purchases from the sale of ironware, and little cash was exchanged except when accounts were periodically settled.

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of Virginia, Weaver-Brady Papers; Letter, James McDowell, Jr., to William Weaver, between July and August, 1828, Duke University, William Weaver Papers; "Receipt of 13 Hogs," November 22, 1854, Duke University, William Weaver Papers; Letter, B. Young, Drover, Fleming County, Kentucky to William Weaver, August 16, 1832, Duke University, William Weaver; Letter, _____, Xenia, Ohio to F. T. Anderson, December 22, 1851, Duke University, F. T. Anderson Papers; Letter, McCorkle, Simpson, and Jones to F. T. Anderson, October 1, 1851, Duke University, F. T. Anderson Papers; Letter, McCorkle, Simpson, and Jones to Thomas H. Burns, October 8, 1851, Duke University, F. T. Anderson Papers; "Receipt from Anderson and Co. to William Weaver," June 5, 1857, University of Virginia, Weaver-Brady Papers.

[56]"Daybook, Union and Buffalo Forge 1825-26, 1826-27," University of Virginia, Weaver-Brady Papers; Letter, John C. Sowers to William Weaver, November 5, 1829, University of Virginia, Weaver-Brady Papers; Holland, p. 76; Letter, Miller and Roberts to William Weaver, November 23, 1832, Duke University, William Weaver Papers; "Ledger 1849-50 Columbia Furnace," Duke University; "Daybook Liberty Furnace 1854-48," University of Virginia, Weaver-Brady Papers; Letter, T. H. Burns to F. T. Anderson, February 7, 1853, Duke University, F. T. Anderson Papers; Letter, Glasgow to Dear Uncle, February 16, 1858, Duke University, F. T. Anderson Papers; "Account with Lee Johnson and Company, Lynchburg, July 1858 to December 1858," University of Virginia, Weaver-Brady Papers; "Richmond William Weaver Account with Shields and Somerville," February 1858 to February 1859, University of Virginia, Weaver-Brady Papers; "William Weaver Account with Lee Rocke & Co., Lynchburg, June 30, 1859, University of Virginia, Weaver-Brady Papers; "Receipt, August 5, 1859," Johnson, Younger and Oley, Richmond, University of Virginia, Weaver-Brady Papers; Letter, W. D. Tompkins and Brothers to William Weaver, October 12, 1859, University of Virginia, Weaver-Brady Papers.

These goods and provisions, including food, dry goods, books, shoes, leather, hardware, hollowware, drugs, and other sundries, were stocked by the general store in the furnace community. The store operated much as commission merchants did, subtracting purchases from the workmen's wages.[57] Little cash was exchanged in this elaborate barter system allowing the ironmaster to operate on limited capital, which surely contributed to the success of the charcoal iron industry.

Labor in the Virginia District

During the antebellum period, from 50 to 100 workmen were employed by each furnace in the Virginia District (Table VIII).[58] Including the families and others living about the furnace, the population of most furnace communities was between 75 and 250 people.

To follow the British and northern pattern of employment, rural population in the South would have had to leave agriculture to take up employment at the furnace or forge.[59] Instead, the labor force in the

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[57]"Daybook, Union and Buffalo Forge 1825-26, 1827-28," University of Virginia, Weaver-Brady Papers; "1849-50 Ledger, Columbia Furnace, Shenandoah County," Duke University, "Ledger 1848-52, Union Forge," Duke University, Lantz and Rinker; "Daybook, Liberty Furnace 1854-1858," University of Virginia, Weaver-Brady Papers; "Ledger, Etna Furnace, 1856-1857," University of Virginia, Weaver-Brady Papers.

[58]Charles B. Dew, Ironmaker to the Confederacy, Joseph R. Anderson and Tredegar Iron Works (New Haven and London: Yale University Press, 1966), p. 228; Ronald L. Lewis, Coal, Iron, and Slaves Industrial Slavery in Maryland and Virginia 1715-1865 (Westport, Connecticut and London, England: Greenwood Press, 1979), p. 7.

[59]Robert S. Starobin, Industrial Slavery in the Old South (London, Oxford, and New York: Oxford University Press, 1970), p. 189; Cappon, "Lucy Selina's Charcoal Era," p. 34.

TABLE VIII

EMPLOYMENT AT BLAST FURNACES
IN THE VIRGINIA DISTRICT[a]

Date	Number of Furnaces	Employment	Average
1820[b]	13	627	48
1840[c]	c	1,742	
1850	29	1,129	39
1860	16	529	33
1870	16	1,033	65

Sources: U.S. Bureau of the Census, unpublished census manuscripts, for 1820, 1850, 1860, and 1870; published census, 1840; Debow's Review and Industrial Resources 18 (January, 1855), p. 113.

[a]These employment data are understated. In some cases the census manuscripts enumerated only those employed about the furnace. Inclusion of black bondsmen in the enumeration is also uncertain. The typical furnace likely employed 75 to 100 workmen.

[b]There were 16 furnaces listed in the manuscript returns for 1820, but no employment data are given for three furnaces.

[c]Includes furnaces, forges, and rolling mills.

Virginia District was largely comprised of slaves, with Scotch-Irish, German, and northern-born ironworkers filling most of the more skilled positions.

The Slave Ironworker

Slave labor was an essential factor in the operation of the furnace, and the ironmaster depended on the Negro to fill most jobs.[60] About one-half to three-fourths of the work force at furnaces east of the Alleghenies were slave ironworkers, but only a few bondsmen were employed at furnaces west of the Alleghenies.[61] During the Civil War slave ironworkers apparently comprised nearly three-fourths of the labor force at furnaces in the Virginia District. Such was the case at Mt. Torry, Australia, Glenwood, Catawba, Cloverdale, Rebecca, and Grace furnaces where 748 workmen were engaged, of whom 551, or 74%, were slaves.[62]

By using bondsmen, the ironmaster-planter enjoyed some beneficial labor arrangements. First, the ironmaster applied slave labor to his best advantage, freely diverting labor between the furnace and farm. Second, a forward integrated firm minimized hiring costs since the ironmaster or agent did the hiring for the furnace, forge, and other

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[60]Cappon, "Lucy Selina's Charcoal Era," p. 34; Holland, p. 125.

[61]Samuel S. Bradford, "The Negro Ironworker in Ante Bellum Virginia," Journal of Southern History 25 (May, 1959), pp. 194-195; Samuel S. Bradford, "The Ante-Bellum Charcoal-Iron Industry of Virginia" (unpublished Ph.D. dissertation, Columbia University, 1958), p. 11.

[62]Lewis, p. 33; James O. Breeden, "The Krupp of the Confederacy: The Tredegar Iron Works, 1861-1865" (unpublished M.A. thesis, University of Virginia, 1961), p. 229.

functions. Third, the bondsmen were conveniently hired from the farmer, planter, and others in the Piedmont region.

Slave hiring. The two basic patterns of industrial slavery were direct ownership and slave hiring.[63] Since the ironmaster had a large capital investment in land and machinery, slave ownership was often beyond his financial means, and slave hiring offered a partial solution to the problem.[64]

The hiring took place at county courthouses and at public auctions held between Christmas and New Year's, with the ironmaster expediting the process through advertisements and personal solicitation. Slaves were usually hired by the year, January through Christmas, although when additional manpower was needed bondsmen were hired by the day, week, month, or task. The hiring contract normally stipulated that the ironmaster would feed, clothe, pay the taxes on, and provide medical care for the slave. Some ironmasters deducted $1 to $2 from the hiring price for medical expenses and occasionally made concessions such as specifying the job or sending the bondsman home during harvest season.[65]

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[63]Starobin, p. 12.

[64]Cappon, "Trend of the Southern Iron Industry under the Plantation System," p. 336; Cappon, "Lucy Selina's Charcoal Era," p. 34.

[65]Holland, p. 67; "Statement of Disbursements for Hires and etc. for 1855," University of Virginia, Anderson Papers; "Certificate of Negro Hire, April 3, 1862," University of Virginia, Graham Family Papers; "Contract between J. H. Winn and F. T. Anderson, December 31, 1855," University of Virginia, Anderson Papers; Letter, Charles to Uncle, September 22, 1859, University of Virginia, Weaver-Brady Papers; "Statement of Negro Hire in Lower Country for 1850," University of Virginia, Anderson Papers; Letter, Hamilton Moseley to F. T. Anderson, April 9, 1862, University of Virginia, Anderson Papers.

The payment for hired slaves was usually deferred until the end of the year, often with some barter payment involved. The deferred payment was another facet of the elaborate barter system which made it possible for the ironmaster to operate on limited capital.

Since slaves hired in the city apparently did not work well in the mountains, hiring in rural areas was more desirable.[66] In rural areas where agricultural profits had decreased, slave masters were glad to rent their slaves in order to compensate for their small earnings or actual deficits.[67] Some ironmasters hired bondsmen in the vicinity of the furnace; however, most slaves were hired in the Piedmont region at hiring marts in Pittsylvania, Louisa, Spotsylvania, Orange, Albemarle, Amherst, Nelson, and Fauquier counties, the major area being Spotsylvania and Louisa counties (Figure 22).[68] Before its decline, the Piedmont region had been an important iron producing area within the district which eventually reverted to agriculture. It is possible that the owners and slaves' familiarity with iron making, as well as the

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[66]Dew, p. 251.

[67]Masters also leased slaves because they were unable to use them profitably, to relieve their indebtedness, or to dispense with the trouble of management. Furthermore, hiring bondsmen may have freed the ironmaster of any yearly wage fluctuations. Cappon, "Trend of the Southern Iron Industry under the Plantation System," p. 336; Starobin, p. 129.

[68]Bradford, "The Ante-Bellum Charcoal-Iron Industry," pp. 100-102; Letter, A. E. Duerson (Spotsylvania) to Dear Sir (F. T. Anderson), January 25, 1856, University of Virginia, Anderson Family Papers.

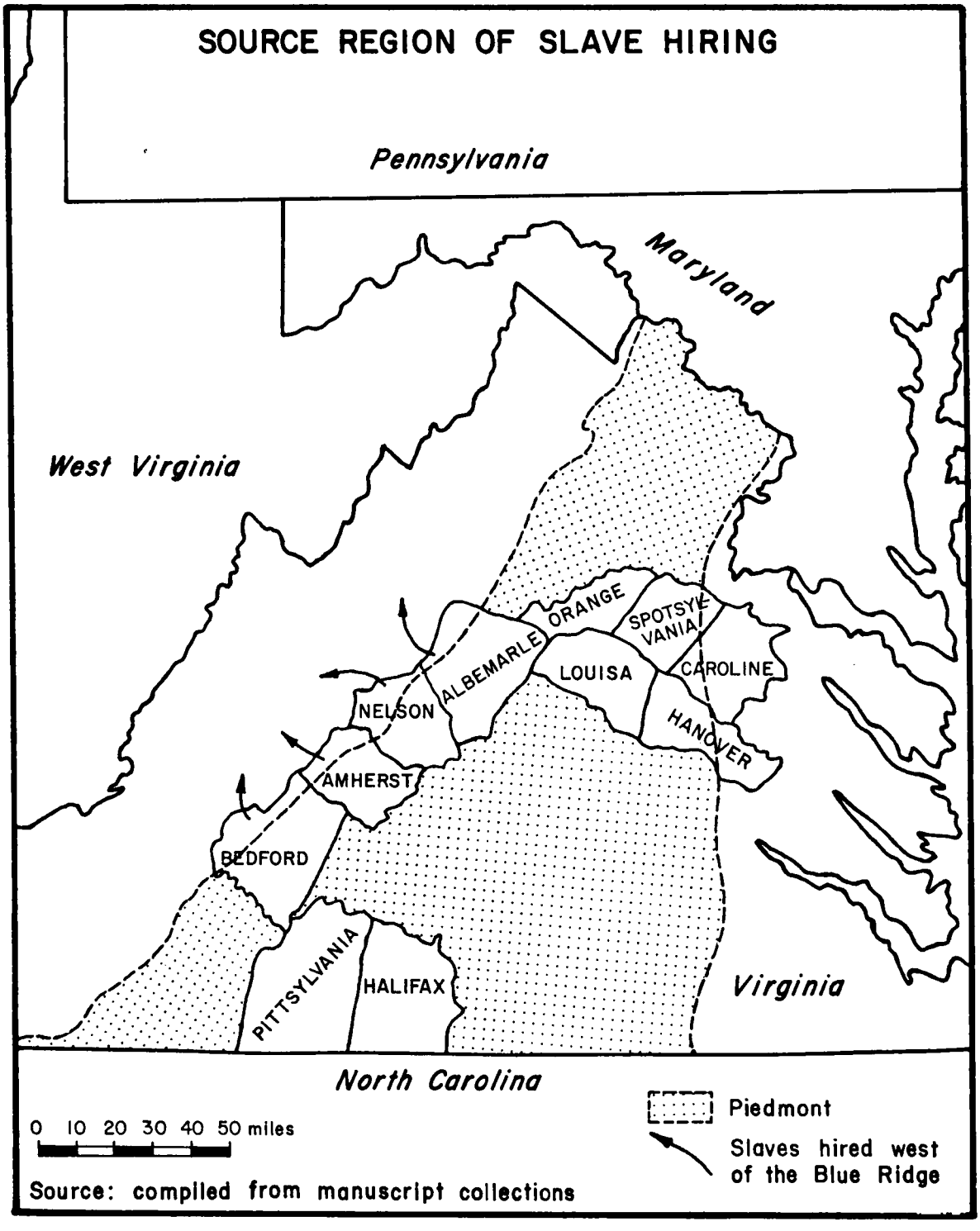

Figure 22. Source Region of Slave Hiring.

surplus of bondsmen in the region, made the Piedmont an important area for slave hiring.[69]

After 1850, Caroline, Orange, and Hanover counties achieved greater significance as places for hiring bondsmen. The pattern of hiring also shifted southward into Bedford, Pittsylvania, and Halifax counties, a change which was possibly caused by an increase in competition for labor.[70]

The cost and competition in slave hiring. The cost of hiring slaves remained relatively stable during the first three decades of the 19th century, dropped after the recession of 1837, and increased rapidly in the 1850's (Tables IX and X).

The average cost of hiring was 14% to 15% lower for the Virginia iron industry than for other southern industries, was usually cheaper than general hiring rates in the Upper South and appreciably less than in the Lower South (Tables IX and X). The lower hiring prices were undoubtedly beneficial to the ironmaster; however, about 1853, the cost of hiring slaves increased. More expensive labor made it difficult for Virginia iron to compete with cheaper northern iron, and since the rise in cost of hired slaves was coincident with a decline in iron

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[69]Cappon, "Trend of the Southern Iron Industry under the Plantation System," p. 366.

[70]Letter, J. W. Schoolfield to William Weaver, December 9, 1825, Duke University, William Weaver Papers.

TABLE IX

THE MEAN ANNUAL COST OF SLAVE HIRING, A COMPARISON

Period	Virginia Iron Industry[a]	Southern Industry
1799-1833	$ 57.08	$ 66.39
1833-1852	$ 86.63	$100.55
1853-1861	$127.21	$150.00

Sources: Starobin, p. 274; the data on the cost of slave hiring in the Virginia District were compiled from various manuscript sources.

[a]The number of observations in the calculation of these data were: 43 for 1799-1833, 71 for 1833-1852, and 260 for 1853-1861.

TABLE X

FIVE YEAR AVERAGES IN THE COST OF SLAVE HIRING

Period	Virginia Iron Industry[a]	Upper South	Lower South
Before 1830	$ 57.63	-	-
1830-1835	53.66	$ 62.00	$127.00
1836-1840	104.17	106.00	-
1841-1845	97.50	83.00	143.00
1846-1850	79.33	99.00	168.00
1851-1855	125.92	141.50	167.00
1856-1860	130.37	142.00	196.50

Source: Robert W. Fogel and Stanely L. Engermann, Time on the Cross: Evidence and Methods (Boston: Little, Brown and Company), p. 73; The Virginia data was compiled from multiple manuscript sources by the author.

[a]The observations for 1830-35, 1836-40, 1841-45 for the Virginia iron industry may be too few to get an accurate cost of hire and must be judged accordingly.

production, it probably contributed significantly to the demise of the charcoal iron industry.[71]

While the rising cost of labor is often ascribed to an increase in demand for bondsmen in the Lower South, it is clear that conditions in Virginia stimulated the prices.[72] A large part of the increase was due to the skills, trades, and experience acquired by the slaves; but the cost of hiring unskilled slaves also increased as the cost differential between skilled and unskilled slave labor narrowed by the 1850's.[73]

This surge in the hiring price was clearly related to the competition for labor. The furnaces, forges, canals, railroads, turnpikes, mines (coal and gold), tobacco factories, and farms and plantations were vying for available bondsmen, forcing the hiring price upward.[74]

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[71]Bradford, "The Ante-Bellum Charcoal-Iron Industry," p. 133; Bradford, "The Negro Ironworker . . .," p. 200; Bruce, "Slave Labor . . .," p. 26; Letter, James C. Davis to Father, January 5, 1856, University of Virginia, W. W. Davis Papers.

[72]Bruce, "Slave Labor . . .," p. 25.

[73]Bradford, "The Ante-Bellum . . .," pp. 109-110, 118; Bradford, "The Negro Ironworker . . .," p. 196; Holland, pp. 125-126.

[74]Letter, T. H. Burns to Dear Sir (F. T. Anderson), June 13, 1851, University of Virginia, Anderson Papers; Bradford, "The Negro Ironworker . . .," p. 196; Bradford, "The Ante-Bellum . . .," pp. 103-104 and 108-109; Cappon, "Lucy Selina's . . .," p. 34; Letter, John Chew to William Weaver, December 5, 1830, Duke University, William Weaver Papers; Letter, Jordan, Davis & Co. to William Weaver, March 4, 1833, Duke University, William Weaver Papers; Letter, James Coleman to William Weaver, December 1856, Duke University, William Weaver Papers; Letter, James C. Davis to Father (W. W. Davis), January 5, 1856, University of Virginia, W. W. Davis Papers; Bruce, "Slave Labor . . .," pp. 25-26; Letter, T. R. Towles to William Weaver, December 11, 1856, Duke University, William Weaver Papers.

The demand for slaves on the farm and plantation not only affected the hiring price, but it also affected the availability of bondsmen, making it more difficult for ironmasters to amass a sufficient work force. The agricultural renaissance of the 1830's and 1840's caused a growing demand for labor in farming, and the Virginia planter and farmer began absorbing the labor of hitherto surplus slaves.[75] The labor demands in agriculture continued to be strong during the 1850's, and even free laborers were scarce. For example, when T. H. Burns tried to hire woodchoppers (free laborers) in the Valley, he stated that:

> . . . it is impossible [to hire them] as they laugh at the idea of the price you offer as they would not cut at the old price for they can get better wages at the canal and harvest and mowing is now at hand.[76]

In 1855 other ironmasters experienced a similar plight, and could hire only half the slaves they needed.[77] The following year, James Cole Davis stated that the difficulty in hiring slaves was on account of "the high price of produce of [the] farm and the consequent demand for their labor in that direction."[78]

The purpose of the overwork system. A partial solution to the smaller number of slaves available for hire, as well as the increase in

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[75]Bruce, "Slave Labor," p. 25.

[76]Letter, T. H. Burns to Dear Sir (F. T. Anderson), June 13, 1851, University of Virginia, Anderson Papers.

[77]Letter, C. W. Newkirk to William Weaver, January 4, 1855, Duke University, William Weaver Papers; Letter, J. R. Towles to William Weaver, November 27, 1854, Duke University, William Weaver Papers.

[78]Letter, James C. Davis to Dear Father (W. W. Davis), January 5, 1856, University of Virginia, W. W. Davis Papers; Holland, p. 125.

cost of hiring, was the overwork system. A slave worked six days a week with certain tasks expected; but when a bondsman exceeded his task or worked on Sundays, holidays, and at night, he received wages commensurate with those paid to the free ironworkers.[79] During the overtime, slaves performed vital tasks, such as woodcutting, coaling, mining ore, hauling raw materials, and making baskets, all of which were essential to either maintain production or keep the furnace in blast.

Some authorities have viewed the practice of paying money and commodities to slaves for overtime as a subtle or indirect means to control and discipline the slaves.[80] Dew states that the objectives of overwork were: (1) to make the individual slave a disciplined and productive worker without heavily relying on physical coercion, and (2) to give the employer a disciplinary tool.[81] If a slave failed to perform his required task, the ironmaster could deduct a sum from the money he earned in overwork. If a slave overdrew his account at the store, he was forced to do extra work to pay the debt. However, as

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[79]Charles B. Dew, "Disciplining Slave Ironworkers in Antebellum Virginia: Coercion, Conciliation and Accommodation," unpublished faculty seminar paper, pp. 16-17; Letter, David Ross to William J. Dunn, May 7, 1813, Virginia Historical Society, David Ross Letterbook; Letter, W. W. Rex to William Weaver, May 21, 1856, Duke University, William Weaver Papers; "Negro Book 1838-41" (Paramount furnace, December 18, 1838), University of Virginia, Graham Family Papers.

[80]Starobin, pp. 95-102.

[81]Dew, "Disciplining Slave Ironworkers . . .," pp. 16 and 20.

previously stated, overwork was sometimes necessary to keep a furnace in blast, maintain, and/or expand its production.[82]

The Pattern of Iron Trade

The patterns of trade in Wythe County and southwestern Virginia, the Shenandoah area, and the James River area were markedly different. The principal differences were: (1) throughout the antebellum era, a large share of the cast iron was fabricated into secondary manufactures in the Wythe County and southwestern Virginia area and sold in the local trade area; (2) the trade for the Shenandoah area, including Shenandoah, Frederick, Warren, Hardy, Hampshire, Jefferson, Page, and Rockingham counties, was directed down the Shenandoah Valley toward northern markets; and (3) the trade for the James River area, including Rockbridge, Botetourt, Alleghany, Augusta, and Campbell counties, was oriented toward Lynchburg and Richmond.

Wythe County and Southwestern Virginia, The Pattern of Trade

Compared to other areas within the district, there were three important differences in the production and trade in the Wythe County and southwestern Virginia area. First, there was a greater number of bloomery forges processing iron ore directly into bar iron for the local market. Second, there was little change through time in the pattern of

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[82]Letters, Charles to Uncle (W. Weaver), September 15, 1859, University, Weaver-Brady Papers; T. H. Burns to F. T. Anderson, February 14, 1852, University of Virginia, Anderson Papers; H. S. Locker to F. T. Anderson, October 2, 1861, University of Virginia, Anderson Papers.

production and trade. Finally, the incidence of forward integration enabled the ironmasters to manufacture a variety of ironware, including pig iron, castings, hollowware (kettles), blooms, plate, nails, and railroad iron.

Throughout the antebellum period, secondary manufacturers in Wythe County fabricated about one-third to one-half of the pig iron production of southwestern Virginia, sending about 400 tons of cast iron to other markets each year. Although some of this iron may have been in the form of castings and hollowware for the local market, the rest was pig iron which was apparently shipped toward Lynchburg and Richmond.[83]

The iron business of David Graham, the most prominent ironmaster in southwestern Virginia, illustrates the characteristics of the iron trade in the area. Graham operated furnaces, a forge, and a rolling mill, enabling him to manufacture pig iron, castings, hollowware (salt kettles), bar iron, and nails for local farmers, planters, salt manufacturers, and others.[84] During the mid-1840's and early 1850's, Graham's forge and rolling mill fabricated pig iron into a variety of secondary manufactures which were purchased by consumers within a 40

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[83]J. A. Whitman, "The Iron Industry of Wythe County from 1792" (Southwest Virginia Enterprise, Revised Edition, 1942), p. 4; "Invoice and Receipt Book, 1845-1852"; "Memo 1859-60," University of Virginia, Graham Family Papers.

[84]Lesley, pp. 73-74, 183, 244-245; "D. Graham in Account with John S. Preston and Co., 1831-32"; David Graham Agreement with James White," November 8, 1832; Letter, Samuel Chastian to D. Graham, December 29, 1832; "Agreement between D. Graham and Alex McCall acting for William King and Company, July 17, 1833; Letter, Henry L. Claiborn to D. Graham, April 1, 1838; "Agreement 17th day of October 1831 between D. Graham and H. C. Preston & Co.," University of Virginia, Graham Family Papers; Whitman, pp. 15-17.

to 50 mile radius.[85] Experiencing relatively little competition, the range of trade extended as far south as Greensboro, North Carolina, but diminished toward the Tennessee border where the demand was supplied by ironmasters in upper east Tennessee.

The Pattern of Production and Trade in the Shenandoah Area

Between 1810 and 1820 the annual production of Shenandoah County was among the largest in the Virginia District, with the forges in the county fabricating most of the pig iron output.[86] Until the 1830's, forges in the Shenandoah area continued to fabricate the majority of the area's pig iron production. Pig iron production exceeded local consumption only after several new furnaces (Paddy, Caroline, Shenandoah, Fort Steam, Oakland, Van Buren, and Shannondale) were built between 1833 and 1837.[87] As the pig iron trade expanded beyond the local markets, primary iron manufacturing lost its frontier character.[88]

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[85] "Invoice and Receipt Book, 1845-1852"; "Memo 1859-1860"; Letters, W. J. McConnel to D. Graham, February 27, 1847 and March 26, 1847; E. Below to D. Graham, January 13, 1847; Tyre Glen to D. Graham, December 30, 1846, University of Virginia, Graham Family Papers.

[86] Tench Coxe, A Statement of the Arts and Manufactures of the United States of America for the Year 1810 (Philadelphia: A. Cornman, 1814); "Return of Salt, Lead, Iron 1815," Virginia State Library, Auditors Item 86; U.S. Bureau of the Census, unpublished census manuscripts, "Census of Manufactures, 1820."

[87] Lesley, pp. 65-69.

[88] Letters, John Tayloe to John Clarke & Co., May 4, 1820; John Tayloe to John Clark, April 27, 1826; B. O. Tayloe to Major John Clarke & Co., October 29, 1829, Virginia Historical Society, Letterbook John Tayloe 1819-1865.

As early as 1837 the Winchester and Potomac Railroad connected the Shenandoah Valley to the Baltimore and Ohio Railroad giving the area better access to Baltimore than to Richmond, prompting ironmasters to direct trade down the valley toward Maryland, Pennsylvania, and Delaware.[89] Another six furnaces were constructed in the Shenandoah area between 1844 and 1850, and in 1850 pig iron production reached 10,600 tons.[90] Forges in the area fabricated about 16% of the area's total pig iron production, leaving nearly 9,000 tons to be shipped to secondary manufacturers in Baltimore, Philadelphia, Wilmington, and other northern marketplaces.[91] Although some forges shipped blooms to northern rolling mills, others were supplying bar iron, tire iron, shovel plate, horse shoe, axe bar, harrow tooth, and other iron products to farmers, planters, artisans, and merchants in a trade area encompassing a 40 to 50 mile radius.

The James River Area: The Lynchburg and Richmond Markets, A Contrast in Demand[92]

Scholars have concluded that Lynchburg and Richmond were principal markets for the James River area but have not quantitatively demonstrated

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[89]Bradford, "The Ante-Bellum Charcoal Iron," p. 179; Lewis, p. 16.

[90]U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850; Lesley, pp. 65-69.

[91]Letters, George F. Hupp to Bush and Lobdell, November 7, 1846; John Hupp to Bush and Lobdell, May 20, 1850; John Hupp to Bush and Lobdell, January 17, 1851, University of Virginia, Bush and Lobdell; Bradford, "The Ante-Bellum Charcoal Iron . . .," pp. 167-168; Lesley, pp. 67-68.

[92]The following discussion is largely based on two case studies (the iron businesses of William Weaver and the Anderson family), but the

their relative importance nor clearly made a distinction between them.[93] During the early period, mountain pig and bar iron were shipped to both Lynchburg and Richmond, with pig and bar iron remaining important in the Lynchburg trade throughout the antebellum period. One or two mountain furnaces could supply Lynchburg's entire demand for pig iron, but agents there were also instrumental in forwarding pig and bar iron to consumers in the Piedmont region.[94]

In the course of time, pig iron came to dominate the Richmond trade; and the increase in pig iron production in the James River area was a response to the growing Richmond market. At midcentury the largest manufacturers in Richmond used 5,400 tons of pig iron in making machinery, steam engines, plows, castings, and bar iron.[95] The expansion of foundry and machine shops during the 1850's created an additional demand for pig iron. In 1856, the four rolling mills in Richmond fabricated an estimated 8,700 tons of pig iron into nearly 7,000 tons of bar iron, spike, chair, and nails.[96] By 1860 the major foundries and rolling mills in the city used over 20,000 tons of pig iron, with Tredegar Iron Works alone consuming more pig iron than the

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conclusions are corroborated by data for Oxford, Roaring Run, Cloverdale #1, Rebecca, Vesuvius, Catawba, Cassandra, Buena Vista, and other furnaces.

[93]Cappon, "Trend of the Southern Iron Industry," pp. 372-373; Holland, pp. 129, 281-282; Lewis, p. 16.

[94]U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850 and 1860.

[95]U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850.

[96]Lesley, p. 244.

furnaces in the Virginia District produced.[97] The additional iron needed by manufacturers in Richmond was purchased in the North.

William Weaver's iron plantation, an example of trade. The iron trade of Weaver's ironworks illustrates the contrasts between the Lynchburg and Richmond markets. In July, 1814, Weaver and Mayburry purchased Union forge, two furnaces, and 5,000 acres in Rockbridge and Botetourt counties.[98] During the subsequent year Union forge fabricated about 50% of one furnace's pig iron. By the latter 1820's Weaver's forge(s) consumed relatively large quantities of pig iron, and by the early 1830's he was purchasing pig iron from the Bryans, Jordan and Irvine, and Bath Iron Works.[99]

As was the case in the other areas of the district, the forge's trade area, elongated eastward along the James River, encompassed a 40 to 50 mile radius. The primary market for the forged ironware was Lynchburg, but commission merchants there also forwarded mountain bar iron to merchants in the Piedmont who in turn carried on trade with farmers, planters, artisans, and others.[100]

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[97]U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1860.

[98]"Returns of Salt, Lead, Iron . . . 1815," Virginia State Library, Auditors Item 86; Bradford, "The Ante-Bellum Charcoal Iron . . .," p. 27.

[99]Journal Bath I.W. 1828-29," University of Virginia, Weaver-Brady Papers.

[100]Letters, John W. Schoolfield to William Weaver, July 3, 1829; Schoolfield to Weaver, July 24, 1829, Duke University, William Weaver Papers; Letters, David Ross to Dear Sir (Samuel Dyer), December 3, 1812;

The pattern of trade during the 1850's was similar to that of the previous decades, with Lynchburg being the most important center for the bar iron trade and Richmond dominating the pig iron trade.[101] Such was the case during 1858 and 1859 when 891 tons of Etna furnace pig metal was sold, of which 485 tons, or 54%, was shipped to Richmond, 275 tons to Lynchburg, and 131 tons consumed by Buffalo forge.[102]

The Anderson family's Richmond connection, 1842-1861. The Richmond market dominated the pig iron trade of the Anderson family. In March, 1841, Joseph R. Anderson became the commercial agent for Tredegar Iron

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David Ross to William Dunn and Robert Richardson, December 3, 1812; David Ross to Samuel Paine, November 1812, Virginia Historical Society, Letterbook David Ross; Letters, L. and R. B. Norvell to William Weaver, June 10, 1830 and March 2, 1831; James Williams to William Weaver, July 27, 1832; S. O. Moon to William Weaver, February 11, 1829; Duke University, William Weaver Papers; Letter, S. O. Moon to William Weaver, March 16, 1829, University of Virginia, Weaver-Brady Papers; Letters, S. O. Moon to W. Weaver, March 3, 1830; S. O. Moon to William Weaver, February 26, 1830 and March 12, 1830; George Chambers to William Weaver, June 11, 1832, Duke University, William Weaver Papers.

[101]"Daybook, Buffalo Forge 1841-44"; "Daybook and Letterbook, 1844-47," June 11, 1847, University of Virginia, Weaver-Brady Papers; Letters, Hugh W. Fry to William Weaver, January 26, 1854; Shields and Somerville to William Weaver, June 5, 1854; H. W. Fry and Co. to William Weaver, May 17, 1856; Younger and Smith to William Weaver, February 8, 1854, March 7, 1854, March 15, 1854, and April 3, 1854; Saunders and Irby to William Weaver, May 13, 1854 and April 10, 1854; Lee and Johnson to William Weaver, July 19, 1854 and September, 1854, Duke University, William Weaver Papers; Letter, Lee Rocke & Co. to William Weaver, January 8, 1859, University of Virginia, Weaver-Brady Papers; Holland, p. 90; "Account Sales Iron Made Lee Rocke & Co. on a/c & Risk Mr. William Weaver," January, 1859 to June, 1859 and August 20, 1859-February 28, 1860, University of Virginia, Weaver-Brady Papers; U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1860.

[102]"Memorandum of Metal Shipped, 1858," University of Virginia, Weaver-Brady Papers.

Works, a Richmond rolling mill.[103] During that year Francis T. Anderson, John T. Anderson, and Colonel Shanks constructed Cloverdale furnace in Botetourt County.[104] By November, 1843 Joseph Anderson had leased Tredegar, but before the lease expired, he moved to gain permanent control and on April 4, 1848, purchased the ironworks for $125,000.[105] The following year his brother Francis T. Anderson became the proprietor of the newly erected Glenwood furnace.

Ironmasters could make a better profit selling large lots of pig iron in Richmond, and furnaces such as Cloverdale, Glenwood, and others erected during the 1840's and 1850's were designed to supply a large, standardized market.[106] Between October, 1842 and June, 1849, 5,905 tons of Cloverdale pig metal were shipped to J. R. Anderson in Richmond, and during the 1850's he purchased every ton of Cloverdale's metal.[107] The major consumers of Glenwood pig iron were Armory Rolling Mill and

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[103]Dew, Ironmaker to the Confederacy, p. 9; Breeden, p. 9.

[104]Lesley, pp. 72-73; "Historical Sketch of Papers," Duke University, F. T. Anderson Papers.

[105]Dew, Ironmaker to the Confederacy, p. 12-13; Breeden, p. 9; Lesley, p. 70.

[106]Letter, S. F. Jordan to W. W. Davis, February 12, 1841, University of Virginia, W. W. Davis Papers; Letter, Samuel F. Jordan to Dear Sir (W. W. Davis), February 28, 1841, University of Virginia, W. W. Davis Papers; Letters, John Tayloe to John Clarke & Co., May 4, 1820, April 27, 1826, Virginia Historical Society, Letterbook John Tayloe; Letter, B. O. Tayloe to John Clarke, October 29, 1829, Virginia Historical Society, Letterbook John Tayloe.

[107]"Account of CD Pig Iron . . .," October 8, 1842 through April 9, 1850, University of Virginia, Anderson Papers.

Tredegar Iron Works, and between 1854 and 1860 over 90% of the Glenwood furnace metal was shipped to Richmond.[108]

Cloverdale and Glenwood furnaces were successful because they produced a quality metal and received invaluable assistance from Joseph R. Anderson. The Andersons had a good business arrangement with their brother Joseph who best summarized the relationship when he stated that "we will always be willing to pay you the highest we can [for your pig iron] and if I can find out any way in which you can get more I will advise you."[109] Even at times when Joseph could purchase cheaper northern iron, he paid a premium price for his brothers' metal, but did not extend the same premium to other Virginia ironmasters.[110]

Joseph R. Anderson was also important to other mountain ironmasters because he either purchased or sold some of their pig iron.[111] Tredegar Iron Works and other secondary manufacturers in Richmond made large purchases of pig iron from Cloverdale, Glenwood, Grace, Roaring Run,

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[108]"Account of Sales and Shipments of Glenwood Pig Iron for the Years_____1854, 1855, 1856, 1857, 1858, and 1859, and letters and receipts of iron shipped in 1860"; Letters, J. R. Anderson & Co. to F. T. Anderson, March 22, 1861; J. R. Anderson & Co. to F. T. Anderson, May 3, 1861, University of Virginia, Anderson Papers.

[109]Letters, J. R. Anderson to Dear Brother, May 23, 1854; J. R. Anderson to Dear Brother (F. T. Anderson), July 17, 1855; J. R. Anderson to F. T. Anderson, May 25, 1860; J. R. Anderson to Dear Brother (F. T. Anderson), May 31, 1855; Anderson Delany & Co. to F. T. Anderson, February 20, 1855; J. R. Anderson to Dear Brother (F. T. Anderson), June 16, 1855, University of Virginia, Anderson Papers.

[110]Dew, Ironmaker to the Confederacy, p. 33.

[111] Bradford, "The Ante-Bellum Charcoal Iron . . .," p. 165.

Rebecca, Vesuvius, Catawba, Cassandra, Buena Vista, and other mountain furnaces in the James River area.[112]

The Demise of the Virginia Charcoal Iron Industry

Successful Competition for Markets in the 1830's

During the early period, Virginia ironmasters successfully competed with northern and foreign iron companies for markets in the Virginia District. Secondary manufacturers in the district needed to purchase pig and bar iron at a price which would allow them to compete with northern ironware.[113] To meet this demand, Virginia ironmasters had to: (1) produce a quality metal, (2) assure prompt delivery, (3) keep prices competitive, and (4) survive periods of poor or overstocked markets.[114]

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[112]Letter, Henry Loving to J. R. Anderson, April 28, 1849, University of Virginia, Anderson Papers; Letter, T. H. Burns to F. T. Anderson, July 14, 1852, Duke University, F. T. Anderson Papers; Letter, J. R. Anderson to F. T. Anderson, March 10, 1854, University of Virginia, Anderson Papers; Bradford, "The Ante-Bellum Charcoal Iron . . .," p. 165; Cappon, "History of the Southern . . .," p. 148, University of Virginia, Cappon; Lesley, pp. 70 and 73; Letters, J. R. Anderson to Brother (F. T. Anderson), May 23, 1854; J. D. Mitchell to F. T. Anderson & Co., April 29, 1852, University of Virginia, Anderson Papers.

[113]Letter, P. Haxall & Co. to William Weaver, April 8, 1829, Duke University, William Weaver Papers.

[114]Letters, D. Ross to John Staples, September 14, 1813 and September 20, 1813, Virginia Historical Society, Letterbook D. Ross; Letters, Haxall & Co. to William Weaver, May 1, 1829; John W. Schoolfield to William Weaver, August 22, 1828; John W. Schoolfield to Dear Sir (William Weaver), April 22, 1830; L. Webb & Co. to William Weaver, October 9, 1830; J. W. Schoolfield to A. W. Davis, October 1, 1830; Lewis Webb & Co. to William Weaver, December 24, 1830, Duke University, William Weaver Papers.

Quality was paramount because inferior iron resulted in customer complaints, often causing them to buy northern and foreign iron. Since late delivery also inconvenienced the consumers, prompt attention to dispatching the iron was likewise important.[115] A merchant summarized the problem of tardy delivery when he wrote that the people "have been waiting to get iron from me to do their Spring work with and the Spring is here and no iron has come."[116] When ironmasters failed to deliver the ironware on time, consumers bought elsewhere.

Other factors affecting production and sales were the quantity and price of iron in the marketplace. In 1820 low demand and competition from foreign iron led Shenandoah County ironmasters to operate furnaces at only two-thirds of their capacity.[117] During the 1820's the limitations of the local forge market and the inability to expand trade beyond the local area made it necessary for the ironmaster of Liberty furnace to operate the furnace at about a quarter of its capacity.[118] The price and presence of northern and foreign bar iron in Richmond also occasionally overstocked the market and lowered the price of Virginia

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[115]Letters, John W. Schoolfield to William Weaver, July 3, 1829 and July 24, 1829; L. and R. B. Norvell to William Weaver, June 10, 1830 and March 2, 1831; S. O. Moon to William Weaver, February 26, 1830, March 3, 1830, and March 12, 1830, Duke University, William Weaver Papers.

[116]Letters, S. O. Moon to William Weaver, March 3, 1830; George Chambers to William Weaver, June 11, 1832, Duke University, William Weaver Papers.

[117]U.S. Bureau of the Census, unpublished census manuscripts, "Census of Manufactures, 1820."

[118]Letter, Walter Newman to William Weaver, April 26, 1831, University of Virginia, Weaver-Brady Papers; Lesley, pp. 179-180; Cappon, "History of Southern," University of Virginia, Cappon, p. 144.

iron.[119] The price in Richmond even influenced the cost of mountain bar iron in the Great Valley of Virginia. In 1829 the consumers in Lexington were discontent because they paid $112 a ton, which they felt was 25% more than the iron was worth.[120] These customers wanted to pay the same price as the manufacturers in Richmond, pointing out that mountain ironmasters would save the freight to Richmond. Convinced that the price had always been too high, the customers asserted that the first ironmaster to abandon the discriminatory prices would get their business.

Although ironmasters were faced with formidable problems, they were generally successful in competing for markets during this early period. However, a firm occasionally failed because of poor quality iron, competition, overstocked market, or indebtedness, but most were able to expand production.

Demise in the 1850's

Ironmasters made little progress in lowering production costs during the last three decades of the antebellum period, placing them at

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[119] Letters, L. Webb & Co. to William Weaver, April 24, 1828; P. Haxall & Co. to William Weaver, May 16, 1828, Duke University, William Weaver Papers; Letter, L. Webb & Co. to William Weaver, March 4, 1829, University of Virginia, Weaver-Brady Papers; Holland, pp. 73-74 and 79; Letters, L. Webb & Co. to William Weaver, September 28, 1829 and March 4, 1829, University of Virginia, Weaver-Brady Papers; Letters, L. Webb & Co. to William Weaver, January 16, 1830; Lewis Webb & Co. to William Weaver, February 2, 1830, March 25, 1830 and March 16, 1833; L. Webb & Co. to William Weaver, September 18, 1830; Lewis Webb & Co. to William Weaver, December 24, 1830, Duke University, William Weaver Papers.

[120] Letter, Caruthers and Alexander to William Weaver, January 8, 1829, University of Virginia, Weaver-Brady Papers; Bradford, "The Ante-Bellum Charcoal Iron," p. 164.

a disadvantage in meeting competition.[121] Pig iron production in the Virginia District declined from 22,163 to 11,646 tons between 1850 and 1860, largely due to the inability of Virginia iron to compete with cheaper northern iron.[122] As early as the 1840's ironmasters had cause for concern because Pennsylvania iron undersold slave-made Virginia iron, and in the 1841, 1843, and 1845 seasons Joseph R. Anderson declared that he could purchase northern iron for less than or the same price as Virginia iron.[123] In 1862 William Weaver, one of the district's most successful ironmasters, asserted that northern iron had always undersold Virginia iron in the Richmond market.[124]

In spite of the competition during the 1840's, pig iron production rose from 18,811 to 22,163 tons between 1840 and 1850, and the amount of pig iron carried down the James River and Kanawha Canal increased to

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[121]Bradford, "The Ante-Bellum Charcoal Iron," pp. 66-67.

[122]Since the decline of iron production in the James River area was largely due to the inability of Virginia iron to compete for markets in Richmond, the demise of the Shenandoah area, with markets in the North, was surely due to competition in the iron trade. Bradford, "The Negro Ironworker," p. 205; Dew, Ironmaker to the Confederacy, pp. 22, 32-34, and 317; Robert R. Russell, "The General Effects of Slavery upon Southern Economic Progress," in Slavery and the Southern Economy, edited by Harold D. Woodman (New York: Harcourt, Brace, and World, Inc., 1966), p. 190; Cappon, "Lucy Selina's Charcoal Era," p. 37; Starobin, p. 14; Clement Eaton, The Growth of Southern Civilization 1790-1860 (New York: Harper and Row, 1961), p. 235; Breeden, pp. 124 and 131; Bradford, "The Ante-Bellum Charcoal Iron Industry," pp. 67 and 184; John D. Cappon, "Virginia Iron Furnaces of the Confederacy," Virginia Cavalcade 17 (Autumn, 1967), p. 13; Lewis, p. 197.

[123]Bradford, "The Ante-Bellum Charcoal Iron Industry," pp. 175-176; Bradford, "The Negro Ironworker," p. 205.

[124]Letter, Henry McCormick to William Weaver, September 5, 1858, University of Virginia, Weaver-Brady Papers; Bradford, "The Ante-Bellum Charcoal Iron Industry," p. 176; Bradford, "The Negro Ironworker," p. 205.

over 8,000 tons in 1847, 1848, and 1849 (Figure 23). After 1849, the tonnage hauled down the canal plummeted to 1,307 tons in 1852, which was little more than a single furnace could manufacture in a season.

Ironmasters had the impression that the change in tariff was a factor in the demise, because when duties were lowered after 1846 some complained of difficulties without it. In 1849 they proclaimed that if a new tariff or some other change did not occur within the year, they would be forced to close their ironworks.[125] Their impression was evidently mistaken as Fogel and Engermann conclusively demonstrate that the maintenance of the tariff at the level of 1842 could have reversed the absolute but not the relative decline in output of charcoal iron.[126]

Thus, the production decline which began during this period was caused by the following interrelated developments: (1) competition from cheaper northern iron, (2) a drop in iron prices, and (3) a rise in cost of labor (slave hiring). Because of these developments, twelve furnaces in the James River area were abandoned between 1849 and 1854; and, at the time of Lesley's survey in the mid-1850's two other furnaces, Clifton and Mt. Torry, had not cast any iron since 1854 and 1855.[127] While these furnaces were being abandoned, others were either being built or rebuilt; but, as already stated, these new and rebuilt furnaces were closely linked to the Richmond market and Joseph R. Anderson.

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[125]Bradford, "The Negro Ironworker," p. 205.

[126]Robert W. Fogel and Stanley L. Engerman, editors, The Reinterpretation of American Economic History (New York: Harper and Row, 1971), p. 161.

[127]Lesley, pp. 69-73.

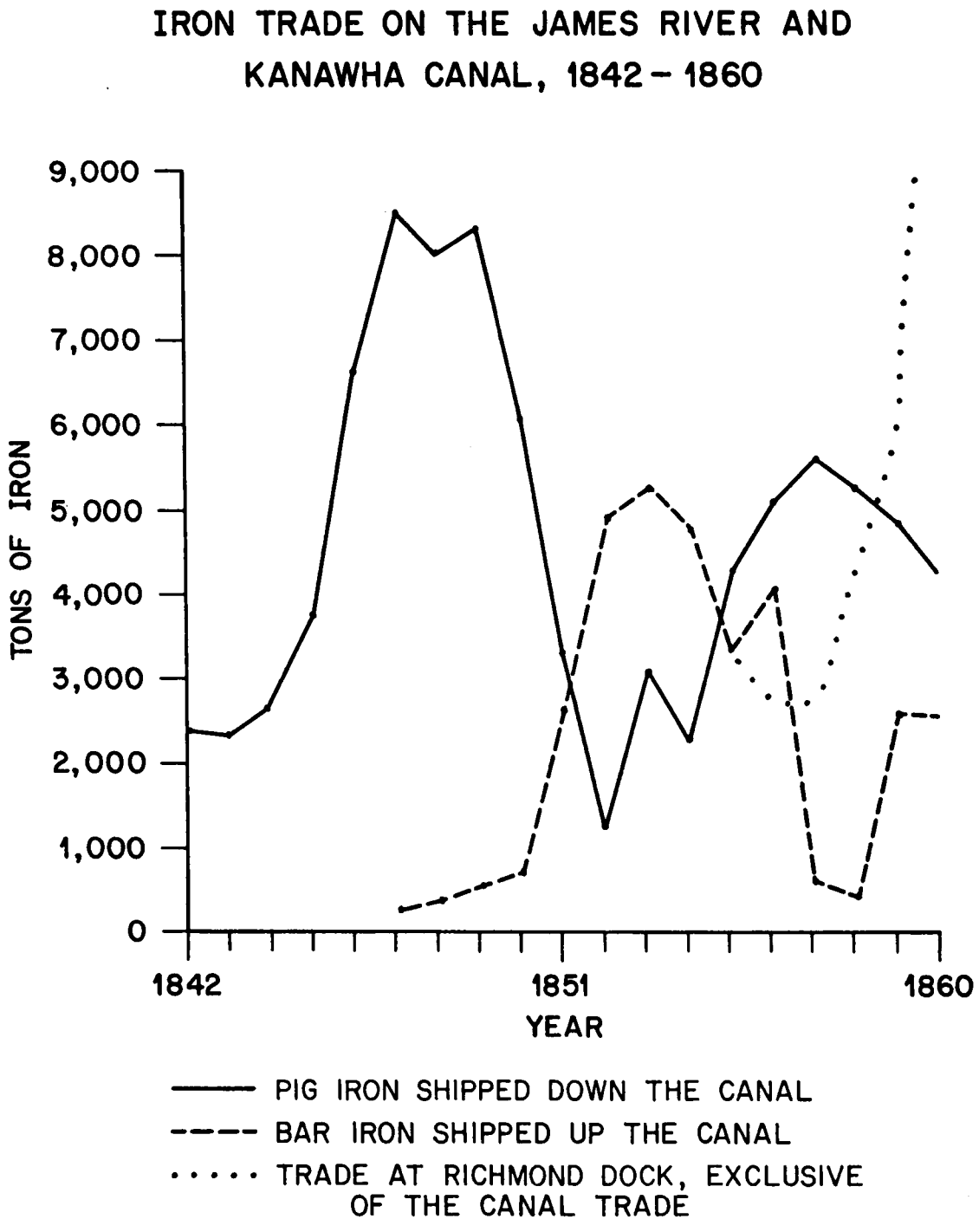

Figure 23. Iron Trade on the James River and Kanawha Canal, 1842-1860.

Source: Annual Report, pp. 70, 787, 802-803.

One of the causes for the decline in production was the rise in cost of labor. About 1853 the cost of hiring slaves increased because of the skills, trades, and experience the bondsmen had acquired. Furthermore, the competition among furnaces, forges, canals, railroads, tobacco factories, farms, and plantations for available slave hirelings and free laborers also forced labor costs upward. Since the rise in labor costs was coincident with the decline in iron production, it undoubtedly contributed to the demise of the district's iron industry.

The other major causes of the demise during the 1850's were competition from cheaper northern iron and the drop in iron prices. During the late 1840's the price of pig iron declined and in 1849 it was selling at only $25 to $28 a ton.[128] The extention of the canal to Buchanan in 1851 gave Glenwood, Buena Vista, and other furnaces direct delivery to Richmond, thereby reducing transportation costs; but it increased the comparative remoteness of other furnaces in Alleghany, Augusta, and northern Rockbridge counties.[129] In spite of the canal offering direct delivery at a reasonably low cost, northern pig iron was still cheaper than Virginia iron in Richmond. That competition was effective is also shown by shipments of bar iron up the canal during the 1850's, undoubtedly causing mountain forges to use less pig iron.

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[128]Letter, Albright Sherred & Co., (Etna I.W.) to William Weaver, January 15, 1850, Duke University, William Weaver Papers.

[129]The more remote furnaces had to wagon or float pig iron down the Cowpasture, Jackson, and other tributaries of the James River, then to Buchanan where iron was transferred to canal freighters. Cappon, "Lucy Selina's Charcoal Era," p. 37.

By the early 1850's the price of iron had declined to between $20 and $23.50 a ton, which was hardly enough to remunerate ironmasters whose production costs were high.[130] Although Joseph R. Anderson agreed to purchase the entire Glenwood output at $25 a ton, by October he could only pay $23 because of the low price of rolled iron and the lag in sales.[131] Anderson could not extend this purchase price through 1852, and he advised his brother to use only the raw materials on hand, unless he could make a profit at $23 a ton.[132] Because of the low prices and poor prospects of selling iron, the profits of H. T. Jordan's firm were being absorbed by interest on the investment. As a consequence, Jordan concluded that he would "moste gladly . . . sell out my [his] interest in both Furnace and Forge at a considerable sacrifice. . . ."[133]

During 1853 there was a general improvement in the price of pig iron. Observing that Baltimore pig iron for forge purposes was selling at $36 a ton, a Virginia ironmaster stated that "this metal is not more than average brand, Good times ahead, at last for iron men!"[134] While the price advanced to between $34 and $45 a ton during the year, most

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[130] Annual Report of the President, pp. 87-88.

[131] Letter, J. R. Anderson to F. T. Anderson, October 28, 1851, Duke University, F. T. Anderson Papers.

[132] Letter, J. R. Anderson to F. T. Anderson, October 28, 1851, Duke University, F. T. Anderson Papers.

[133] Letters, H. J. Jordan to Frank, January 14, 1851; Hegelziah T. Jordan to Dear Frank (Ira F. Jordan), January 7, 1854, Virginia State Library, Jordan Family Papers.

[134] Letter, S. C. Robinson to F. T. Anderson, January 7, 1853, Duke University, F. T. Anderson Papers.

was sold at $35 to $36.[135] In anticipation of a good year, J. R. Anderson advised his brother to make all the pig iron he could, even though Anderson and others were reluctant to pay these relatively high prices.[136]

In 1855 Virginia pig iron was priced at $32 to $38 a ton, $5 to $6 less than in the previous year, and was difficult to sell because the best Baltimore pig iron was quoted at $30 a ton. J. R. Anderson was of the opinion that there was little chance of selling his brothers' iron in Richmond, and advised his friends to beware of expanding production because of the poor chance for sales during the spring.[137]

Although J. R. Anderson was normally willing to pay his brothers a premium price ($32 a ton) for their pig iron, it was apparently necessary for him to purchase the cheaper northern iron. Anderson advised his brother to sell his pig iron in Lynchburg if possible because "it will be better for us as we are offered a Foundry Iron in Phila very soft and of mill quality at $26 which costs not more than

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[135]Letter, Lewis D. Crenshaw & Co. to H. T. Jordan & Co., April 29, 1853, Virginia State Library, Jordan Family Papers.

[136]Letter, Lewis D. Crenshaw and Co. to H. T. Jordan and Co., April 29, 1853, Virginia State Library, Jordan Family Papers; Letter, J. R. Anderson to F. T. Anderson, October 24, 1853, University of Virginia, Anderson Papers.

[137]Letters, J. R. Anderson to Dear Brother (F. T. Anderson), February 19, 1855; J. R. Anderson to F. T. Anderson, March 13, 1855, University of Virginia, Anderson Papers; Letter, Anderson Delany & Co. to Dear Sir, April 27, 1855, Duke University, F. T. Anderson Papers; Letters, J. R. Anderson to F. T. Anderson, April 28, 1855; J. R. Anderson to F. T. Anderson, May 31, 1855, University of Virginia, Anderson Papers.

$28 in our yard."[138] Thus, throughout the 1840's and 1850's Anderson paid a premium for his brothers' pig iron and loaned them considerable sums of money. Without this assistance, Cloverdale, Glenwood, and Grace furnaces would have been unable to continue production.[139]

While the Panic of 1857 began too late to affect pig iron production in that year, it did affect sales.[140] Ironmen believed that an inactive season was inevitable as business was slow during the spring of 1858.[141] Primary and secondary ironware from the North continued to undersell the slave-made Virginia iron. After 1857, pig iron shipped down the canal began to decline again, while the amount of pig iron received at the port of Richmond from outside the district increased geometrically. (See Figure 23.)

The ironmaster of Etna furnace sold less pig iron in 1859 than in the previous year, encouraging him to curtail production.[142] Glenwood furnace was affected in much the same way, and in January, 1859, J. R.

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[138]Letter, J. R. Anderson to F. T. Anderson, June 16, 1855, University of Virginia, Anderson Papers.

[139]Dew, Ironmaker to the Confederacy, pp. 33-34.

[140]Letters, J. R. Anderson & Co. to F. T. Anderson, March 2, 1857; John T. Anderson to Dear Brother, July 9, 1857, Duke University, F. T. Anderson Papers; Letters, F. T. Glasgow to F. T. Anderson, September 10, 1857; George Dayton to F. T. Anderson, October 16, 1857, University of Virginia, Anderson Papers.

[141]Letter, F. T. Glasgow to Dear Sir (F. T. Anderson), March 17, 1858, Duke University, F. T. Anderson Papers; Letter, F. T. Anderson to D. K. Colbourne, April 26, 1858, University of Virginia, Anderson Papers; Letter, Charles (Gorgas) to Uncle (William Weaver), October 25, 1858, Duke University, William Weaver Papers.

[142]Holland, p. 93; Letter, Lee Rocke & Co. to William Weaver, September 17, 1859, University of Virginia, Weaver-Brady Papers.

Anderson expressed the concern that "if you [Glenwood] would be barely remunerated at $35 per ton you [Glenwood] must I fear lose money at $28 and really I see no prospect at present of your [Glenwood] selling at more."[143] With other furnaces supplying the demand at $28 a ton, Anderson predicted that there was little chance for sale of Glenwood metal.

In 1860 the lower priced northern anthracite and charcoal pig iron continued to hamper the production and sale of Virginia iron.[144] During the spring, northern charcoal pig iron was quoted at $25 a ton delivered to Baltimore, which made it competitive in the Virginia District.[145] If northern charcoal ironmasters could make money at $25 a ton, Anderson declared that his brother should get rich at $30, the price he was willing to pay.[146] Anderson began making heavy purchases of Pennsylvania anthracite pig iron in 1,000 ton lots at $19 to $21 per ton in Philadelphia and Baltimore during 1859 and 1860. By the fall of 1860, the rolling mill at Tredegar Iron Works used four tons of northern

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[143]Letters, J. R. Anderson to Dear Brother (F. T. Anderson), January 18, 1859; J. R. Anderson to F. T. Anderson, January 14, 1859, University of Virginia, Anderson Papers.

[144]Letters, J. R. Anderson to Dear Brother (F. T. Anderson), January 18, 1859; J. R. Anderson to F. T. Anderson, January 14, 1859; J. R. Anderson to F. T. Anderson, February 5, 1859, May 18, 1860 and May 25, 1860, University of Virginia, Anderson Papers; Dew, Ironmaker to the Confederacy, pp. 32-33; Cappon, "Lucy Selina's Charcoal Era," p. 37.

[145]Letter, J. R. Anderson and Co. to F. T. Anderson, May 18, 1860, University of Virginia, Anderson Papers.

[146]Letters, J. R. Anderson to F. T. Anderson, May 25, 1860 and May 30, 1860, University of Virginia, Anderson Papers; Letter, J. R. Anderson and Co. to F. T. Anderson, May 18, 1860, University of Virginia, Anderson Papers.

iron for every ton of Virginia metal, and these northern purchases deprived mountain ironmasters of a major customer.[147] In 1860 Tredegar and other major secondary manufacturers in Richmond used over 20,000 tons of pig iron of which no more than 4,000 to 5,000 tons were produced in the Virginia District.

In addition to the competition from northern pig iron, another factor contributing to the demise of the industry was the loss of the local forge market. The products of the rural forge were gradually replaced by urban secondary manufactures, and in January, 1859, a Lynchburg commission merchant informed William Weaver that if ironmasters (furnaces and forges) continued to go out of business as they had in the past year, none would be in operation by 1860.[148] One by one they had gone out of business during the 1850's, and as two scholars have noted, the charcoal iron industry in the Old Dominion was indeed moribund by 1861.[149]

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[147] Dew, Ironmaker to the Confederacy, p. 33.

[148] Letter, Lee Rocke and Co. to William Weaver, January 8, 1859, University of Virginia, Weaver-Brady Papers; Holland, p. 90; Letter, Lee Rocke and Co. to William Weaver, January 22, 1859, University of Virginia, Weaver-Brady Papers.

[149] Bradford, "The Ante-Bellum Charcoal Iron Industry," p. 185; Dew, Ironmaker to the Confederacy, pp. 33-34.

CHAPTER IV

THE WESTERN IRON DISTRICT, 1820-1860

The Western Iron District extended from the Ohio River to the Alabama border (Figure 24), but most of the furnaces in the district were located below Nashville near the Cumberland and Tennessee rivers (Figure 25).[1] The major features of the pattern were: (1) a concentration of furnaces near the Cumberland River; (2) a southward extension from the Cumberland River below Clarksville, Tennessee, through Dickson, Hickman, Lewis, and Wayne counties; and (3) a secondary concentration near the Tennessee River and dividing range between the rivers. The small iron production in Muhlenberg, Bullitt, Nelson, Green, and Russell counties, Kentucky, is treated as an outlier of the district, though the major emphasis in this chapter is given to the Western Iron District.

Pig Iron Production in the Western Iron District

During the 1790's the first iron was produced in the district at Cumberland furnace in Dickson County, Tennessee.[2] Production increased

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[1]John P. Lesley, The Iron Manufacturer's Guide to the Furnaces, Forges, and Rolling Mills of the United States (New York: J. Wiley, 1859), pp. 127-137.

[2]Ernest F. Burchard, The Brown Iron Ores of the Western Highland Rim, Tennessee, Bulletin 39 (Nashville: Division of Geology, 1934), pp. 7 and 15.

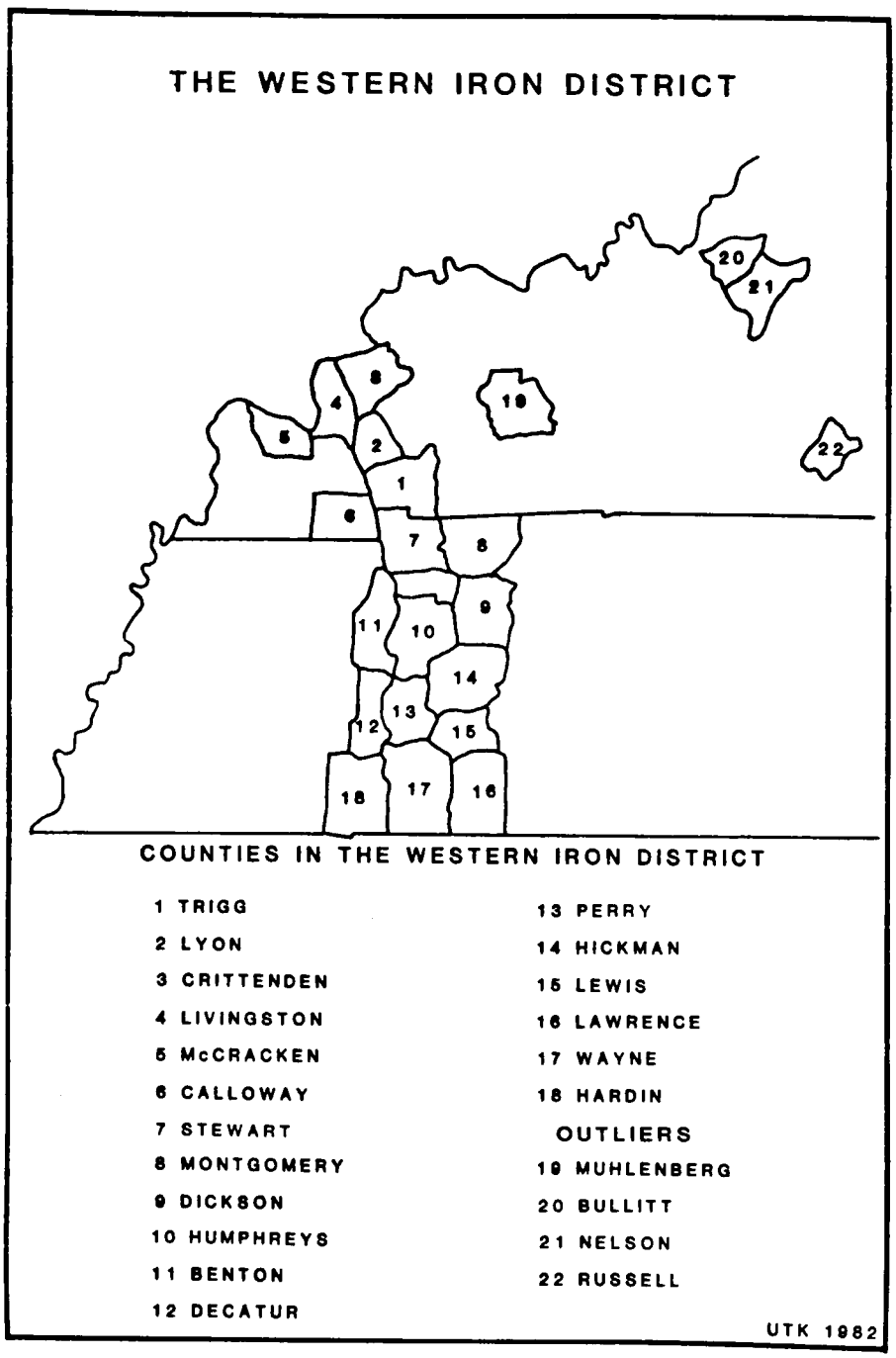

Figure 24. The Western Iron District.

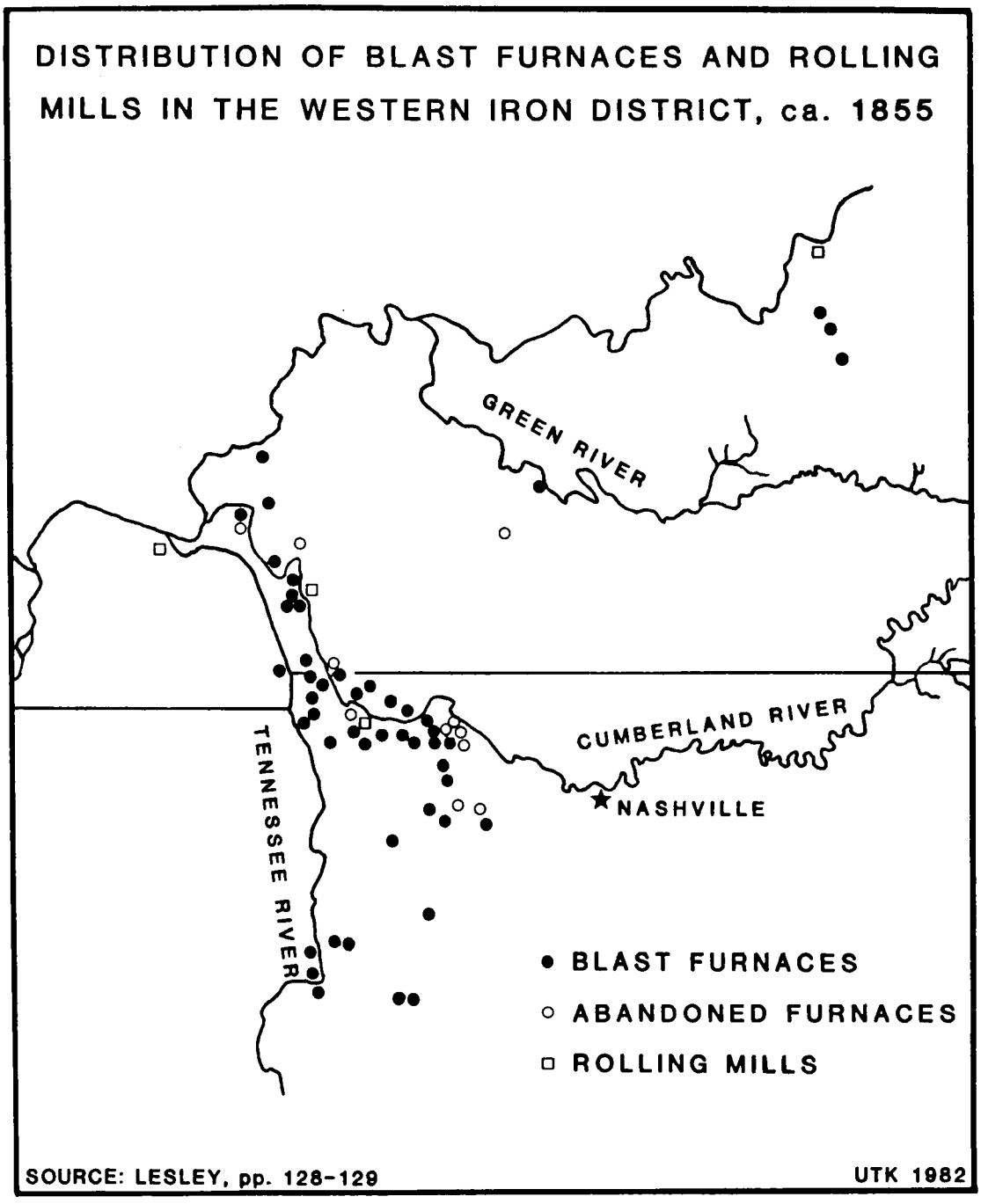

Figure 25. Distribution of Blast Furnaces and Rolling Mills in the Western Iron District, ca. 1855.

slowly in the first three decades of the 19th century, but in the 1830's new furnaces rapidly increased capacity.[3] By 1840 the Western Iron District produced 16,250 tons, which was 20% of total southern iron production; outlying areas produced an estimated 3,500 additional tons (Table XI). Because a number of furnaces were either built or rebuilt during the 1840's, the district's production increased to 40,636 tons by 1850, rising to a peak of 49,419 tons in 1854 (Table XI). During the mid-1850's the Western Iron District was responsible for over one-third of the southern iron production, and was the fifth largest iron producing district in the nation. After 1854, however, there was a slow absolute decline until 1857, when production plummeted from 42,858 tons to 26,640 tons in 1860.

The Pattern and Changes in Production 1820-1860

In 1810 four blast furnaces in Dickson and Montgomery counties, Tennessee, manufactured 587 tons of cast iron.[4] By 1820 three furnaces in Dickson County produced 1,526 tons of pig iron, hollowware, and machinery.[5] Stacker and Watson built a furnace near Eddyville, Kentucky, in 1830, and at the beginning of 1832 six furnaces were

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[3]Burchard, p. 8; Gerard Troost, Third Geological Report to the General Assembly of the State of Tennessee (Nashville: S. Nye and Co., 1835), pp. 28-29; Lesley, pp. 127-137.

[4]Tench Coxe, A Statement of the Arts and Manufactures of the United States of America, for the Year 1810 (Philadelphia: A. Cornman, Jr., 1814).

[5]United States Bureau of the Census, unpublished census manuscripts, "Census of Manufactures," 1820.

TABLE XI

PIG IRON PRODUCTION IN THE WESTERN IRON DISTRICT, 1840-1880
(IN TONS)

Year	Western Iron District	Percentage of Southern Production	Outlying Areas of Production	Tennessee Counties of the Western Iron District	Percentage of Tennessee's Iron Production	Kentucky Counties of the Western Iron District	Percentage of Kentucky's Iron Production
1840	16,250	20%	3,500[a]	13,000	81%	3,250	14%
1850	40,636	34%	1,164	28,336	93%	12,300	42%
1854	49,419	35%	n.d.	37,183	94%	12,236	35%
1855	47,347	37%	n.d.	33,683	96%	13,664	46%
1856	47,064	31%	n.d.	32,162	97%	14,902	41%
1857	42,858	-	2,396	27,050	-	15,808	-
1860	26,640	20%	3,000	20,390[c]	91%	6,250	19%
1870	18,866	9%	3,900[b]	15,686[d]	55%	3,180	6%
1880	7,536			5,036	11%	2,500	4%

Sources: U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860, and 1870; U.S. Bureau of the Census, published censuses of manufacturers 1840-1880; J. P. Lesley, pp. 748-754; James M. Safford, A Geological Reconnaissance . . ., pp. 52-53.

[a]The 1840 census listed 10,000 tons for Nelson County, which is probably incorrect. I inferred 1,000 tons.

[b]Infer two furnaces making 1,950 tons each equals 3,900 tons.

[c]Estimated for Dickson and Hickman counties.

[d]Estimated using $56.25 per ton of pig iron.

operating in the Tennessee section of the district.[6] In the next few years there was a rapid expansion of production as twenty-one furnaces were erected in the Tennessee counties, and by 1835 the pattern of production was similar to that of 1840 (Figure 26).[7] The major feature of the 1840 pattern was the heavy production by furnaces near the Cumberland and Tennessee valleys, particularly those in Stewart and Montgomery counties (Figure 26). In other counties furnaces produced up to 2,000 tons, and those in outlying Muhlenberg and Nelson counties manufactured 2,500 and 1,000 tons, respectively.

The change in production between 1840 and 1850 was one of general increase (Figure 27). By midcentury the industry was widespread, but a concentration of furnaces in Montgomery, Stewart, Trigg, and Caldwell counties accounted for over two-thirds of the district's pig iron production (Figure 28). Twelve furnaces in Montgomery and Stewart counties produced nearly 19,000 tons of pig iron and castings, or 47% of the district's production, while the secondary manufacturers in Dickson, Montgomery, Stewart, and Caldwell counties fabricated a large quantity of pig iron into about 12,000 tons of bloom, bar, boiler, and sheet iron (Figure 28). The furnaces in outlying Muhlenberg and Nelson counties were idle in 1850, but those in Bullitt and Green counties produced 1,164 tons (Figures 27 and 28).

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[6]Burchard, p. 8; Troost, Third Report, p. 28; Lesley, p. 129.

[7]Troost assumed that each furnace had an annual production of 1,000 tons, giving the Tennessee section of the district a total production of 27,000 tons. This was probably the capacity of production, with the actual total more on the order of 13,000 to 19,000 tons. Troost, Third Report, pp. 28-29.

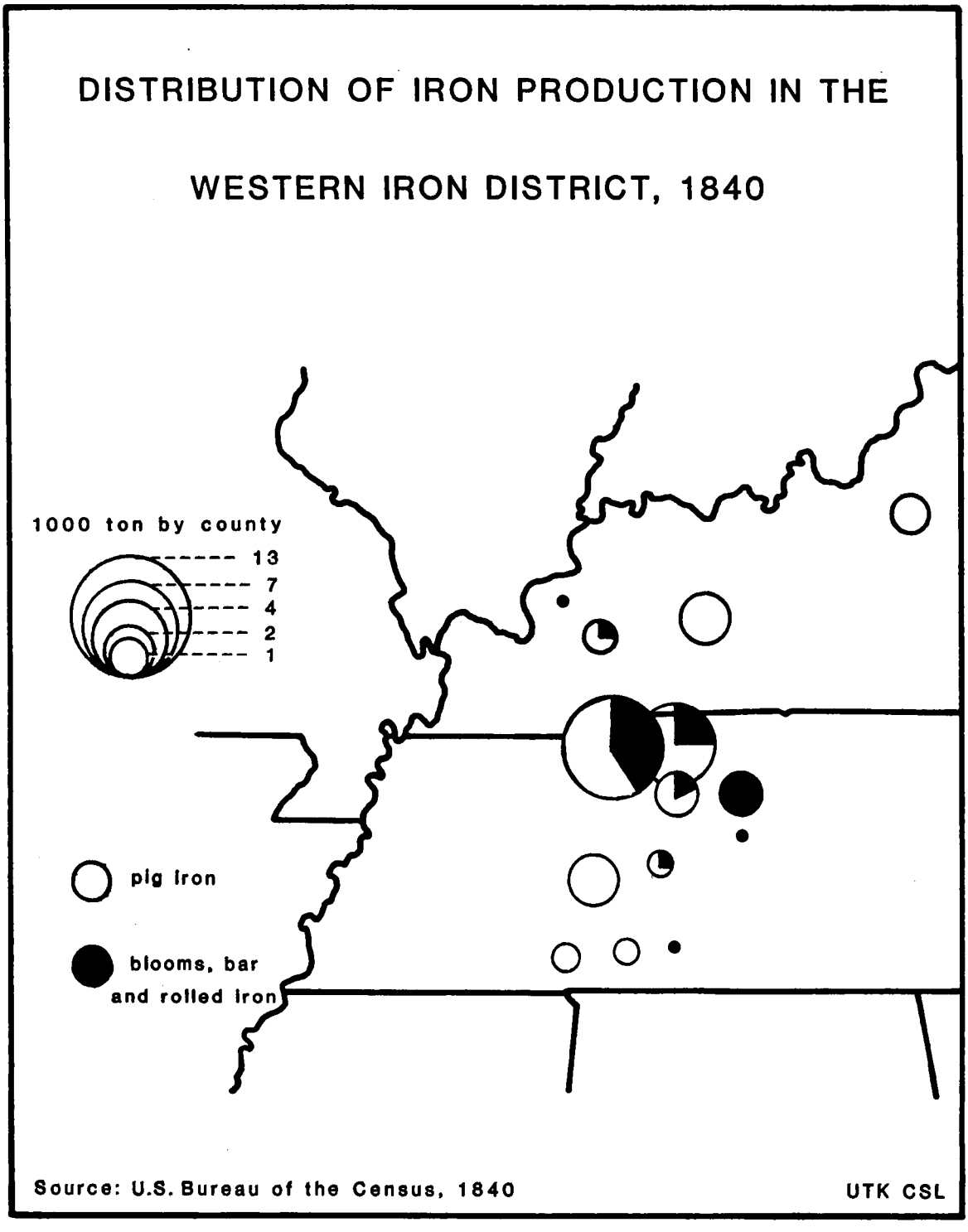

Figure 26. Distribution of Iron Production in the Western Iron District, 1840.

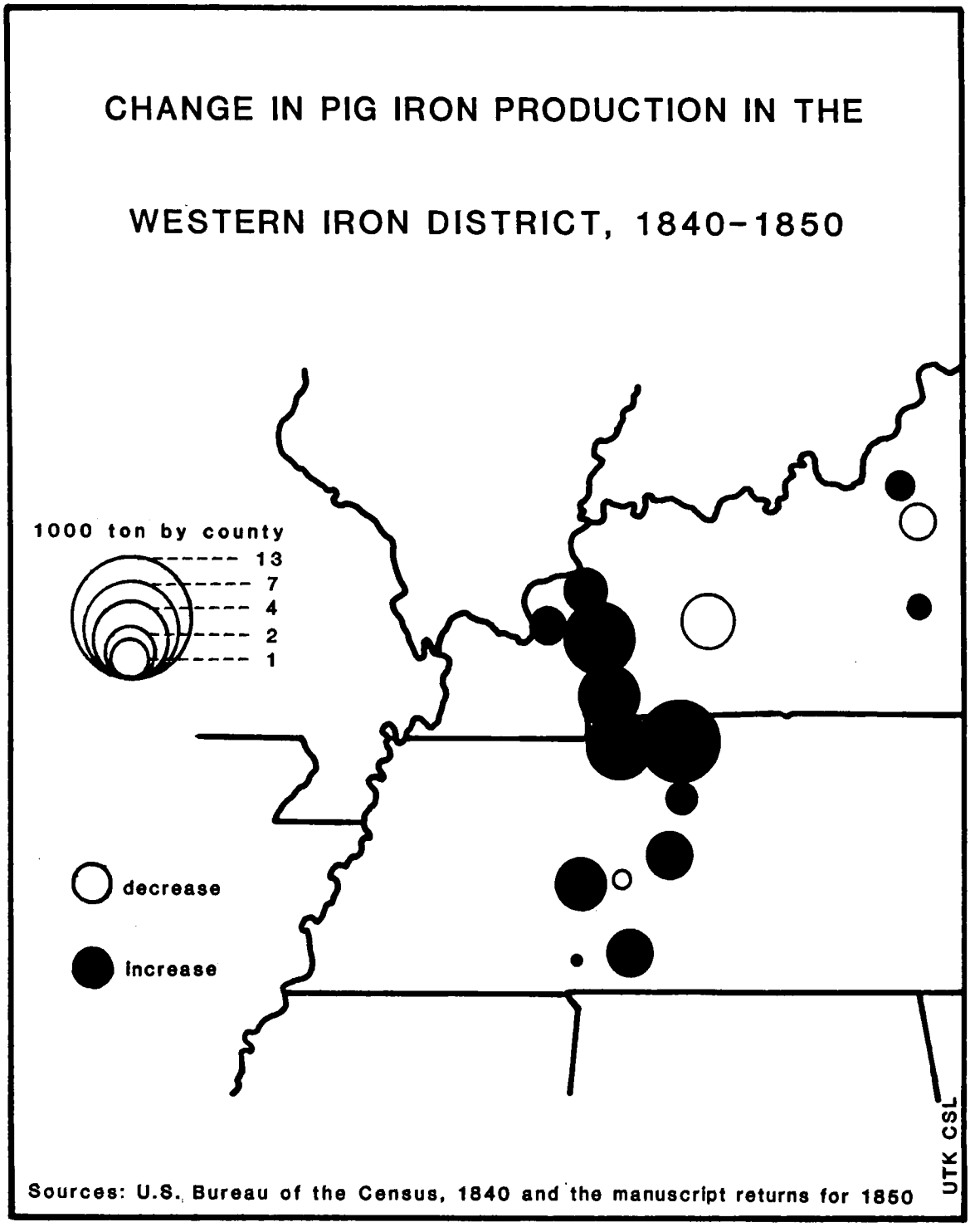

Figure 27. Change in Pig Iron Production in the Western Iron District, 1840-1850.

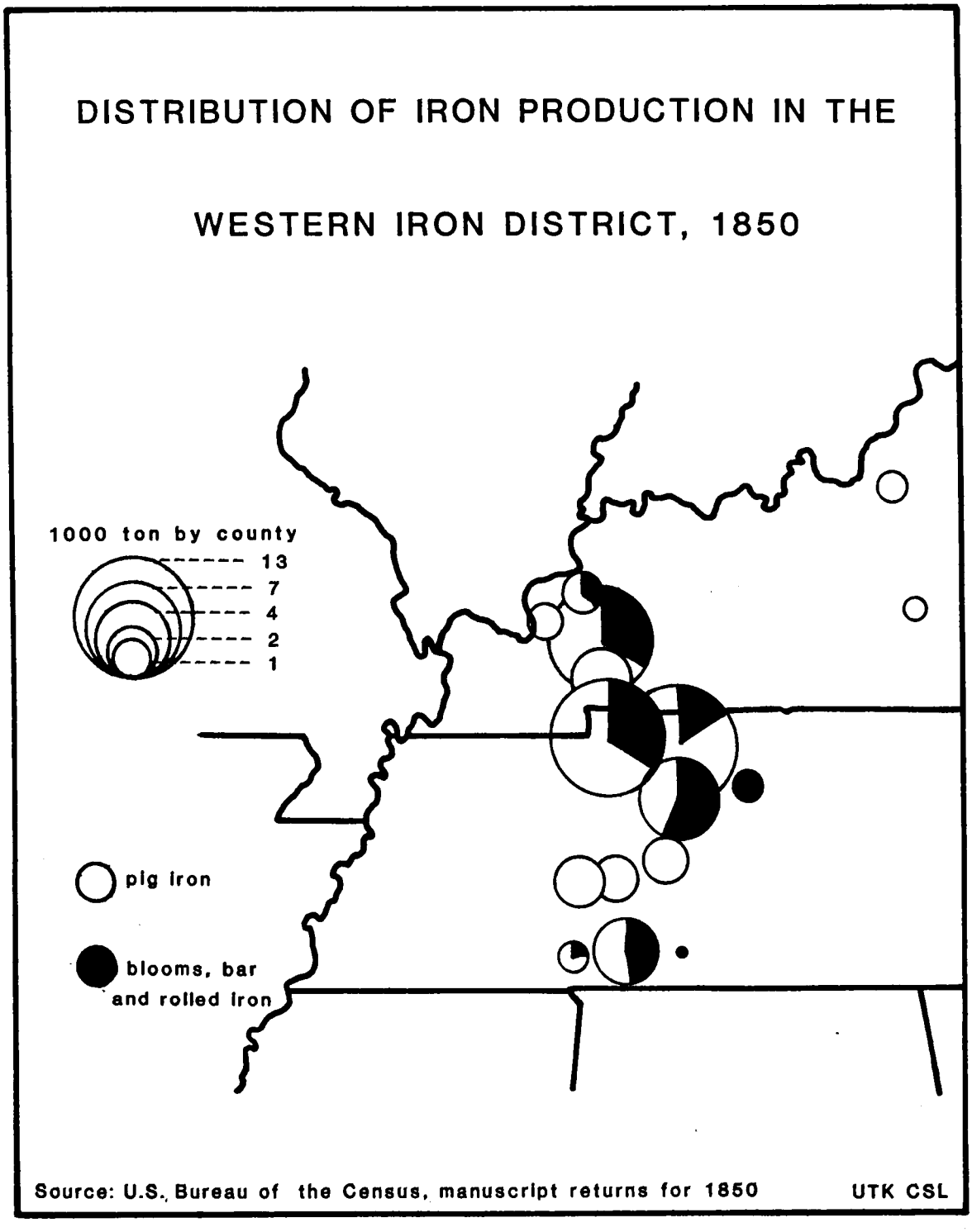

Figure 28. Distribution of Iron Production in the Western Iron District, 1850.

Rapid changes in patterns of production were characteristic of the district in the 1850's. Between 1850 and 1854 iron production in the Kentucky section was stable, but in the Tennessee counties production grew from 28,336 to 37,183 tons (Table XI and Figure 29). The major reason for the increase was the building and rebuilding of furnaces in Stewart and Dickson counties. In 1850 five furnaces in Stewart County produced 8,700 tons of pig iron, but by 1854 twelve furnaces in the county manufactured 14,167 tons.[8] Moreover, the six furnaces in Dickson County produced 5,964 tons in 1854.

After 1854 production in the Tennessee section of the district experienced an absolute decline (Figure 30), but in the Kentucky section production continued to increase until 1857 (Table XI). After 1857 production in the Western Iron District declined rapidly, and by 1860 the production and areal extent of iron making were substantially smaller than that of 1850 (Figures 31 and 32).

Weekly and Annual Production Averages

The capacity of production was between 21 and 42 tons a week during the first four decades of the 19th century.[9] By the 1840's one firm operating three furnaces had a total capacity of 125 tons a week (42 tons per furnace), which one writer claims was the largest output of any

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[8]Burchard, pp. 11-13 and 15-16; Lesley, pp. 130-133.

[9]Burchard, p. 8; Gerard Troost, Sixth Geological Report to the General Assembly of the State of Tennessee (Nashville: B. R. M'kennie, 1841), p. 43.

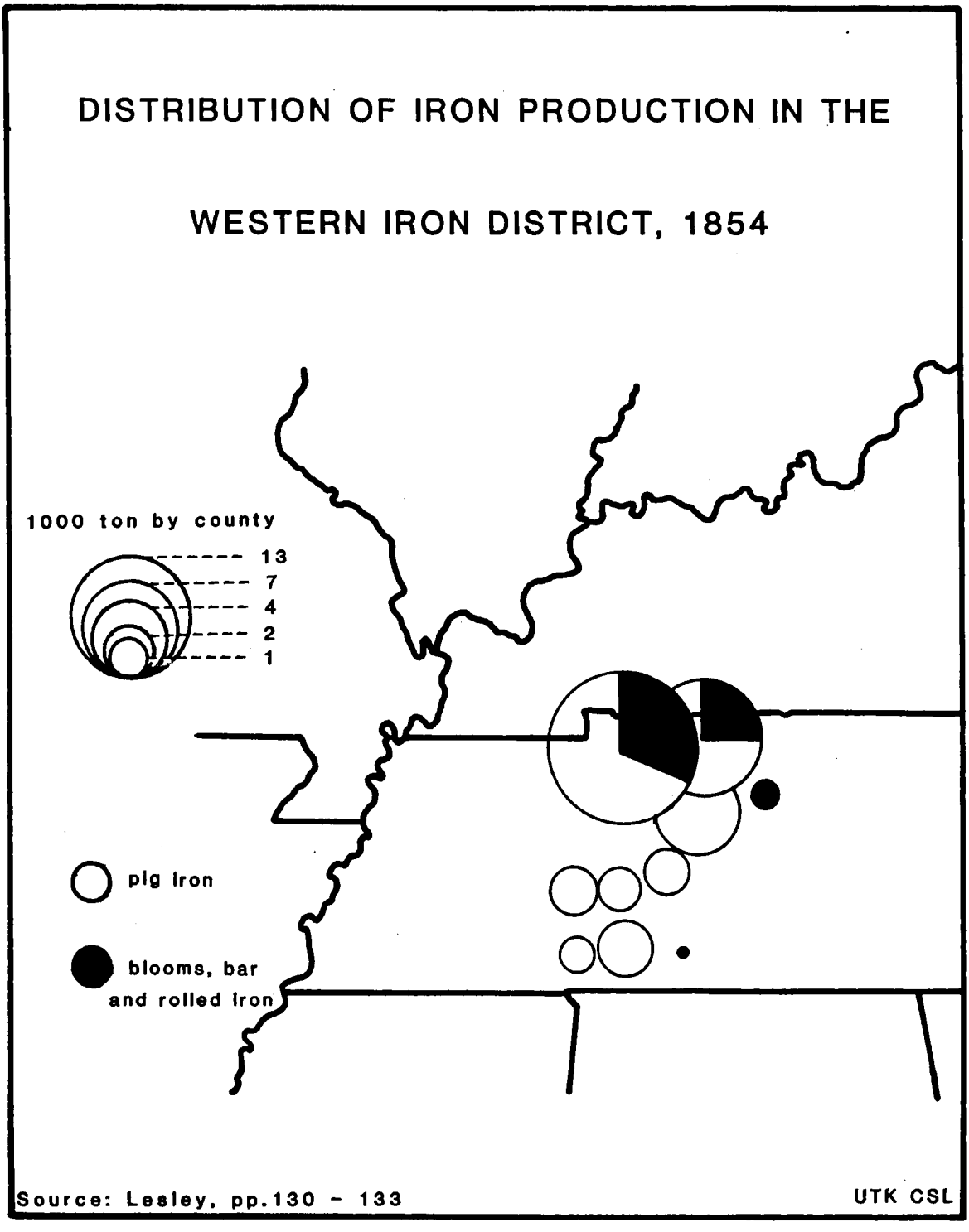

Figure 29. Distribution of Iron Production in the Western Iron District, 1854. No data was available for the Kentucky counties of the district.

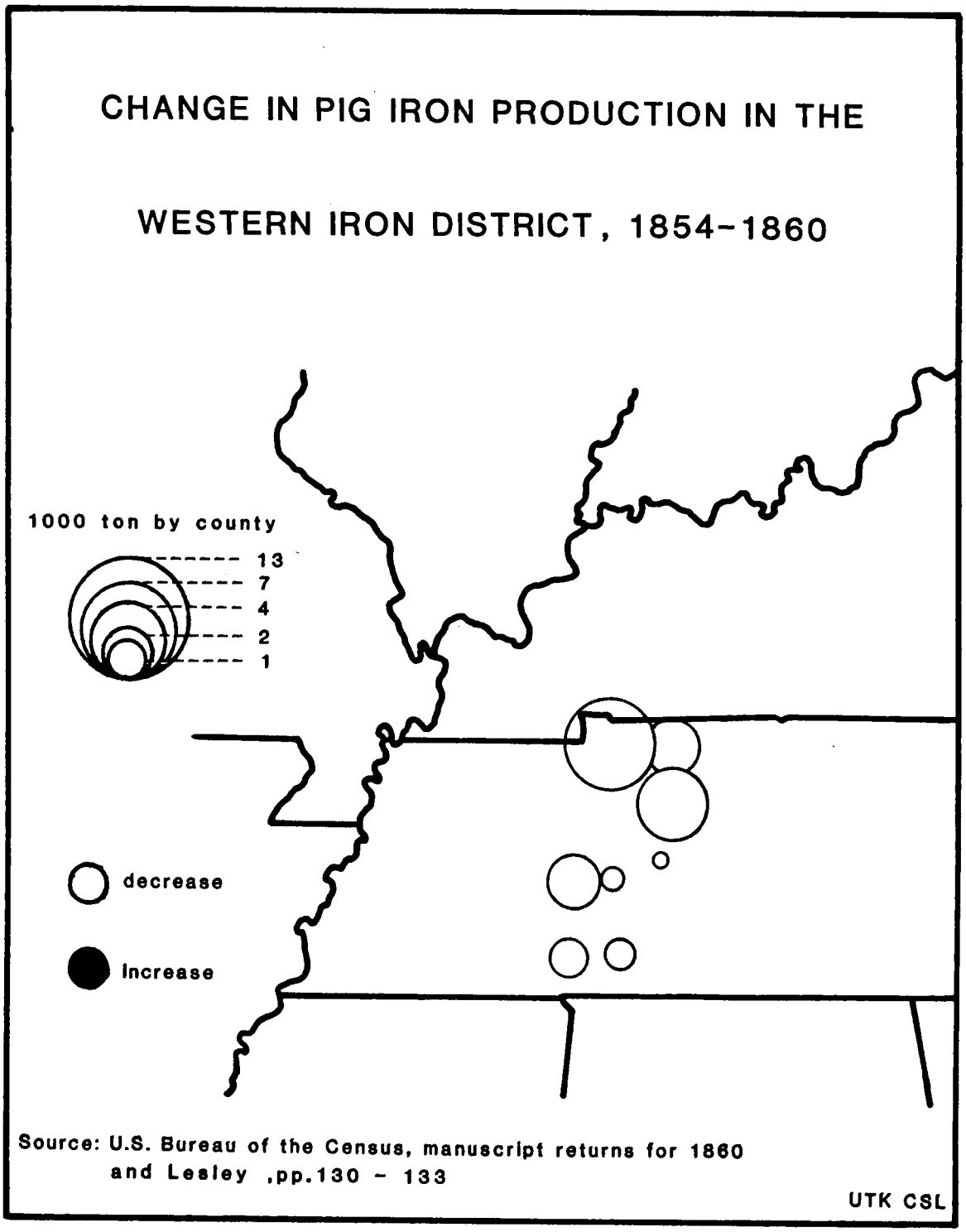

Figure 30. Change in Pig Iron Production in the Western Iron District, 1854-1860. No data was available for the Kentucky counties of the district.

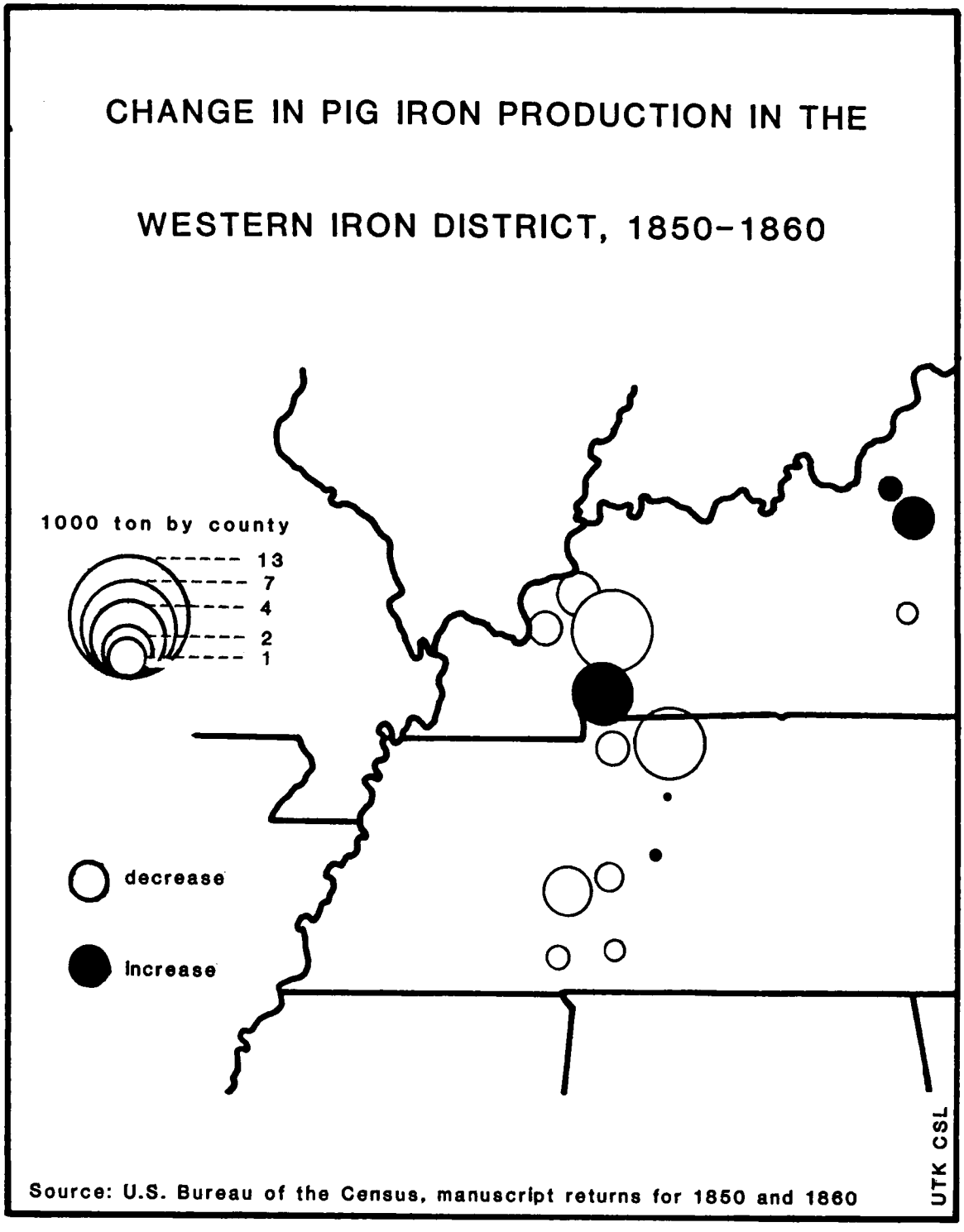

Figure 31. Change in Pig Iron Production in the Western Iron District, 1850-1860.

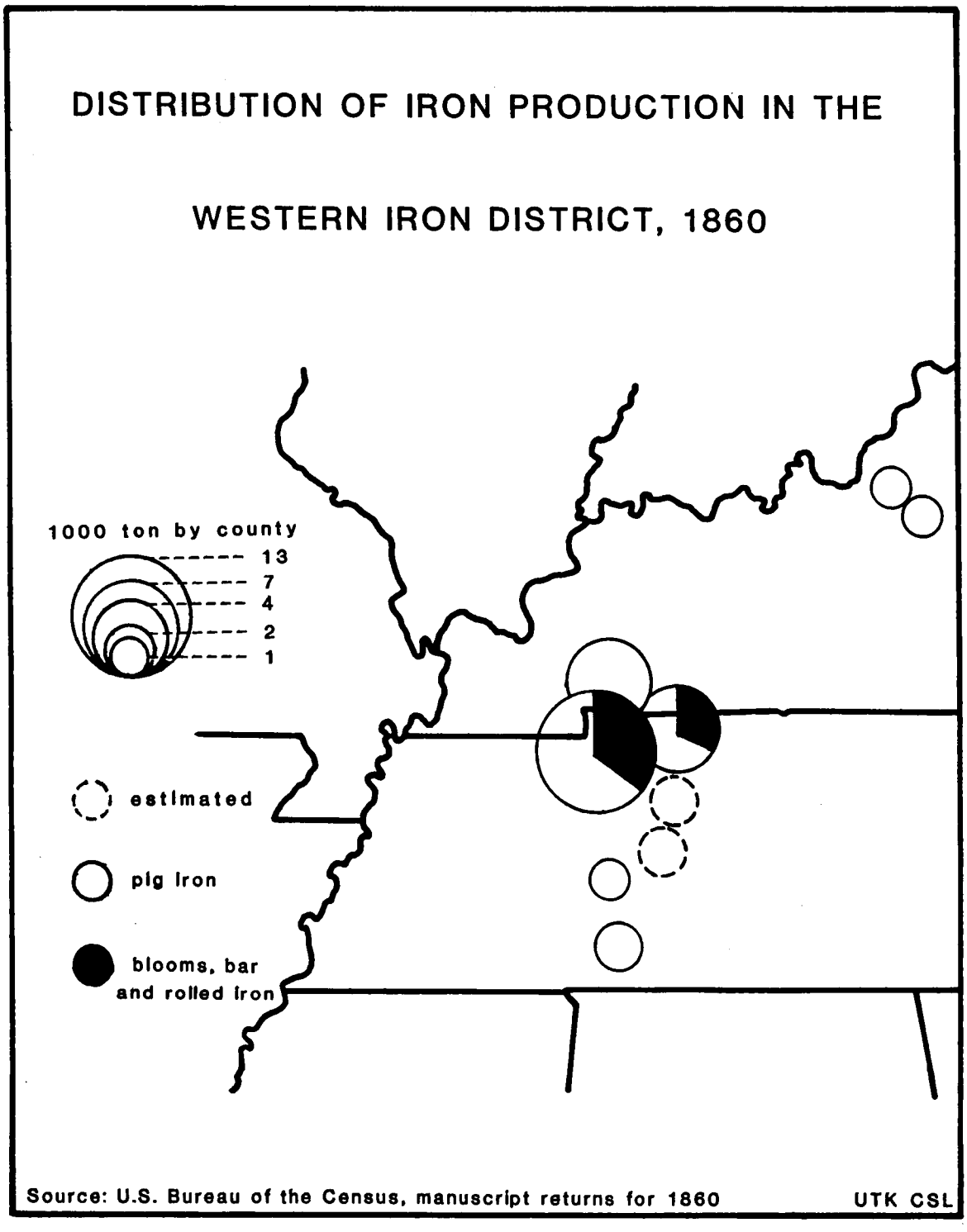

Figure 32. Distribution of Iron Production in the Western Iron District, 1860.

single firm in the South or West.[10] Iron Mountain, Bellwood, and Ashland furnaces in Stewart County produced an average of 50 to 60 tons a week during the 1850's, but most furnaces in the district averaged only 30 to 50 tons.[11]

The mean annual production was less than the weekly average might suggest because furnaces were in operation for only part of the year. Furnaces in the Western Iron District were in blast an average of 7, 7½, 9, 10, and 9 months in 1850, 1854, 1855, 1856, and 1857, respectively.[12] The length and seasonal operation of the blast were coordinated with the assemblage of raw materials, labor supply, business prospects, and, where waterpower was used, sufficient runoff to generate the power.

In 1850 the mean annual production of the furnaces in the Western Iron District was 1,401 tons, slightly less than the 1,498 ton mean for the rest of the nation. During the mid-1850's the mean annual production for furnaces listed in Table XII was similar to that of 1850. However, by 1860 the mean annual production of the remaining furnaces in the district had increased to 1,908 tons, partly on the strength of a record production by Hillman's furnace. The Trigg County furnace

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[10]J. B. Killebrew, "A Sketch of the Life of Daniel Hillman," an address read before the Tennessee Historical Society, January 1888, Tennessee State Library and Archives, Killebrew Collection, p. 4.

[11]James M. Safford, A Geological Reconnaissance of the State of Tennessee (Nashville: G. C. Torbett and Co., 1856), pp. 52-53; Lesley, pp. 127-137.

[12]These figures are based on selected furnaces; the number of observations used for each cross-section were 16 for 1854, 10 for 1855, 5 for 1856, and 13 for 1857. Lesley, pp. 127-137.

TABLE XII

ANNUAL PRODUCTION FOR SELECTED FURNACES IN THE WESTERN IRON DISTRICT, 1850-1860 (IN TONS)

Furnace	1850	1852	1854	1855	1857	1860
Peytona	1,700	1,800	1,220	-	1,812	1,700
Bellwood	1,200	1,700	2,006	-	2,035	2,188
Bear Spring	1,300[a]	1,500	855	-	-	-
Rough and Ready	1,400	1,400	1,050	-	0	-
Ashland	-	1,600	1,200	-	1,150	-
Poplar Spring	1,700	1,600	1,175	1,300	-	-
Yellow Creek	600	700	600	1,050	-	300
Phoenix	-	1,700	1,500	-	-	-
Louisa	-	1,800	2,154	2,034	-	-
Cumberland	1,600	1,800	1,926	-	1,831	n.d.
Worley	-	1,000	950	-	1,200	n.d.
Caroll	500	1,300	1,050	-	984	n.d.
Stacker (Lineport)	1,700	1,500	-	-	-	-
Empire	1,600	1,700	-	1,836[b]	-	4,650
Laura					1,638	1,600

Sources: Safford, pp. 52-53; Lesley, pp. 127-137; Hunt's Merchants' Magazine and Commercial Review, Volume 28 (1853), pp. 644-645.

[a]In addition to the 1,300 tons, 700 tons of run-out metal was cast.

[b]This production is for 1856 instead of 1855.

produced an extraordinary 4,650 tons, setting an antebellum record for the Western Iron District and the Southern Iron Region.[13]

The Resource Base

Iron Ore

Deposits of limonite or brown ore along the Cumberland and Tennessee rivers extended from near the Ohio River in the north to northwestern Alabama in the south. In Tennessee, the ore was concentrated in a 15-mile wide band which broadened to forty miles in Montgomery and Stewart counties before narrowing along the Cumberland and Tennessee rivers in Kentucky (see Figure 5, Chapter 2, page 35).[14]

The mining of a quality ore. Mining in the district began as early as 1797 in Dickson, 1802 in Montgomery, and 1832 in Stewart and Wayne counties, Tennessee.[15] The ore was generally covered by soil, clay, chert, gravel, sand, and other unconsolidated material to a depth of about thirty feet and was relatively cheap to mine because the only major expense was the removal of the overburden.[16] Using picks and

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[13]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1860.

[14]Burchard, p. 24; J. B. Killebrew, Tennessee: Its Agricultural and Mineral Wealth (Nashville: Tavel, Eastman, and Howel, 1874), p. 133.

[15]Burchard, p. 221.

[16]Burchard, p. 25; Killebrew, Tennessee: Its Agricultural and Mineral Wealth, p. 181; J. B. Killebrew, Iron and Coal of Tennessee (Nashville: Tavel and Howel, 1881), p. 14; William B. Caldwell, "Report on the Limonite Ores of Trigg, Lyon, and Caldwell Counties," in Geological Survey of Kentucky, Western Coal Field (Frankfort: D. Yeoman Press, 1884), p. 8; Gerard Troost, Fifth Geological Report to the General Assembly of Tennessee (Nashville: J. George Harris, 1840), p. 41.

shovels the miners removed only the large pieces of lump ore from the shallow pits and surface deposits, leaving nine-tenths of the shot ore in the mine.[17]

In the late 1830's the state geologist was surprised to discover that there was a general lack of knowledge concerning the varieties of ore, as some ironmasters were rejecting the best ore.[18] These ironmasters were apparently selecting ores by trial and error, and success was often achieved by chance.

Nevertheless, the district's ore was held in high esteem. Supposedly knowledgeable ironmasters contended that the ore could not be better and if pig iron was judged as inferior in quality, it was not the fault of the ore.[19] The ore usually ranged from 38% to 52% iron content, averaging about 46%.[20] To improve its efficiency and yield in the furnace, however, ironmasters roasted and screened the ore to remove

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[17]Lesley, p. 607; Troost, Fifth Geological Report, p. 34; A. H. Purdue, "The Iron Industry of Lawrence and Wayne Counties," in Resources of Tennessee, Tennessee State Geological Survey, 2 (October, 1912), pp. 373 and 375; J. B. Killebrew, Life and Character of James Cartwright Warner (Nashville: Publishing House of the Methodist Episcopal Church, South, Barber and Smith agents, 1897), pp. 47-48.

[18]Troost, Fifth Geological Report, p. 33.

[19]Troost, Third Geological Report, p. 30; Killebrew, Tennessee: Its Agricultural and Mineral Wealth, p. 136; J. B. Killebrew, Introduction to the Resources of Tennessee (Nashville: Bureau of Agriculture, 1874), pp. 301, 853-854.

[20]Burchard, p. 27; Lesley, p. 606; J. B. Killebrew, The Western Iron Belt: Its Relation to the Growth and Prosperity of Nashville (Nashville: Commercial Club, 1890), p. 4.

moisture and eliminate adhering clay.[21] As a result, raw ores yielding 35% to 40% were improved to 55% to 58% when roasted and screened.[22]

The quantity and cost of ore. During the early period it required about three tons of ore to produce a ton of pig metal. At midcentury an average of 2.77 tons was used in making a ton of pig iron in the Western Iron District, the amount changing little during the 1850's (Table XIII).

The cost of ore was lower in the Western Iron District than in the other southern iron districts. Throughout the antebellum era, the district's ore generally, cost between $1.00 and $1.50 a ton. In 1850 the average cost was about $1.14 a ton, and ore to manufacture a ton of pig metal cost $3.16 (Table XIII). The ore was relatively cheap because of the widespread pattern of deposits, short distance to the ore banks, and the low cost of mining. While several ironmasters were able to mine ore at the furnace site, the mean distance between ore banks and furnaces in the Western Iron District was only about 1.56 miles in the mid-1850's, the shortest distance of any southern iron district.[23]

Within the Western Iron District, however, there was considerable spatial variation in the quantity and cost of ore used in making pig iron. Since the percentage of iron content was higher in the Tennessee

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[21]Killebrew, Western Iron Belt, p. 4; Purdue, p. 375; Dawson A. Phelps and John T. Willett, "Iron Works on the Natchez Trace," Tennessee Historical Quarterly 12 (December 1953), p. 317.

[22]Lesley, p. 607; Killebrew, Iron and Coal, p. 110; Killebrew, J. C. Warner, p. 49.

[23]Lesley, pp. 127-137; Purdue, p. 373; Caldwell, pp. 8-11.

TABLE XIII

THE QUANTITY AND COST OF ORE USED IN MAKING PIG IRON IN THE WESTERN IRON DISTRICT, 1850-1860

	Ore Used in Making a Ton of Pig Iron		Cost of a Ton of Ore		Cost of Ore to Make Pig Iron	
	1850	1860	1850	1860	1850	1860
Western Iron District	2.77	2.7	$1.14	$1.22	$3.16	$3.29
Kentucky Counties	3.0	3.22	0.80	1.15	2.40	3.70
Tennessee Counties	2.7	2.5	1.41	1.28	3.80	3.20
Outlying Areas	3.6	2.83	1.71	3.00	6.16	8.49

Source: U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850 and 1860.

ores, furnaces in the Tennessee section of the district, particularly those in Hickman, Perry, Decatur, and Wayne counties, used less ore per ton of pig metal.[24] In contrast, the quantity and cost of ore needed to produce a ton of metal in outlying counties were significantly higher than in the core area of the Western Iron District. Finally, for some unknown reasons (such as proximity of ore, ease of mining, different processing, etc.), the ore was cheaper in the Kentucky section of the district, costing only $2.40 to manufacture a ton of pig iron in 1850 (Table XIII).

Ironmasters and writers of the period thought that there was an inexhaustible supply of ore in the Western Iron District,[25] as few furnaces experienced problems in obtaining supplies of ore during the early period. Nevertheless, several furnaces failed during the 1850's due to problems in mining, exhaustion of conveniently located ores, and increasing distance to usable ore banks,[26] thus suggesting that problems in supplying ore were another factor in the demise of the district. Most of these furnaces failed because of the depletion of ore in the vicinity of the furnace, as about four miles was considered the maximum

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[24]Burchard, pp. 19 and 221; Killebrew, Introduction to the Resources, p. 301; Killebrew, Tennessee: Its Agricultural and Mineral Wealth, p. 177.

[25]Safford, A Geological Reconnaissance, p. 48; Killebrew, Tennessee: Its Agricultural and Mineral Wealth, pp. 135-137, 177, 179, 185, 188; Killebrew, Introduction to the Resources of Tennessee, pp. 755, 797, 929, and 976; Killebrew, Iron and Coal, pp. 102, 115-116, and 129; J. B. Killebrew, Middle Tennessee as an Iron Centre (Nashville: Tavel, Eastman, and Howel, 1879), p. 12; Troost, Fifth Geological Report, November 1839, p. 34; Lesley, p. 604.

[26]Burchard, pp. 39 and 42; Lesley, pp. 133, 606-608.

range that ore could be profitably transported. Obtaining supplies of ore from distant deposits increased the cost of making iron. At Laurel furnace, where the distance to the ore was excessive, the ironmaster paid $2.00 a ton for ore in 1850, nearly twice the district's average cost.[27]

Charcoal Fuel

In 1820 the furnaces in Dickson County used an average of nearly 400 bushels of charcoal per ton of metal in making 1,526 tons of iron.[28] The amount of charcoal used in making pig iron decreased in the course of time, and by 1850 an average of 237 bushels per ton was used. The charcoal necessary to manufacture a ton of metal continued to decline during the 1850's, requiring an average of only 200 bushels in 1860.[29]

The amount of fuel used by furnaces in the Western Iron District was relatively high in comparison to other districts. Temin states that it required an averaged of 180 bushels to manufacture a ton of pig iron,[30] but during the 1850's it required well over 200 bushels in the Western Iron District. The higher consumption was primarily due to the widespread use of the cold blast process which required more fuel than

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[27]Lesley, p. 608; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850.

[28]United States Bureau of the Census, unpublished census manuscripts, "Census of Manufactures," 1820; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850.

[29]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860, and 1870.

[30]Peter Temin, Iron and Steel in Nineteenth-Century America: An Economic Inquiry (Cambridge, Massachusetts: M.I.T. Press, 1964), p. 83.

the hot blast process. In the mid-1850's only six furnaces in the district were hot blast furnaces, and two of these used a combination of hot and cold blast.[31]

Nevertheless, the number of bushels used in making a ton of pig iron gradually declined. The practice of roasting and screening the ore in the Western Iron District was a particularly effective means of achieving greater fuel economy. Other reasons for the decline were similar to those of the Virginia District.

The adequacy of the fuel supply. With a cord making 40 bushels of charcoal and an acre of cordwood in the Western Iron District yielding 40 to 60 cords and second growth timber 30 cords, an acre produced enough wood to make 1,200 to 2,400 bushels of charcoal.[32] Using the charcoal from an acre of timber the typical furnace could manufacture from 6 to 10 tons of pig metal in 1850, and it follows that a furnace making 1,401 tons a year, the mean annual production for the district, annually consumed the timber from 138 to 208 acres.

The typical iron plantation in the Western Iron District was probably well over 10,000 acres, which usually gave the ironmaster enough timber to operate for a long period of time. At the average rate

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[31]Safford, A Geological Reconnaissance, pp. 52-53; Lesley, pp. 127-137.

[32]Temin, p. 83; Killebrew, Tennessee: Its Agricultural and Mineral Wealth, pp. 176, 184, 187, 189; Killebrew, Introduction to the Resources of Tennessee, pp. 930 and 975; Killebrew, Iron and Coal, p. 109.

[33]Lesley, pp. 127-137; Lester J. Cappon, "History of Southern Iron Industry to the Close of the Civil War," unpublished manuscript, University of Virginia Manuscript Section, Cappon, pp. 92-93.

of consumption an iron estate with 10,000 to 15,000 acres of timberland could operate for 50 to 75 years without depending on second growth timber. The formulae used to determine the rate of timber consumption are partly speculative, and other factors such as the ironmaster's attitude toward resource management and the increasing distance to the timber supply were also important.

It seems clear, however, that the required timber supply was sufficient to last through the antebellum era, a conclusion supported by primary and secondary sources. Lester J. Cappon stated that it was long after the introduction of the mineral fuel technology that the abundant supply of southern timber began to fail through rapid deforestation, and then only at certain sites.[33] During the mid-1850's Lesley and Safford both stated that the wood supply for charcoal fuel was abundant and cheap in the Western Iron District and would be for many years.[34]

Some postbellum reports were also optimistic. A good timber supply surrounded Trigg and Center furnaces, and even though these furnaces had been in blast for years, the timber had not been thinned out.[35] The 60,000 acres held by the owners of Cumberland Iron Works included 30,000 acres of virgin timber, and 20,000 acres of second growth timber of which 6,000 acres were suitable for coaling.[36] Other reports also

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[34]Lesley, pp. 605-606; Safford, A Geological Reconnaissance, p. 50.

[35]Caldwell, pp. 9 and 11.

[36]Killebrew, Tennessee: Its Agricultural and Mineral Wealth, p. 178.

confirm that in general wood was plentiful, cheap, and easily supplied.[37]

Pessimistic postbellum reports usually pertained to specific furnace sites. In the 1870's Killebrew issued a cautious warning that while the timber supply was abundant, it was being consumed at a rate of 6,000 acres annually, with the timber having been cut down for a distance of 3 to 4 miles about the old furnaces.[38]

Such warnings were made during the postbellum period long after the relative and absolute decline in the district's iron production. When iron production began to decline, wood for charcoal fuel was still reported as abundant. The size of iron estates and acreages cutover each year also suggest that there was enough fuel for operations well beyond the period of decline. Finally, if charcoal had been in short supply during the 1850's, there should have been a sharp rise in its price, and this did not occur.

The cost of charcoal fuel. The cost of a bushel of charcoal changed little during the first half of the 19th century.[39] In 1850 charcoal cost 3¢ a bushel, and the total cost of fuel to manufacture a ton of pig metal was $7.11. At midcentury the cost varied from 3¢ to

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[37]Killebrew, Introduction to the Resources, pp. 238 and 931; Killebrew, Tennessee: Its Agricultural and Mineral Wealth, p. 180; Killebrew, Iron and Coal, p. 121; P. N. Moore, "Report upon the Airdrie Furnace and Property, Muhlenberg County, Kentucky," in Geological Survey of Kentucky, Volume 2, Part IV, Second Series, p. 23.

[38]Killebrew, Introduction to the Resources, pp. 242 and 975; Killebrew, Tennessee: Its Agricultural and Mineral Wealth, pp. 142 and 181.

[39]Lesley, p. 605.

4¢ a bushel, and during the 1850's the cost increased to 4¢ a bushel. Meanwhile, the amount of charcoal used in making pig iron declined; and in 1860 the cost of fuel to make a ton of metal was $8.00, which was only moderately higher than it had been in 1850.[40] Fuel costs probably declined during the 1850's for those ironmasters who installed the hot blast process and/or paid cheaper rates for charcoal fuel.

Other On-Site Location Factors: Limestone and Power

Compared to the large quantities of ore and charcoal, only small amounts of limestone were needed as a fluxing agent. The limestone consumption varied widely, but most furnaces in the district annually used between 100 and 700 tons.[41] Ironmasters usually paid from 50¢ to $1.00 a ton for limestone delivered to the furnace, and they had little difficulty in obtaining it.[42]

Steam and waterpower were used to force air into the furnace, causing the charcoal to burn hot enough to melt the ore and limestone. Water was the initial source of power in the Western Iron District, and

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[40]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860, and 1870; Lesley, p. 605.

[41]United States Bureau of the Census, unpublished census manuscripts, "Census of Manufactures," 1820; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850 and 1860.

[42]United States Bureau of the Census, unpublished census manuscripts, "Census of Manufactures," 1820; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850 and 1860; Burchard, pp. 69-70; Killebrew, Tennessee: Its Agricultural and Mineral Wealth, pp. 139-140 and 183; Killebrew, Introduction to the Resources, pp. 239, 976, and 1052; Caldwell, p. 9; Moore, p. 21.

Cumberland, Bear Spring, Wayne, Buffalo, Aetna, and others were among the early furnaces using waterpower.[43]

The stream flow in the Western Iron District was generally adequate,[44] but the seasonal fluctuations did affect the operation of some furnaces and forges. The stream flow was fairly constant at Aetna furnace, but Vanleer's ironworks on Barton's Creek had only enough water to operate about ten months a year.[45] The uncertainty of the stream flow was apparently one reason that the annual production of furnaces using waterpower was less than those using steam power. In 1850 the mean annual production of the furnaces using waterpower was only 528 tons, far below the 1,401 ton mean for the Western Iron District.[46] Production was certainly reduced in 1854 when four bloomery forges were only operated half of the season because of the unusually low stage of water, which undoubtedly affected the operation of the two furnaces using waterpower.[47]

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[43]Burchard, pp. 7, 76-77; Purdue, p. 374; Troost, Fifth Geological Report, pp. 42-43; Phelps and Willett, p. 314; United States Bureau of the Census, unpublished census manuscripts, "Census of Manufactures," 1820; Iris Hopkins McClain, A History of Stewart County, Tennessee (Columbia, Tennessee: by the Author, 1965), p. 24.

[44]Killebrew, Introduction to the Resources, p. 929; Killebrew, Tennessee: Its Agricultural and Mineral Wealth, pp. 176 and 184; Burchard, pp. 76-77.

[45]Troost, Fifth Geological Report, pp. 42-43; Troost, Sixth Geological Report, October 1841, p. 43.

[46]The two furnaces using a combination of steam and waterpower averaged 2,050 tons. United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850.

[47]Safford, A Geological Reconnaissance, p. 54; James M. Safford, Geology of Tennessee (Nashville: S. C. Mercer, 1869), p. 467.

Steam power was apparently first introduced in the 1830's, and during that decade Vanleer's furnace at Brownport in Perry County, Tennessee, was driven by steam power.[48] Worley furnace, constructed south of Dickson in 1844, was the first stack in the Cumberland Valley to use steam power. A rapid shift to steam power followed, and by 1850 83% of the furnaces in the Western Iron District depended at least partly on steam.[49] Only five furnaces in the district, including two in Hickman, two in Montgomery, and one in Dickson counties, Tennessee, still used waterpower. By the mid-1850's every furnace operating in the district employed steam power, making the Western Iron District more advanced in this respect than the rest of the nation.[50]

The Size, Form, and Function of the Furnace Community

Since it was costly to run short of iron ore, charcoal, or limestone, furnace owners tended to amass large estates in order to produce their own raw materials. A portion of some estates in the Western Iron District was acquired through land grants, as the state government tried to promote industrial development by providing

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[48]Troost, Sixth Geological Report, p. 43; Robert E. Corlew, "Some Aspects of Slavery in Dickson County," Tennessee Historical Quarterly 10 (September, 1951), p. 227; Lesley, p. 135.

[49]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850.

[50]Safford, A Geological Reconnaissance, pp. 49, 51-53; Lesley, pp. 127-137; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1860.

incentives to those willing to erect an ironworks.[51] Tennessee encouraged and protected the industry through tax incentives, land grants, and road building.[52] In 1824 legislation eliminated taxation on iron and salt, and subsequent legislation provided land grants of 3,000 acres or more of land judged to be unsuitable for agriculture.[53]

The Size of the Iron Plantation

While the government may have provided initial incentives, most ironmasters tried to accumulate additional land, machinery, and slaves. The iron plantations were among the largest enterprises in the district, whether measured by capital investment, value of products, or acreage, the estates averaging about 10,000 to 11,000 acres. Cumberland Iron Works was one of the district's largest estates. In 1840 this industrial complex, containing three furnaces (Dover, Bear Spring, and Bellwood), a rolling mill and forge, was situated on an 110,000 acre estate (Table XIV).[54]

The central focus of these large estates was the furnace community. The laborers necessary to conduct the iron business were either housed in cabins in the community or at convenient sites on the furnace farms.

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[51]Phelps and Willett, pp. 311 and 313; Cappon, unpublished manuscript, pp. 78-79, 124, and 126-127; Killebrew, "Sketch of Daniel Hillman," pp. 16 and 36.

[52]Cappon, unpublished manuscript, p. 55.

[53]Phelps and Willett, pp. 311-312; Cappon, unpublished manuscript, pp. 55-56, 124, and 126-127; Killebrew, "Sketch of Daniel Hillman," pp. 16 and 36.

[54]Burchard, p. 50; Lesley, pp. 131-132, 259; Killebrew, Tennessee: Its Agricultural and Mineral Wealth, p. 178.

TABLE XIV

SIZE OF THE IRON PLANTATIONS IN THE WESTERN IRON DISTRICT

Furnace, Firm, or Ironmaster	Size of Landholdings (in Acres)	Approximate Date
Buffalo Iron Works	10,000	1828
Cumberland Iron Works	110,000[e]	1840
Dover furnace		
Bear Spring furnace		
Bellwood furnace		
M. Bell	10,000	1833
A. Vanleer (Cumberland furnace)	20,000[b]	1850
Elias W. Napier	15,300	1850
Wayne furnace	21,000	1865
Rough and Ready furnace	8,000[c]	1870's
Lagrange Iron Works	45,000	1870's
Lagrange furnace		
Clark furnace		
Eclipse furnace		
Peytona furnace	8,595	c. 1840's-50's
Great Western furnace	12,000	
Napier furnace	7,000[d]	1881
Aetna Iron Property	28,000	1880's
Brush Creek furnace	5,000[a]	c. 1820's
Aetna furnace	10,500[a]	1826
Buckner and Churchill	5,000[a]	1837-38
Airdrie furnace	17,000[a]	1850's

Sources: Phelps and Willet, pp. 311-313; Coleman, p. 235; McClain, pp. 23-24; Cappon, "History of the Southern Iron Industry," pp. 117, 119, and 124; Burchard, pp. 42, 50, and 77; Anonymous Author, "Furnaces and Forges," p. 190; Corlew, p. 234; Safford, 1869, p. 462; Purdue, p. 374; Killebrew, Tennessee: Its Agricultural and Mineral Wealth, pp. 178, 180, and 183; Killebrew, Iron and Coal, pp. 99, 128; Killebrew, Resources of Tennessee, pp. 929-931; Moore, "Report on Airdrie furnace," pp. 5-6; Killebrew, J. C. Warner, p. 54; Small Collections, "Cumberland Iron Works Papers 1842-1880," Tennessee State Library; "Peytona furnace Deed to Thomas Kirkman," no date, Tennessee State Library, Dr. Milton Henry Papers; Killebrew, Pamphlet Number 46, p. 11, Tennessee State Library, Killebrew.

[a]Furnaces in the outlying areas of the Western Iron District (in Green, Hart, and Muhlenberg counties).

[b]Corlew indicates Vanleer owned 12,500 acres in 1850. Another source states that the furnace had 16,000 acres.

[c]Killebrew stated the furnace property was 16,000 acres.

[d]Napier furnace may have succeeded Buffalo Iron Works.

[e]Woods, Yeatman and Co., the firm was formerly known as Dover Iron Works.

The dwellings and outbuildings in the community were clustered or semiclustered about the furnace, and they generally included the ironmaster's house, family dwellings, slave cabins, boarding house, company store, church, school, smokehouses, sheds, stock barns, and other buildings housing the various economic components.[55]

Economic Components and Functions of the Furnace Community

The furnace community was often located in an isolated, rural area, and it served as a central place for the surrounding population. The general store was stocked with foodstuffs, shoes, clothing, tobacco, hardware, and other goods, and an active business was conducted with those living in the community and its vicinity. The workmen made purchases on credit in exchange for their labor, and little cash was involved except when accounts were periodically settled. The ironmaster also transacted other business on a debit-credit system, enabling him to operate with limited capital, a hallmark of many successful furnaces.

Other enterprises commonly operated in conjunction with the furnace were grist mills, saw mills, secondary iron manufactures, and agriculture. Of these, secondary iron manufactures and agriculture, which required more time and labor, were the most profitable.

Agriculture and industry: the demand for provisions. The ironmasters' involvement in agriculture often contributed to the success

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[55] Tennessee Valley Authority, The Iron Industry in the Land between the Lakes, no date, p. 2; J. Winston Coleman, Jr., "Old Kentucky Iron Furnaces," Filson Club Historical Quarterly 31 (July, 1957), p. 235.

of the charcoal iron industry. The association of agriculture with iron making was a compatible arrangement in which the agricultural sector of the iron business produced all or part of the food to maintain the furnace community. The extent of involvement in agriculture varied among ironmasters, ranging from the ironmaster-planter to the pioneer industrialist.

The ironmaster-planter was actively engaged in agriculture. After timber for making charcoal was cut, the best arable land was put into cultivation to produce a good share of the community's provisions.[56] The ironmaster-planter also augmented the food supply through trade with the local farmers. This trade was often imperative when drought or other problems curtailed farm productivity.[57]

Cumberland Iron Works was apparently one of the most self-sufficient iron plantations. During the late 1830's about 100 farm hands were employed to produce and process the 300,000 pounds of pork, 7,000 barrels of corn, and 300 barrels of flour consumed annually by the furnace community.[58] In 1840 corn, hogs, hay, and other provisions, totaling 5,500 tons and valued at $350,000 were raised.[59] By 1861 the four furnace farms at Cumberland Iron Works produced 45,000 bushels of

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[56]Killebrew, Introduction to the Resources, pp. 924-25, 929.

[57]Letter, John Bell to H. C. Yeatman, November 3, 185(8), Tennessee State Library and Archives, Yeatman-Polk Collection; Burchard, p. 50; Killebrew, Introduction to the Resources, pp. 924, 929, 932.

[58]During the 1830's firm was known as Dover Iron Works. Troost, Fifth Geological Report, 1839, pp. 35-36.

[59]The date (1840) given here is an inference. Burchard, p. 50.

corn, 2,000 bushels of oats, 300 bushels of barley, 200 bushels of rye, and 1,000 tons of clover, timothy, and herd grass hay.[60] Potatoes, turnips, cabbage, and other vegetables sufficient to support about 3,000 people were also raised.

In contrast to the ironmaster-planter, other ironmasters were less involved in farming, although they often held large acreages of improved land and assigned a number of hands to agricultural chores. At midcentury 500 acres of Vanleer's furnace property was cleared land suitable for cultivation, and in 1860 the ironmaster owned 1,131 acres of improved land.[61] Vanleer used fourteen slaves in agriculture, while another ironmaster engaged ten prime field hands in farming.

In contrast, the pioneer industrialist was solely engaged in the iron business, depending upon farmers and planters to supply their provisions. The local farmer often was confronted with poor transportation, and he found that the furnace community was an excellent market for his surplus corn, pork, and other products.

Whether the furnace owner was an ironmaster-planter or pioneer industrialist, it is clear that the furnace communities created a substantial demand for provisions which fostered agricultural development. In 1852 the people in the communities of nineteen furnaces, nine forges, and two rolling mills in the Cumberland Valley consumed 1,460,000 pounds of pork and 35,000 barrels of corn (Table XV).

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[60]Killebrew, Tennessee: Its Agricultural and Mineral Wealth, pp. 178 and 180.

[61]Corlew, pp. 234-235.

TABLE XV

THE ANNUAL CONSUMPTION OF CORN AND PORK AT CUMBERLAND VALLEY IRONWORKS (ALONG WITH NUMBER EMPLOYED),[a] IN 1852

	Corn	Pork	Laborers		
	in Barrels	in Pounds	Total	White	Negro
Furnaces					
Hopewell	1,200	50,000	130	70	60
Crittenden	1,000	50,000	120	50	70
Sewanee	1,600	70,000	165	80	85
Mammoth	1,500	65,000	145	60	85
Fulton	1,200	50,000	120	50	70
Empire	1,500	60,000	135	60	75
Stacker	1,300	60,000	150	65	85
Peytona	1,500	60,000	135	60	75
Bellwood	1,500	60,000	130	50	85
Bear Spring	1,600	60,000	135	60	75
Rough and Ready	1,200	50,000	120	50	70
Ashland	1,000	60,000	130	80	50
Popular Spring	1,500	60,000	130	60	70
Yellow Creek	600	30,000	70	30	40
Phoenix	1,500	60,000	135	60	75
Louisa	1,500	60,000	130	50	80
Cumberland	1,500	60,000	130	40	90
Worley	800	40,000	80	30	50
Carroll	900	45,000	110	40	70
TOTAL	24,400	1,050,000	2,400	1,045	1,355
Rolling Mills					
Tennessee	1,200	60,000	125	50	75
Cumberland	1,000	50,000	105	40	65
Nine Forges	8,400	300,000	670	260	410
GRAND TOTALS	35,000	1,460,000	3,300	1,395	1,905[b]

Source: "Manufacture of Iron on the Cumberland River, Tennessee," Hunt's Merchants Magazine 28 (1853), pp. 644-645.

[a]The employees are those engaged in the manufacture of iron only.

[b]Hunt's data totaled 1,910 Negroes, but the column only tabulated to 1,905.

The laborers enumerated were those employed in the manufacture of pig iron, bar iron, and blooms, and no estimate is made for the hands needed to raise the corn and hogs. Moreover, the numerous draft animals (mules) in the Western Iron District required large quantities of fodder.

When iron making was a rural industry, the association of agriculture with iron making was a compatible arrangement with mutually beneficial effects. Labor was sent out each morning to perform agricultural and/or industrial tasks, and in the view of one 19th century observer, the ". . . business was organized and conducted with system and dispatch."[62] The laborers were assigned particular tasks but could conveniently be diverted to the industrial or agricultural sectors in order to maximize their use. In the postbellum period ironmasters abandoned the antebellum practice of combining agriculture with iron making, contributing to the decline in number of blast furnaces.[63]

Forward integration: the forge and rolling mill. The forge and/or rolling mill linked in a productive chain with the furnace was another compatible and renumerative component of the iron plantation. Some ironmasters found it advantageous to fabricate part of their own pig iron production, because of the local and regional demand for blooms

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[62]W. L. Cook, "Furnaces and Forges," Tennessee Historical Magazine 9 (October, 1925), p. 190.

[63]Some ironmasters made arrangements with tenants to cultivate furnace farms during the postbellum period. Killebrew, Tennessee: Its Agricultural and Mineral Wealth, pp. 180 and 187; Killebrew, Introduction to the Resources, p. 977; Killebrew, Iron and Coal, pp. 135-136; Burchard, p. 10.

and other ironware. These secondary manufactures enabled them to supply farmers, planters, craftsmen, merchants, and others with more valuable ironware, and the blooms were used by rolling mills.

It is estimated that one-fifth to one-third of the furnaces in the Western Iron District were linked to a forge or rolling mill.[64] In 1820 A. W. Vanleer, one of three ironmasters in Dickson County at the time, operated a furnace and two forges. The ironmaster cast 400 tons of pig iron, 200 tons of hollowware and castings, and 10 tons of machinery at the furnace, and his forges fabricated 293 tons of pig into bar iron, mill spindles, plow molds, and other products.[65]

In 1832 ten forges producing blooms and bar iron were attached to six furnaces in the Tennessee section of the Western Iron District.[66] However, as new furnaces were erected, the incidence of forward integration probably became less prevalent. Between 1832 and 1835 twenty-one furnaces were built, and only two were linked to a forge and/or rolling mill and nailery. Nonetheless, throughout the rest of the antebellum period, a number of forges and two rolling mills were operated by furnace owners.[67]

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[64]The integrated firms were owned by some of the most successful ironmasters, including the Vanleers, Hillmans, Napiers, Stackers, R. Baxter, William Kelly, James Bell, Mr. Woods, and others.

[65]United States Bureau of the Census, unpublished census manuscripts, "Census of Manufactures," 1820.

[66]Troost, Third Geological Report, p. 28.

[67]Burchard, p. 8.

Population and Labor

The furnace communities with the largest populations were those forward integrated firms whose furnace, forge, and/or rolling mill were situated in the same locality. In the 1830's the largest furnace community was Cumberland Iron Works, which had an estimated population of 600 to 1,000 people.[68] By 1861 the population of this community had increased to approximately 3,000 people.[69] Another large settlement was at the Hillman brothers' ironworks, where an estimated 800 to 1,000 people were clustered in the vicinity of Tennessee rolling mill, Tennessee forge, and Empire, Fulton, and Center furnaces.[70]

These examples were larger than the typical furnace community, which had a population of between 200 and 500 people. In 1850, with twenty-nine furnaces operating, the aggregate population dependent on the industry was between 6,000 and 14,000 people.[71] When 40 to 50 furnaces were in blast during the period of peak iron production, it is estimated that 8,000 to 20,000 people resided in the furnace communities of the Western Iron District.[72]

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[68]Troost, Fifth Geological Report, p. 36.

[69]Killebrew, Tennessee: Its Agricultural and Mineral Wealth, pp. 178 and 180.

[70]Lesley, pp. 129-130, 214, and 259; "Manufacture of Iron on the Cumberland River, Tennessee," Hunt's Merchants' Magazine and Commercial Review 28 (1853), pp. 644-645.

[71]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850.

[72]A. W. Putnum, "Iron Works of Tennessee," DeBow's Review 17 (July-December, 1854), pp. 407-408.

Direct Employment by the Furnace

The furnaces, forges, and rolling mills were among the largest employers in the Western Iron District, but the number directly employed was smaller than the community population implies. Through the 1830's the typical furnace employed an estimated 40 to 80 workmen. By midcentury the furnaces in the district had an average of 91 employees, and during the 1850's between 90 and 126 workmen were needed to operate the furnace and gather, process, and haul raw materials (Table XVI).[73]

Over half of the workmen were usually engaged in producing, processing, and hauling the raw materials to the furnace. After a sufficient stockpile of raw materials were accumulated, the blast was begun, and the balance of hands were needed to keep the furnace in operation (Table XVII).

The Predominance of Slave Labor

Negroes were clearly the dominant ethnic group at the furnaces, forges, and rolling mills in the Western Iron District; however, ironmasters also employed Chinese, Scotch, Irish, and German laborers. William Kelly, an abolitionist, was one of the first industrialists in the nation to introduce Chinese labor.[74] The Chinese laborers proved

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[73]It is estimated that women and children comprised between 5% and 10% of the labor force in the district, although higher percentages were engaged at selected furnaces. Letter, James Woods to John Bell, Nashville, no date given, Tennessee State Library and Archives, Dr. Milton Henry Papers.

[74]Kelly was also the innovator who invented the air-boiling process (the Bessemer process). Fritz Redlich, History of American Business Leaders (Ann Arbor, Michigan: Edward Brothers, Inc., 1940), p. 94.

TABLE XVI

NUMBER EMPLOYED AT BLAST FURNACES
IN THE WESTERN IRON DISTRICT

Date	Number of Establishments	Employment				Average per Furnace
		Total	Male	Female	Children	Negroes	
1820	3[a]	229	193	17	19	n.d.	76
1850	29	2,645	2,509	137	none	n.d.	91
1852	19[a]	2,400				1,355	126
1860	14	1,219	1,119	100	none	n.d.	87
1870	10	1,040	945	20	75		104

Sources: U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860, 1870; published census 1860 and 1870; Hunt's Merchants Magazine 28 (1853), pp. 644-645.

[a]The number of blast furnaces given in 1820 and 1852 is less than the total operating in the district.

TABLE XVII

DISTRIBUTION OF THE LABOR FORCE
AT AETNA FURNACE, 1839

Occupations	Number Employed	Percentage of Employment by Category
"Coaling"		33%
Master Collier	1	
Assistant Colliers	10	
Wood Haulers	2	
Ore (Miners)	6	15%
Furnace Hands		42%
Upper Furnace	8	
Lower Furnace	9	
Teamsters	4	10%
TOTAL	40	100%

Source: Troost, Fifth Geological Report, pp. 42-43.

so satisfactory at his ironworks near Eddyville, Kentucky, that Kelly made unsuccessful plans to import fifty more.[75] Another application of immigrant labor was given a trial at Airdrie furnace in outlying Muhlenberg County when Robert Alexander began his iron business with the exclusive employment of Scotchmen.[76] At Ashland and Antonio furnaces in Stewart and Montgomery counties the miners and teamsters were Irish and German, the slaves being employed at other tasks.[77]

The number of slave ironworkers. At other furnaces in the Western Iron District, however, slaves also mined and hauled iron ore.[78] Slaves were, in fact, employed in every facet of the industry, though most were unskilled laborers engaged in gathering and hauling raw materials.[79] Some ironmasters developed the skills of their bondsmen, teaching them how to operate every facet of the furnace and forge with little assistance from white supervisors.[80]

The development of the iron industry brought the first influx of slaves into Dickson County,[81] as the manufacture of iron became heavily dependent upon slave labor. About twelve new furnaces were built and others rebuilt between 1852 and 1856, and Professor Dew estimates that

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[75]Cappon, unpublished manuscript, p. 121.

[76]The ironmaster attempted to operate the furnace after the Scotch pattern, and the furnace failed (mismanagement) because the raw materials here required different techniques of processing. Coleman, p. 238; Miller, pp. 317-318; Lesley, p. 127; Moore, pp. 24-25.

[77]Lesley, p. 605.

[78]Lesley, p. 605.

[79]Cook, p. 191; Corlew, p. 246.

[80]Corlew, pp. 229 and 246.

[81]Corlew, pp. 226-227.

these developments increased the number of slaves in the district to about 3,000.[82] Starobin estimated that 10,000 bondsmen were employed at southern ironworks, and if his estimates are correct, the Western Iron District employed nearly one-third of the South's slave ironworkers.[83] Slaves outnumbered white employees at every furnace in the Cumberland Valley except Hopewell, Ashland, and Antonio, where the unusual policy of employing Irish and German miners and teamsters led to a majority of white laborers.[84]

Slave labor was essential to the success of iron making in the district, and failure to assemble an adequate work force meant that the furnace would either remain idle or operate at a reduced capacity. Hillman, Vanleer and Company tried to establish the iron business in Humphreys County, Tennessee, but they had to dissolve their partnership because they were unable to secure enough workmen from the small number of slaves and sparse population in the county. Hillman later moved to Lyon and Trigg counties, Kentucky, where he purchased slaves from the profits earned in the iron business. Slave ownership gave the ironmaster greater control, assuring him of a dependable labor force at a relatively fixed cost.[85]

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[82]Charles B. Dew, "Black Ironworkers and the Slave Insurrection Panic of 1856," The Journal of Southern History 41 (August, 1975), p. 325; Lesley, pp. 128-137 and 215.

[83]Robert S. Starobin, Industrial Slavery in the Old South (London, Oxford, and New York: Oxford University Press, 1970), p. 15.

[84]Lesley, p. 605.

[85]Killebrew, "Sketch of Daniel Hillman," p. 5; Temin, pp. 91 and 112; Starobin, p. 183.

Slave ownership and slave hiring practices. The ironmasters were among the largest slave owners in the Western Iron District. During the 1820's and 1830's eight ironmasters in Dickson County, including the Napiers, Montgomery Bell, and A. W. Vanleer, owned more than twenty-five slaves each. In 1820 ironmasters owned about one-fifth of the county's slave population, but by 1840 they held one-fourth of the bondsmen.[86]

Other ironmasters in the district, such as the proprietors of Cumberland Iron Works, James Bell, and Daniel Hillman, also owned a large number of slaves.[87] During the early 1840's the proprietors of Cumberland Iron Works owned 350 bondsmen, and by 1852, 365 Negroes were living in the furnace community.[88] The largest slave owner among the ironmasters in the Kentucky section of the district was apparently Daniel Hillman, who owned 250 to 300 bondsmen.[89]

To augment their labor force, ironmasters hired additional slaves from farmers and slave owners in the Western Iron District and its vicinity.[90] Beginning in late December the ironmaster or his agent would visit slave owners in order to hire enough bondsmen for the coming season. Because of the skill required in iron making, the slaves hired

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[86]Corlew, p. 235.

[87]Corlew, pp. 229, 357-359; McClain, pp. 24 and 27; Starobin, p. 15; Killebrew, Tennessee: Its Agricultural and Mineral Wealth, p. 180; Killebrew, "Sketch of Daniel Hillman," p. 5.

[88]Burchard, p. 50; Letter, James Woods to John Bell, September 4, 1852, Tennessee State Library and Archives, Dr. Milton Henry Papers.

[89]Killebrew, "Sketch of Daniel Hillman," p. 5; Lesley, p. 121.

[90]Troost, Fifth Geological Report, p. 36; Corlew, p. 227; Lesley, p. 606.

to work at furnaces evidently brought higher prices than those hired for agricultural work.[91] The usual hiring price for slaves was $80 to $100, but the cost of hiring bondsmen in the iron business ranged from $100 to $200, depending upon their experience and training.[92]

The terms of the hiring contract usually stipulated that the ironmaster would provide the slave with the customary provisions, two or three suits of clothes, hat, three pairs of shoes, blanket, and an overcoat for teamsters.[93] A physician was hired by the year to provide health care for the slaves, which protected the ironmaster's interest since he paid the hiring price regardless of illness or death.[94]

The customary food ration for slave ironworkers in the Western Iron District was greater than that in the rest of the South. While the usual meat ration in the South was only 2 to 5 pounds a week, slaves in the Western Iron District were given 7 to 9 pounds of bacon and pork, a peck of meal, and a quantity of molasses.[95] To supplement their diet, slave ironworkers would occasionally barter part of their food to local whites in exchange for melons, eggs, and other commodities.

The slaves who were owned by the ironmasters were given the same food ration, clothing allowance, and overwork pay as those who were

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[91]Corlew, p. 247.

[92]Cook, p. 191; Corlew, pp. 246-248; "Louisa Furnace Daybook," Volume 1, December 24, 1853 entry, University of North Carolina, Southern Historical Collection, Louisa Furnace.

[93]Cook, p. 191; Corlew, p. 247; Lesley, p. 606.

[94]Corlew, pp. 246-247.

[95]Sam Bowers Hilliard, Hog Meat and Hoecake Food Supply in the Old South, 1840-1860 (Carbondale and Edwardsville: Southern Illinois University Press, 1972), p. 56; Cook, p. 191; Corlew, p. 247; Starobin, p. 52.

hired.[96] The overwork system was similar to that of the Virginia District. If a slave worked on Sundays, holidays, or beyond the normal workday, he earned money or credit at the store. The slave made purchases of tobacco, flour, knives, clothes, and other goods with the money earned through overtime, and little cash was exchanged except when accounts were settled.[97]

The overwork system was also reportedly used as a disciplinary tool, with ironmasters subtracting money from a slave's account for breaches of discipline. Such practices led Starobin to conclude that the overwork system was a subtle way to control and discipline the slave,[98] even though as documented in the previous chapter, overwork was probably mandatory either to expand production or to keep some furnaces in blast.

The effect of the 1856 insurrection panic. The most serious breach of discipline in the Western Iron District was the insurrection of 1856.[99] The first report of large-scale unrest occurred in Texas in September 1856, but it was late November or early December when the supposed conspiracy broke out along the Cumberland Valley in the Western Iron District.[100] The alleged plan involved conquering the whites in

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[96]If a slave failed to use his clothing allowance, he received its value in cash or trade. Cook, p. 191.

[97]Starobin, p. 100; "Louisa Furnace Account Book, Negro Volumes 1 and 2," University of North Carolina, Southern Historical Collection, Louisa furnace.

[98]Starobin, pp. 95, 102, 104, and 115.

[99]Starobin, p. 89; Corlew, p. 360.

[100]Dew, "Black Ironworker," pp. 322 and 324.

the area and fleeing north. Montgomery and Stewart counties were among the most terror-stricken areas of the South, and a number of slaves were severely disciplined and some executed.[101] After careful evaluation of newspaper accounts of the insurrection, one scholar concluded that white hysteria rather than a black plot lay at the bottom of the bloody panic.[102]

Whatever its origins, the panic caused serious financial losses for furnace owners and operators, as twenty-five furnaces were forced to suspend operation.[103] Two writers concluded that the panic had a lasting impact and was the cause of the closing of Great Western, Iron Mountain, and Eclipse furnaces.[104] Great Western and Iron Mountain, however, had been idle since 1855, so their closing must be attributed to other causes.[105]

It is doubtful that the demise of production in the Tennessee section of the district can be attributed to the insurrection, because the trend of decline had been established before the panic. Production in the Kentucky section actually increased during the panic, which strongly suggests that it had little or no effect. (See Table XI, page 139.) The panic took place when furnaces were ending the 1856 blast or preparing for the 1857 season, which minimized its impact; and

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[101] Starobin, pp. 89-80; Corlew, pp. 360-362.

[102] Dew, "Black Ironworker," pp. 322, 327, 330, 332-333, and 338.

[103] Dew, "Black Ironworker," p. 321; Corlew, p. 362.

[104] McClain, pp. 25-26; Burchard, p. 39.

[105] Lesley, pp. 130-131.

the furnaces affected were back in operation during the 1857 season.[106] This leads to the conclusion that the primary cause of the decline during the late 1850's was competition in the iron trade.

The Pattern of Iron Trade

While secondary manufactures supplied an important local market, the Western Iron District was important in supplying other markets as well. The principal trade areas for the district were: (1) the Western Iron District and its vicinity, (2) the Lower South, and (3) the Ohio Valley and Midwest.

The Local Trade Area: The Western Iron District and Vicinity

During the early years of settlement, Mr. Robertson recognized the need for ironware and in the 1790's built Cumberland furnace to supply the early settlers.[107] Between the 1790's and 1830's other furnaces were built, and the ironmasters cast a large share of their metal into pots, kettles, and other castings to outfit the farmers, planters, and other settlers. The balance of the molten metal was cast into pig iron, part of which was fabricated by the secondary manufactures in the local trade area. Between 1832 and 1835 production increased more rapidly than the local market, and an increasing proportion of the district's pig iron was marketed outside the district.[108]

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[106] Lesley, pp. 131-135 and 215.

[107] Killebrew, "The Western Iron Belt," p. 5.

[108] Troost, Third Geological Report, pp. 28-29.

About half of the Louisa furnace's trade was transacted in the local market, particularly in Nashville, during the 1831 and 1832 season.[109] Since the secondary manufacturers in the local trade area were using an estimated 7,900 tons, or 49%, of the district's production in 1840, many furnaces in the Western Iron District were probably selling about half of their iron in the local trade area. The local market continued to grow slowly but took a declining portion of the district's production, and in 1850 the secondary manufacturers in the district fabricated an estimated 16,675 tons, or 41%, of the pig iron production. During the 1850's there was an absolute decline in local consumption, and by 1860 the local market consumed only 4,320 tons, or 16%, of the district's pig iron (Table XVIII).

The forge market. The forges in the district were the principal local market for pig iron. In 1820 the forges in Dickson and Montgomery counties fabricated over one-third of the Dickson County pig iron production.[110] By 1832 ten forges were the primary market for six furnaces in the Tennessee section of the district.[111]

These forges hammered the pig iron into blooms, bar iron, plow molds, mill spindles, and other ironware, though blooms were the

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[109]"Louisa Furnace Account Books," Volume 1, University of North Carolina, Southern Historical Collection, Louisa furnace; Lesley, p. 134, 215-216.

[110]United States Bureau of the Census, unpublished census manuscripts, "Census of Manufactures," 1820.

[111]Troost, Third Geological Report, p. 28.

TABLE XVIII

THE PRODUCTION AND CONSUMPTION OF PIG IRON AND BLOOMS IN THE WESTERN IRON DISTRICT, 1840-1870 (IN TONS)

	Pig Iron					Bloom Iron	
	Production	Estimated Consumption		Surplus for Other Markets		Production	Estimated Consumption
Year	Tons	Tons	%	Tons	%	Tons	Tons
1840	16,250	7,900	49	8,350	51	5,269	2,150
1850	40,636	16,675	41	23,961	59	9,807	2,500
1852[a]	30,600[a]	15,900	52	14,700	48	10,600	5,600
1854[b]	48,000[b]	15,000	31	33,000	69	2,000	-
1854[c]	37,183[c]	10,300	28	26,883	72	6,808	-
1856/57	47,064	15,675	33	31,389	67	10,442	-
1860	26,640	4,320	16	22,320	84	2,588	6,256
1870	18,866	6,020	32	12,846	68	1,214	1,054

Sources: Hunt's Merchants Magazine 28 (1853), pp. 644-645; DeBow's Review 17 (July-Dec., 1854), p. 407; U.S. Bureau of the Census, published and unpublished census manuscripts; Safford, A Geological Reconnaissance, pp. 51-56.

[a]Does not represent the entire district, only the Cumberland Valley.

[b]It is assumed these data represent the entire district.

[c]These data are only for the Tennessee counties of the district.

dominant item produced.[112] In 1850 the forges in the district fabricated 15,360 tons of the district's pig iron into 9,807 tons of blooms, making the Western Iron District the leader among the southern districts in bloom iron production. By 1854 the thirteen forges in the Tennessee counties of the district manufactured 6,808 tons of blooms, which accounted for 93% of the state's production. After 1856 there was a decline in the district's bloom iron production because of competition in the Ohio Valley trade and because rolling mills increasingly used pig iron in place of blooms. As a result, two forges in the Western Iron District only manufactured 2,588 tons of blooms in 1860 (Table XVIII).

The rolling mill market. Cumberland and Tennessee rolling mills were the primary local market for the district's bloom iron production. Cumberland rolling mill was erected in 1829 on the left bank of the Cumberland River, and Tennessee rolling mill was located on the right bank of the river about ten miles above Eddyville, Kentucky.[113] Until the mid-1850's it is estimated that these rolling mills fabricated between one-fourth and one-half of the district's blooms into bar iron, boiler plate, plow plate, nails, sheet, and other ironware (Table XIX).

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[112]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850; Lesley, pp. 214-216; Killebrew, Tennessee: Its Agricultural and Mineral Wealth, p. 183; Safford, A Geological Reconnaissance, p. 54.

[113]Another rolling mill on the periphery of the district was Southern Iron Works in Paducah, Kentucky, which produced 1,576 tons of bar iron, sheet, and nails in 1857; the rolling mill was apparently idle in 1860. Lesley, pp. 258-259; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1860.

TABLE XIX

IRON PRODUCTION OF CUMBERLAND IRON WORKS, 1839-1860
AND TENNESSEE IRON WORKS, 1850-1860
(IN TONS)

	Pig Iron		Bloom Iron		Bar, Sheet, Etc.	
Year	Cumberland	Tenn.	Cumberland	Tenn.	Cumberland	Tenn.
1839	3,000	-	550	-	2,000[d]	
1850	3,200	3,200[b]	700	-	2,100	2,500
1852	3,200	3,300[b]	1,500	2,500	2,200	2,500
1854	3,242	-	2,069	-	2,224	-
1856	-	3,976[c]	-	3,384	2,530	3,351[e]
1860	4,453[a]	4,650	2,388	-	2,669	3,000

Sources: U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850 and 1860; Lesley, p. 259; Troost, Fifth Geological Report, pp. 34-36; Safford, A Geological Reconnaissance, pp. 52-53, 56; Hunt's Merchants Magazine 28 (1853), pp. 644-645.

[a]Of the 4,453 tons, 3,810 tons were pig iron and 733 tons were castings.

[b]Vanleer produced an additional 1,800 tons of pig iron (if he was still part of the firm, Hillman, Vanleer & Company).

[c]In 1856 Center and Empire furnaces made 2,140 and 1,826 tons, respectively; in 1857 Fulton furnace cast 1,044.

[d]The firm also produced 5,000 kegs of nails.

[e]These data are for 1857 instead of 1856.

The rolling mills in the district were linked in a productive chain with forges and furnaces, and the production and profits of these integrated firms were high. Throughout the antebellum period, the proprietors of Cumberland Iron Works were operating two furnaces, a forge, and a rolling mill. Between 1834 and 1839 the firm sold $1,950,000 worth of bar iron, nails, castings, and pig iron, and the profits from the sale of iron between 1835 and 1837 totaled nearly $400,000.[114] The firm continued to be one of the district's most successful ironworks, manufacturing nearly $2,000,000 worth of pig iron, bar iron, and blooms in 1854.[115]

The other rolling mill, part of Tennessee Iron Works, was operated by the Hillman family. In 1856 G. W. Hillman was the manager of Tennessee rolling mill and forge, and Daniel Hillman was the owner and manager of Fulton, Center, and Empire furnaces.[116] During the latter 1850's the Hillmans annually manufactured about 4,000 tons of pig iron, 3,384 tons of blooms, and 3,351 tons of sheet, plate, and bar iron (Table XIX). In 1860 the pig and bar iron made by the Hillman brothers was valued at $452,250, and between 1855 and 1862 the firm reportedly earned a net profit of $1,300,000.[117]

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[114]Troost, Fifth Geological Report, p. 36; Cappon, unpublished manuscript, p. 125; Lesley, pp. 132-133.

[115]Safford, A Geological Reconnaissance, p. 56.

[116]Lesley, pp. 129-130, 214, and 259.

[117]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1860; Ethel Armes, The Story of Coal and Iron in Alabama (Birmingham: The Book-Keepers Press, 1972), p. 210.

The majority of the ironware made at Cumberland and Tennessee rolling mills was either sold in the local market or the Lower South trade area.[118] During the 1830's Cumberland Iron Works made inroads in the Nashville market, where nails, chains, shovels, castings, and other iron products were in great demand.[119] Moreover, other ironmasters, including Woods, Stacker and Company, the Vanleers, Baxters, Hillmans, and Hicks, Ewing and Company, carried on an active trade through agents and stores in Nashville.[120] In 1854 Cumberland rolling mill sold 1,223 tons, or 55%, of its production either in Nashville (800 tons) or at the rolling mill, with the balance shipped to the Lower South.[121]

The Lower South Market

Cumberland rolling mill shipped 1,000 tons, or 45%, of its production to marketplaces in the Lower South such as Memphis, Vicksburg, and New Orleans, and presumably Tennessee rolling mill shipped ironware to the Lower South as well.[122] The iron trade with the

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[118]Safford, A Geological Reconnaissance, p. 56; Safford, Geology of Tennessee, pp. 468-469; Armes, p. 286.

[119]McClain, p. 23.

[120]Secondary iron manufacturers in Nashville also gave ironmasters another local market for pig iron. In 1850 two foundries and other firms used over 1,000 tons of pig iron in the manufacture of castings, plows, corn shellers, and other agricultural implements. Lester J. Cappon, "Trend of the Southern Iron Industry under the Plantation System," Journal of Economic and Business History 2 (1929-1930), pp. 360 and 370; Clement Eaton, The Growth of Southern Civilization, 1790-1860 (New York: Harper and Row, 1961), p. 233; Cappon, unpublished manuscript, pp. 129-130.

[121]Safford, A Geological Reconnaissance, p. 56; Safford, Geology of Tennessee, pp. 468-469.

[122]Armes, p. 286; Safford, A Geological Reconnaissance, p. 56; Safford, Geology of Tennessee, pp. 468-469.

Lower South was dominated by secondary manufactures, including bar iron, sugar kettles, and other castings, which were purchased by the planter, farmer, and artisan.[123]

Sugar kettles cast by a few ironmasters in the Western Iron District became an important item in the Lower South trade. Sugar planters had originally purchased kettles from Scotland because it was the general impression they were the only ones which could withstand the expansion and contraction during the boiling season.[124] However, the Stacker brothers of Lafayette furnace in Montgomery County, Tennessee, began making sugar kettles for the Louisiana market in 1825, and sugar kettles from the Western Iron District soon made inroads into the market formerly held by Scottish and Pennsylvania firms.[125] Other firms in the Western Iron District such as Woods, Yeatman and Company, Kelly and Company, and Erwin Lewis and Company also supplied superior brands of sugar kettles to Louisiana and Mississippi cane plantations.[126]

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[123]"Sketches," Tennessee State Library and Archives, Montgomery Bell Papers, pp. 37-38; McClain, p. 22; Burchard, p. 8; Corlew, pp. 227-228; Purdue, p. 373; Cappon, unpublished manuscript, pp. 36, 107C and 122; Lesley, p. 129.

[124]Cappon, unpublished manuscript, p. 124; J. B. Killebrew, "Address delivered before Montgomery Farmers' Club, White Chapel, Tennessee, March 12, 1870, pp. 19-20, Tennessee State Library and Archives, Killebrew Papers; Newspaper Article, May 18, 1932, Tennessee State Library and Archives, M. Bell Papers.

[125]Killebrew, The Western Iron Belt, p. 5; J. B. Killebrew, Montgomery County, Its Agricultural and Mineral Wealth (Clarksville: Ingrum and Doak, Leaf Printing Office, 1870 or 1871), p. 20.

[126]Troost, Eighth Geological Report, p. 16; Cappon, unpublished manuscript, p. 129; "Manufacture of Iron on Cumberland River, Tennessee," Hunt's Merchants' Magazine and Commercial Review 28 (1853), p. 644; Killebrew, Montgomery County, Its . . ., p. 20; Killebrew, Tennessee:

The sale of sugar kettles netted these ironmasters a good profit. In 1850 a minimum of 1,800 tons of kettles were sold for $108,000, which was nearly three times the value of pig iron.[127] By 1854 about 3,000 tons of crude metal were cast into sugar kettles valued at $200,000.[128]

Historians have concluded that one of the fundamental economic problems of the South was that planters were content to import the manufactured goods they needed.[129] Blast furnace capacity in the Southern Iron Region was adequate to meet the demand, but there was a lag in the large scale development of rolling mills, foundry, and machine shops to convert southern pig iron into finished ironware and machinery. There was a relatively small foundry and rolling mill development in the South, but on the eve of secession southern ironmongers were still complaining about the Southern habit of purchasing machinery and implements in the North, even though a better article at a lower price could be made at home.[130]

Its Agricultural and Mineral Wealth, p. 138; The Nashville Banner, Wednesday, May 18, 1932 in Tennessee State Library and Archives, Montgomery Bell Papers.

[127]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850; "Manufacture of Iron on Cumberland River, Tennessee," Hunt's Merchants' Magazine 28 (1853), p. 644.

[128]Putnam, p. 407.

[129]Cappon, "Trends of the Southern Iron Industry," pp. 361-362; H. H. Chapman, The Iron and Steel Industry of the South (Birmingham: University of Alabama Press, 1953), p. 101.

[130]Cappon, "Trends of the Southern Iron Industry," pp. 363 and 370; Cappon, unpublished manuscript, pp. 130-131; A. P. Foster, "History of Tennessee Industry," in Tennessee Industry Volume 1, Part 2 (March, 1931), p. 12.

It appears that the Lower South was primarily a market for secondary manufactures such as sugar kettles, castings, and bar iron. The seasonal demands of the planter provided only part of the trade for the district's ironmasters, and the progressive ironmaster, increasingly involved in making pig iron and blooms, established trade with the foundries and rolling mills in the Ohio Valley and Midwest.[131] As a result, the ironmasters in the Western Iron District were less bound by the industrial limitations of the southern agricultural regime and were able to expand the production of pig iron.

The Ohio Valley and Midwest Market

The Ohio Valley and Midwest became the principal trade area for the Western Iron District's surplus pig iron and blooms. The rapid expansion of population after 1815 and the growth of commercial- industrial centers to service the expanding agrarian economy resulted in the large consumer demand for ironware.[132] The rural ironmaster prospered as the effect of this growing market was felt in every part of western industry.

The pig iron dealers of Cincinnati, Louisville, St. Louis, and other towns soon learned where a dependable supply of superior iron could be purchased, and by 1840 they were purchasing about half of the

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[131]Cappon, "Trend of the Southern Iron Industry," pp. 361 and 369.

[132]Alfred D. Chandler, Jr., "Anthracite Coal and the Beginnings of the Industrial Revolution in the United States," Business History Review 46 (Summer, 1972), p. 149; Arthur Lippincott, A History of Manufacturing in the Ohio Valley to the Year 1860 (New York: Knickerbocker Press, 1914), pp. 55 and 97.

district's pig iron.[133] At midcentury an estimated 23,961 tons, or 59%, of the district's pig metal was shipped to consumers in the Ohio and Mississippi valleys. The quantity shipped rose to 31,389 tons by 1857, and it is estimated that one-half to five-sixths of the district's pig iron was shipped outside of the local trade area during the 1850's. (See Table XVIII, page 182.)

The St. Louis, Missouri, area was an important market for the Western Iron District, and before 1853 the city received its entire supply of crude metal from furnaces in the Cumberland, Tennessee, and Ohio valleys.[134] During the 1831-32 season slightly over half the value of the Louisa furnace trade was directed toward Missouri and Illinois, with the majority of the transactions in St. Louis.[135] Almost two decades later (1848), the pattern of Louisa furnace trade was similar, but the trade area had been extended into northwestern Illinois, eastern Iowa, and southern Wisconsin.

The developing secondary manufactures in St. Louis created a demand for pig iron and blooms, and in 1856 they fabricated the crude metal into ironware worth $5,000,000.[136] By 1858 there were five rolling

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[133]Killebrew, J. C. Warner, pp. 39, 43-44; Killebrew, "Sketch of Daniel Hillman," p. 4; Killebrew, The Western Iron Belt, 1890, p. 5; Cappon, unpublished manuscript, p. 121; Killebrew, Tennessee: Its Agricultural and Mineral Wealth, p. 179; Killebrew, Iron and Coal, pp. 99, 113, and 117; Cappon, "Trend of the Southern Iron Industry," p. 361.

[134]Lippincott, p. 171.

[135]It is possible that the trade also involved forge products.

[136]Arthur B. Cozzens, "The Iron Industry of Missouri," The Missouri Historical Review 35 (July, 1941) and 36 (October, 1941), p. 511.

mills in the St. Louis area, and it is estimated that from one-seventh to one-fourth of the Western Iron District's pig metal was shipped to the St. Louis, Missouri, area.[137] The majority of iron shipped outside the Western Iron District, however, was sent to consumers in Cincinnati, Covington, Newport, Louisville, and other towns in the Ohio Valley and Midwest.[138]

The foundry and machine shops in these towns and cities fabricated the pig iron into stoves, machinery, and other castings, and the rolling mills used pig iron and blooms to manufacture bar iron, boiler plate, or sheet.[139] The boiler plate made from the district's blooms was especially famous in the manufacture of steamboat engines.[140] About one-half to three-fourths of the district's blooms were apparently shipped to the St. Louis and the Ohio Valley markets, with consumers in Cincinnati, Covington, and Newport particularly important.[141] However,

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[137]At least three or more furnaces in the district were shipping pig iron to St. Louis. Lesley, pp. 128-137.

[138]Other marketplaces for the district's iron were Paducah, Evansville, Madison, Portsmouth, Ironton, Wheeling, and Pittsburgh. Safford, 1856, pp. 55-56; Lesley, pp. 128-129 and 606; Cappon, unpublished manuscript, p. 121; Purdue, p. 374; Corlew, p. 227; Killebrew, J. C. Warner, p. 39; Louisa furnace, University of North Carolina, Southern Historical Collection, Louisa furnace; Louis C. Hunter, Economic History of the Ohio Valley (New York: Da Capo Press, 1973), p. 104.

[139]Lesley, pp. 253-260.

[140]Killebrew, "Sketch of Daniel Hillman," p. 4; Killebrew, The Western Iron Belt, p. 5; Cappon, unpublished manuscript, p. 121.

[141]Safford, A Geological Reconnaissance, pp. 55-56; Lesley, pp. 128-129 and 606; Cappon, unpublished manuscript, p. 121; "Louisa Furnace Daybook, Volume 1," University of North Carolina, Southern Historical Collection, Louisa Furnace.

a decline in the bloom iron trade in the latter 1850's caused a decline in pig iron consumption in the local trade area, hastening the demise of the Western Iron District.

The Demise of the Western Iron District

Lippincott noted that the decline in western iron prices between 1818 and 1830 suggests that ironmasters surrounded by great resources and protected by high freight charges were able to supply the demand without fear of domestic and foreign competition.[142] However, ironmasters in outlying Green and Hart counties, Kentucky, were more concerned about the threat of competition. In 1820 the supply of iron in the outlying area was about equal to the demand. When British and Swedish iron arrived by steamboat, a Green County forge operator complained that it reduced the demand and price of his iron. However, the ironmaster of Aetna furnace in Hart County thought that his interior location would keep the imported iron from effectively competing with him.[143]

In spite of the concerns about competition, production continued to increase. After 1832 iron production expanded rapidly, and in 1854 the Western Iron District reached its peak production of 49,419 tons. This was followed by a slow absolute decline which accelerated after 1857, and between 1857 and 1860 the district's production plummeted from 42,858 to 26,640 tons. (See Table XI, page 139.)

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[142]Lippincott, p. 97.

[143]United States Bureau of the Census, unpublished census manuscripts, "Census of Manufactures," 1820.

Unfortunately, the manuscript data are inadequate to conclusively document the cause of the demise. There is a possible correlation between the demise of the Western Iron District and the rise of production in the Hanging Rock and Missouri iron districts. The Western Iron District was undergoing a period of decline after 1854, while between 1854 and 1857 production was increasing by nearly 17,000 tons in the Hanging Rock District.[144] Furthermore, the charcoal iron production of the Missouri District increased by 4,676 tons between 1854 and 1856, and by the late 1850's the furnaces in Missouri possibly produced over 15,000 tons of pig iron.[145]

The trade areas of these iron districts overlapped in the Ohio Valley and Midwest, and the competition in trade during the 1850's apparently caused the decline in the Western Iron District's production. Ironmasters in the Missouri District began supplying the St. Louis market, which was once a primary market for the Western Iron District, and by 1853 the Missouri ironmasters were shipping pig iron and blooms to secondary manufacturers in the Ohio Valley.[146] The sale of Hanging Rock iron was also prevalent in the middle and lower Ohio Valley.

Some of the Western Iron District's pig and bloom iron was also shipped as far as Pittsburgh.[147] During the 1850's new competition in

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[144]Lesley, p. 753.

[145]Lesley, pp. 137-139, 750 and 753; Lippincott, p. 173.

[146]Cozzens, p. 50.

[147]Safford, A Geological Reconnaissance, pp. 55-56; Cappon, unpublished manuscript, p. 121; Lesley, pp. 128-129 and 606.

Pittsburgh developed, as iron made with anthracite and bituminous coal and coke entered the marketplace. This competition was a principal factor in the decline of the Hanging Rock District, possibly having a similar but less dramatic effect on the Western Iron District. If Hanging Rock ironmasters experienced competition in Pittsburgh, then iron from the Western Iron District was surely at a disadvantage because of the high cost of transportation. Another possible consequence of this competition was to force Hanging Rock ironmasters to intensify trade in the middle Ohio Valley and Midwest, thereby selling to the same consumers as the ironmasters in the Western Iron District.

In addition to the competition in the pig iron trade, other causes of the decline were: (1) the high cost of transportation from remote areas of the Western Iron District, (2) the decline in demand for pig iron in the local trade area, and (3) problems in supplying iron ore.

The high cost of transportation from more distant locations reduced the profit margin for furnaces in the Western Iron District. Killebrew claimed that the decrease in number of furnaces in the district between 1854 and 1874 was directly related to the lack of cheap transportation.[148] Many of the old charcoal furnaces were located at some

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[148]Safford, Geology of Tennessee, pp. 461-462; Safford, A Geological Reconnaissance, p. 50; Killebrew, "Sketch of Daniel Hillman," p. 5; Killebrew, Tennessee: Its Agricultural and Mineral Wealth, p. 136; Aubrey Starke, "The Indigenous Iron Industry of Illinois," Journal of Illinois State Historical Society 27 (April 1934-January 1935), p. 437; Cappon, unpublished manuscript, p. 118; Lippincott, p. 173; Coleman, p. 240; Burchard, pp. 76-77; Cozzens, p. 531; Killebrew, Iron and Coal, p. 135; Killebrew, Introduction to the Resources, pp. 755 and 797; Reese F. Rodgers, "The Iron Ore Deposits of Lewis County," Tennessee State Geological Survey, Resources of Tennessee 5 (July, 1915), p. 95.

distance from the river and railroad, and the cost of hauling pig metal over bad roads was too high for these furnaces to remain competitive.

Another cause of the district's demise was a decline in demand for pig iron in the local trade area, as forges made fewer blooms out of the district's pig iron. The bloom iron production in the Western Iron District plummeted after 1857, causing a decline in the consumption of pig iron in the local trade area.[149] The decline in bloom iron production was apparently caused by competition in the Ohio Valley trade, as had been the case with pig iron, although the trend of rolling mills (the principal consumer of blooms) using pig iron in place of blooms and the poor prospect of sales in the late 1850's were also important.[150]

Problems in supplying iron ore were another possible cause of the district's demise. Several furnaces failed during the 1850's because of problems in mining, exhaustion of conveniently located ore, and increasing distance to usable ore banks. Most of these firms failed because of depletion of ore in the vicinity of the furnace, as about four miles was considered the maximum range that ore could be profitably transported.

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[149] If bloom iron production had been maintained at the 1856 rate, pig iron production would still have experienced an absolute decline, thus suggesting that much of the decline was due to competition in the pig iron trade.

[150] Letter, John Bell to H. C. Yeatman, November 3, 1858, Tennessee State Library and Archives, Yeatman-Polk Collection; Louis C. Hunter, "Influence of the Market upon Technique in the Iron Industry in Western Pennsylvania up to 1860," Journal of Economics and Business History 1 (February, 1929), p. 247; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850 and 1860; Cozzens, p. 50.

The Tennessee counties of the Western Iron District were the first to experience a decline in production, but about 1857 the plight of the Kentucky section of the district was similar. J. P. Lesley recognized that while the industry was well established and ore deposits south of the Kentucky-Tennessee border were rich, the future of the industry was in the Midwest.[151] In August, 1858, only 15 of the 42 furnaces in the Tennessee counties were operating, and by 1860 the number dropped to only 12.[152] There were ten furnaces operating in the Kentucky counties during the mid-1850's, but by 1860 only two remained in operation.[153] Between 1854 and 1860 the Western Iron District's production plummeted from 49,419 to 26,640 tons, a trend which continued until the demise was nearly complete in 1880, when the furnaces only produced 7,536 tons.

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[151]Lesley, p. 754.

[152]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1860; Lesley, p. 754.

[153]Lesley, pp. 128-130; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1860.

CHAPTER V

THE HANGING ROCK IRON DISTRICT, 1818-1870's

The historical geography of the charcoal iron industry of southern Ohio and eastern Kentucky is largely that of the Hanging Rock District. In 1856 Ohio and Kentucky were ranked second and third in the nation in charcoal iron production, the Hanging Rock District accounting for the lion's share of this production.[1]

The district got its name from a shipping site near a sandstone bluff which protruded over the Ohio Valley, the pig iron shipped from the landing becoming favorably known as Hanging Rock iron. The district was elliptical in shape and encompassed 1,800 to 2,000 square miles in Greenup, Carter, Lawrence, and Boyd counties, Kentucky, and Lawrence, Scioto, Gallia, Jackson, Vinton, and Hocking counties, Ohio.[2] The

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[1]John Peter Lesley, The Iron Manufacturer's Guide to the Furnaces, Forges, and Rolling Mills of the United States (New York: J. Wiley, 1859), pp. 759-760.

[2]Wilbur Stout, "The Charcoal Iron Industry of the Hanging Rock Iron District--Its Influence on the Early Development of the Ohio Valley," Ohio Archaeological and Historical Quarterly 42 (January, 1933), pp. 73-73; Vernon David Keeler, "An Economic History of Jackson County Iron Industry," Ohio Archaeological and Historical Quarterly 42 (April, 1933), p. 139; H. R. Collins and D. K. Webb, Jr., "The Hanging Rock Iron Region," (Columbus, Ohio: The Ohio Historical Society Pamphlet, n.d.); T. M. Adams, "Sketch of the Hanging Rock Iron Region," University of Kentucky Archives, Seaton Papers; Gerald W. Cowell, "When Iron Was King in Ohio," The Columbus Dispatch Sunday Magazine, December 11, 1966, Cincinnati Historical Society; P. N. Moore, "Some Notes Upon the Iron Manufacture in the Kentucky Division of the Hanging Rock Iron District," Geological Survey of Kentucky (Frankfort: Yeoman Press, 1884), p. 3.

outlying areas of production discussed in this chapter include Adams County, Ohio, and Bath and Estill counties in east-central Kentucky (Figure 33).[3]

Although iron production in the Hanging Rock District completely overshadowed the output in these outliers, the iron industry had an earlier beginning in the outlying areas. The first furnace in Kentucky was erected in 1791 along Slate Creek in Bath County.[4] By 1806 another furnace had been constructed near the Red River in Estill County, about ten miles above its confluence with the Kentucky River.[5] In outlying Adams County, Ohio, a furnace was built along Brush Creek in 1811, but the ironmasters were attracted to the Ohio section of the Hanging Rock District by the discovery of ore and built Union furnace in Lawrence County, Ohio, in 1826.[6] The maiden furnace in the Hanging Rock District, however, was erected in 1818, when Argillite furnace was built in Greenup County, Kentucky.[7]

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[3]P. N. Moore, "Report on the Iron Ores and Iron Manufacture of the Kentucky Red River Iron Region," Geological Survey of Kentucky (Frankfort: Yeoman Press, 1884), p. 3.

[4]Willard Rouse Jillison, The Red River Iron Works, A Narrative Account of the Rise and Decline of a Basic Industry in Eastern Central Kentucky, 1787-1830 (Frankfort: Roberts Printing Company, 1964), p. 13.

[5]Jillison, pp. 7 and 13; Moore, "Report on the Red River Iron Region," p. 24; Lester J. Cappon, "History of the Southern Iron Industry to the Close of the Civil War," University of Virginia manuscript section, Cappon, p. 62.

[6]Stout, p. 74; Albert Lawson, The Iron Industries of Ironton and the Hanging Rock Iron Region of Ohio (Cincinnati: Block and Company, 1871), p. 4; Isaac Lippincott, A History of Manufactures in the Ohio Valley to the Year 1860 (New York: The Knickerbocker Press, 1914), pp. 99-100.

[7]Stout, p. 74.

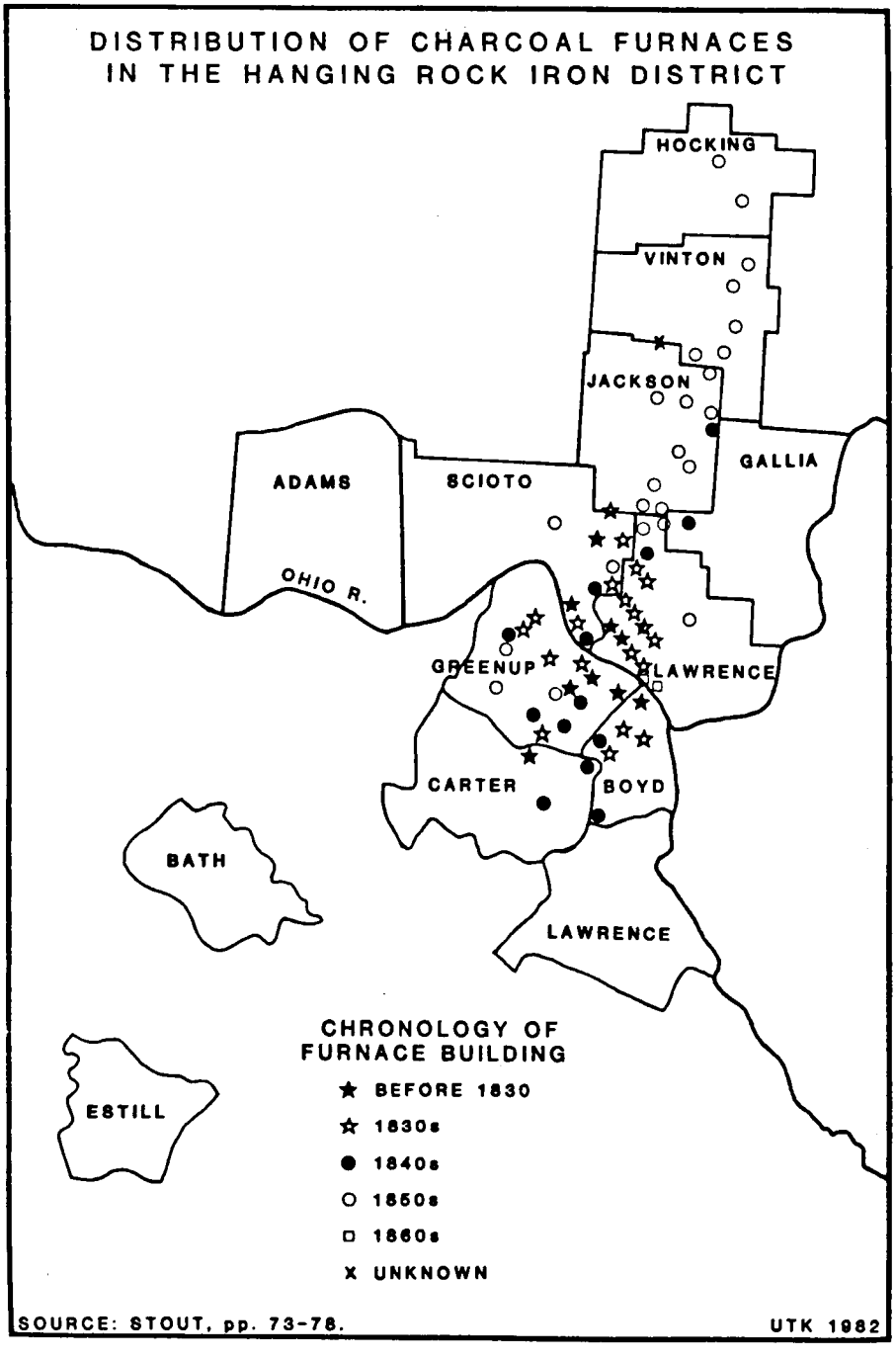

Figure 33. Distribution of Charcoal Furnaces in the Hanging Rock Iron District.

Iron Production in the Hanging Rock District

Charcoal iron was manufactured in the Hanging Rock District between 1818 and 1916, but the most dynamic period of production was before the Civil War.[8] In 1830 ten furnaces in the district produced an estimated 6,000 to 8,000 tons of pig iron. Between 1832 and 1834 fifteen furnaces were erected, and by the later 1830's twenty-five furnaces had an annual capacity of 37,500 tons, though actual production was probably closer to 20,000 tons.[9]

The capacity developed by the late 1830's was realized in 1840 when the furnaces in the district produced 37,355 tons (Table XX). Furnace construction was again active in the 1840's, and by midcentury production had increased to 56,491 tons. The 1850's were the most energetic period of furnace construction, particularly in the Ohio section of the district, and in 1856 furnaces in the Hanging Rock District produced 92,116 tons. The district accounted for 61% of southern iron production and ranked second in the nation to the anthracite district of eastern Pennsylvania (eastern Pennsylvania and Maryland).[10]

The rapidly increasing production during the 1850's reached a peak of 96,000 tons in 1857. An absolute decline followed, and in 1860 the furnaces in the district produced only 84,170 tons. By 1870 charcoal

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[8]Collins and Webb, no page.

[9]Stout, pp. 75-79; "Scrapbook 1857-63," University of Kentucky Archives, Means Family Papers.

[10]Lesley, p. 754.

TABLE XX

CHARCOAL PIG IRON PRODUCTION IN THE HANGING ROCK DISTRICT, 1840-1870
(IN TONS)

Year	Hanging Rock District	Percentage of Southern Production	Outlying Area of Production	Ohio Counties of the Hanging Rock District	Percentage of Ohio's Production	Kentucky Counties of the Hanging Rock District	Percentage of Kentucky's Production
1840	37,355	46%	2,300	23,799	68%	13,556	60%
1850	56,491	47%	1,600	42,446	81%	14,045	48%
1854	79,010	55%		56,081	83%	22,929	65%
1855	64,162	51%		47,982	83%	16,180	54%
1856	92,116	61%		70,455	81%	21,661	59%
1857	96,000	-	1,418	-	-	-	-
1860	84,170	64%	600	60,446	54%	23,724	71%
1870	103,816[a]	47%[a]	4,050[a]	85,081	28%	18,735[a]	38%

Sources: U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860, and 1870; U.S. Bureau of Census, published censuses 1840-1870; J. P. Lesley, pp. 748-754.

[a]The data for 1870 includes only charcoal iron production. The Hanging Rock District produced 126,896 tons, or 58%, of southern production; however, 21,200 and 1,880 tons of pig iron were made with mineral fuels in Ohio and Kentucky, respectively. Furthermore, two stone coal and coke furnaces in Kenton County, Kentucky, an outlier, produced an additional 19,500 tons.

iron production had risen again, this time to 103,816 tons; but despite the absolute increase, charcoal iron production of the district declined as a proportion of the nation's total production.

The Patterns and Changes in Iron Production, 1830's-1860

Before 1830 the district's production came from a small number of furnaces clustered near the Ohio River. During the 1830's furnaces in Greenup, Lawrence, and Scioto counties produced the majority of the district's iron, and in 1840 the pattern was dominated by the production in Lawrence and Greenup counties (Figure 34). Between 1840 and 1850 these counties experienced a small decline in production, but this was offset by an increase in Scioto County and the extension of the industry southward into Carter and Lawrence counties, Kentucky (Figures 35 and 36).

Rapid changes in the patterns were characteristic of the district in the 1850's (Figure 37). The anticipation of railroad construction encouraged ironmasters to erect furnaces in Jackson, Vinton, and Hocking counties, which greatly expanded the district's production. However, iron production in the older areas, including Lawrence and Scioto counties, Ohio, and Lawrence County, Kentucky, experienced a small decline.[11]

The increase in production between 1850 and 1860 is somewhat deceptive, because the production in 1860 was nearly 12,000 tons less

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[11]The decline in Lawrence County, Kentucky, may be due to a change in the county's boundary.

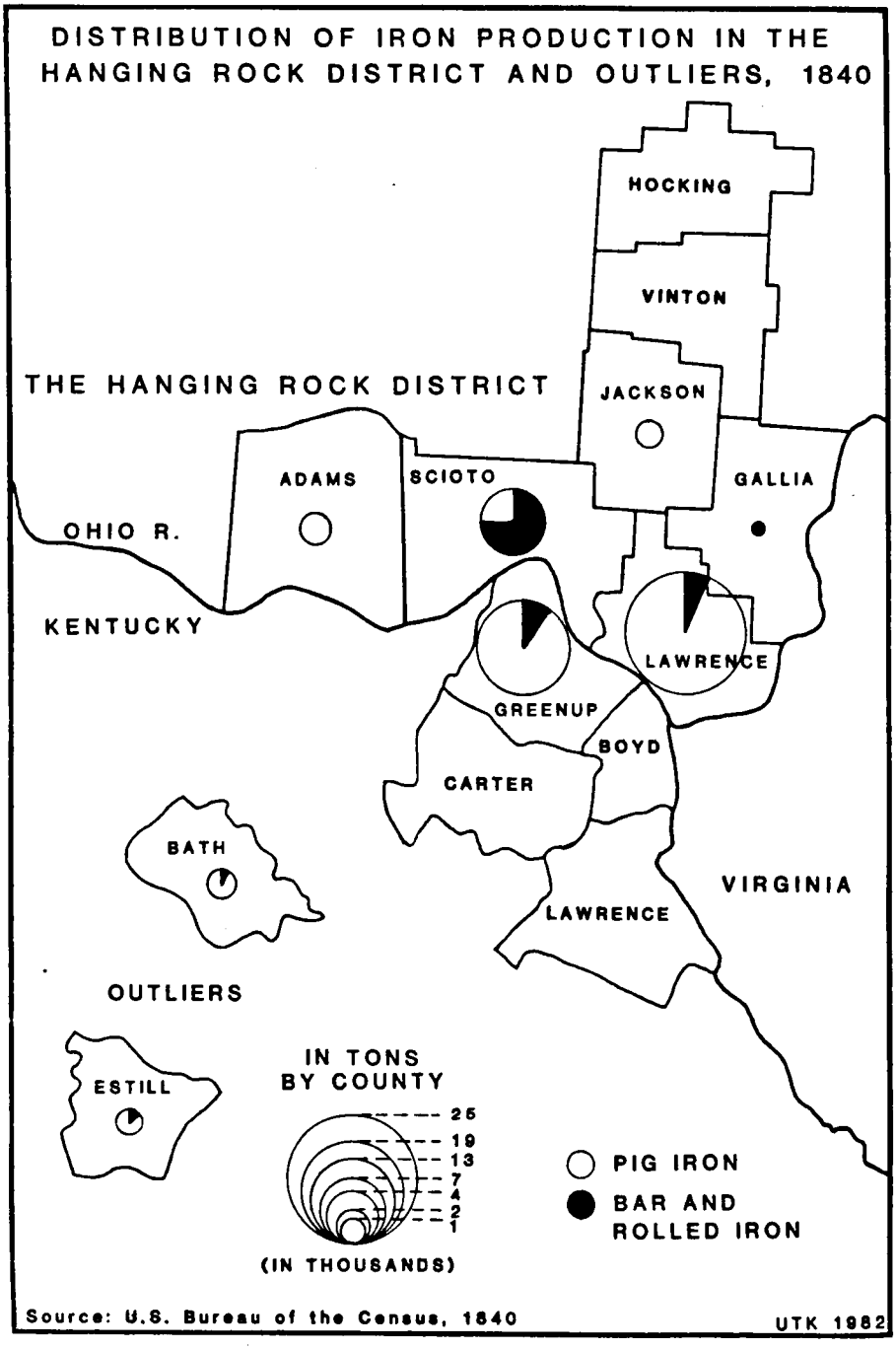

Figure 34. Distribution of Iron Production in the Hanging Rock District and Outliers, 1840.

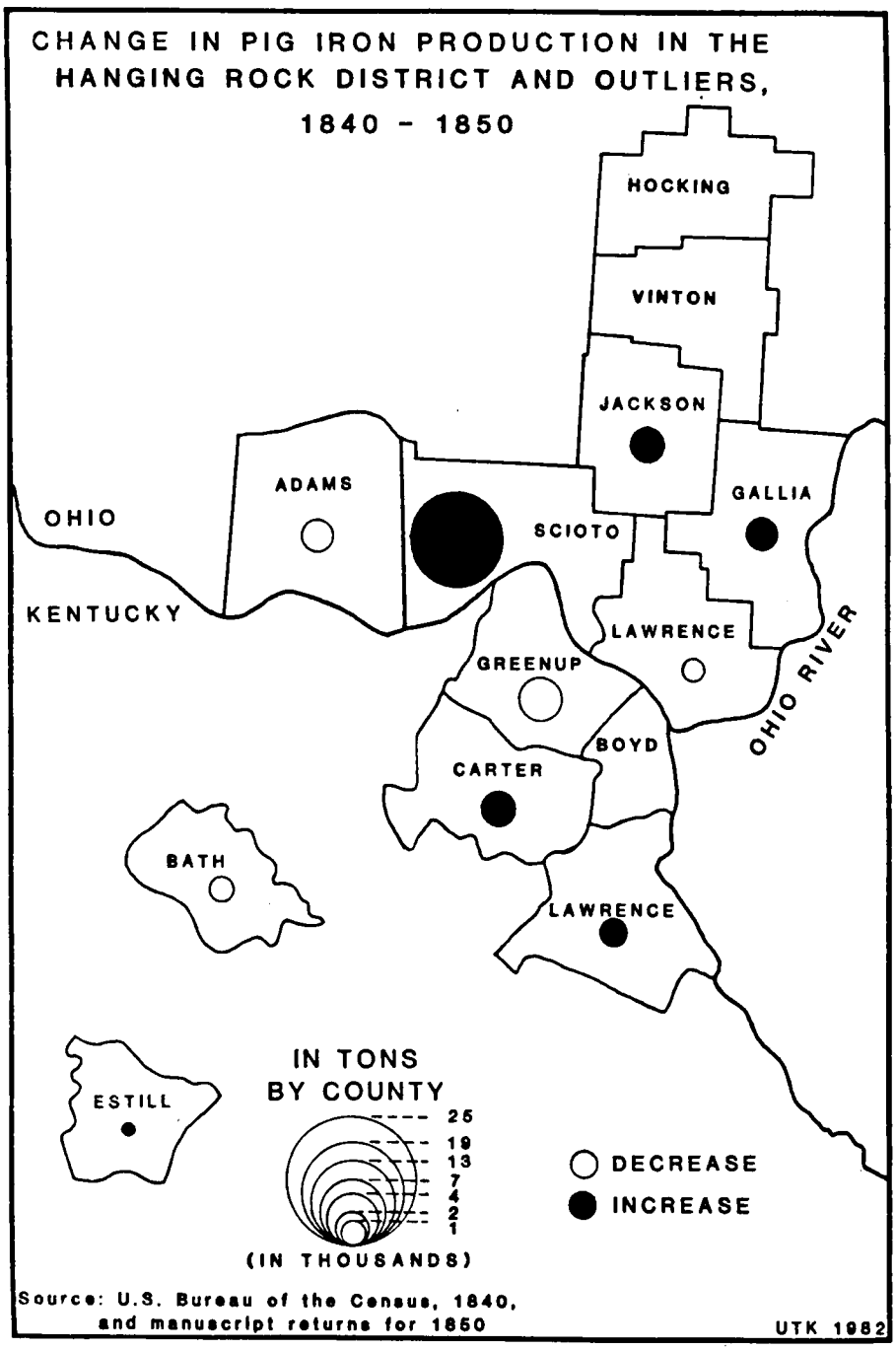

Figure 35. Change in Pig Iron Production in the Hanging Rock District and Outliers, 1840-1850.

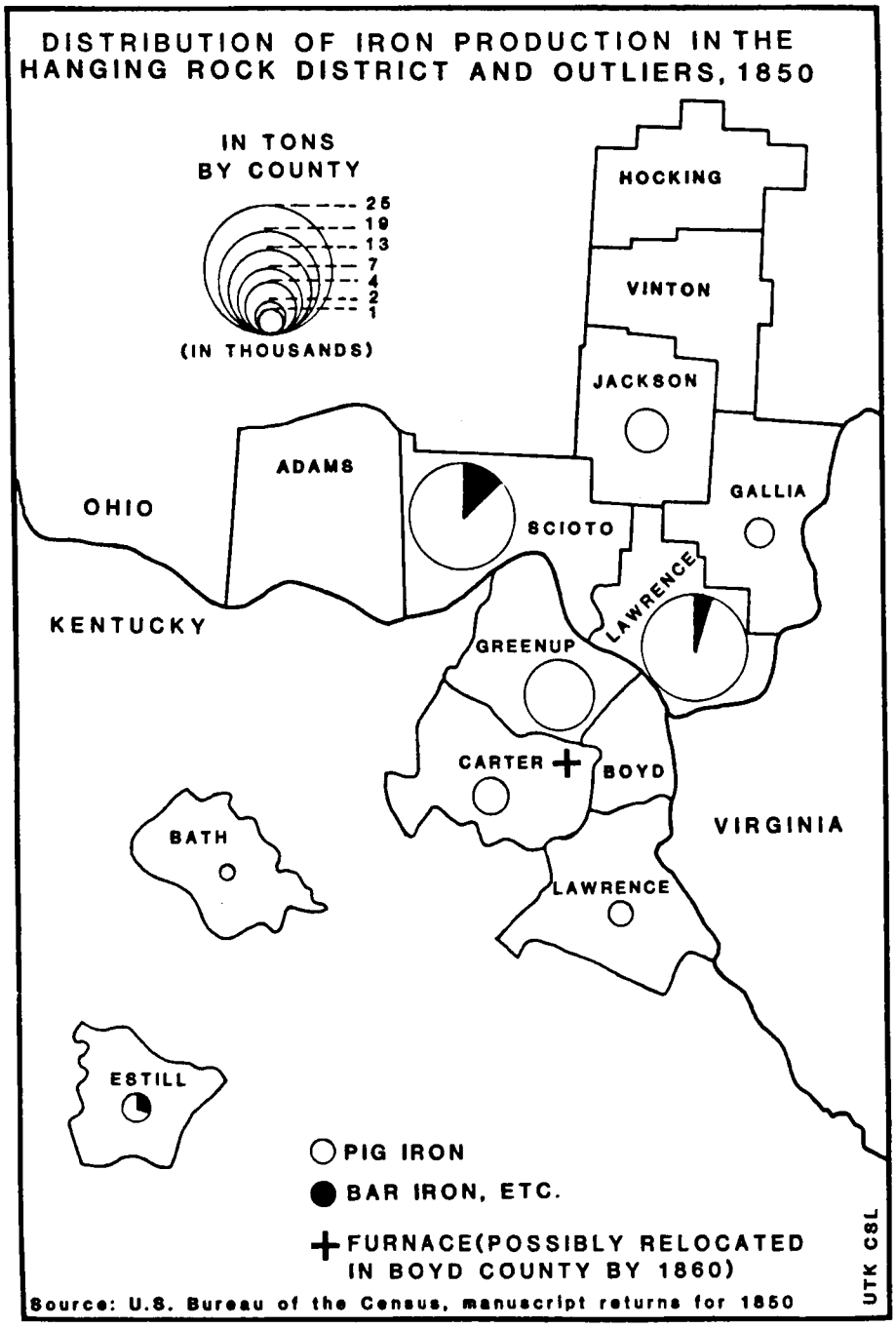

Figure 36. Distribution of Iron Production in the Hanging Rock District and Outliers, 1850.

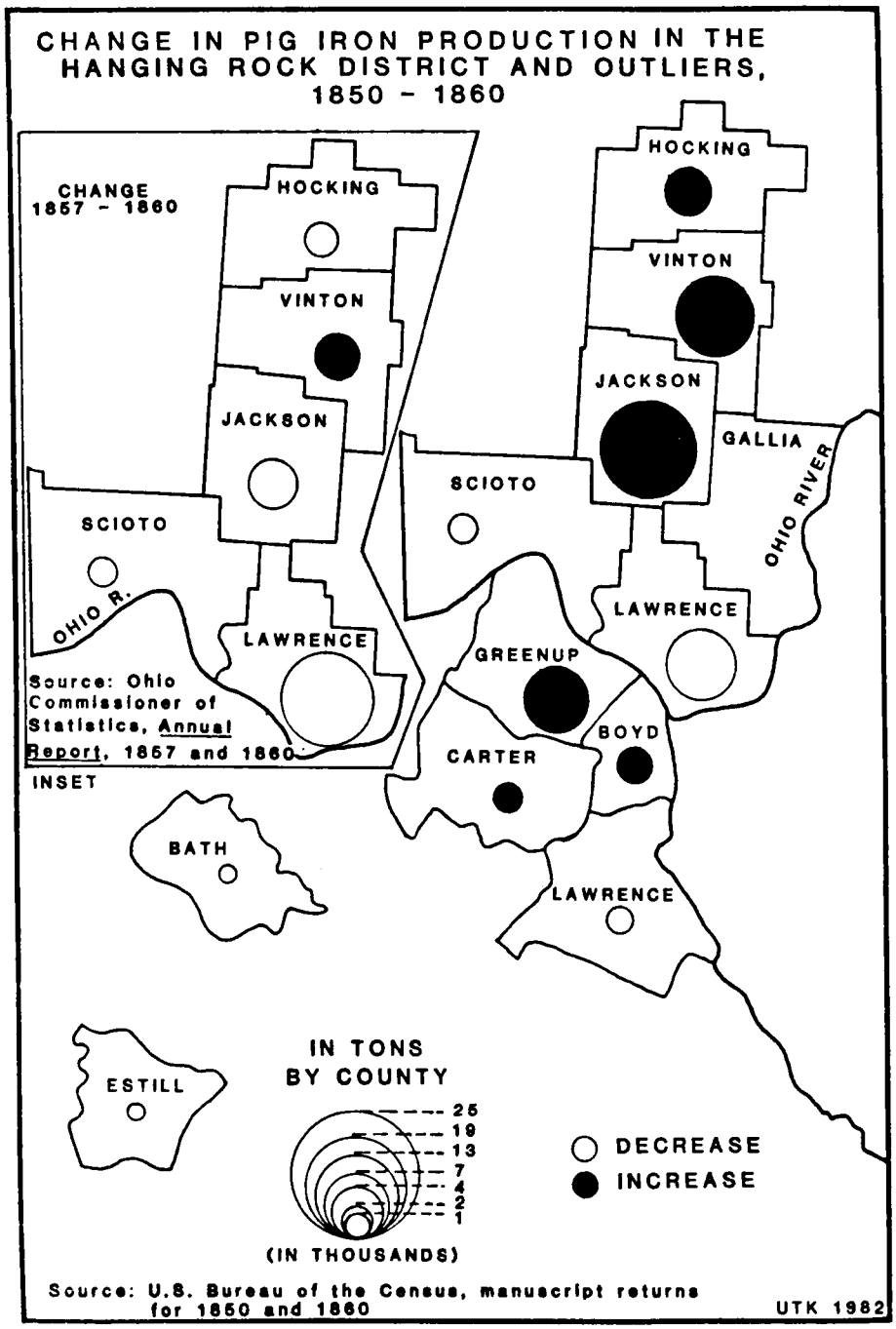

Figure 37. Change in Pig Iron Production in the Hanging Rock District and Outliers, 1850-1860.

than the peak production in 1857 (Figure 37 inset and Table XX). The decline in charcoal iron production after 1857 occurred too late to drop the output below the 1850 level, so that the 1860 pattern was much expanded over that of 1850 (Figure 38).[12] The inset map in Figure 37, however, shows the absolute decline during the late 1850's.

Weekly and Annual Production

Blast furnaces reportedly cast between 7 and 21 tons of metal a week during the early period, although some furnaces produced as much as 28 tons during the 1820's.[13] By the late 1830's furnaces were producing from 28 to 35 tons a week, and in the 1840's Pine Grove, Franklin, and Keystone furnaces routinely made between 42 and 70 tons of metal a

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[12] The Annual Report of the Commissioner of Statistics for the Year 1857 (Columbus: Richard Nevins, 1858), p. 90; Fourth Annual Report of the Commissioner of Statistics, 1860 (Columbus: Richard Nevins, 1861), pp. 96-121.

[13] Keeler, pp. 145-146, 159-161, 169, and 237; Stout, pp. 74 and 79; Lawson, p. 4; Moore, "Kentucky Division of the Hanging Rock Iron District," p. 6; "Scrapbook 1857-1873," University of Kentucky, Means Family Papers; Donald H. Purnam and others, A History of Ashland, Kentucky, 1786-1954 (Ashland: Centennial Committee, 1954), p. 83; U.S. Treasury Department, Documents Relative to the Manufactures in the United States (Washington: D. Green, 1833), p. 867; Cappon, unpublished manuscript, p. 108; Edwin Henderson, "Historical Sketch of Early Cincinnati," Enquirer, February 24, 1924, Cincinnati Historical Society; Ester Fleming, "Hope Furnace," Columbus Dispatch Magazine, December 28, 1958, Ohio University; "Sketch of Vesuvius Furnace," Marietta College Archives, Iron Furnaces; J. Winston Coleman, Jr., "Old Kentucky Iron Furnaces," The Filson Club History Quarterly 31 (July, 1957), pp. 229, 232, and 236; Mack Henry Gillenwater, "The Development of the Iron Industry in the Ashland, Kentucky, Area of the Hanging Rock Iron Region" (unpublished M.A. Thesis, Marshall University, 1958), pp. 97-98.

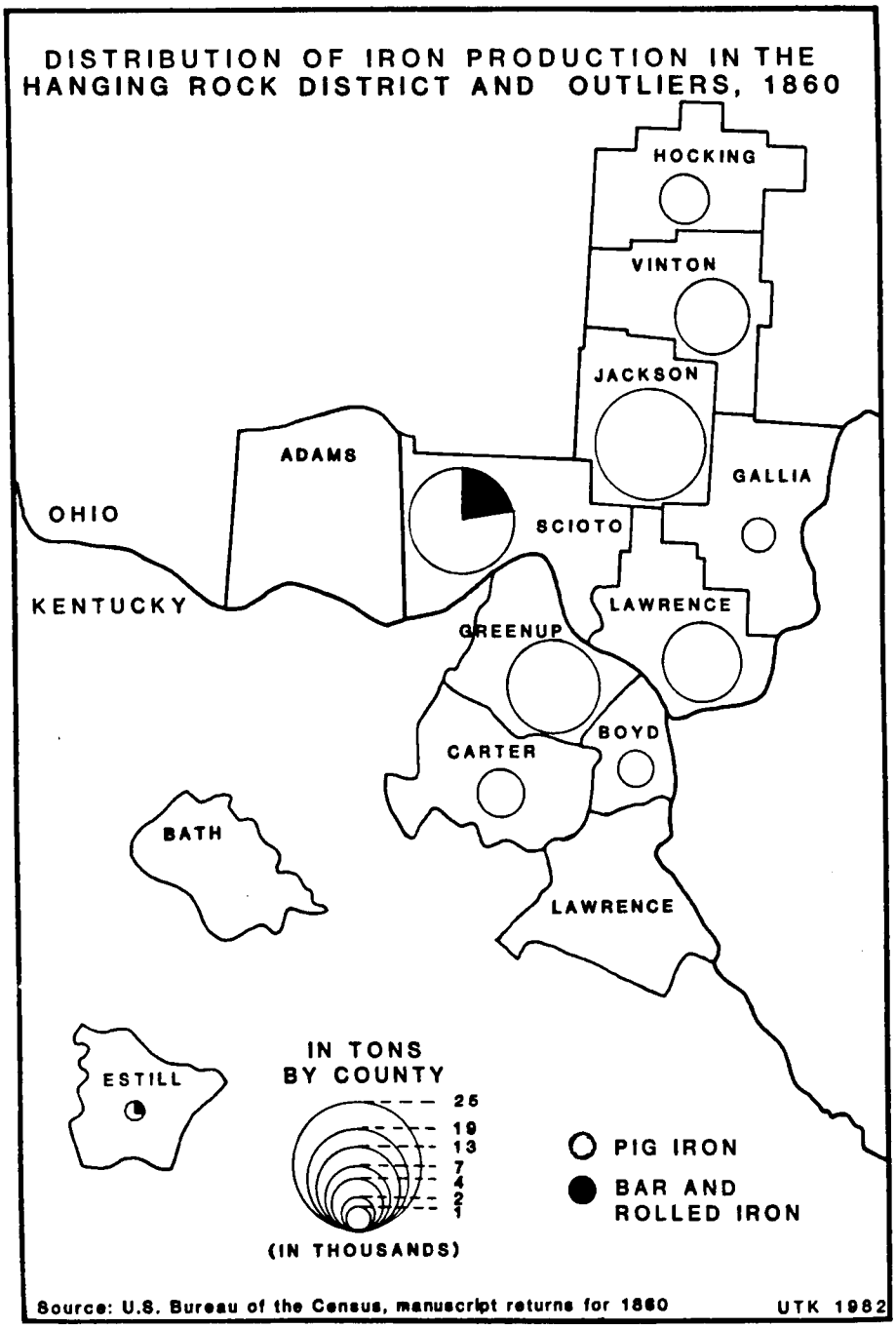

Figure 38. Distribution of Iron Production in the Hanging Rock District and Outliers, 1860.

week.[14] By the mid-1850's the typical weekly production in the district was between 50 and 65 tons.[15]

The annual production was less than the weekly output suggests, because the typical furnace was in blast for only 7 to 9 months a year.[16] The raw materials for the blast were assembled during the winter and early spring when additional workmen were available, providing a stockpile for the forthcoming season. The furnace blast was

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[14]Keeler, pp. 189-90; Journal of the House of Representatives of the Commonwealth of Kentucky (Frankfort: A. G. Hodges, 1837), p. 162; "Inventory File," University of Kentucky, Means and Seaton Family Papers; Kendall Gordon Seaton, The Rise and Growth of the Iron Industry in and about Ashland, Kentucky (Ashland: POAGE Chapter of the D.A.R., November, 1948), p. 22.

[15]Lesley, pp. 113-126; Stout, p. 77; "Iron Furnace Questionnaire, about 1856," Marietta College Archives, Iron Furnaces; "Furnace Sketch Pine Grove Furnace," Ironton Register September 14, 1854, Marietta College Archives, Iron Furnaces; Frank H. Rowe, History of the Iron and Steel Industry in Scioto County, Ohio (Columbus: Ohio State Archaeological and Historical Society, Volume 10, 1938), pp. 77-79; Keeler, p. 160.

[16]Documents Relative to the Manufactures in the United States, p. 867; Keeler, p. 146; Coleman, p. 236; "Franklin Furnace Account of Several Blasts 1845-1857," Marietta College Archives, Iron Furnaces; "Sketch of Vesuvius Furnace," Marietta College Archives, Iron Furnaces, pp. 9-11; "Time Book 1869-1875," Ohio Historical Center, Madison Furnace Collection; "Iron Furnace Questionnaire, c. 1856," Marietta College Archives, Iron Furnaces. United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1870; "Facts about Various Furnaces," n.d., Marietta College Archives, Iron Furnaces; "Scrapbook, 1857-73," University of Kentucky, Means Family Papers; "Daybook 1847-1854" and "Daybook-Journal 1854-1863," Cincinnati Historical Society, Sinton and Means Collection; "Journal 1869-1889," Ohio Historical Center, Madison Furnace Collection; "Annual Statement of Means, Kyle and Company for Year Ending March 31, 18__" 1869-77, 1878-89, University of Kentucky, Means Family; Lesley, pp. 113-126; Journal of the House, 1837, p. 161; "Furnace Sketch, Pine Grove, September 14, 1854, Marietta College Archives, Iron Furnaces; Cappon, unpublished manuscript, pp. 108 and 110.

usually started in March, April, or May, ending the following December or January.[17]

The furnaces in the Hanging Rock District were among the most productive in the country. Union furnace's annual production in 1827 was even equal to that of blast furnaces in England.[18] By the late 1830's furnaces in the district were producing 1,000 tons or more a year (Table XXI); and Raccoon and Bellefonte furnaces, which produced 1,300 and 1,200 tons respectively, were among the country's most productive furnaces.[19]

The larger output of furnaces in the Hanging Rock District was probably due to technological advances, such as hot blast and steam power, and rise in demand for charcoal iron in the Ohio Valley and Midwest. In 1840 the mean annual production for furnaces in the district was four times greater than that of the rest of the country (Table XXI and Table III, Chapter 2, page 55). Although this large differential in mean annual production per furnace had narrowed by 1850, furnaces in the Hanging Rock District were probably more productive than those of the rest of the nation through 1857. During the late 1850's a

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[17]"Sketch of Vesuvius Furnace" and "Buena Vista Furnace" June 8, 1857, Marietta College Archives, Iron Furnaces; "Scrapbook 1857-73" and "Annual Statement of Means, Kyle and Company," University of Kentucky, Means Family Papers; "Journal 1869-89," Ohio Historical Center, Madison Furnace; "Furnace Sketches, Pine Grove Furnace," Marietta College Archives, Iron Furnaces.

[18]Seaton, p. 22.

[19]Journal of the House, 1837, p. 485; Coleman, p. 236; "Scrapbook 1857-63," University of Kentucky, Means Family Papers.

TABLE XXI

AVERAGE FURNACE PRODUCTION IN THE HANGING ROCK DISTRICT, 1820's-1870 (IN TONS)

Year(s)	U.S.	Hanging Rock District	Ohio Counties of the Hanging Rock District	Kentucky Counties of the Hanging Rock District	Outlying Areas
1820's[a]	-	400			
1830's[a]	-	867			
1840	357	1,437	1,487	1,356	860
1840's[a]	-	1,768			
1850	1,498	1,712	2,021	1,170	800
1850's[a]	-	1,932			
1856	1,402[b]	-	1,718		
1860	3,453	1,830	1,889	1,825	600
1870	5,318	2,307[c]	2,363[c]	2,082[c]	2,025

Sources: U.S. Bureau of the Census, unpublished census manuscripts, 1820, 1850, 1860, and 1870; published census, 1840-1870; Lesley, pp. 759-760.

[a]The data for the decades are compiled from individual furnace production. The total production is divided by number of observations. (Some furnaces included more than once.)

[b]Includes pig iron made with all fuels.

	No.	Tons	Average	
Anthracite	121	394,509	3,260	
Coke	24	44,481	1,853	
Raw Bit. Coal	19	25,073	1,320	
Charcoal	416	348,854	839	
TOTAL	580	812,917	1,402	Average

[c]Charcoal furnaces only. In Hanging Rock District stone coal furnaces averaged 3,847 tons.

reduction in number of furnaces and the expansion of the mineral fuel technology caused an advance in mean annual production of the nation's furnaces to 3,453 tons by 1860, surpassing the 1,830 ton annual average for the Hanging Rock District.[20]

The Resource Base

Iron Ore

To maintain this annual production, the ironmaster had to assemble large quantities of iron ore, charcoal, and limestone. Since the location of furnaces was oriented toward raw materials, particularly ore, the distribution of charcoal furnaces corresponds to the areal extent of the iron ore. The ore region was elongated in a north-northeastward direction, broadening along the Ohio River to a relatively narrow band between Ashland and Union furnace landing, about six miles below Ironton.

The Hanging Rock ores were limonites and siderites, the ironmasters commonly exploiting three varieties known as limestone, block, and kidney ore.[21] The limestone or ferriferous ore veins varied from a few inches up to seven feet in thickness, averaging about twelve inches, and

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[20]United States Bureau of the Census, "The Statistics of the Wealth and Industry of the United States" (Washington: GPO, 1872), p. 602; Lesley, pp. 759-760.

[21]The ores belong to the same general mineralogical class and geological position, but they differ in appearance, chemical composition, and circumstance of deposition. Lawson, p. 2; P. N. Moore, "Report on the Iron Ores of Greenup, Boyd, and Carter Counties, the Kentucky Division of the Hanging Rock Iron Region," Geological Survey of Kentucky (Frankfort: Yeoman Press, 1884), p. 15.

were found lying upon or near limestone.[22] The limestone ore was the most highly valued of the ores because of its wide distribution, comparative purity and richness, uniform character, and ease of smelting.[23] As a result, the most successful furnaces were located near outcrops of limestone ore.

The majority of furnacemen, however, mixed different varieties of ore, the most common mixture being limestone and block ores.[24] The block ore occurred as strata from one or two inches to several feet in thickness interbedded with clay and bituminous shale and was named after the rectangular blocks in which it was extracted.[25] Kidney ore, named after its prevalent kidney or ellipsoid shape, was scattered through the shale and sandstone in irregular masses ranging in size from a few pounds to half-ton boulders.[26]

Since furnaces were located near the outcrops of limestone ore, mining was accomplished by stripping or benching. The outcrops were stripped along the hillsides and ridges, transforming the contours into

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[22]Moore, "Report on the Iron Ores of Greenup, Boyd, and Carter Counties," pp. 11-12; Stout, p. 91; Lawson, p. 2; "Sketch of Vesuvius Furnace," Marietta College Archives, Iron Furnaces.

[23]Moore, "Report on the Iron Ores of Greenup, Boyd, and Carter Counties," pp. 11-12; Stout, p. 91; Lawson, p. 2; Lesley, pp. 113-122.

[24]Lesley, pp. 113-122.

[25]Stout, p. 90; Moore, "Report on the Iron Ores of Greenup, Boyd, and Carter Counties," p. 11; Lawson, p. 2.

[26]Moore, "Report on the Iron Ores of Greenup, Boyd, and Carter Counties," pp. 25 and 28; Lawson, pp. 2 and 15.

narrow terraces.[27] As a general rule one foot of overburden was removed for each inch of the vein, using picks, shovels, wheelbarrows, and possibly horse-drawn scrapers. When the overburden exceeded 10 to 15 feet removal was no longer profitable, and the miners would move to the next outcrop.[28]

The cost of mining the ore was between 40¢ and $1.00 a ton.[29] In addition to the labor, the cost of the ore was determined by the richness of the ore, the extent of processing and handling, and the distance between the furnace and ore bank.[30] The distance to the ore was particularly important, and data for seven furnaces in the district indicate that the average distance between the furnace and ore deposits was 2½ miles, with the distance ranging to nearly 4 miles.[31] A distance over four miles was considered too great for profitable operation.[32] The development of railroads during the 1850's, however, extended the range that ore could be profitably transported.[33]

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[27]Stout, p. 92; Lawson, pp. 2 and 15; Moore, "Report on the Iron Ores of Greenup, Boyd, and Carter Counties," pp. 25 and 28.

[28]Collins and Webb, no page; Stout, p. 92; Moore, "Report on the Iron Ores of Greenup . . . ," p. 76.

[29]"Ore Journal 1859-67," Ohio Historical Center, Madison Furnace; Stout, p. 93; Rowe, p. 88.

[30]Stout, p. 93; Keeler, pp. 190-191; Rowe, p. 87.

[31]Lesley, pp. 113-122; Coleman, p. 228.

[32]Moore, "The Red River District," p. 16.

[33]Lesley, p. 116; "Iron Furnace Questionnaire, c. 1856," Marietta College Archives, Iron Furnaces.

The yield and cost of ore in making pig iron. The better ore in the Hanging Rock District had an iron content of 30% to 40%, but when roasted the yield was improved to 45% to 55%.[34] Because of the early practice of roasting and the widespread use of limestone ore, the amount of ore used in making pig iron during the 1830's was remarkably similar to that in 1860 (Table XXII).[35] In the early 1830's manufacture of a ton of pig iron required nearly three tons of ore at a cumulative cost of $3.75 to $4.50. By midcentury the average requirement in the Hanging Rock District was 2.55 tons of ore at a cost of $5.00. During the 1850's the amount of ore used to produce a ton of pig iron increased to a level similar to that of the 1830's, so that in 1860 it required 2.8 tons of ore at a cost of $7.11 to make a ton of pig iron. This increase in cost of ore per ton of metal from $5.00 to $7.11 between 1850 and 1860 was due in part to an increase in the amount of ore required, but more importantly, it was caused by a general rise in the cost of raw materials in the late antebellum era. The rising costs continued during the 1860's. The cost of a ton of ore at Madison furnace rose from $1.55 to $3.65 between 1859 and 1866.[36] Since the average cost of ore in the

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[34]Collins and Webb, no page; Journal of the House, 1837, p. 160; Stout, pp. 92-93; Lesley, pp. 713-716; Moore, "The Red River District," pp. 10-11, 16-17, 27-28; Lawson, p. 15; Moore, "The Kentucky Division of the Hanging Rock Iron District," pp. 14-15; Letter, _____, Bellefonte Furnace to W. A. Mengold and Company, November 6, 1889, University of Kentucky, Seaton Family Papers; Rowe, p. 105.

[35]Journal of the House, 1837, pp. 161-162, 485; "Sketch of Vesuvius," Marietta College Archives, Iron Furnaces.

[36]"Ore Journal 1859-1867," Ohio Historical Society, Madison Furnace.

TABLE XXII

THE QUANTITY AND COST OF ORE USED IN MAKING PIG IRON IN THE HANGING ROCK DISTRICT, 1830's-1870

	Hanging Rock District	Kentucky Counties	Ohio Counties	Outlying Areas
Tons of Ore Used in Making a Ton of Pig Iron				
1830's[a]	2.98	2.82	-	-
1850	2.55	2.86	2.44	2.50
1860	2.80	2.95	2.66	3.00
1870	2.76	2.87	2.69	2.93
Cost of a Ton of Ore				
1830's	-	$2.56	-	-
1850	$1.96	2.11	$1.91[b]	$2.84
1860	2.54	2.60	2.49	2.50
1870	4.20	3.96	4.35	3.69
Total Cost of Ore Used in Making One Ton of Pig Iron				
1830's	-	$7.22	-	-
1850	$5.00	6.04	$4.66	$7.10
1860	7.11	7.67	6.62	7.50
1870	11.59	11.37	11.70	10.81

Sources: These data were calculated from various sources including: U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860, and 1870; McLane Report, pp. 865-867; Journal of the House, 1837, pp. 161-162, 485.

[a]These data are for 1832 and 1837 in Ohio and Kentucky, respectively; and include furnaces in Greenup County, Kentucky, and Scioto and Lawrence counties, Ohio.

[b]Includes only Scioto and Vinton counties.

district was $4.20 ton in 1870, the cost of ore to manufacture a ton of pig iron was $11.59, which was 63% greater than the cost in 1860 (Table XXII). The factors contributing to the rise in cost through the 1870's were underground mining, greater distance to the ore banks, and some mixing of Hanging Rock ore with Virginia, Missouri, and Lake Superior ores.[37]

Charcoal Fuel

The amount and cost of charcoal used in making pig iron. Between 200 and 348 bushels of charcoal were consumed in making a ton of pig metal during the 1830's. The average consumption in the Ohio and Kentucky areas of the district was about 275 and 284 bushels respectively (Table XXIII).[38] The relatively large consumption was due to the exclusive use of cold blast, poor quality of ore at some sites, and inexperience of some ironmasters in processing, mixing, and smelting the ore.

Charcoal consumption gradually declined, and by 1850 it required an average of only 208 bushels per ton of metal (Table XXIII). The trend continued during the 1850's, and by 1860 the mean consumption per ton of metal dropped to 178 bushels. This decline in charcoal consumption was

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[37]Lawson, p. 15; Stout, p. 92; Keeler, pp. 190-191; "Report of the Statistics Collected of Pomeroy, Gallopolis . . . ," infer 1879, Ohio Historical Center, Charles Parrott; Annual Report, Commissioner of Statistics, 1857, p. 569.

[38]Documents Relative to the Manufactures of the Unites States, pp. 864-866; "Sketch of Vesuvius Furnace," Marietta College Archives, Iron Furnaces; Journal of the House, 1837, pp. 161 and 485.

TABLE XXIII

THE AVERAGE AMOUNT AND COST OF CHARCOAL USED IN MAKING A TON OF PIG IRON IN THE HANGING ROCK DISTRICT, 1832-1870 (IN BUSHELS AND DOLLARS)

	1830's		1850		1860		1870	
	Amount	Cost	Amount	Cost	Amount	Cost	Amount	Cost
Hanging Rock District	-	-	208	$7.45	178	$8.01	160	$11.42
Kentucky Counties	284	$9.47[a]	244	9.15	183	8.24	167	11.41
Ohio Counties	275	9.17[a]	197	6.74[b]	174	7.83	156	11.61

Sources: U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860, and 1870; Journal of the House, 1837, pp. 161-62, 485; McLane Report, pp. 864-866.

[a]The 1832 data for Ohio is figured at 3 1/3¢; however, the cost ranged from 3¢ to 3½¢ per bushel. The 1837 data for the Kentucky counties ranged from 2½¢ to 3½¢, averaging 3 1/3¢.

[b]These data are figured without Gallia County where ironmasters supposedly paid 1¢ a bushel; however, this writer believes this to be in error.

caused by the increasing application of the hot blast process, which required less fuel. Hot blast was first installed at Vesuvius furnace in 1837, and by the mid-1850's about 80% of the furnaces in the Hanging Rock District were using hot blast or a combination of hot and cold blast.[39]

The decrease in the amount of charcoal used in smelting offset the modest rise in cost of fuel (Table XXIII). Before 1840, the cost of charcoal was 2¼¢ to 3½¢ a bushel, and by midcentury it was a little over 3½¢.[40] In 1850 the cost of fuel to manufacture a ton of pig metal was $7.45. The cost of a bushel of charcoal rose to 4½¢ during the 1850's, but because of a decrease in fuel consumption, it cost only $8.00 to manufacture a ton of metal in 1860. Paralleling the trend in the cost of iron ore, the price of fuel to make one ton of pig iron had increased to $11.40 by 1870 (Tables XXII and XXIII).

The primary cost of charcoal was the labor involved in cutting and coaling cordwood, which required considerable time and manpower. The season for cutting cordwood generally lasted about six months, extending from mid-October to mid-April. While a skilled axman could fell and rank three cords a day, an average of two cords was considered a fair day's work.[41] Woodchoppers were paid 25¢ a cord during the first

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[39]Lesley, pp. 113-126; Stout, p. 85; "Iron Furnace Questionnaire, c. 1856," Marietta College Archives, Iron Furnaces.

[40]"Brush Creek Furnace Ledger, 1828-1830," Ohio Historical Center.

[41]Stout, p. 85.

quarter of the 19th century, but by the mid-1850's, labor cost was figured at about 50¢ a cord.[42]

The adequacy of the fuel supply. The observation that ironmasters were faced with supplying fuel from a narrow radius about the furnace has led some writers to conclude that the depletion of timber was a reason for the demise of the charcoal iron industry.[43] Clearly there were limits to growth under the charcoal technology, but it seems probable that the timber supply at the regional scale was sufficient to support charcoal iron making throughout the antebellum period.

Furnacemen generally considered the timber from 300 to 350 acres sufficient to supply the annual needs of a furnace.[44] If, however, one figures an average yield of 35 cords per acre and 40 bushels per cord, it would appear that the typical furnace would use only 150 to 300 acres of timber each year (Tables XXIV and XXV).[45]

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[42]Keeler, pp. 144 and 174; "Brush Creek Furnace Ledger 1828-1830," Ohio Historical Center; "Wood Book, New Hampshire Furnace," University of Kentucky, Seaton Family Papers; Arthur B. Cozzens, "The Iron Industry of Missouri," The Missouri Historical Review 35 (July, 1941), p. 529.

[43]Lawson, pp. 6-7, 10; Coleman, p. 240; Moore, "Kentucky Division of Hanging Rock," p. 4; Collins and Webb, no page; Seaton, p. 10.

[44]Stout, p. 86.

[45]Louis C. Hunter, "Influence of the Market Upon Technique in the Iron Industry in Western Pennsylvania Up to 1860," Journal of Economics and Business History 1 (February, 1919), p. 261; Stout, p. 86; Moore, "Kentucky Division of Hanging Rock," p. 13; Collins and Webb, no page; Keeler, p. 153; "Facts about Various Furnaces," Marietta College Archives, Iron Furnaces; N. S. Shaler and A. R. Crandall,, "Report on the Forests of Greenup, Carter, Boyd, and Lawrence Counties," Geological Survey of Kentucky (Frankfort: Yeoman Press, 1884), p. 22.

TABLE XXIV

ESTIMATED ACREAGE CUTOVER ANNUALLY TO PROVIDE CHARCOAL FOR THE TYPICAL FURNACE IN THE HANGING ROCK DISTRICT, 1832-1870

	1832	1837	1850	1860	1870
Average Tonnage Produced	1,000	845	1,712	1,830	2,307
Average Number of Bushels Per Ton	275	284	208	178	160
Total Number of Bushels Consumed	275,000	239,980	356,096	325,740	369,120
Cordwood Needed to Produce the Charcoal (in Cords)	6,875	6,000	8,902	8,143	9,228
Number of Acres Needed to Supply the Fuel[a]	196	171	254	233	264

Source: Compiled by author from data in manuscript sources.

[a]If 40 cords per acre were obtained, the acreage cutover would be less, e.g., 172, 150, 223, 204, and 231 acres would have been used in 1832, 1837, 1850, 1860, and 1870, respectively.

TABLE XXV

THE CHARCOAL, CORDWOOD, AND ESTIMATED ACRES OF CORDWOOD USED BY SELECTED FURNACES IN THE HANGING ROCK DISTRICT ABOUT 1856

Furnaces	Bushel of Charcoal Used by the Furnace	Cordwood Cut	Price Per Cord (in dollars)	Bushel Per Cord[a]	Estimated Acres of Cordwood Cut to Provide the Fuel
Scioto	445,660	14,400	0.50	31	411
Cincinnati	540,000	13,000	0.50	42	371
Bellefonte	340,000	9,000	0.45	38	257
Etna	400,000	9,000	0.50	45	257
Franklin	341,200	7,700	0.50	44	220
Jackson	500,000	12,000	-	42	343
Junior	298,800	8,500	1.00	35	243
Kenton	305,400	7,000	0.43	44	200
Keystone	503,400	10,500	0.47	48	300
Latrobe	-	10,820	0.50	-	309
Madison	501,200	12,000	0.50	42	343
Oak Ridge	-	8,000	0.45	-	229
Vesuvius	421,993	11,310	-	37	323
AVERAGES	417,969	10,249	0.53	40	293

Source: "Iron Furnace Questionnaire, c. 1856," Marietta College.

[a]The writer has assumed that all the cordwood was used to make the charcoal.

To supply this demand for wood, the ironmaster often controlled a large landholding. One writer concluded that only the estates as large as 12,000 to 15,000 acres could be permanent, because they alone afforded time for second-growth timber to mature before the original stand was exhausted.[46] Given the annual rate of consumption for the Hanging Rock District, however, estates of 6,000 to 10,000 acres could support a permanent operation.[47] The typical landholdings in the Hanging Rock District were 7,000 to 8,000 acres, which afforded the ironmaster the opportunity to maintain a permanent operation.

Through reforestation second-growth timber had time to develop before the landholding was cutover, and second- and third-growth timber was considered good or superior for making charcoal.[48] Unfortunately, there is little evidence to document ironmasters' attempts at reforestation, although one writer asserted that before 1879 ironmasters did follow something of a reforestation plan.[49] The fact that some ironmasters eventually became dependent upon second-growth timber suggests that they did manage the renewable resource.[50]

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[46]Moore, "Kentucky Division of Hanging Rock," p. 15; Shaler and Crandall, p. 22.

[47]Stout, p. 86; Collins and Webb, no page; Crandall, p. 22.

[48]Collins and Webb, no page; Shaler and Crandall, p. 21; Lesley, pp. 119-120, and 123.

[49]Keeler, p. 186; Shaler and Crandall, p. 9.

[50] Collins and Webb, no page; Shaler and Crandall, p. 21; Lesley, pp. 119-120, 123; Keeler, pp. 161, 170; "Jefferson Furnace Daybook, 1854-57," Ohio Historical Society.

The estates in the Hanging Rock District were large enough to provide fuel for a period of 30 to 35 years without depending on second-growth timber or purchasing wood from others (Table XXVI). The majority of furnaces in operation during the mid-1850's had been built recently on the periphery of the older area of iron making, and the landholdings of these furnaces provided a plentiful supply of timber. Since these furnaces were just beginning their operation, and given the number of years it took to cutover an estate, even a small one, the timber supply at the regional scale was surely adequate during the antebellum period (Tables XXVI and XXVII).

In the older area which had been in production for nearly thirty years, only Franklin furnace had depleted its timber supply (Table XXVII). Pine Grove, Etna, and Vesuvius, on the other hand, had not depleted their timber, though the original stand at Etna had probably been cutover.[51]

The trend in cost of raw materials also suggests that charcoal was not in short supply. If charcoal had been scarce during the 1850's, its price should have risen sharply. Instead, the cost of iron ore increased at a faster rate than charcoal, and by 1870 the cost of ore to manufacture pig iron was equal to that of the fuel.[52] The relatively

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[51]"Sketch of Vesuvius Furnace," Marietta College Archives, Iron Furnaces.

[52]The unit price of charcoal rose more rapidly than that of the ore between 1854 and 1870; however, since the number of bushels used in making iron declined, the cost of ore used to manufacture pig iron rose more rapidly.

TABLE XXVI

ESTIMATED NUMBER OF YEARS TO CUTOVER THE TYPICAL FURNACE LANDHOLDING IN THE HANGING ROCK DISTRICT (AT 230 ACRES PER YEAR)

Size of the Landholding (in Acres)	Number of Years to Cutover the Landholding
3,000	13
4,000	17
5,000	22
6,000	26
7,000	30
8,000	35
9,000	39
10,000	44
11,000	48
12,000	52
13,000	57
14,000	61
15,000	65

Source: Compiled by author.

TABLE XXVII

THE CORDWOOD AND CHARCOAL SUPPLY FOR SELECTED FURNACES IN THE HANGING ROCK DISTRICT

Furnaces[a]	Date Built	Years of Operation	Iron Production During the Years of Operations (Tons)	Cordwood Cut to Produce the Iron (Cords)	Size of Furnace Landholding	Estimated Timberland on the Estate
Franklin	1827	1845-1857	28,905[b]	3,438	3,000[b]	negative
Pine Grove	1828	1829-1854	35,511[b]	5,073	8,000[b]	2,927
Etna	1832	1832-c.1856	34,000	5,246	6,000	754
Vesuvius	1833	1834-1839 1849-1857	3,316 12,859	2,715	5,077	2,362
Keystone	1849	1848-1851	14,500	2,175	9,230	7,055
Cincinnati	1853	1854-1857	5,000	722	4,742	4,020

Sources: "Iron Furnace Questionnaire" (1856), taken in 1857; Franklin Furnace, "Account of Several Blasts, 1845-1857"; Furnace Sketches and Pine Grove Furnace from Ironton Register September 14, 1854; "Sketch of Vesuvius Furnace," Marietta College Archives, Iron Furnaces; Stout, pp. 75-77.

[a]Vesuvius, Pine Grove, and Etna furnaces are located in Lawrence County, Ohio, Franklin in Scioto, Keystone in Jackson, and Cincinnati in Vinton counties.

[b]Production could have been 30,511; Pine Grove and Ohio furnaces were on 16,000 to 18,000 acres.

modest increase in the cost of charcoal may have been related to supply, but much of the increase must be due to the general advance in cost of all raw materials.

The near depletion of the timber at the regional scale must have been a postbellum phenomenon. Consequently, the relative and absolute decline of iron production during the late 1850's and the relative decline during the 1860's must have had other causes.

Other On-Site Location Factors: Limestone and Power

Since limestone strata were found near the iron ore, ironmasters in the district generally procured the fluxing agent from nearby sources, though some ironmasters had to haul limestone as far as fifteen miles.[53] The amount of limestone used in smelting was small, although it varied greatly because some ores required more fluxing agent. In 1837 the mean annual consumption of limestone at Bellefonte, Raccoon, and Caroline furnaces was 349 tons.[54] The mean annual consumption of the furnaces in the Hanging Rock District was 337, 403, 404, and 409 tons in 1850, 1856, 1860, and 1870, respectively.[55] A miner and team working a crude quarry could supply the annual needs of a furnace.[56]

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[53]Stout, pp. 94-95.

[54]Journal of the House, 1837, pp. 161-62.

[55]In 1837 the cost of limestone was $1 to $2 a ton. The average cost of a ton in 1850, 1860, and 1870 was $1.28, $1.40, and $3.11, respectively. United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860 and 1870; "Iron Furnace Questionnaire, c. 1856," Marietta College Archives, Iron Furnaces; "Facts about Various Furnaces," Marietta College Archives, Iron Furnaces.

[56]Stout, pp. 94-95.

Another location factor was the selection of a site which provided ample power to operate the furnace. Since furnaces in the district were operated by waterpower during the initial stage of development, it was necessary to locate the furnace along a dependable stream. A seasonally low volume of stream flow, which interrupted the blast and curtailed production, was the major disadvantage of waterpower. Because of the uncertainty of waterpower, as well as the desire to produce more iron, ironmasters soon abandoned waterpower in favor of steam.[57]

The ironmaster at Brush Creek furnace in outlying Adams County was one of the first in the country to install steam power, and by 1820 two of the three furnaces in the county used steam.[58] By the early 1830's five existing furnaces and four under construction in Lawrence and Scioto counties, Ohio, were all equipped with steam power.[59] The majority of furnaces in the Kentucky area of the district were also operated by steam.[60] Steam power rapidly became dominant in the Hanging

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[57]Louis C. Hunter, Studies in the Economic History of the Ohio Valley, pp. 36-37; Documents Relative to the Manufactures of the United States, pp. 864-865; Moore, "Kentucky Division of the Hanging Rock," p. 6; Coleman, pp. 228-29; Cappon, unpublished manuscript, p. 108; Wilber Stout, "Early Forges in Ohio," The Ohio Archaeological and Historical Quarterly 46 (January, 1937), p. 31; Moore, "Red River Iron District," p. 23.

[58]Keeler, p. 144; Lawson, p. 4; United States Bureau of the Census, unpublished census manuscripts, "Census of Manufactures," 1820.

[59]The bituminous coal found near the ore was used to drive the steam engines. Journal of the House, 1837, p. 162; Documents Relative to the Manufactures of the United States, p. 867; Cappon, unpublished manuscript, p. 108.

[60]Cappon, unpublished manuscript, p. 108; Journal of the House, 1837, pp. 161-62; Ironton Journal May 20, 1870, Marietta College Archives, Iron Furnaces.

Rock District, and by 1850 every active furnace in the district was using it.[61]

Labor and Population in the Hanging Rock District

A diversity of labor, including colliers, miners, teamsters, and furnace hands, was employed to assemble raw materials and operate the furnace. The distribution of labor among various occupations depended upon the site and situation of the furnace, but usually about two-thirds of the labor force was engaged in supplying, processing, and hauling charcoal, iron ore, and limestone (Table XXVIII).[62] To operate the furnace only about twenty workmen were needed, including a foundryman, two engineers, five to nine men charging the furnace, a keeper and helper, three to five men casting iron and hauling it to the yard, and two to four men in the yard hauling iron and supplying the furnace.[63]

Workmen and Others Dependent Upon the Furnace Community

Between 1818 and the 1830's about 60 to 100 workmen were employed by each furnace (Table XXIX).[64] The employment increased as iron

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[61]Lesley, pp. 113-126; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850.

[62]Stout, pp. 95-96; "Iron Furnace Questionnaire," Marietta College Archives, Iron Furnaces.

[63]Stout, pp. 95-96; Rowe, pp. 87-88.

[64]United States Bureau of the Census, unpublished census manuscripts, "Census of Manufactures," 1820; Documents Relative to the Manufactures of the United States, p. 867; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850 and 1860; Journal of the House 1837, p. 160.

TABLE XXVIII

THE LABOR AND POPULATION AT SELECTED FURNACES IN THE HANGING ROCK DISTRICT, ABOUT 1856

Furnaces	Population of the Furnace Community	Total Employment	Colliers	Ore Diggers	Teamsters	Furnace Hands and Others
Scioto	400	123[a]	43	40	20	20
Cincinnati	500	250	80	75	95	-
Bellefonte	600	150	24	60[b]	20	46[b]
Etna	500	80	6	25[b]	15	34[b]
Franklin	400	100	40	30	8	22
Hocking	-	100[a]	-	-	-	-
Jackson	-	-	8	15	24	-
Junior	250	-	25	40	14	-
Kenton	220	82	4	12	9	57
Keystone	280	150	40	25	20	65
Latrobe	300	105	-	30	14	-
Madison	400	150	40	25	15	70
Vesuvius	478	127	34	45	15	33
Oak Ridge	300	-	-	-	-	-
TOTALS	4,628	1,417	344	422	269	342
AVERAGES	386	129	31	35	22[c]	43
Percent of Labor Force by Category[1]	-	-	24%	27%	13%	36%

Source: "Iron Furnace Questionnaire," Marietta College Archives, Iron Furnaces.

[1]These percentages are for only seven furnaces in the table, i.e., Scioto, Bellefonte, Etna, Franklin, Kenton, Keystone, Madison and Vesuvius.

[a]Inference made as to the number employed at the furnace.

[b]Ore diggers 20 to 30 and furnace hands and others 29 to 39.

[c]Without Cincinnati furnace's 95 teamsters, the mean is only 16 teamsters.

TABLE XXIX

ESTIMATED EMPLOYMENT AND POPULATION DEPENDENT ON THE FURNACES IN THE HANGING ROCK DISTRICT, 1830-1860

Year	Average Furnace Employment	Average Population of Furnace Communities	Population Directly Dependent on the Furnace Communities
1832	102	345	5,520
1837	56[a]	-	-
1840	56[b]	-	-
1846	100	500	15,000
1850	95	-	-
1856	129	386	22,330
1857	103	-	31,000
1860	85	-	-
1870	82	-	-

Sources: U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860, and 1870; published census reports, 1840, 1860, 1870; Howe, p. 289; McLane Report.

[a]This figure is based on Greenup County only, where eight furnaces employed 400 to 500 hands.

[b]The average employment could range up to 66 hands.

production was expanded, averaging about 90 to 100 workmen per furnace during the mid-1840's and early 1850's. At the peak rate of production in the mid-1850's, the furnaces employed an average of 100 to 130 ironworkers (Tables XXVIII and XXIX).

The average employment declined to only 85 workmen in 1860 and 82 in 1870 (Table XXIX). The decreasing number of hands engaged in iron making was probably due to more economical use of raw materials and a trend away from backward integration as selected firms began purchasing some raw materials.

The population of the furnace community, including the workmen, their families, and others living about the furnace, was usually between 200 and 500 people, the majority of settlements falling in the upper range of the estimate (Tables XXVIII and XXIX). The population of the furnace communities in Lawrence County, Ohio, fluctuated, as 500 woodchoppers from the mountains of Virginia and Kentucky migrated to the county each winter to cut cordwood.[65]

The total population directly dependent on the charcoal iron industry is estimated at 5,500, 15,000 and 31,000 for 1832, 1846, and 1857, respectively (Table XXIX). These figures probably represent the minimum number of people depending upon the furnaces. When one includes the farmers, artisans, secondary iron manufacturers, and others in support services indirectly connected with the industry, the population supported was much greater. In 1871, Lawson estimated that Ironton,

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[65]Henry Howe, Historical Collections of Ohio (Cincinnati: Derby, Bradley, and Co., 1847), p. 290.

Hanging Rock, Ashland, Greenupsburg, and the surrounding area contained about 40,000 people who were almost exclusively supported by primary and secondary iron manufactures.[66]

Ethnic Background and the Absence of the Slave Ironworker

Before migrating to the Hanging Rock District, many of the ironmasters, foundrymen, colliers, and others had knowledge of, or direct contact with, iron making ventures in New England, New Jersey, Pennsylvania, Virginia, and South Carolina.[67] By the 1850's, however, the workmen at some well established furnaces in the district were born and raised in the furnace communities.

The ironworkers were primarily of Scotch-Irish, English, Pennsylvania German, and Welsh heritage.[68] The settlements were usually ethnically heterogeneous, but Welshmen almost exclusively made up the labor forces of Jefferson, Buckeye, and Cambria furnaces in Jackson County, Ohio.[69] Slave ironworkers, so commonly employed in the other southern iron districts, were not employed by ironmasters in the Hanging

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[66] Lawson, p. 1.

[67] Stout, pp. 81-82; Rowe, pp. ix and 6; Seaton, pp. 8-9; Cappon, "unpublished manuscript," p. 58; "Inventory File," University of Kentucky, Means and Seaton Family Papers.

[68] Rowe, p. 78; Stout, pp. 81-82; Cappon, "unpublished manuscript," p. 58.

[69] Rowe, pp. 78-79; Keeler, pp. 166, 169-170; "Buckeye Furnace," The Messenger October 15, 1972, Ohio University Archives; Edwin Henderson, "Historical Sketch of Early Cincinnati," Enquirer, February 24, 1924, Cincinnati Historical Society.

Rock District. After the Civil War, however, Negroes were employed in small numbers at a few places.[70]

In contrast, the ironmasters in outlying Bath and Estill counties, Kentucky, owned and hired slaves throughout the antebellum period.[71] In 1856 a minimum of twenty bondsmen were hired to work at Estill furnace at a cost of $2,445. The annual cost of hire ranged from $110 for a collier to $125 for others, averaging a little over $122 per bondsman.[72] The hiring practices there were similar to those of other southern iron districts.

The Size, Form, and Function of the Furnace Community

The majority of furnace communities were situated in small stream valleys, and the usual settlement was a self-contained community whose life focused about the furnace.[73] The typical community contained about fifty to seventy-five cabins, a boarding house, general store, school, church, sheds, and other outbuildings housing the various economic components of the operation.

The most opulent homes were those of the ironmaster, storekeeper, and others in managerial positions. The workmen lived in modest to

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[70]Stout, p. 82.

[71]Jillison, p. 26; Cappon, "unpublished manuscript," pp. 58 and 61; "Ledger 1817-1820," University of Kentucky, Thomas Dye Owings Papers; Coleman, p. 241.

[72]Hiring Bonds, University of Kentucky, Buckner Papers.

[73]Rowe, p. 88; Cozzens, p. 528; Furnace Sketch, "Pine Grove," September 14, 1854, Marietta College Archives, Iron Furnaces.

primitive homes, maintaining a garden and keeping chickens and a cow(s) in adjacent sheds.[74] Many of the homes of the laborers were one-story, one-room deep cabins with rear appendages.[75] The ironmaster at Bellefonte furnace evidently provided the workmen with a house and garden plot gratis, but it is unclear whether this was the usual practice in the Hanging Rock District. The proprietor at Bellefonte furnace stated that he would have to fall in line with other furnaces and eliminate the old custom of providing a house and garden, implying that it was no longer a common practice.[76]

The Size and Form of the Estate

The furnace communities were situated on landholdings ranging in size from 3,000 to 30,000 acres (Table XXX). The average size of the estates was between 9,000 and 9,500 acres, but excluding the very large estates, a more realistic estimate of the mean size is 7,000 to 8,000 acres.

Some estates were symmetrically shaped, contiguous landholdings, but others became fragmented as ironmasters acquired land on a piecemeal basis.[77] In 1865, for example, the Union furnace landholding was twice

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[74]Letter, Means, Russell, and Means, to W. A. Mengold and Co., November 6, 1889, University of Kentucky, Seaton Family Papers; "Sketch of Vesuvius Furnace," Marietta College Archives, Iron Furnaces.

[75]Rowe, p. 10; "Sketch of Vesuvius Furnace," Marietta College Archives, Iron Furnaces; Howe, p. 289.

[76]Letter, Means, Russell, and Means to W. A. Mengold and Co., November 6, 1889, University of Kentucky, Seaton Family Papers.

[77]"Deed to Thomas W. Means for Property of Union Furnace in Lawrence and Scioto County, December 12, 1865," Cincinnati Historical

TABLE XXX

SIZE OF THE FURNACE LANDHOLDINGS IN THE HANGING ROCK IRON DISTRICT (IN ACRES)

Furnace	Date Built	County	Size of the Antebellum Landholding[a]
Laurel	1848	Greenup	7,500
Buena Vista	1848	Boyd	6,000
Sandy	1847	Greenup	24,000[b]
Pine Grove	1828	Lawrence	10,000[b]
Ohio	1845	Scioto	7,000[b]
Bloom	1832	Scioto	7,000
Union	1826	Lawrence	6,615
Bellefonte	1826	Greenup	8,000[d]
Scioto	1828	Scioto	10,982
Vesuvius	1833	Lawrence	5,077
Cincinnati	1853	Vinton	4,742
Etna	1832	Lawrence	6,000
Franklin	1827	Scioto	3,000
Jackson	1838	Jackson	6,200
Kenton	1856	Greenup	11,000
Keystone	1849	Jackson	9,230
Latrobe	1854	Jackson	5,000
Madison	1854	Jackson	3,400
Oak Ridge	1856	Lawrence	9,500
Buckeye	1851	Jackson	4,500
Iron Valley	1853	Jackson	5,000
Monroe	1856	Jackson	6,000[e]
Lawrence	1834	Lawrence	9,700[e]
Hecla	1833	Lawrence	14,000[e]
Howard	1853	Scioto	7,300[e]
Bourbon		Bath[c]	9,000
Estill	1830	Estill[c]	24,500

Sources: McLane Report, pp. 865-66; Keeler, pp. 161, 167, 196, 197, and 202; Lawson, pp. 16-19; Rowe, p. 85; Stout, "Early Forges," pp. 32 and 41; Coleman, pp. 227-228; also numerous references in the following manuscript collections: University of Kentucky, Means Family Papers, Seaton Family Papers, and Buckner Papers; Ohio Historical Society, Madison furnace; Marietta College, Iron Furnaces; Cincinnati Historical Society, David Sinton.

[a]The sizes given here are all likely for the antebellum era, particularly the 1850's for several. If ranges were given, i.e., 5,000 to 6,000 acres, the midpoint (5,500) was selected.

[b]Pine Grove and Ohio furnaces were owned by same firm and held 16,000 to 18,000 acres. Another reference has indicated 18,000 acres for Pine Grove, so I have inferred 7,000 for Ohio furnace.

[c]These furnaces are located in outlying areas of east-central Kentucky.

[d]One reference gives 30,000 acres for Bellefonte, which was probably its size in the 1850's.

[e]The data are given in 1871, but it probably represents the antebellum period as well.

its original size and had become a fragmented estate made up of longlots in the Ohio Valley and selected acreages in the rectangular surveyed area of southeastern Ohio.

Trade Function of the Furnace Community

Situated on a large estate, the furnace community had a number of economic components. In contrast to other southern iron districts, however, the Hanging Rock District had a marked industrial character, and the furnace communities were less self-contained. While the furnace communities served as low-order central places for the surrounding population, they relied on trade with higher-order centers more heavily than those in other southern districts. The trade generated by the furnace communities fostered the development of transportation, promoted financial institutions, and contributed to the development of urban-industrial centers. The communities also created a demand for agricultural commodities and gave seasonal employment to farmers and others in the vicinity.

The trade for food and provisions: the iron industry's impact on agriculture. An important local impact of the charcoal iron industry came through the large demand for food and provisions, which resulted in the expansion and prosperity of nearby agricultural areas.[78] In addition to purchasing agricultural commodities from the farmer, the

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Society, David Sinton; Means, Russell, and Means to W. A. Mengold and Co., November 6, 1889, University of Kentucky, Seaton Family Papers.

[78] Annual Report, Commissioner of Statistics, 1857, p. 35.

ironmaster purchased raw materials from him, cleared his land, and gave him seasonal employment.

The furnace communities gave considerable support to agriculture because the annual food consumption by workmen, their families, and others in the community was enormous (Table XXXI). The meat diet of the community was principally bacon and pork, although beef comprised about one-third of the diet, with hands at a few furnaces eating fish occasionally. Corn, flour, coffee, sugar, molasses, and garden vegetables were also major staples in the diet.

During the 1850's the people in the 58 furnace communities of the Hanging Rock District annually consumed about 1,822,418 pounds of bacon and pork, 744,952 pounds of beef, 678,832 bushels of corn, 408,726 pounds of coffee, 34,510 barrels of flour, and large quantities of sugar, molasses, salt, vegetables, and other foodstuffs (Table XXXII). In addition, those indirectly connected with the iron industry such as the artisans, traders, merchants, secondary manufacturers, and others gave further support to agricultural development.

The 4,000 to 5,000 work animals in the furnace communities were also a source of income for local farmers. The farmers probably supplied the replacement animals and were hired to augment the work force, particularly as teamsters. An average of 60 head of work animals, mostly oxen, were maintained by each furnace community in 1832.[79] By the mid-1850's the ironmaster kept 70 to 80 work animals,

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[79] Documents Relative to the Manufactures of the United States, pp. 863-867.

TABLE XXXI

THE ANNUAL FOOD CONSUMPTION OF SELECTED FURNACE COMMUNITIES IN THE HANGING ROCK DISTRICT, ABOUT 1856

Furnaces	Population of the Furnace Community	Bushels of Corn	Barrels of Flour	Pounds of Bacon	Pounds of Beef	Pounds of Coffee	Pounds of Sugar	Gallons of Molasses	Bushels of Salt
Scioto	400	7,200	520	13,509	4,319	8,000	5,000	1,800	-
Cincinnati	500	7,000	1,000	25,000	40,000	-	-	-	-
Bellefonte	600	10,000	550	25,000	10,585	a	a	a	-
Etna	500	18,000	300	50,000[b]	10,000	7,000	5,000	-	500
Franklin	400	13,000	540	12,000[b]	6,000	6,000	10,000	1,400	300
Jackson	-	20,000	520	-	-	-	-	-	-
Junior	250	12,000	750	-	-	-	-	-	-
Kenton	220	1,268	500	32,000	10,000	-	-	-	-
Keystone	280	14,000	600	-	-	-	-	-	-
Latrobe	300	9,000	520	20,000[b]	7,000[d]	8,320	5,550	2,080	c
Madison	400	16,000	800	50,000[b]	15,000[d]	6,000	6,000	2,000	800
Vesuvius	478	12,982	534	28,919[b]	12,687	6,960	4,576	989	308
TOTAL		140,450	7,134	256,428	115,591	42,280	36,126	8,269	1,908
AVERAGES		11,704	595	28,492	12,844	7,047	6,021	1,654	477

Source: "Iron Furnace Questionnaire," Marietta College Archives.

[a]Forty sacks of coffee, one barrel of sugar, and one barrel of molasses used per week.

[b]Franklin, Latrobe, and Vesuvius furnaces also used 150 barrels, 3,000 pounds, and 23,211 pounds of bulk pork, respectively.

TABLE XXXII

AN ESTIMATION OF THE ANNUAL FOOD AND PROVISIONS CONSUMED BY FURNACE COMMUNITIES IN THE HANGING ROCK DISTRICT, 1847-1857

	1847		1849-50		1856		1857	
Commodities	One Furnace	Hanging Rock District	One Furnace	Hanging Rock District	One Furnace	Hanging Rock District	One Furnace	Hanging Rock District
Corn (bu.)	10,000	330,000	-		11,704	678,832	15,500	930,000[b]
Flour (barrels)	560	18,480	500	16,500	595	34,510	900	54,000
Corn Meal (bu.)	1,000	33,000	-		-	-	-	-
Bacon (lbs.)	50,000	1,650,000	40,000[a]	1,320,000	31,421[a]	1,822,418	31,000	1,860,000
Beef (lbs.)	20,000	660,000			12,844	744,952		
Potatoes (bu.)	1,500	49,500			-	-		
Coffee (lbs.)					7,047	408,726		
Sugar (lbs.)					6,021	349,218		
Molasses (gal.)					1,654	95,932		
Salt (bu.)					477	27,666		

Sources: Keeler, p. 157; Howe, p. 289; "Facts about Various Furnaces"; "Iron Furnace Questionnaire," Marietta College Archives, Iron Furnaces; Seaton, pp. 28-29; Kentucky Iron, Coal, and Manufacturing Company, p. 7.

[a]Includes bacon and other pork.

[b]Kentucky Iron, Coal, and Manufacturing Company gives the following data for 53 furnaces in the district: 848,000 bushels of corn; 31,800 barrels of flour; 15,900 bushels of corn meal; 2,650,000 pounds of bacon.

three-fourths of which were oxen.[80] The work animals and livestock in a furnace community annually consumed about 11,000 to 12,500 bushels of corn at an estimated cost of $5,500 to $6,500 (Table XXXII).[81] The feed was also supplemented with roughage (hay), rye, and oats.

These figures illustrate the support iron making gave to agricultural development, and the data on the cost of foodstuffs further emphasizes its impact. The typical furnace community annually purchased an estimated $15,000 worth of food and provisions, and collectively the furnace communities in the Hanging Rock District used over $1,000,000 worth of feed and foodstuffs each year (Table XXXIII). These findings are corroborated by an 1857 report which stated that the communities consumed corn, flour, and bacon valued at $975,000. In addition to foodstuffs, the furnace communities used $3,982,128 worth of merchandise in 1857.[82]

Much of the land in the Hanging Rock District was considered relatively poor for agriculture, and local production was often inadequate to meet the demand.[83] The ironmasters also owned large

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[80]"Iron Furnace Questionnaire, c. 1856"; "Facts about Various Furnaces," Marietta College Archives, Iron Furnaces; Howe, p. 289; Keeler, p. 157.

[81]"Sketch of Vesuvius Furnace"; "Iron Furnace Questionnaire, c. 1856"; "Facts about Various Furnaces," Marietta College Archives, Iron Furnaces; Letter, Means, Russell, and Means to W. A. Mengold and Co., November 6, 1889, University of Kentucky, Seaton Family Papers; Howe, p. 289; Keeler, p. 157.

[82]Kentucky Iron, Coal and Manufacturing Company, Ashland (New York: W. H. Arthur and Co., 1857), p. 7.

[83]Journal of the House, 1837, pp. 160-161; Stout, p. 97; Documents Relative to the Manufactures of the United States, p. 867.

TABLE XXXIII

THE COST OF FOOD AND PROVISIONS IN THE HANGING ROCK DISTRICT ABOUT 1856

Commodities	A Blast Furnace		Hanging Rock District	
	Quantity	Cost[a,b]	Quantity	Cost[a,b]
Corn (bu.)	11,704	$5,852	678,832	$339,416
Flour (barrels)	595	3,570	34,510	207,060
Bacon (lbs.)	31,421	3,142	1,822,418	182,242
Beef (lbs.)	12,844	385	744,952	22,349
Coffee (lbs.)	7,047	881	408,726	51,116
Sugar (lbs.)	6,021	602	349,218	34,922
Molasses (gals.)	1,654	1,042	95,932	60,437
Salt (bu.)	477	5	27,666	277
TOTAL COST		$15,479		$897,819

Sources: Tables XXXI and XXXII.

[a]Cost data 1856-57 from Kentucky Iron, Coal and Manufacturing Company, p. 7: Corn, 50¢ a bushel; Flour, $6.00 a barrel; Bacon, 10¢ a pound.

[b]Cost data 1846-47 from Rowe, pp. 92-93: Coffee, 12½¢ a pound; Sugar, 10¢ a pound; Molasses, 63¢ a gallon; Salt, 1¢ a bushel.

tracts of land which were unavailable for agricultural use, so the furnace community had to draw on more favored agricultural areas for food and provisions.[84] Corn, pork, much of the flour, and other necessities were received principally from the Scioto Valley.[85] The corn was shipped via the Ohio and Erie Canal to Portsmouth and then by river to the furnace landings in the Hanging Rock District.[86] Farmers in the Hanging Rock District and adjacent areas of western Virginia and east-central Kentucky also shipped feed and foodstuffs to the furnace communities.[87] During the 1860's and 1870's corn and other provisions were still being received from Portsmouth, Chillicothe, Jackson, Rio Grande, and other places nearby.[88]

Although the furnace communities in the Hanging Rock District were less self-sufficient in agriculture than those in other southern iron districts, ironmasters and laborers did plant gardens and cultivate some of the arable land on the furnace property. In addition to planting vegetable gardens, the workmen at Bellefonte furnace raised all the hay

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[84]Lawson, p. 4; Stout, pp. 97-98.

[85]Lawson, p. 9; "Statement of the Iron Railroad of Ohio, the Iron Region, and City of Ironton" (Cincinnati: Clark, 1868), Cincinnati Historical Society.

[86]Lawson, p. 9.

[87]"Receipt of Nathan Ellis," University of Kentucky, Seaton Family Papers; Howe, p. 290.

[88]Numerous references from Madison furnace Papers, Ohio Historical Society; "Report on the Statistics . . . ," Ohio Historical Center, Charles Parrott; Lawson, p. 9.

and part of the rye and oats consumed by the work animals.[89] The hands at Madison furnace raised corn and provided pasture for livestock in return for compensation in rent, supplies, and cash during the 1860's.[90] Some ironmasters also were involved in raising stock cattle, hogs, and sheep.[91]

In contrast to the Hanging Rock District, the ironmasters in outlying east-central Kentucky were apparently more involved in agriculture. At Red River Iron Works the cultivation of 800 acres of good bottom was enough to support the whole works when in full operation. The manager also operated another 200-acre farm near the furnace. He made sure that the cattle were kept out of the woodland pasture, indicating a concern for protecting timber for future use.[92]

The general store. The ironmaster made considerable profit at the general store where workmen and others in the vicinity purchased food,

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[89]Letter, Means, Russell, and Means to W. A. Mengold and Co., November 6, 1889, University of Kentucky, Seaton Family Papers.

[90]Keeler, pp. 169-170; "Journal February-September, 1869," "Peters Clare and Co. Timebook 1869-75," "Journal August-November, 1870," Ohio Historical Center, Madison Furnace Collection; "Inventory of Bellefonte," December 31, 1903, University of Kentucky, Seaton Family Papers.

[91]"Agreement between Andrew Lowell and Josiah Jackson, June 1857, University of Kentucky, Buckner Papers; "Scrapbook 1857-73," University of Kentucky, Means Family Papers; "Clare, Duduit and Co. Timebook 1875-79," Ohio Historical Center, Madison Furnace Collection; "Commissioner's Sale of the Red River Iron Works," December 16, 1865, University of Kentucky, Buckner Papers.

[92]"Commissioner's Sale of the Red River Iron Works," December 16, 1865, University of Kentucky, Buckner Papers.

clothing, hardware, and incidentals.[93] In fact, one storekeeper stated that a profit of 75% to 100% was expected as a fair return.[94] This rate of profit was, in part, due to the fact that workmen made purchases in exchange for their labor, a system of barter involving little cash except when accounts were settled.[95] In comparison to other southern districts, the sales and profits at general stores in the Hanging Rock District were undoubtedly higher, since the workmen had more purchasing power than the slave ironworkers.

During the 1850's the general stores in six furnace communities were selling from $16,500 to $35,000 worth of goods a year, including about $2,100 worth of boots and shoes and $5,000 to $6,000 worth of dry goods.[96] Since the mean annual sales of the stores at Franklin, Kenton, Madison, and Vesuvius furnaces were about $22,250, it is estimated that the company stores in the Hanging Rock District sold over $1,290,500 worth of goods each year. During the postbellum period, the value of goods sold at Keystone, Buckeye, and Vinton furnaces averaged between

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[93]Keeler, pp. 155 and 166; Stout, p. 96; Debtor William Word in Account with Slate Furnace, 1824," University of Kentucky, Thomas Dye Owings Papers; "Union Furnace Landing Daybook, February 1, 1851," University of Kentucky, Seaton Family Papers; "Daybook A Ohio Furnace, 1849," University of Kentucky, Means Family Papers; "Ledger 1817-1820," University of Kentucky, Thomas Dye Owings Papers; Rowe, pp. 92-93; Inventory File, University of Kentucky, Thomas Dye Owings Papers; Stout, "Early Forges," p. 39.

[94]Keeler, p. 155.

[95]Rowe, p. 10; Keeler, p. 155; "Clare, Duduit and Co. Journal 1874-1876," Ohio Historical Center, Madison Furnace Collection.

[96]"Iron Furnace Questionnaire," Marietta College Archives, Iron Furnaces.

$40,000 and $60,000 a year.[97] Lawson concluded that furnace stores averaged about $35,000 in sales during 1870-71.[98] If so, the stores in the district collectively transacted about $1,575,000 worth of business.

During the early period some of the ironmasters obtained clothing and other goods from the east, principally New York.[99] As furnacemen in the Hanging Rock District began to develop the iron trade with Cincinnati and Pittsburgh, however, wholesale houses in these cities became the main suppliers.[100]

Forward integration. Secondary iron manufactures which fabricated pig iron were another economic component of the furnace community. During the early period there were advantages in locating a forge or rolling mill near the blast furnace, and in 1832 one writer claimed that a forge unconnected with a furnace would barely break even.[101] However, it is estimated that during the antebellum period less than one-fifth of the furnaces in the Hanging Rock District were linked in a productive

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[97] "Report of Statistics . . . ," Ohio Historical Center, Charles Parrott.

[98] Lawson, p. 9.

[99] Documents Relative to the Manufactures in the United States, p. 867; Cappon, "unpublished manuscripts," pp. 60-61.

[100] Portsmouth and other nearby towns also began supplying the furnace communities. Stout, p. 99; Lawson, p. 9; "Receipt of Freight Notice July 30, 1870," Ohio Historical Center, Madison Furnace Collection.

[101] Documents Relative to the Manufactures of the United States, p. 865; Moore, "Red River Iron District," p. 24.

chain with a forge or rolling mill.[102] The incidence of forward integration was probably greater during the early history of the district, becoming less common in the 1840's and 1850's.[103] The operation of forges in the Hanging Rock District tended to be shortlived. By the time of Lesley's survey in the mid-1850's, every forge except Red River forge, in outlying Estill County, had been abandoned.[104] The decline in number of forges and the lack of forward integration in the district were caused by foundries and rolling mills displacing the rural forge. By the mid-1850's seven rolling mills were operating in the Hanging Rock District (in Lawrence and Scioto counties, Ohio), but it is unknown how many of these mills were linked to furnaces in the district.[105] Nevertheless, the rolling mills were a principal market for the district's pig iron.

The development of secondary manufactures in towns and cities of the Ohio Valley created additional markets for Hanging Rock iron. The merchants and bankers provided the rural ironmaster with wholesale, financial, and other services, and the ironmonger handled the iron

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[102]Peter Temin, Iron and Steel in Nineteenth-Century America (Cambridge: MIT Press, 1964), p. 94; Coleman, p. 230; Inventory File; "Ledger 1817-18," University of Kentucky, Thomas Dye Owings Papers; Cappon, "unpublished manuscripts," pp. 60 and 112; Moore, "Red River Iron District," p. 24; "Commissioner's Sale of Red River Iron Works and Estill Steam Furnace," December 6, 1865, University of Kentucky, Buckner Papers; Lesley, p. 258.

[103]Documents Relative to the Manufactures of the United States, pp. 863-867; Lesley, pp. 213-214; Journal of the House, 1837, p. 485; Stout, p. 75.

[104]Lesley, pp. 213-214.

[105]Lesley, p. 253.

trade. In short, the increase in charcoal iron making and the development of secondary manufactures were attended by an increase in large towns. Moreover, the demand for feed and foodstuffs encouraged the development of the evolving corn-livestock region, and the shipment of agricultural commodities, pig iron, and other merchandise promoted the improvement of transportation facilities to handle the new and enlarged trade.

The Pattern of Iron Trade for the Hanging Rock District

The rapid development of the Hanging Rock District is best explained on the basis of the increasing demand for pig iron by the secondary manufacturers in the urban-industrial centers of the Ohio Valley.[106]

The Pattern of Production and Consumption in the Ohio Valley and Midwest

In the early years, it is estimated that about one-half to two-thirds of the Hanging Rock District's metal was manufactured into castings and hollowware.[107] Following this stage of development, ironmasters began to manufacture more pig iron and fewer castings, molding one-third or less of the district's metal into castings and

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[106] Isaac Lippincott, A History of Manufactures in the Ohio Valley to the Year 1860 (New York: Knickerbocker Press, 1914), p. 97; Harry N. Scheiber, Ohio Canal Era: A Case Study of Government and the Economy 1820-1861 (Athens, Ohio: Ohio University Press, 1969), p. 221.

[107] United States Bureau of the Census, unpublished census manuscripts, "Census of Manufactures," 1820.

hollowware.[108] The principal consumers of the increasing supply of pig iron were the foundry, rolling mill, and forge. The rural forge, which produced bar iron, was gradually abandoned in favor of the rolling mill; and the foundry offered greater possibilities for the fabrication of strong, intricately shaped pieces of iron and was better equipped than the furnace and forge to supply a variety of needs.[109]

After a slow beginning, these secondary manufactures developed rapidly, and the Hanging Rock District entered a third stage of development (circa the late 1830's-1840's) when pig iron was almost exclusively made for the foundry and rolling mill markets. These secondary manufacturers were located in urban areas and were more closely associated with their consumers than the rural furnace. Since there was a small weight loss in the manufacturing process, it was profitable to transport pig iron to the urban-industrial centers for fabrication.

By 1850 the blast furnaces in the Hanging Rock, Red River, Western, and Missouri iron districts, as well as other outlying areas, produced 131,874 tons of pig iron and castings, which was nearly a quarter of the nation's total iron production (Table XXXIV). The consumption (demand) of pig iron by foundries, rolling mills, and forges was nearly equal to the supply, with the Pittsburgh market likely receiving the balance of the metal.

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[108] Documents Relative to the Manufactures of the United States, pp. 863-867.

[109] Temin, p. 38.

TABLE XXXIV

THE PRODUCTION AND CONSUMPTION OF PIG IRON IN THE OHIO VALLEY AND MIDWEST IN 1850 (IN TONS)

State	Pig Iron Production	Pig Iron Used in Castings	Pig Iron Used in Wrought Iron	Total Consumption	Pig Iron Production Minus Consumption
Kentucky	24,245	9,731	2,000	11,731	+12,514
Ohio	52,658	37,555	13,675	51,230	+1,428
Tennessee Counties of the Western Iron District[1]	28,336	1,783	14,110[a]	15,893	+12,443
Missouri	19,250	5,100	1,204	6,304	+12,946
Indiana	1,850	1,968	50	2,018	-168
Illinois	2,700	4,818	-	4,818	-2,118
Michigan	660	2,494	-	2,494	-1,834
Wisconsin	1,000	1,371	-	1,371	-371
Western Virginia[2]	1,175	1,971	8,625	10,596	-9,421
TOTALS	131,874	66,791	39,664	106,455	+25,419
U.S.	564,755	345,553[b]	251,491[c]	597,044	

Sources: U.S. Bureau of Census, published and unpublished census.

[1]Includes the Tennessee counties of the district, plus Giles, Henry, Madison, Maury, Robertson, Shelby, Sumner.

[2]The wrought iron includes forged, rolled, and nails. The counties include only those near the Ohio Valley, particularly Ohio, Wood, and Kanawha.

[a]Bloom iron.

[b]Another 11,416 tons of old metal and 9,850 tons of ore were used.

[c]Another 33,344 tons of blooms and 78,787 tons of ore were used.

The foundry and machine shop. After a slow beginning during the first three decades of the 19th century, the foundry and machine shop business grew rapidly in the Ohio Valley and Midwest.[110] While Hanging Rock iron had an excellent reputation for bar iron and castings, it was generally more distinguished for foundry uses.[111] It equaled Scotch pig iron for foundry purposes and surpassed the quality of Juniata and Salisburg iron for special uses requiring tension.[112] By the 1830's the foundry and machine shop was a principal market for the district's metal, as Hanging Rock iron proved to be the very kind of iron that foundrymen wanted.[113]

In 1850 the foundry and machine shops in the Ohio Valley and Midwest were the primary consumers of Hanging Rock pig iron, using 66,791 tons, or 51%, of the production (Table XXXIV). The secondary manufacturers in Ohio, particularly those in Cincinnati, were the largest consumers of this pig iron.

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[110]Lippincott, pp. 98 and 103; United States Bureau of the Census, unpublished census manuscript, "Census of Manufactures," 1820; Documents Relative to the Manufactures of the United States, pp. 862-863 and 865; Cozzens, p. 511; Rowe, p. 14.

[111]"Statement of the Iron Railroad," p. 9, Cincinnati Historical Society; Collins and Webb, no page; Keeler, pp. 135, 157, 161; Moore, "Kentucky Division of Hanging Rock," p. 3; Lawson, pp. 6 and 17; Howe, p. 289.

[112]Howe, p. 289; Lawson, p. 6.

[113]Keeler, p. 147; Moore, "Kentucky Division of Hanging Rock," p. 10; Letter, McCurdy and Loomis to H. Means & Co., February 11, 1853, University of Kentucky, Means Family Papers; Lesley, pp. 113-126; Lawson, pp. 18-20, 13; Letter, George S. Moore & Co. to Clare Duduit & Co., February 26, 1874, Ohio Historical Center, Madison Furnace Collection; "Furnace Sketch, Pine Grove, September 14, 1854, Marietta College Archives, Iron Furnaces.

Between 1841 and 1851 the value of ironware manufactured in Cincinnati quadrupled.[114] At midcentury the secondary manufacturers in Cincinnati fabricated 26,785 tons of pig iron--which was over half the pig iron consumption of the state--into castings, stoves, steam engines, and other iron products. By 1857 the ironware made by firms in the city was valued at $7,000,000 and was sold in every state in the Mississippi Valley.[115]

The value of machinery manufactured in Ohio increased by 125% between 1850 and 1860, while that for the rest of the country advanced by only 16%. By 1860 Ohio ranked fourth in the nation in the value of machinery produced, with manufacturers in Cincinnati accounting for nearly half the total value.[116]

The rolling mill market, 1850-1857. Another principal urban-industrial market for Hanging Rock iron was the rolling mill. At midcentury, rolling mills clustered around the Wheeling, Hanging Rock, and Cincinnati areas fabricated about 25,554 tons of pig iron into bar, sheet, wire, nails, and boiler iron.[117] By the mid-1850's a greater number of rolling mills were in operation in the Ohio Valley, using a

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[114]Scheiber, p. 221.

[115]Annual Report, Commissioner of Statistics, 1857, pp. 25-26; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850.

[116]Lippincott, p. 175.

[117]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850; Lesley, pp. 256 and 756-758.

much larger quantity of pig iron than in 1850 (Figure 39). The rolling mills clustered in the Cincinnati and Hanging Rock areas fabricated an estimated 40,000 to 50,000 tons of pig iron and blooms into 19,000 and 14,000 tons of rolled iron, respectively. The rolling mills in the St. Louis, Missouri, area fabricated another 9,000 tons of pig iron and blooms into over 7,000 tons of iron products.[118]

The largest concentration of rolling mills, however, was in the upper Ohio Valley. The rolling mills clustered in the Pittsburgh and Wheeling areas used an estimated 112,000 and 20,000 tons of pig iron to manufacture 89,779 and 16,398 tons of bar iron, nails, sheet, railroad iron, and other products, respectively.[119] In addition, the foundries and machine shops, some manufacturing steam engines, in Pittsburgh used another 56,200 tons of pig iron in 1857, making Pittsburgh the largest iron-using center in the Ohio Valley and Midwest.[120]

The Pattern of Iron Trade for the Hanging Rock District through the 1830's

During the early period a large share of the production was in the form of casting and hollowware. The ironmasters sold these pots, kettles, and other castings to local farmers and other settlers,

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[118] Lesley, pp. 259-260.

[119] These estimates are based on 1¼ tons of pig iron being equivalent to one ton of bar iron. Two rolling mills in Wheeling are omitted from these data, thus suggesting the tonnage is slightly understated. Lesley, pp. 247-255; B. F. French, History of the Rise and Progress of the Iron Trade of the United States, from 1621 to 1857 (New York: Wiley and Halsted, 1858), p. 171.

[120] French, pp. 171-173.

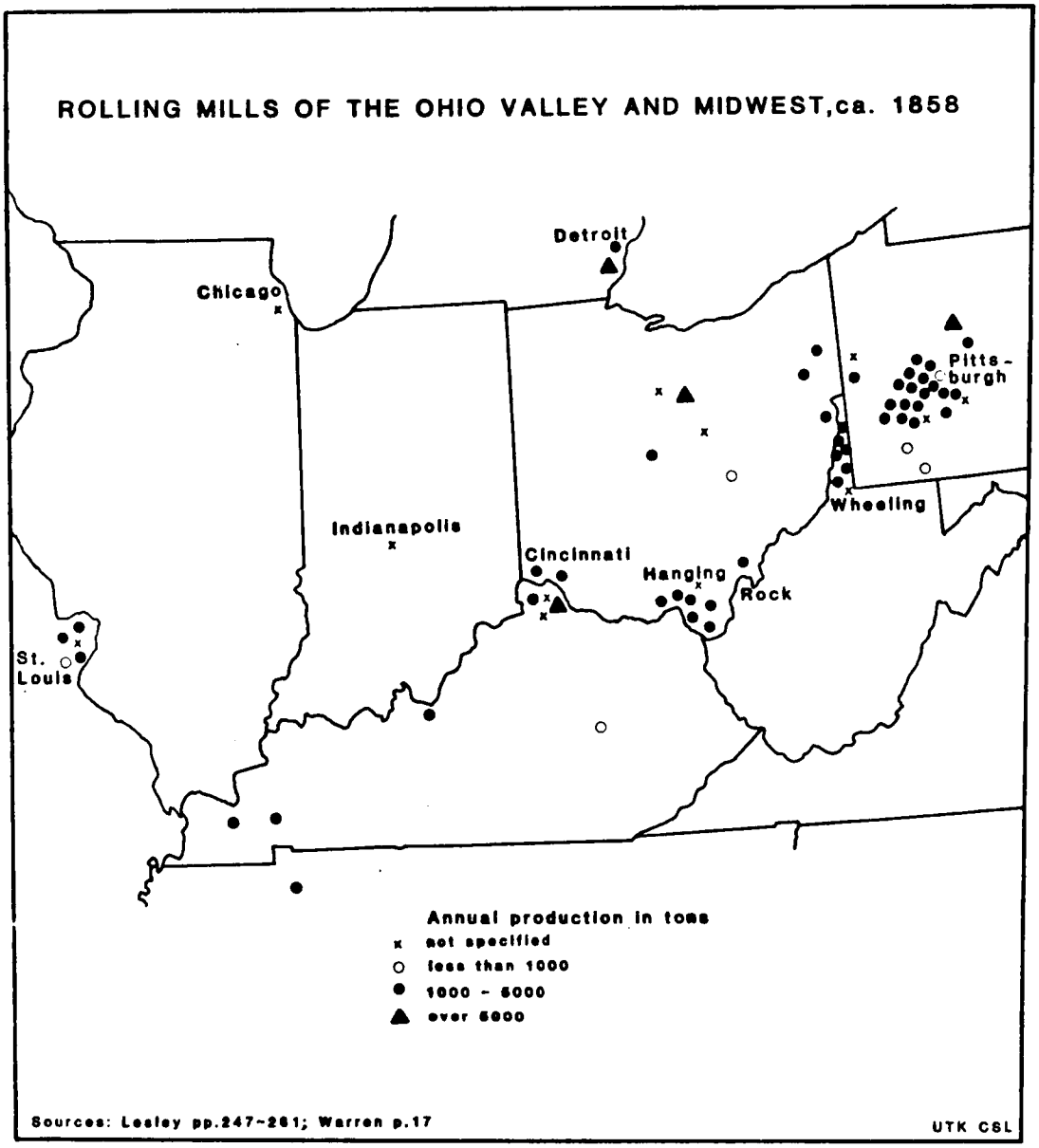

Figure 39. Rolling Mills of the Ohio Valley and Midwest, ca. 1858.

shipping the surpluses to merchants and iron stores in Chillicothe, Portsmouth, Piketon, Jackson, Cincinnati, Louisville, Lexington, Owingsville, and other towns regularly stocking ironware.[121] The balance of molten metal was cast into pig iron, which was either sold to local forges or shipped to developing urban-industrial centers such as Pittsburgh, Cincinnati, Louisville, and other towns in the Ohio and Mississippi valleys.[122]

The iron industry was a competitive business, and Hanging Rock iron regularly came into direct competition with Pennsylvania, Virginia, Maryland, Tennessee, and foreign iron.[123] Ironmasters had mixed opinions as to the effect of this competition. In 1820 an ironmaster in Bath County, Kentucky, noted that a supply of iron from Ohio and Pennsylvania had overstocked the river trade, limiting his sales to the interior of Kentucky.[124] Although some ironmasters thought that competition was unlikely in the interior because of excessive transportation costs, they still complained about the decline in demand and profits

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[121]Keeler, p. 143; Coleman, pp. 230, 232, and 235; Rowe, p. 4; Stout, "Early Forges," pp. 34-35; Jillison, pp. 12, 16, 26, and 28.

[122]Journal of the House, 1837, pp. 160-162.

[123]Lippincott, pp. 102-103; Keeler, p. 143; Seaton, p. 8; Rowe, p. 4; Kenneth Warren, The American Steel Industry 1850-1870, A Geographical Interpretation (Oxford: Clarendon Press, 1973), p. 36; United States Bureau of the Census, unpublished census manuscripts, "Census of Manufactures," 1820.

[124]United States Bureau of the Census, unpublished census manuscripts, "Census of Manufactures," 1820.

caused by competition and rise in production costs.[125] Others asserted that no area of the West was beyond the reach of foreign competition, insisting that without tariffs they would be driven out of business.[126]

In spite of the competition, periodic decline in iron prices, and increases in production costs, ironmasters in the Hanging Rock District were able to expand production and supply the local and regional markets at a profit. With pig iron selling freely at $30 a ton in 1832, four ironmasters in the district netted from 10% to 34% on their capital investments, which was a good return.[127]

The profits on the sale of iron during the late 1830's were also considerable. In 1837 the iron trade of eleven furnaces and five forges in Greenup County, Kentucky, was worth between $500,000 and $750,000.[128] Based on these figures, it is estimated that the value of pig iron sold by furnaces in the Hanging Rock District was worth about $1,000,000. The pattern of trade was similar to the early stages of development, as ironmasters were supplying local forges and shipping surplus metal to secondary manufacturers in Pittsburgh, Cincinnati, Louisville, and other towns in the Ohio and Mississippi valleys.

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[125] Documents Relative to the Manufactures of the United States, pp. 863-864.

[126] Documents Relative to the Manufactures of the United States, pp. 866-867.

[127] Documents Relative to the Manufactures of the United States, pp. 863-864, 866-867.

[128] Coleman, p. 236; Journal of the House, 1837, pp. 485-486, 160-162.

The Pattern of Trade for the Hanging Rock District, 1846-1860

In 1846, Henry Howe stated that the principal markets for Hanging Rock iron were Pittsburgh and Cincinnati, but the trade involved other areas.[129] During the 1847 season, the iron trade of Ohio and Union furnaces was directed toward the middle Ohio Valley and Midwest, the proprietors shipping over 3,457 tons of pig iron to Cincinnati, Louisville, New Albany, Madison, St. Louis, Springfield, and Pittsburgh (only 204 tons).[130] The pattern of trade for other furnaces in the Hanging Rock District was similar to that of Ohio and Union furnaces, supplying the demand in the middle Ohio Valley and Midwest.[131] During the early 1850's the pattern of trade for Ohio, Union, and Buena Vista furnaces was still directed toward the middle Ohio Valley and Midwest, as the ironmasters recorded sales in Portsmouth, Cincinnati, Covington, Louisville, New Albany, Madison, Evansville, Dayton, Mansfield, Cleveland, New Orleans, and in Columbus, Richmond, and Shelby County, Indiana.[132]

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[129]This discussion is based on manuscript records containing information on over twenty furnaces, with particular reference to Union, Ohio, Pine Grove, Buena Vista, Bellefonte, and Madison furnaces. Howe, p. 289; Keeler, p. 157; Stout, pp. 98-99; "Scrapbook 1857-73," University of Kentucky, Means Family Papers.

[130]Another 1,300 tons were shipped to unspecified locations. "Daybook January 25, 1847 to April 3, 1854," Cincinnati Historical Society, Sinton and Means; "Certificate of Pig Iron landed from Flatboats . . . ," University of Kentucky, Seaton Family Papers.

[131]Keeler, pp. 145, 155, 159-160, 162, 165 and 168; Lesley, pp. 113-126 and 213-214.

[132]This statement is based on the frequency that places were listed in the manuscript records. However, the firm did ship 1,035 tons via

While these manuscript records indicate that the majority of trade was oriented toward the middle Ohio Valley and Midwest, a significant quantity of Hanging Rock iron was also sold in upper Ohio Valley marketplaces such as Wheeling and Pittsburgh. During 1853 and 1854 Pittsburgh ironmongers, McCurdy and Loomis, handled the sales for several furnaces in the Hanging Rock District.[133] It was in the Pittsburgh trade, however, that competition from pig iron made with anthracite coal triggered the decline of the Hanging Rock District.

The Relative Decline of the Hanging Rock Charcoal Iron Industry 1853-1877

Ironmasters in the Hanging Rock District were successful in competing for markets through the early 1850's and were able to expand production. The 1850's were the most energetic period of investment and establishment of new furnaces, particularly in the Ohio counties of the district, where twenty-one furnaces were built between 1853 and 1856 (see Figure 33, page 199).[134] Ironmasters were encouraged to invest in

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flatboat to New Albany, Madison, Dayton, Evansville, Newport, Covington, Cincinnati, and Tiffin. "Ledger A 1847-59," "Daybook Journal 1847-1854," Cincinnati Historical Society, Sinton and Means; Letter, Kratz and Heilmann to Russell, Means & Co., January 3, 1858, University of Kentucky, Means Family Papers; "Daybook 1847, 1854," Cincinnati Historical Society, David Sinton.

[133]"Statement from M. Ford, City Weigher, Wheeling," July 4, 1854, University of Kentucky, Means Family Papers; Letter, McCurdy and Loomis to H. Means & Co., February 11, 1853, University of Kentucky, Means Family Papers; Keeler, pp. 162 and 165.

[134]Stout, p. 79.

Ohio, because new railroad construction improved the prospect of assembling raw materials and transporting iron to the market. In addition, the profit margin was greater in the Ohio section than that in the Kentucky section of the district, and the lower investment per ton in Ohio meant an even higher profit rate (Table XXXV).

The 1850's were a dynamic period as production rose from 56,491 tons in 1850 to a peak rate of 96,000 tons in 1857. In the late 1850's, however, iron production of the Hanging Rock District suffered a relative and absolute decline, and in 1860 the output fell to 84,170 tons.

The Relative and Absolute Decline in the Late Antebellum Period

The decline of the Hanging Rock District can be largely explained by the inability of ironmasters to compete successfully for markets. This competition was experienced first in the Pittsburgh trade in the 1850's, extending to other marketplaces in the Midwest during the postbellum period. The interrelated causes of the regional demise were: (1) the direct and indirect competition from cheaper domestic (anthracite pig iron) and foreign iron; (2) the expansion of the railway network that allowed anthracite iron to enter the Pittsburgh trade and established the basis for the development of pig iron made with bituminous coal and coke; (3) the rise of pig iron made with bituminous coal and coke in the latter 1850's, which provided new competition;

TABLE XXXV

CALCULATED PROFITS FROM PRODUCING PIG IRON
IN THE HANGING ROCK DISTRICT IN 1850

	Hanging Rock District	Ohio Counties of the District	Kentucky Counties of the District	Red River Iron District
Selling Price	$30	$30	$30	$30
Less Transport	5	5	5	5
Furnace Price Per Ton	$25	$25	$25	$25
Less Ore and Flux	5	4.65	5.89	8.17
Charcoal	7.28	6.74	9.15	6.54
Labor	2	2	2	2
Interest	2	2	2	2
General Expenses	2	2	2	2
	$18.28	$17.39	$21.04	$20.71
Profit Margin Per Ton	$6.72	$7.61	$3.96	$4.29
Investment Per Ton	$33.70	$32	$39	-

Sources: U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850; Temin, p. 64.

(4) the fluctuating and periodic decline in iron prices; and (5) the rise in cost of raw materials, labor, and supplies.[135]

By the 1850's the cost of transportation had declined enough to allow anthracite pig iron to compete with charcoal iron in places other than the eastern seaboard.[136] The Pennsylvania Railroad connected eastern and western Pennsylvania in 1852, and merchants began quoting the price of anthracite metal in Pittsburgh, which affected western iron prices. The sale of foreign iron in the Atlantic states also had the effect of reducing prices.[137]

While the railroad increased the demand for iron products by stimulating the economy, the eastern pig iron reduced the demand and price for charcoal iron in western Pennsylvania. The resulting downward drift in iron prices helped produce the rapid decline in charcoal iron production in western Pennsylvania, plummeting production by one-half

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[135]According to Moore, furnaces failed because of: poor location, exhaustion of timber supply, and unsuccessful management. Coleman states that the district's decline in the 1860's and 1870's was caused by: (1) native ores becoming harder to reach; (2) the timber supply beginning to diminish; (3) anthracite coal furnaces in the North began to drive the expensively-made charcoal iron from the markets; and (4) remoteness. Moore, "Kentucky Division of Hanging Rock," p. 4; Coleman, p. 240.

[136]As early as October, 1842 pig metal from the interior of Pennsylvania limited the sale of Hanging Rock iron in Pittsburgh. Letters, Semple and Barker to Samuel Seaton, October 1, 1842, December 2, 1842, University of Kentucky, Seaton Family Papers; Peter Temin, "A New Look at Hunter's Hypothesis about the Antebellum Iron Industry," American Economic Review 54 (May, 1964), p. 348; Temin, Iron and Steel in Nineteenth-Century America, p. 77; Warren, p. 31.

[137]Ninth Annual Report of the Commissioners of Statistics for 1865 (Columbus: Richard Nevins, 1866), p. 24.

between the peak rate in the 1840's and the outbreak of the Civil War.[138] The initial impact on production in the Hanging Rock District was less dramatic than that in western Pennsylvania, because Hanging Rock ironmasters were less dependent on the Pittsburgh market.

Nevertheless, the competition from the anthracite metal in Pittsburgh was a paramount factor in initiating the decline of the Hanging Rock District. In February 1853, a Pittsburgh agent summarized the problem of competition in the following statement:

> We are now reluctantly constrained to say the price of Hanging Rock Hot blast metal cannot be sustained here, there is daily rects from over the mountains by RR of such metal as will answer foundries for almost any purpose, especially hollowware, it sells for about 40 to 43 $ per ton as in quality--this is new competition and will continue so long as prices here rule higher than in Eastern markets.[139]

This competition was particularly serious, because the foundry was a primary consumer of Hanging Rock metal. Although pig iron made with bituminous coal and coke entered the trade in the 1850's, it was a more notable feature of the competition in the postbellum period.

In addition to the competition, ironmasters in the Hanging Rock District experienced financial difficulties between 1855 and 1862, because of the business recession and low iron prices.[140] Pig iron,

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[138]Temin, Iron and Steel in Nineteenth-Century America, p. 77; Warren, p. 31.

[139]Letter, McCurdy and Loomis to H. Means & Co., February 11, 1853, University of Kentucky, Means Family Papers.

[140]Some writers have incorrectly concluded that none of the district's furnaces were making a profit between 1856 and 1860, but Ohio, Madison, and others made profits and paid dividends during this period. Another factor in the decline may have been the change in furnace management as 18 furnacemen in Lawrence County, Ohio, and Greenup County, Kentucky, died between 1849 and 1858. Rowe, p. 100;

which was selling for $50 a ton in 1853, commanded only $35 in 1854. All business except farming began to lag, and because of the lack of funds some of the newly constructed furnaces in the district were unable to operate.[141] The poor prospect of the iron business was aptly summarized by Mr. Means who stated:

> From 1854-1861 I kept my furnaces going, but sold very little iron--only enough to keep me in ready money . . . For eight years before the war, nearly all the furnace-owners were in debt, but creditors did not distress them, for they were afraid of iron, the only asset they could get, so they carried their customers the best they could, hoping all around the better times.[142]

While the panic of 1857 developed too late to affect production, large inventories were evidently accumulated because only small quantities of pig iron were sold.[143] The presence of anthracite iron in Pittsburgh and the rise in costs of production continued to limit the potential for Hanging Rock ironmasters to make a profit.[144] At a

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Keeler, pp. 168-169, 172, and 183; Gillenwater, pp. 75-76; "Scrapbook 1857-1873," University of Kentucky, Means Family Papers; Lesley, pp. 756-758; "Ledger 1859-1864," Vol. 2, Cincinnati Historical Society, David Sinton; "Memorandum of Stock Used and Iron Made at Madison furnace in Fifteen Years," in "Time Book, 1869-1875 Peters, Clare & Co.," Ohio Historical Center, Madison Furnace Collection.

[141]Keeler, pp. 168-169.

[142]Keeler, p. 179; Rowe, p. 78.

[143]Lesley, p. 752; Keeler, p. 179; Temin, p. 25; Letter, Jack and Brother to J. A. Jackson, June 15, 1858, University of Kentucky, Buckner Papers; "J. D. Clare Diary, Scrapbook 1888-1897," Ohio Historical Center, Madison Furnace Collection; Gillenwater, pp. 75-76.

[144]"Sketch of Vesuvius Furnace," Marietta College Archives, Iron Furnaces; "Scrapbook 1857-73," University of Kentucky, Means Family Papers; Letter, Archibald Means to John Means, November 12, 1864, University of Kentucky, Seaton Family Papers; Letter, George S. Moore to Jackson and Jones, March 7, 1860, University of Kentucky, Buckner Papers.

meeting in December, 1858, Hanging Rock ironmasters concluded that because of the great disparity between the price of pig iron and the cost of labor, raw materials, and supplies, they were unable to operate at a profit.[145] Between 1858 and 1861 pig iron was sold at low prices, and in 1861 it was selling at only $10 to $14 a ton,[146] which was less than the cost of production.

The Relative Decline during the Civil War and Postbellum Period

The Civil War period. Charcoal furnaces began an active period of operation in 1862, when the price and demand of pig iron improved.[147] By 1863 pig iron was selling at $40 a ton and in 1864 netted one ironmaster $80 a ton.[148] These high prices made the charcoal iron industry profitable again, but production during the Civil War was probably less than in the periods before and after the War.[149] One

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[145]"Scrapbook, 1857-1873," December 2, 1858, University of Kentucky, Means Family Papers.

[146]Keeler, p. 179; Rowe, p. 78.

[147]Rowe, p. 100; Letter, Thomas W. Means to John Means, December 1, 1862, University of Kentucky, Means Family Papers; Keeler, pp. 180-181; Letter, John Moorhead to Thomas W. Means, November 21, 1862, University of Kentucky, Means Family Papers; "Journal 1855-1873, Union Furnace Landing," December 11, 1862, University of Kentucky, Means Family Papers; "Ledger 1855-1890 Ohio Furnace," University of Kentucky, Means Family Papers.

[148]Keeler, p. 179; Rowe, p. 78.

[149]Rowe, p. 78; Keeler, pp. 135, 183; Seaton, pp. 23-24; Frank C. Morrow, A History of Industry in Jackson County Ohio (Athens, Ohio: Lawhead Press, 1956), p. 32; "Ledger 1859-1864," Vol. 2, Cincinnati Historical Society, David Sinton; "Memorandum of Stock Used and Iron Made at Madison Furnace in Fifteen Years," in "Time Book 1869-1875," Ohio Historical Center, Madison Furnace Collection.

writer concluded that the growth of Ironton, Ohio, was slow, that property sold cheap, and that the iron industry was depressed during the War.[150] Two circumstances contributed to the supposedly smaller output during the War. First, ironmasters operated furnaces at a reduced capacity until the stocks of iron accumulated before the War were sold. Secondly, the demand for pig iron to make ordnance and other military ironware did not counterbalance the checked market for railway equipment, structural, and other ironware.[151]

The mineral-fuel technology: iron production 1860-1875. Another immediate effect of the high prices during the Civil War was the erection of stone-coal furnaces in the Hanging Rock District.[152] The mineral-fuel technology was successfully introduced in 1864 when Star furnace was erected in Jackson County, Ohio, and by 1870 the mineral-fuel furnaces in the district produced over 23,000 tons.[153] Meanwhile, the district's charcoal iron production rose from 84,170 to 103,816 tons between 1860 and 1870, but in spite of the increase the Hanging Rock District experienced a decline relative to the rest of the nation's iron industry, including the charcoal sector.

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[150] Lawson, p. 8.

[151] Keeler, p. 179; Rowe, p. 78; Temin, p. 25; Victor S. Clark, History of Manufactures in the United States 1860-1893 Vol. 2 (New York: McGraw-Hill, 1929), pp. 15-16.

[152] Keeler, p. 183.

[153] Ironmasters were discussing the possibility of using the mineral-fuel technology in 1854 or before, and in 1856 stone-coal furnaces were operated unsuccessfully in the Hanging Rock District. Keeler, pp. 174-176 and 184-185; Lesley, p. 116.

Pig iron made with bituminous coal and coke in the United States was increasing at a rapid rate between 1860 and 1870, and the increase was at the expense of charcoal iron in the Midwestern market.[154] The production of the nation's bituminous coal and coke furnaces accounted for 10% of the national output in 1859; by 1864 production had increased by 263,000 tons, the coal and coke furnaces accounting for 112,000 tons of this increase.[155] By 1875 pig iron made with bituminous coal and coke accounted for 42% of the nation's total production, exceeding that made with anthracite and a mixture of anthracite and coke.[156]

In part, the rate of growth may be attributed to the fact that coal and coke pig iron was used extensively by secondary manufactures, such as rail mills, that were rapidly growing. Charcoal iron, on the other hand, was used increasingly for such relatively slow-growing items as malleable castings, cast-iron stoves, wagon axles, hand tools, firearms, and other foundry uses.[157]

Railroad impact on the development of the mineral-fuel technology. Railroads facilitated the assembly of raw materials and opened new markets, which provided the stimulus for the development of pig iron made with bituminous coal and coke. According to Warren, the use of Connellsville coking coal, which improved the quality of coke pig iron so that it was interchangeable with anthracite metal, awaited the

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[154]Lesley, p. 752.

[155]Temin, p. 266; Warren, p. 38.

[156]Temin, pp. 266-268.

[157]Fogel and Engermann, "A Model," pp. 160-161; Temin, p. 214.

construction of railroads into the coalfield.[158] In 1855 the Pittsburgh and Connellsville Railroad, following the Youghiogheny Valley, reached the main coal basin, five miles west of Connellsville. With other branch lines and extensions of railroads improving the assemblage of raw materials and opening new markets, coke smelting grew rapidly in the Pittsburgh area.[159]

This rapid rise of Pittsburgh as an iron-smelting center was based, first and foremost, on the hard, firm, almost sulphur-free coke made from Connellsville coal and only secondly on the iron ores of the district.[160] Further impetus was given to the large-scale development of the mineral-fuel industry by the simultaneous use of Lake Superior iron ores, the completion of the original Soo Canal in 1855, the development of specialized ore steamships, and the construction of ore-carrying railroads from the lake.[161] The Lake Superior ore was brought by rail from Lake Erie ports to the Pittsburgh area, where it met the superior Connellsville coking coal brought by rail and water. The railway network also linked Pittsburgh with the rapidly growing

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[158]Temin, "A New Look at Hunter's Hypothesis," pp. 348-349; Warren, pp. 37-38; Temin, p. 79.

[159]Warren, pp. 37-38.

[160]Norman J. G. Pounds, The Geography of Iron and Steel (London: Hutchinson & Co., 1963), pp. 121-122.

[161]Pounds, p. 122; Alfred D. Chandler, Jr., editor, The Railroads: The Nation's First Big Business (New York: Harcourt, Brace & World, Inc., 1965), p. 32.

markets in the west and the older industrial centers of the east.[162] As the quality of coke pig iron was improved, Hanging Rock charcoal iron became increasingly difficult to sell.

The impact of the railroad on the Hanging Rock District. The charcoal ironmasters in the Hanging Rock District were responsible for developing the first railroads, which served as feeder lines to river transportation. By 1851 the Iron Railroad, a 13-mile track extending from Ironton to Center furnace, was carrying pig iron to the river for several furnaces.[163] In October, 1853, the Hocking and Scioto Valley Railroad was extended to Jackson, connecting Jackson and Portsmouth and opening a new line of trade north through Columbus. In 1856 the route was extended from Jackson to Hamden in southern Vinton County, Ohio, where it made connections with the Marietta and Cincinnati Railroad.[164] These railways accommodated charcoal furnaces and were the stimulus for the construction of numerous furnaces in the Hanging Rock District.[165] In the Kentucky section of the district, a 10-mile stretch of the Lexington and Big Sandy Railroad was in operation between Ashland and Princess in November, 1857, carrying pig iron to the river for transshipment to Cincinnati.[166] Although the railroads opened new lines of trade to such marketplaces as Cincinnati, Columbus, Chicago, and other

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[162]Pounds, p. 122.

[163]Stout, pp. 99-100.

[164]Keeler, pp. 165 and 167; Stout, p. 100.

[165]Stout, p. 100; Seaton, p. 24.

[166]Gillenwater, p. 75.

cities, the river trade maintained its dominance. In 1871 Lawson noted that 82,500 tons of pig iron, accounting for about two-thirds of the Hanging Rock District's production, were shipped from Ironton, Ashland, Hanging Rock, Petersburg, and other river landings.[167] Thus, through 1871 railroads were largely serving as feeder lines to the river and did not drastically alter the pattern of trade. Instead, railroads made possible the distribution of cheaper iron products of Pittsburgh,[168] furthering the demise of the Hanging Rock District.

Competition from the mineral-fuel industry, 1865-1877. Charcoal iron from the Hanging Rock District could not compete on even terms with iron made with mineral fuels, and the charcoal iron industry gradually declined from its preeminent position. Between 1860 and 1870 the cost of raw materials to make a ton of charcoal iron increased from $15.25 to $23.27, and any further increases in cost of labor, supplies, and/or provisions caused an increase in cost of production which reduced the profit margin.[169] The presence of cheaper iron made with mineral fuels affected the sale of charcoal iron, and charcoal ironmasters found it difficult to meet financial commitments during periods of uncertain sales and declining prices.

The firm of Sinton and Means (Pine Grove furnace) sold only 200 tons of pig iron in 1864, and their customers in Cincinnati were short

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[167]Lawson, p. 5.

[168]Pounds, p. 133.

[169]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860, and 1870.

of money and slow in paying for small lots.[170] The sale of charcoal iron in Pittsburgh was also slow during the spring of 1865. Hanging Rock charcoal iron was being held at $50 to $65 a ton in Pittsburgh, but consumers there were able to purchase a quality anthracite foundry iron at $41 to $44 a ton.[171] Competition made it impossible for Sinton and Means, one of the most successful firms in the district, to make sales and pay the $25,000 principal and interest on their loan, causing them to dissolve their partnership in 1865. When Buena Vista furnace became unprofitable, moreover, Hugh Means sold his interest in the furnace.[172]

During the next few years, other charcoal furnaces in the Hanging Rock District experienced hardships, because pig iron made with mineral fuels continued to undersell Hanging Rock charcoal iron. In October, 1868, Scotch pig iron was quoted at $40 a ton in New York and at $44 to $46 in St. Louis and Chicago. A Cincinnati ironmonger stated that consumers would not purchase any Hanging Rock iron at over $40 a ton and would take little at $40 while the price of Scotch pig iron was declining.[173] Secondary manufacturers in Cleveland were buying Lake

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[170]Letter, W. Means to John Means, January 12, 1865, University of Kentucky, Means Family Papers.

[171]Letters, W. Means to John Means, January 12, 1865; A. Means to J. Means, June 29, 1865, University of Kentucky, Means Family Papers.

[172]"Indenture Made between Hugh Means of Boyd County, Kentucky and Thomas W. Means of Lawrence County, Ohio, August 1, 1865"; "Scrapbook 1857-1873," University of Kentucky, Means Family Papers; "Ledger 1859-1864," Cincinnati Historical Society, David Sinton; Letters, John Kyle to Dear Sir (Means), January 2, 1865; James G. Kyle to John Means, October 27, 1868, University of Kentucky, Means Family Papers.

[173]Letter, James G. Kyle to John Means, October 27, 1868, University of Kentucky, Seaton Family Papers.

Superior and Massillon and Todds (northeastern Ohio) iron at $40 to $43 a ton, refusing to purchase any Hanging Rock metal in Cincinnati at $40 a ton.

Between 1869 and the early 1870's there was an improvement in the market for Hanging Rock iron, but after the panic of 1873 profits were significantly reduced when iron prices plummeted.[174] The ironmaster of Madison furnace could not sell any large quantities of charcoal iron in Pittsburgh, because anthracite metal, selling at $10 less per ton, had filled the market.[175] In July, 1873, Midwest consumers were being supplied from Pittsburgh because the price of Hanging Rock metal was too high.[176] In December, an ironmonger stated the Mt. Savage and Laurel furnaces of the Hanging Rock District and Stonewall furnace of Alabama were selling pig iron to his usual customers, filling the demand and making it impossible for him to sell other brands of Hanging Rock iron.[177]

After 1873 the price of charcoal iron dropped to $25 to $30 a ton, and between 1874 and 1876 the cost of making and transporting iron to

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[174]"J. D. Clare Diary-Scrapbook 1888-1897"; "Time Book 1869-1875," Ohio Historical Center, Madison Furnace Collection.

[175]Letters, Loomis and Collard to Clare, Duduit & Co., August 6, 1873; Loomis and Collard to Clare, Duduit & Co., August 19, 1873, Ohio Historical Center, Madison Furnace Collection.

[176]Letter, W. L. Davis to Clare, Duduit & Co., July 17, 1873, Ohio Historical Center, Madison Furnace Collection.

[177]Letter, Addy, Hull & Co. to Clare, Duduit & Co., December 13, 1873, Ohio Historical Center, Madison Furnace Collection.

the market brought the ironmaster into debt.[178] In March, 1876, a Pittsburgh agent informed a Hanging Rock ironmaster that there was nothing encouraging about the future, and a change in the iron trade must occur, ". . . but when and who will be standing when all is over."[179] One after another the charcoal furnaces were left standing as relics of the past as the demise of the charcoal iron industry continued during the next decade. By 1889 the charcoal iron production of Ohio and Kentucky, of which the Hanging Rock District was a major producer, had fallen to only 29,253 tons.[180]

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[178]"Annual Statement of Means, Kyle & Co. for the year ending March 31, for Ohio and Pine Grove Furnaces 1869-1877," University of Kentucky, Means Family Papers.

[179]"Account of Sales and Charges of Madison by Loomis and Collard, Pittsburgh," March 11, 1876, Ohio Historical Center, Madison Furnace Collection.

[180]"Scrapbook No. 1," Newspaper clipping, Tennessee State Library, J. B. Killebrew Papers.

CHAPTER VI

THE UPLAND SOUTH IRON DISTRICT

The Upland South District includes the Carolina Piedmont, east Tennessee, northwestern Georgia, and northern and central Alabama. The iron industry in the district began in North Carolina during the colonial period, perhaps as early as 1725.[1] The industry was established in South Carolina about 1773, and during the Revolutionary Period ironworks were operating in Union, Spartanburg, and York districts.[2] After the Revolution, the industry was begun in east Tennessee about 1784 when an ironworks was erected at the mouth of Steel's Creek in Sullivan County by Colonel James King.[3]

The iron industry developed later in Georgia and Alabama because of later settlements, difficulties with Indians, early emphasis on agriculture, and a limited local market for ironware.[4] The first furnace

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[1]James M. Swank, History of the Manufacture of Iron in All Ages (Philadelphia: The American Iron and Steel Association, 1880), pp. 209 and 213; H. H. Chapman, The Iron and Steel Industries of the South (Birmingham: University of Alabama Press, 1953), p. 98.

[2]Swank, p. 213; Ernest M. Lander, "The Iron Industry in Antebellum South Carolina," Journal of Southern History 20 (August, 1954), p. 337.

[3]Chapman, pp. 98-99; Samuel C. Williams, "Early Iron Works in the Tennessee Country," Tennessee Historical Quarterly 6 (March-December, 1947), p. 42; Raymond F. Hunt, Jr., "The Pactolus Ironworks," Tennessee Historical Quarterly 25 (Summer, 1966), pp. 176 and 195; A. D. Foster, "History of Tennessee Industry," Tennessee Industry 1 (January, 1931), pp. 7-8.

[4]Lester J. Cappon, "History of the Southern Iron Industry to the Close of the Civil War," unpublished manuscript, University of Virginia, Manuscript Section; Cappon, p. 171; Swank, p. 216.

in Alabama was erected in 1818 about five miles west of Russellville in Franklin County.[5] While bloomery forges were operated in coastal Georgia about 1790, it was not until 1832 that the first blast furnace was built near Clarksville in Habersham County.[6]

Iron Production in the Upland South District

In spite of the early beginning of the iron industry and growth of population in parts of the Upland South District, the industry made comparatively little progress during the antebellum era (Table XXXVI). Iron production in the Upland South was less than that of other southern iron districts due to the lack of secondary manufactures and the inaccessibility to markets outside the district. Production increases that did occur were undoubtedly in response to increasing needs of the planters and yeoman farmers rather than an expression of industrial growth for its own sake.[7]

Between the late 18th and mid-19th centuries, about 55 furnaces were built in the Upland South Iron District, over half being erected in east Tennessee.[8] The major period of new furnace construction occurred

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[5]Woodward stated that the first furnace in Alabama was completed in 1815 and abandoned about 1827. Joseph H. Woodward II, "Alabama Iron Manufacturing, 1860-1865," The Alabama Review 7 (July, 1954), p. 199; Chapman, p. 99; John P. Lesley, The Iron Manufacturer's Guide to the Furnaces, Forges, and Rolling Mills of the United States (New York: John Wiley, 1859), p. 79.

[6]Swank, pp. 216-217; Lesley, p. 76.

[7]Cappon, unpublished manuscript, p. 185.

[8]This discussion is based on the chronology of only 44 furnaces, since Lesley does not indicate when the other 11 furnaces were built. Lesley, pp. 74-83.

TABLE XXXVI

PIG IRON PRODUCTION[1] IN THE UPLAND SOUTH IRON DISTRICT, 1830-1889 (IN TONS)

Area	1830	1840	1850	1854	1855	1856	1860	1870	1880	1889
Alabama	no data	30	552[b]	c	c	c	1,742[e]	6,273	62,336[h]	791,425[h]
East Tennessee	n.d.	3,124[a]	2,995[b]	1,845[c]	1,516[c]	2,931[c]	2,946[e]	13,002	42,837[h]	294,655[h]
Georgia	n.d.	494	900	2,391[d]	2,715[d]	2,807	1,100	1,220	23,099	27,559
North Carolina	1,800	968	400	1,820[d]	1,830[d]	450	-	1,422	-	2,898
South Carolina	n.d.	1,250	-	d	d	1,506	-	180	-	-
Upland South (Total)	-	5,866	4,847	6,056[f]	6,061	7,694	5,788	22,097[g]	128,272[i]	1,116,537[i]
Percentage of the Southern Iron Region's Production	-	7%	4%	4%	5%	5%	4%	10%	-	-

Sources: Lesley, pp. 750 and 759; Debow's Review and Industrial Resources 18 (January, 1855), p. 113; U.S. Bureau of the Census, Seventh Census 1850, p. 156; Tenth Census 1880, Vol. 2, pp. 10-13; U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860, and 1870 for Tennessee and Alabama; Cappon, "Trend of the Southern Iron Industry . . .," p. 379; "Scrapbook of J. B. Killebrew No. 1," pp. 81-82, Tennessee State Library, J. B. Killebrew papers.

[1]Selected entires may also include some castings and hollowware.

[a]This figure was determined by subtracting the production of the Western Iron District from the state's production.

[b]The figure includes 805 tons of castings and hollowware.

[c]The production includes east Tennessee and Alabama; it is inferred that the Alabama furnaces produced 1,213, 967, and 1,495 tons in 1854, 1855, and 1856, respectively, while east Tennessee furnaces cast 632, 549, and 1,436 tons, respectively.

[d]The South Carolina production is included in the North Carolina data.

[e]There is a discrepancy between the published (1,912 tons) and manuscript censuses. The manuscript returns are used here. Since the census manuscripts are incomplete, the production for Union and Claibourne counties is estimated at 503 and 133 tons, respectively.

[f]Safford indicated that east Tennessee produced 3,186 tons in 1854; consequently, the production for the Upland South District may be as high as 8,610 tons in 1854.

[g]This tonnage may include some iron made with coal and coke in east Tennessee.

[h]Includes all of Tennessee; in 1880, it is estimated that the iron production of east Tennessee was 37,801 tons.

[i]In 1880, the total production with all fuel was 128,272 tons, of which 48,398 tons were made with charcoal fuel. The breakdown in fuels is as follows (in tons):

	1880		1889	
	Charcoal	Coal and Coke	Charcoal	Coal and Coke
Alabama	35,124[h]	27,212[h]	110,472[h]	680,998[h]
East Tennessee	6,475[h]	36,362[h]	50,224[h]	244,431[h]
Georgia	6,799	16,300	5,171	25,286
TOTAL	48,398	79,874	165,822	950,715

during the 1830's and 1840's, when 25 furnaces were built, the majority in east Tennessee (13) and South Carolina (6). As a result peak iron production was evidently reached in the late 1840's when the furnaces in the Upland South produced an estimated 7,000 to 8,000 tons.[9] In spite of the new but small development of iron making in Georgia and Alabama during the 1840's, by 1850 production had declined to 4,847 tons. Construction of 16 new furnaces in east Tennessee, Georgia, and Alabama during the 1840's and 1850's, however, pushed production in the Upland South in the mid-1850's to a rate similar to that of the late 1840's (Table XXXVI). Like other southern districts, after 1857 production declined, dropping to 5,788 tons in 1860.[10]

The Pattern and Changes in Production 1840-1860

The major change in the pattern between 1840 and 1856 was the increase in production in northern Georgia and Alabama, in Claiborne, Roane and Monroe counties, Tennessee, and in the Spartanburg District, South Carolina (Figures 40 and 41). This increase in production offset the demise in upper east Tennessee and North Carolina, as production was almost 2,000 tons more in 1856 than it was in 1840 (Table XXXVI).

Between 1856 and 1860 there was a decline in pig iron production in northwestern Georgia, and by 1860 iron making had almost disappeared in the Carolina Piedmont and in most of east Tennessee (Figure 42). The

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[9]The furnaces in South Carolina produced about 4,000 tons of the total production. Lander, p. 354; Cappon, p. 166.

[10]Clement Eaton, The Growth of Southern Civilization (New York: Harper and Row, 1961), p. 235.

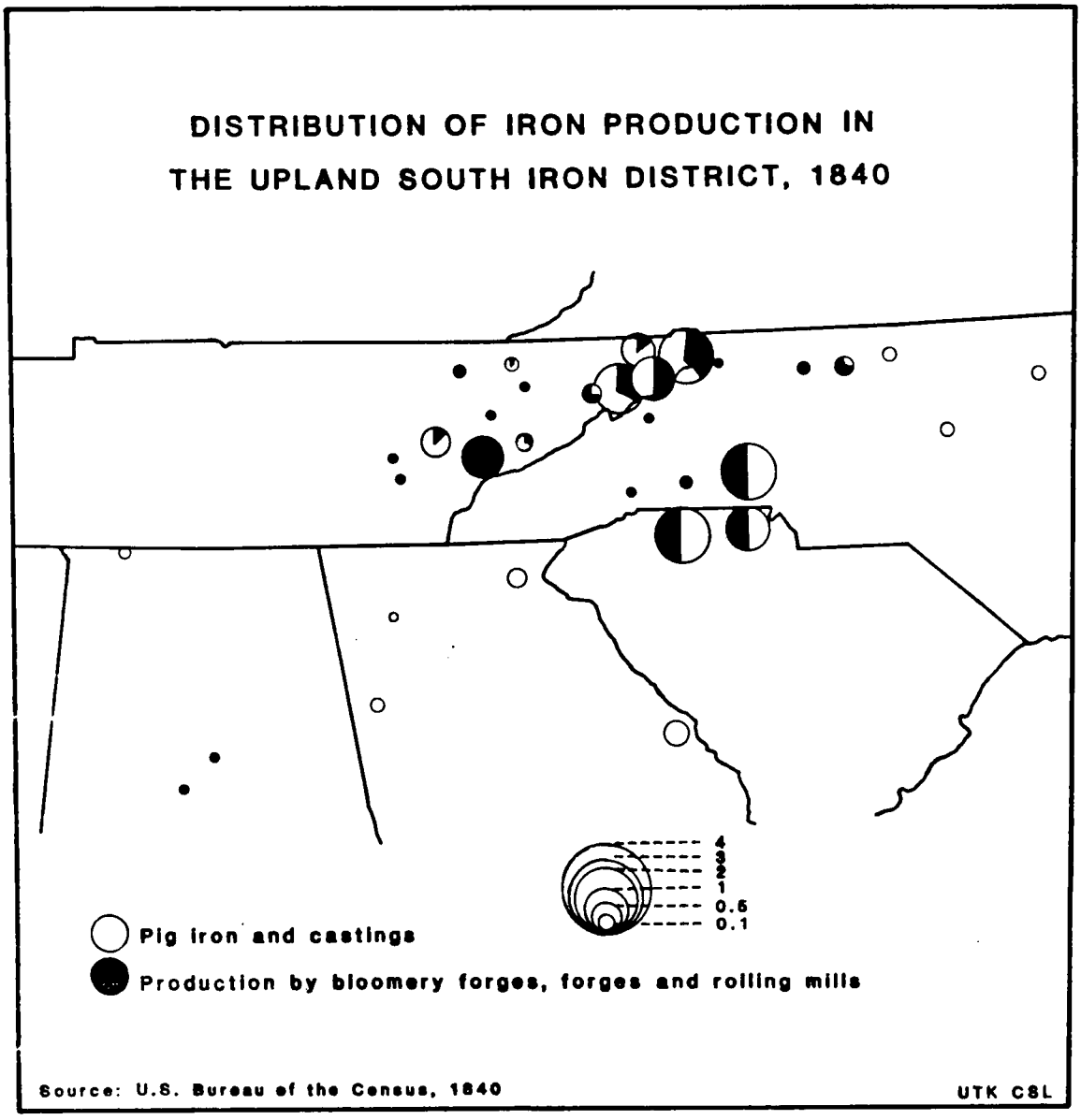

Figure 40. Distribution of Iron Production in the Upland South Iron District, 1840 (in thousands of tons).

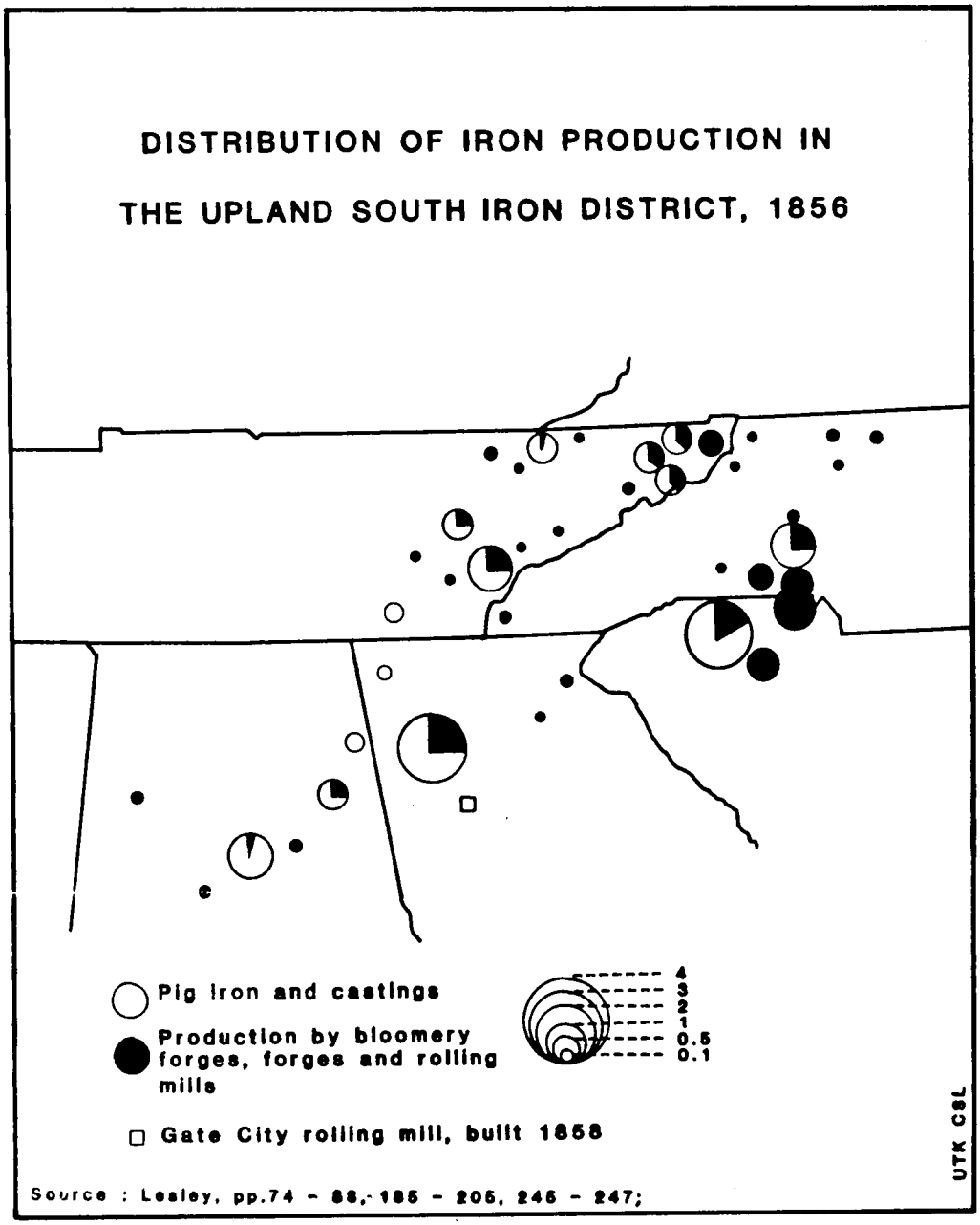

Figure 41. Distribution of Iron Production in the Upland South Iron District, 1856 (in thousands of tons).

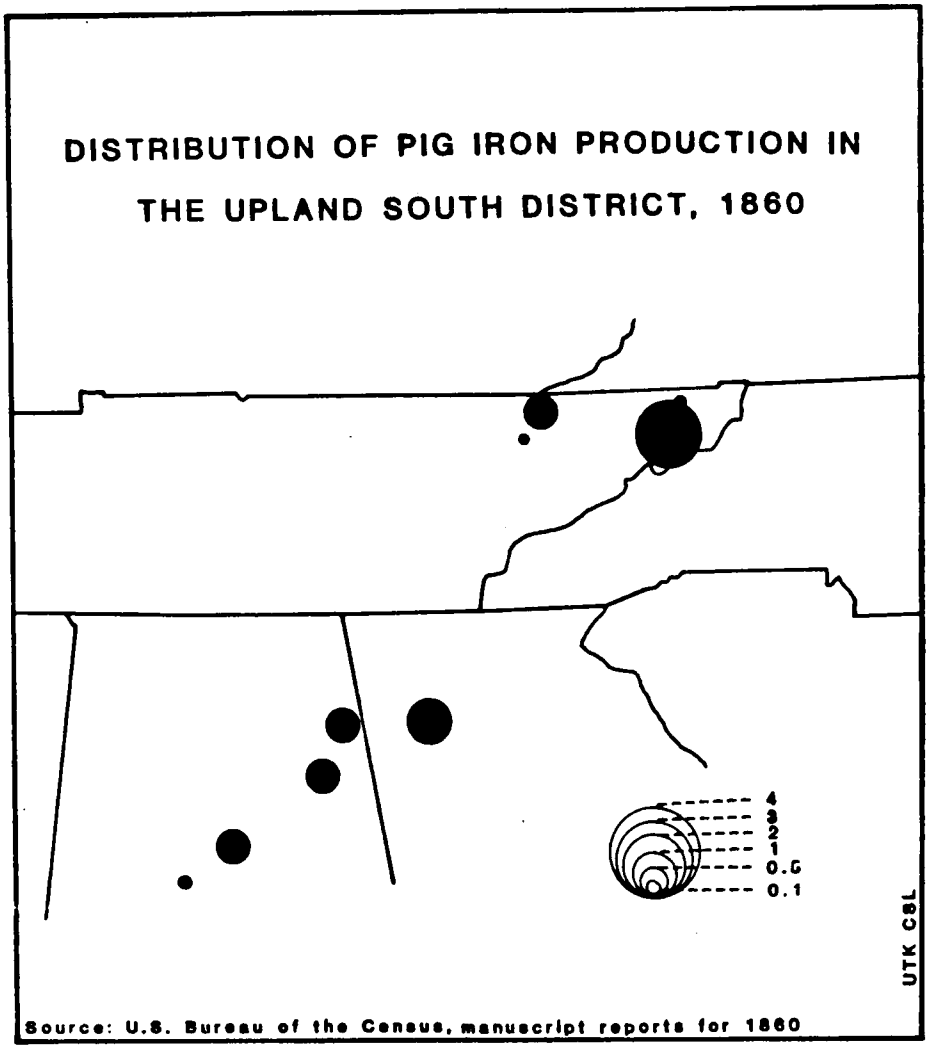

Figure 42. Distribution of Pig Iron Production in the Upland South District, 1860 (in thousands of tons).

remaining small pig iron production in the Upland South in 1860 was concentrated in upper east Tennessee and in an area extending from Cass County, Georgia, to Bibb County, Alabama.

Bloomery forges making bar iron by the direct process were a distinctive feature of the Upland South District, with about half the bloomery forges of the nation located in the district.[11] The primary concentration of these bloomery forges was in upper east Tennessee and northwestern North Carolina. Although the annual production of the individual bloomery forge was small, ranging from a few tons to about 100 tons, most of the bar iron produced in 1840 and 1856 was produced in bloomery forges. In 1856, the 106 bloomery forges in the Upland South District made 3,336 tons of bar iron, the rest of the bar iron and nails (2,475 tons) being produced by rolling mills in Washington County, Tennessee, Cass County, Georgia, Gaston County, North Carolina, and Spartanburg, Union, and York districts, South Carolina.[12]

The bloomery forge remained an important mode of production in the isolated, mountainous country of east Tennessee, northwestern North Carolina (particularly near the magnetic ore deposits), and southwestern Virginia, since the artisan and farmer were able to operate the forge periodically when they were not engaged in other enterprises or the price and demand of bar iron were good.[13] The direct process died

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[11]Lesley, pp. 449-450 and 749; Swank, p. 229; Cappon, pp. 30 and 166.

[12]Lesley, pp. 245-257, 259, 760 and 762.

[13]Cappon, unpublished manuscripts, pp. 94-95.

slowly in remote areas where raw materials were abundant and capital was scarce,[14] but the bloomery forge was gradually driven out of business as the area became more accessible and the character of the Upland South's iron industry began to change.

Charcoal Iron Production and the Transition to a Mineral Fuel Technology, 1860-1880's

The forces responsible for changing the character of the iron industry included the development of railroads that improved the accessibility to markets in the Midwest and North, use of coal and coke, use of red hematite ore, increase in furnace capacities, development of secondary manufactures, and geological surveys and reports promoting resource development. The impact of these developments, however, did not greatly affect production until the postbellum period, when a record amount of charcoal iron was produced in the district.

While the antebellum industry demonstrated the possibilities of iron making in east Tennessee, Georgia, and Alabama, it was unclear as to which area would predominate. In 1860 production in the Upland South was only 5,788 tons of pig iron and castings, rising to 22,097 tons in 1870 (Table XXXVI, page 275). The leading areas of production were in east Tennessee and Alabama, where furnaces produced 13,002 and 6,273 tons, respectively. The revival of the iron industry in the Upland South following the Civil War was initially based on a charcoal

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[14]Cappon, unpublished manuscripts, pp. 168-169 and 94-95.

technology, and charcoal iron production soon exceeded prewar production.[15]

Mineral fuel technology expanded the district's production as well. Although pig iron made with coal and coke was attempted in the 1850's, commercial success was not achieved until 1867, when Roane Iron Company at Rockwood, Tennessee, began the manufacture of pig iron with mineral fuels.[16] By 1874, 11,543 tons were reportedly made in Tennessee, while furnaces in Georgia were manufacturing 5,576 tons with bituminous coal and coke.[17]

In Alabama, W. S. McElwain made pig iron with coke during the Civil War, but the lack of an adequate coal supply halted production.[18] Nevertheless, the use of Red Mountain ore during the Civil War and the discovery of a superior coking coal in the Warrior field in 1874 laid the foundation for the development of the Birmingham, Alabama, area.[19] Finally, on February 28, 1876, the first successful manufacture of pig

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[15]James M. Swank, Annual Report of the Secretary of the American Iron and Steel Association (Philadelphia: AISA, 1881), pp. 44-45.

[16]Morrow Chamberlain, A Brief History of the Pig Iron Industry of East Tennessee (Chattanooga: Morrow Chamberlain, 1942), p. 3; James Bowron, "The History of the Iron and Steel Industry in the South," in the Yearbook (New York: American Iron and Steel Institute, 1914), p. 474; Chapman, p. 102.

[17]Swank, Annual Report, 1881, pp. 44-45.

[18]Swank, History of the Manufacture of Iron, p. 231; Chapman, p. 102; Woodward, p. 204; Cappon, unpublished manuscript, p. 214.

[19]The railroad was also an important factor in the development of Birmingham. Chapman, pp. 101-102.

iron with coke was begun in Alabama, and by 1880 over 27,000 tons were produced in the state (Table XXXVI, page 275).[20]

In 1880 iron made with all fuels in east Tennessee, Georgia, and Alabama had increased to 128,272 tons, with coal and coke furnaces producing 79,874 tons and charcoal furnaces producing 48,398 tons (38%) of this output (Figure 43 and Table XXXVI). Charcoal iron production continued to expand; and by 1889 charcoal furnaces in Alabama produced 111,427 tons. In spite of the increase, charcoal iron production represented a declining share of the district's production as pig iron made with coal and coke rose to 950,715 (Table XXXVI).

Change in Weekly and Annual Pattern of Production through 1870

The weekly production of furnaces in the Upland South was small, changing little during the course of the antebellum period. Furnaces were generally casting from 3 to 21 tons a week during the early period, increasing to between 12 and 21 tons a week by the mid-1850's.[21]

During the Civil War, it was reported that a Confederate government furnace in Bibb County, Alabama, was averaging 91 tons a week, while

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[20]Bowron, p. 473; Chapman, p. 102; Swank, Annual Report, pp. 44-45.

[21]In 1854, Pleasant Valley, Eagle, and Tellico furnaces in east Tennessee averaged 33, 33, and 26 tons per week, respectively, while Shelby furnace in Alabama averaged 28 tons in 1856. Swank, History of the Manufacture of Iron, p. 227; Bowron, p. 466; Chapman, p. 99; James M. Safford, A Geological Reconnaissance of the State of Tennessee (Nashville: G. C. Torbett and Co., 1856), p. 51; Cappon, unpublished manuscript, p. 40.

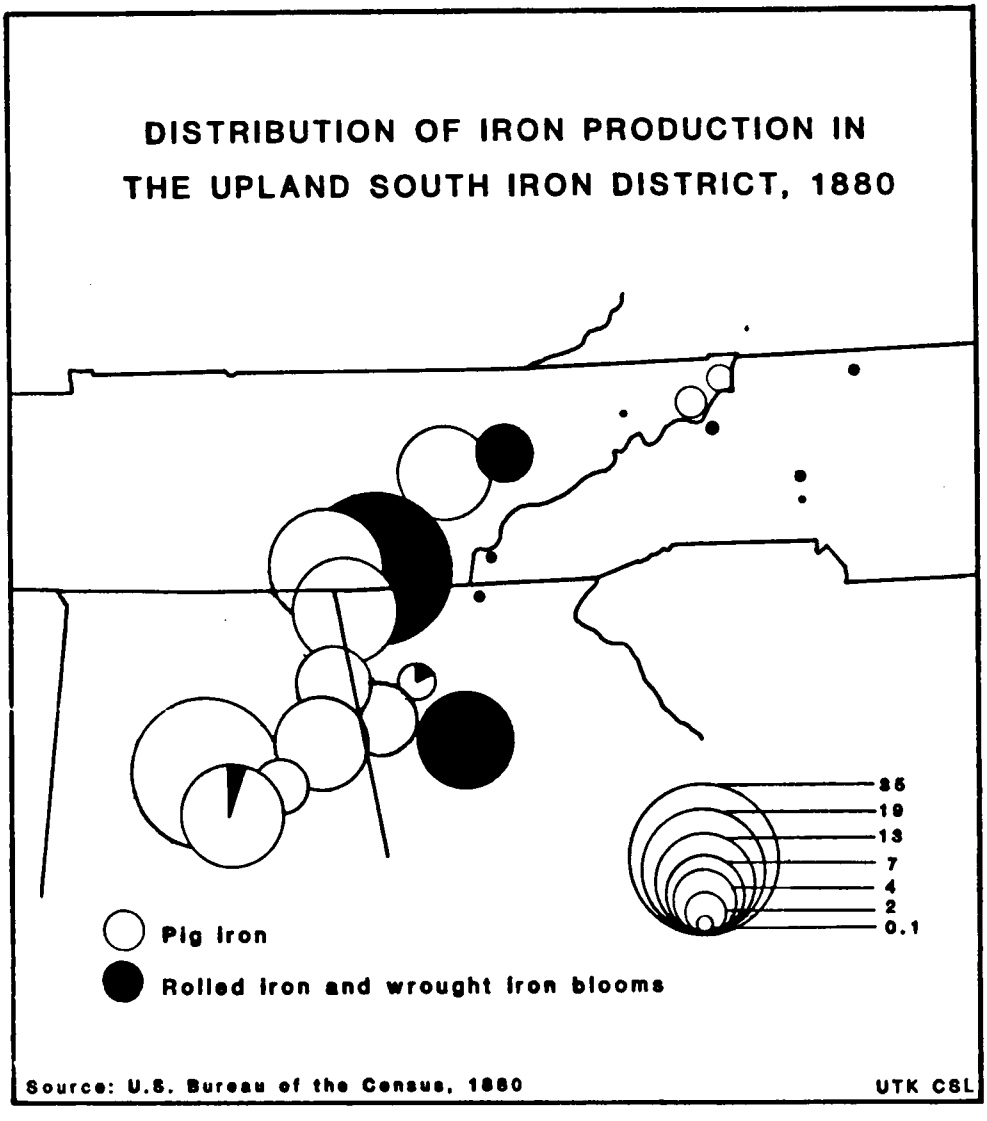

Figure 43. Distribution of Iron Production in the Upland South Iron District, 1880 (in thousands of tons).

another furnace was reportedly casting 70 tons.[22] For a variety of reasons, some of them war-related, weekly production seldom, if ever, exceeded 28 tons.[23] By 1870, three charcoal furnaces in Alabama had a combined capacity of 231 tons a week, though the weekly average was only about 58 tons per furnace.[24] The most productive furnace in the state was Shelby furnace, which produced 4,508 tons in 1870 for a weekly average of 126 tons. In east Tennessee, the weekly capacity of furnaces was nearly 50 tons, but weekly production was barely above the area's most productive antebellum furnaces.[25]

Since the weekly production was small and blasts were short, the mean annual production of furnaces in the Upland South was also relatively low, ranging from 150 to 450 tons (Table XXXVII). The average length of a blast was only about 6 months,[26] but the most productive furnaces in the district, such as Tellico, South Twin, Etowah,

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[22]Bibb County Iron Company reportedly produced 175 tons per week, but this production may have come from two stacks. Cappon, unpublished manuscript, p. 214; Woodward, p. 200.

[23]Woodward, p. 203.

[24]United States Bureau of the Census, unpublished manuscripts, "Products of Industry," 1870; Lesley, p. 79.

[25]Joseph Buckner Killebrew, Tennessee: Its Agricultural and Mineral Wealth (Nashville: Tavel, Eastman, and Howell, 1874), pp. 125 and 133; J. B. Killebrew, Introduction to the Resources of Tennessee (Nashville: Tennessee Bureau of Agriculture, 1874), pp. 23, 234, and 481; J. B. Killebrew, Iron and Coal of Tennessee (Nashville: Tavel and Howell, 1881), pp. 11, 23, 26, 53-54, 136, and 234; James M. Safford, Geology of Tennessee (Nashville: S. C. Mercer, 1869), pp. 454-455.

[26]Lesley, pp. 74-83; Stuart W. Maher, The Brown Iron Ores of East Tennessee (Nashville: State of Tennessee Department of Conservation Division of Geology, Report No. 19, 1964), p. 3; Hunt, pp. 177-178.

TABLE XXXVII

MEAN ANNUAL FURNACE PRODUCTION FOR THE UPLAND SOUTH IRON DISTRICT BY STATE, 1840-1870 (IN TONS)

	1840	1850	1854	1854-56	1860	1870
Alabama	30	642	n.d.	658	436[a]	2,091
East Tennessee	261	392	455	256	465[a]	3,250
Georgia	35	300	no data	435	550	305
North Carolina	121	200	no data	225	none	129
South Carolina	313	none	no data	493	none	90
Upland South District	151	305		364	432	920

Sources: J. P. Lesley; U.S. Bureau of the Census, unpublished census manuscripts, in 1850, 1860, and 1870 for Alabama and Tennessee; Safford, pp. 52-53.

[a]There are discrepancies between the manuscript and published censuses as to the number of furnaces in east Tennessee and Alabama. The published census listed 5 furnaces for east Tennessee, in which case the average would be 382 tons. In Alabama, if one uses only 3 furnaces (instead of the 4 used here) in the calculation, the average would be 521 tons.

and Shelby, were in blast about 9 months and, along with Pleasant Valley and Eagle furnaces, made about 800 tons a year.[27]

The Resource Base

As in the other southern iron districts, the iron industry of the Upland South was completely dependent upon local resources.[28] Even during the postbellum period, this self-contained character persisted as the charcoal, iron ore, and limestone were assembled under the central control of an ironmaster.[29]

Iron Ore

The three types of ore smelted in the Upland South District during the antebellum era were red hematite, magnetite, and brown ore. The ironmasters apparently favored brown ore because it was (1) found just beneath the surface and was easily mined in open pits; (2) easily smelted with less fuel; and (3) good for making heavy castings and a soft, tough bar iron of superior quality.[30] With the exception of two

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[27]Lesley, pp. 74-83; Woodward, p. 200; Safford, A Geological Reconnaissance, p. 51; Lester J. Cappon, "Iron Making--A Forgotten Industry of North Carolina," North Carolina Historical Review 9 (October, 1932), p. 339; Cappon, unpublished manuscript, p. 43.

[28]Edward H. Sanborn, "Iron-Making in the South," Manufacturer's Record (Baltimore-Southern Supplement, December 14, 1899), p. 39, Tennessee State Library Archives.

[29]Archer Brown, "Southern Iron and Coal Properties," Manufacturer's Record (Baltimore-Southern Supplement, December 14, 1899), p. 47, Tennessee State Library Archives.

[30]Gerard Troost, Third Geological Report of the State of Tennessee (Nashville: S. Nye and Co., 1835), p. 30; Chamberlain, p. 2; Woodward, p. 199; Cappon, unpublished manuscript, p. 91; Safford, A Geological Reconnaissance, p. 34; Killebrew, Tennessee: Its Agricultural, p. 164; Lesley, p. 464.

or three furnaces, ironmasters in Tennessee almost exclusively smelted brown ore during the 1830's. In northwestern Georgia, brown hematite was also the main variety smelted during the 1840's, but it was a general practice there to mix the ore with either black or red oxide ores.[31] In Alabama, the ironmaster at Shelby furnace smelted brown hematite, while at Polkville furnace the ironmaster mixed two-thirds brown ore with one-third "honeycomb ore."[32]

In east Tennessee during the 1850's, there was widespread use of brown ore, although ironmasters in the red hematite ore region used the dyestone ore and those in Sullivan County smelted red hematite, brown ore, and a mixture of the two.[33] The ironmaster at Round Mountain furnace in Alabama exclusively smelted red hematite, but some ironmasters in Alabama and Georgia mixed red hematite with other ores.[34] Near Lincolnton, North Carolina, ironmasters used magnetic ore, while those in the Spartanburg District of South Carolina either smelted hematite or a mixture of half magnetite and half hematite (brown or red) ore.[35]

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[31]Lesley, pp. 76-78 and 463.

[32]Lesley, pp. 78-79 and 595; Cappon, unpublished manuscript, p. 68.

[33]Safford, A Geological Reconnaissance, p. 51; Lesley, pp. 74-83 and 594; Killebrew, Tennessee: Its Agricultural, p. 133; Killebrew, Introduction to the Resources, p. 234.

[34]Lesley, pp. 74-83, 78-79, and 594-595; Cappon, unpublished manuscript, p. 68; Safford, 1856, p. 51.

[35]Lesley, pp. 74-75 and 448.

During the Civil War, the Confederate government used financial assistance to promote the use of red hematite.[36] After the war the widespread use of red hematite near coal deposits, the use of coal and coke, and the large capital investment in the development of iron, coal, and railroads changed the character and pattern of production in the Upland South.[37] Brown ore, so prevalent in the antebellum period, gave way to the use of red hematite because brown ore deposits were small in size, dispersed, and lacking in uniformity of grade and composition.[38]

The quantity and cost of ore used in making pig iron. While the Upland South had the smallest pig iron production of any southern iron district, the furnaces in the district used less ore to manufacture a ton of pig iron (Table XXXVIII). In 1850 and 1860 about two tons of ore, at a total cost of less than $4.00, were used in making a ton of pig iron.[39]

At midcentury ironmasters in east Tennessee were paying an average of $1.91 a ton for ore, dropping to only $1.63 in 1860. The cost of ore was also modest in Georgia where the ore was delivered at an estimated cost of $1.12 in 1846. Ironmasters in Alabama were figuring the cost at $1.00 a ton in 1850, perhaps the cheapest ore in the district.

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[36]Chapman, p. 101; Cappon, unpublished manuscript, p. 87.

[37]Chapman, pp. 100-101; Maher, p. 5.

[38]Killebrew, Iron and Coal, pp. 136-137; Maher, p. 33.

[39]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850; United States Bureau of the Census, unpublished census manuscripts, "Census of Manufactures," 1820; Pactolus, University of North Carolina, Southern Historical Collection, "Pactolus I.W. 1811-1828"; Hunt, pp. 183-184.

TABLE XXXVIII

THE QUANTITY AND COST OF IRON ORE
TO MAKE A TON OF PIG IRON

	1850		1860		1870	
	Tons	Dollars	Tons	Dollars	Tons	Dollars
Upland South Iron District[1]	2.10		2.07			
Alabama	2.12	$2.12	2.22	$3.84[b]	1.82[c]	$4.84
East Tennessee[2]	1.95	$3.72	1.78	$2.90[b]	2.25[c]	
Georgia	a		2.44		1.92	
North Carolina	2.25				2.20	
South Carolina					3.33	

Sources: U.S. Bureau of the Census, unpublished census manuscripts, 1850, 1860, and 1870 for Alabama and east Tennessee. Cappon manuscript, p. 175; U.S. Bureau of the Census, Ninth Census 1870, "The Statistics of Wealth and Industry of the U.S. . . .," Volume 3 (Washington: GPO, 1872), pp. 602-603.

[1]The data for the Upland South Iron District only includes Alabama, east Tennessee, and North Carolina.

[2]Monroe and McMinn counties are excluded from these data.

[a]The data for Georgia are suspect for 1850.

[b]The cost data only includes Roane, Sullivan, and Washington counties.

[c]These data are for all of Tennessee. In the Western Iron District, the furnaces averaged 2.33 tons per ton of pig iron.

The spatial variation in cost was due to a number of factors, including differences in mining, distance to the ore bank, and the amount of processing necessary. Mining the ore was the major factor, accounting for about one-half to three-fourths of the cost.[40] Since surface deposits were abundant, the ore was mined in open pits with little difficulty; miners abandoned the quarries when they became too deep for convenient ore removal.[41]

Another important factor in the cost of ore was the distance between the furnace and ore bank. The mean distance between the furnaces and ore banks in the Upland South during the mid-1850's was about two and two-thirds miles. However, in Alabama, the mean distance was only two-thirds of a mile, accounting for the low cost of ore there.[42]

Finally, processing the ore, a common practice among some ironmasters in east Tennessee, South Carolina, and Alabama, also

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[40]Lesley, p. 631; Moore, pp. 9 and 14; "Pactolus Iron Works, 1811-1828," University of North Carolina, Southern Historical Collection; Killebrew, Tennessee; Its, pp. 128, 164, 166, and 481; Cappon, unpublished manuscript, pp. 175 and 181.

[41]Swank, History of the Manufacture, p. 213; Chamberlain, p. 2; Cappon, unpublished manuscript, p. 453; "Stockholders Journal, Vol. 8," February 7, 1842, University of North Carolina, Southern Historical Collection, William P. Bynum Papers; Hunt, p. 176; Letter, Sam S. Marshall to J. A. Jackson, February 7, 1859, University of Kentucky, Buckner Papers.

[42]Since Bluff furnace in Hamilton County, Tennessee, hauled its ore 60 miles, it is excluded from these figures. The Carolinas are also excluded from the figures because of insufficient data. Lesley, pp. 74-83.

increased the cost.[43] Nevertheless, roasting the brown ore expelled water and other impurities, improving its yield in the furnace and saving charcoal fuel.[44]

Charcoal Fuel

The amount of charcoal used to manufacture pig iron in the Upland South was relatively high in comparison to other southern districts. In 1850, the furnaces in Alabama, east Tennessee, North Carolina, and Georgia consumed an estimated 277, 291, 375, and 477 bushels per ton of pig iron, respectively.[45]

The high rate of consumption during the antebellum era was partly due to the widespread use of the cold blast process, which required more fuel,[46] and largely accounted for the high fuel consumption in Georgia, South Carolina, and North Carolina, where every furnace, except one, used cold blast. In the mid-1850's, less than one-third of the furnaces

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[43]Hunt, p. 176; Swank, History of the Manufacture of Iron, p. 213; Cappon, unpublished manuscript, p. 185; Lesley, pp. 630-631.

[44]In the postbellum period, roasting and screening ore were replaced by washing ore. Moreover, the increase in height of furnaces partly roasted the ore before it reached the melting zone. Hunt, p. 176; Killebrew, Tennessee: Its, p. 126; Lesley, pp. 78 and 630-631; Letter, Sam S. Marshall to J. A. Jackson, February 7, 1859, University of Kentucky, Buckner Papers.

[45]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850 Tennessee and Alabama; United States Bureau of the Census, The Seventh Census, Report of the Superintendent (Washington: Robert Armstrong, 1853), p. 156.

[46]Hard charcoal used in a hot blast furnace provided a 20% fuel saving and augmented production by 50%. Peter Temin, Iron and Coal in Nineteenth-Century America: An Economic Inquiry (Cambridge, Massachusetts: MIT Press, 1964), pp. 58-59.

in the Upland South District engaged hot blast.[47] Since hot blast improved production, it is not surprising that the hot blast furnaces in east Tennessee, Georgia, and Alabama accounted for about 40% of the district's iron production.

Fortunately, as ironmasters developed a better understanding of the smelting process and instituted technical changes, such as the installation of hot blast, they were able to reduce fuel consumption. The results of these changes were apparent by 1860; and during the 1860's and 1870's cold blast furnaces in east Tennessee were consuming 180 to 250 bushels per ton of iron, while hot blast furnaces were using only 112 to 120 bushels.[48] Meanwhile, the ironmasters in Alabama were also reducing fuel consumption from 277 bushels in 1850 to 202 and 143 bushels in 1860 and 1870, respectively.[49]

The persistence of the bloomery forge. In addition to the furnace, the bloomery forge, which made bar iron by the direct process, was a major consumer of charcoal. The indirect process of making bar iron was usually more fuel efficient, since mineral fuels were often used in puddling and rolling pig iron into merchant bar. In 1850, John Blair and Company in Washington County, Tennessee, used charcoal fuel exclusively in making rolled iron by the indirect process, with the

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[47]Safford, 1856, p. 51; Lesley, pp. 74-83.

[48]Killebrew, Tennessee: Its, p. 125; Killebrew, Iron and Coal, p. 11; Bowron, pp. 472-473; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1860.

[49]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860, and 1870.

furnace, forge, and rolling mill consuming about 900 bushels of charcoal per ton of rolled iron.[50] On the other hand, bloomery forges in the area were consuming between 333 and 933 bushels per ton of bar iron, averaging about 600 to 650 bushels.[51] Since the bloomery was apparently as fuel efficient, and perhaps as economical, as the indirect process in 1850, it is not surprising that the bloomery lasted so long in upper east Tennessee, northwestern North Carolina, and southwestern Virginia. In remote areas where the cost of transportation was often prohibitive, the bloomery forge, producing a consistent and high grade bar iron, was a viable alternative to the more elaborate and expensive indirect process.

However, the indirect process in the area became more fuel efficient, and probably more economical, than the bloomery forge during the 1850's when the ironmaster of the firm in Washington County installed the hot blast process.[52] Moreover, as improved transportation facilities made the area more accessible, the bloomery forge was slowly displaced by secondary manufactures.

The cost and supply of charcoal. Since the furnace and forge consumed large quantities of charcoal, it was necessary for the ironmaster to control a large estate. According to one ironmaster in

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[50]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850.

[51]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850.

[52]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850 and 1860.

east Tennessee, in order to keep a furnace making 20 tons a week in continuous and sustained operation, it required between 7,000 and 10,000 acres of mountain land.[53] Iron plantations in the Upland South District were between 7,000 and 11,000 acres in size, suggesting that with reforestation there was a potential for supplying fuel on a sustained basis. Indeed, one ironmaster instructed woodchoppers to leave trees under three inches in diameter, indicating a concern for a future timber supply.[54] In spite of this report, we know little about the ironmasters' policies and attitudes toward reforestation.

Other evidence also supports the hypothesis that the Upland South did not face any serious shortage of timber at the regional scale. The stable cost of charcoal during the antebellum era suggests that timber was abundant. If charcoal was in short supply, the unit cost should have risen, but the average cost remained relatively stable at an estimated 3¢ to 4¢ a bushel between 1820 and 1860.[55] Between 1850 and 1860, a decrease in charcoal consumption in east Tennessee and Alabama actually caused a decline in cost of fuel used in making pig iron.[56]

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[53]Gerard Troost, Fifth Geological Report (Nashville: J. George Harris, 1840), p. 37; Cappon, unpublished manuscript, p. 93; Hunt, pp. 189-90.

[54]Hunt, p. 176.

[55]United States Bureau of the Census, unpublished census manuscripts, "Census of Manufactures," 1820; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850 and 1860; Lesley, p. 464; Cappon, unpublished manuscript, pp. 168 and 175.

[56]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850, 1860, and 1870; Killebrew, Tennessee: Its, p. 128.

During the 1860's the unit price of charcoal rose, and by 1870 charcoal was priced at 5 3/4¢ to 9 1/2¢ a bushel.[57] Although consumption continued to decline, the decline was insufficient to offset the rise in unit cost, and the cost of fuel to manufacture a ton of metal rose from about $5.50 in east Tennessee and $8.00 in Alabama in 1860 to about $12.00 in 1870.

Despite this increase in cost during the 1860's, the record charcoal iron production in east Tennessee, Georgia, and Alabama in the postbellum era indicates that the timber supply was sufficient to support an enlarged antebellum industry. Other secondary sources and reports by 19th century commentators also indicate that the Upland South suffered almost no shortage of timber in the antebellum period.[58] According to Killebrew, there was an abundant timber supply in east Tennessee, and ironmasters obtained quantities at nearly the cost of cutting.[59] Furthermore, Lesley pointed out that there was a good supply of timber in northwestern Georgia as the area was covered by original stands of good hardwood.[60] He also claimed that the timber could be

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[57]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850 and 1860; Killebrew, Tennessee: Its, pp. 163-164, 124-125, and 128; Killebrew, Introduction to the Resources, p. 481; Killebrew, Iron and Coal, pp. 11, 18, 22, and 24-25.

[58]Cappon, unpublished manuscript, p. 93; Lesley, pp. 465 and 468-469; Killebrew, Iron and Coal, pp. 17-18.

[59]While Killebrew's statement primarily refers to Carter and Johnson counties, it is applicable to a broader area. Killebrew, Iron and Coal, pp. 17-18 and 24-25.

[60]Lesley, pp. 465 and 468-469.

depended upon for a long time, and that access to the bituminous coal near Chattanooga might be of some consequence to the iron mines if wood did become scarce.[61] The case was undoubtedly the same in Alabama.

While reports concerning the timber supply were optimistic for east Tennessee, Georgia, and Alabama, those for the Carolina Piedmont were mixed. According to Cappon, the generous timber supply along the Tyger and Pacolet rivers in South Carolina kept the price of charcoal at a reasonable rate.[62] Other reports suggest that by 1850 ironmasters in the Carolina Piedmont were experiencing problems in supplying fuel. By the late 1850's, it was reported that the fuel supply at Twin furnace in the Spartanburg District of South Carolina, was nearly exhausted, with the timber about the Nesbitt works having been depleted.[63] A traveler also observed that the whole country around the South Carolina Manufacturing Company was cut over for miles, leaving a most desolate and gloomy landscape.[64] In North Carolina, the ironmaster at Rehoboth furnace and Tirzah forge recommended the purchase of new coaling ground, because he was dissatisfied with the way the firm was located in relation to the old coaling ground.[65] These sources point to the Carolina Piedmont as one area of the Upland South District where the

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[61]Lesley, p. 469.

[62]Cappon, unpublished manuscript, p. 166.

[63]Cappon, unpublished manuscript, p. 167; Lander, pp. 354-355.

[64]Lander, pp. 354-355.

[65]Letter, Robert A. Brevard to R. A. Brevard, March 21, 1842, State Archives, North Carolina, Brevard Papers; Cappon, "Iron-Making in North Carolina," p. 344.

adequacy of the fuel supply was a problem and suggest that it was a factor in the decline of the Carolina iron industry.[66]

Limestone and the Dominance of Waterpower

In comparison to the other raw materials, the amount and cost of limestone used in smelting the ore were relatively low.[67] Since limestone was conveniently situated about most furnaces in the district, ironmasters easily assembled the needed quantities at a relatively low cost.[68]

Waterpower was predominately employed in providing the cold blast used in smelting the ores of the Upland South District. In 1850, the furnaces in east Tennessee and Alabama used waterpower exclusively, but by the mid-1850's, Eagle, Bluff, Round Mountain, and Shelby charcoal hot blast furnaces were using steam power.[69] Meanwhile the furnaces in North Carolina, South Carolina, and Georgia were apparently driven by

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[66]Lander, pp. 354-355.

[67]Cappon, unpublished manuscript, p. 140 and 175; Killebrew, Introduction to the Resources, p. 232; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1860; Killebrew, Introduction to the Resources, p. 481; Killebrew, Tennessee: Its, p. 45; Ethel Armes, The Story of Coal and Iron in Alabama (Birmingham: Book-Keepers Press, 1972), p. 79.

[68]Killebrew, Introduction to the Resources, p. 440; Hunt, pp. 176 and 184; Lesley, p. 464; Armes, pp. 29, 63, 66, and 79; Cappon, "Iron-Making in North Carolina," p. 344; Cappon, unpublished manuscript, p. 163.

[69]Safford, A Geological Reconnaissance, p. 51; Lesley, pp. 78-79 and 82-83; Fink, p. 55; Killebrew, Iron and Coal, pp. 16 and 53-54; Cappon, unpublished manuscript, pp. 135-136; Killebrew, Tennessee: Its, p. 124; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850 and 1860.

waterpower, although steam power may have been used at some sites as either an auxiliary or primary source of power.[70]

Labor in the Upland South Iron District

The number of workers employed at furnaces and forges in the Upland South District is difficult to ascertain, because the reliability of employment data is the poorest for any of the southern iron districts. There are incomplete returns and discrepancies between published and manuscript censuses, with assistant marshals, in some cases, reporting only the labor involved in operating the furnace.

Despite these data shortcomings, it is estimated that the furnaces in the Upland South Iron District were employing between 35 and 75 workmen, though the most productive furnaces undoubtedly were engaging 50 to 150 laborers.[71] The integrated firms, operating a furnace, forge, and/or rolling mill, were the largest employers, engaging an estimated 100 to 200 workmen. During the 1830's and 1840's, it is possible that the integrated firms in the Carolina Piedmont employed an even larger work force, with Etowah works in Cass County, Georgia, employing 500 hands.[72]

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[70]Lesley, pp. 74-83 and 464; Lander, pp. 349-350; Cappon, unpublished manuscript, pp. 30, 166, 171, and 175; Swank, History of the Manufacture of Iron, pp. 217-218.

[71]Armes, pp. 66 and 96-97; Cappon, unpublished manuscript, p. 181; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1860 and 1870.

[72]Lander, pp. 344, 347, and 350; Cappon, unpublished manuscript, pp. 175 and 177.

Slave Labor

Slaves were the principal workmen at many of the furnaces, forges, and rolling mills. The firms in South Carolina were primarily dependent on Negro labor, though a few local and northern whites occupied the skilled and managerial positions.[73] In North Carolina the families in the iron business also employed plantation slaves in most tasks, and the typical firm in the Carolina Piedmont engaged between 50 and 200 bondsmen.[74]

Woodward pointed out that most of the work building furnaces in Alabama was performed by slave hirelings, and the gathering and hauling of charcoal, iron ore, and limestone was almost certainly conducted by slaves.[75] Unfortunately, less is known about the prevalence of slave labor in east Tennessee and Georgia; although, 100 Negroes were employed by Etowah works in Georgia.[76] According to Cappon, ironworks in remote areas of upper east Tennessee and North Carolina primarily relied on white workmen, though bondsmen were employed at bloomery forges in Carter County, Tennessee.[77]

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[73]Lander, p. 350.

[74]Cappon, "Iron-Making in North Carolina," pp. 333, 340, and 345; "Stockholders Journal," Vol. 8, University of North Carolina, Southern Historical Collection, William P. Bynum Papers; Lesley, pp. 75 and 245; Robert S. Starobin, Industrial Slavery in the Old South (New York: Oxford University Press, 1970), p. 15; Lander, pp. 344, 347, and 350; Cappon, unpublished manuscript, pp. 166-167.

[75]Armes, pp. 77, 94, 96, and 130; Woodward, p. 200; Cappon, unpublished manuscript, p. 185.

[76]Cappon, unpublished manuscript, pp. 175-176.

[77]Cappon, unpublished manuscript, p. 107e; Robert T. Nave, "A History of the Iron Industry in Carter County, to 1860" (unpublished M.A. thesis, East Tennessee State University, 1953), p. 102.

Slave ownership was perhaps the most advantageous arrangement in the Upland South, because there are scattered reports concerning the scarcity of skilled and unskilled labor.[78] During the 1840's and 1850's it was difficult for ironmasters in Alabama to secure and control labor, and furnaces were frequently idle on this account.[79] To guard against such shortages, Horace Ware (Shelby furnace) and others developed the skills of their bondsmen, and those placed in responsible positions proved to be diligent and efficient workmen.[80]

In addition to slave ownership, ironmasters also hired slaves, though little is known about the extent and cost of slave hiring in the district. Apparently the hiring practices were similar to those of the Virginia and Western iron districts, although ironmasters in the Upland South evidently paid more for hirelings than their counterparts in the other southern districts.[81]

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[78]Cappon, unpublished manuscript, pp. 21-22 and 49-50; Cappon, "Iron-Making in North Carolina," p. 334; Armes, p. 77.

[79]Armes, p. 77.

[80]Armes, p. 77; Cappon, "Iron-Making in North Carolina," pp. 340-341; Lander, p. 350; Starobin, pp. 154-155.

[81]"Stockholders Journal," University of North Carolina, Southern Historical Collection, William P. Bynum Papers; Robert William Fogel and Stanley L. Engerman, Time on the Cross: Evidence and Methods (Boston: Little Brown and Company, 1974), p. 73; Starobin, pp. 180 and 182; Lander, p. 350; Cappon, "Iron-Making in North Carolina," p. 341; Agreement with D. Froneberger and Company for Jim's Services July 2, 1855," University of North Carolina, Southern Historical Collection, William P. Bynum Papers; "Endor I.W. Ledger 1864-68," April 11, 1864, University of North Carolina, Southern Historical Collection; John a/c with A. Brevard July 18, 1820, University of North Carolina, Southern Historical Collection, Brevard and McDowell Papers; Frank E. Vandiver, "The Shelby Iron Company in the Civil War: A Study of a Confederate Industry," Alabama Review (January, 1948), p. 120.

The Size and Function of the Iron Plantation

The slaves and other workmen lived in a furnace community, which was comprised of the usual buildings arranged in a semiclustered to clustered settlement. Because of the use of waterpower and water transportation, the distribution of settlements created a riverine pattern, a common furnace site being along a small stream near its confluence with such rivers as the Nolichucky, Watauga, Tennessee, Broad, Pacolet, Etowah, and Coosa.

To provide raw materials, particularly cordwood, the furnace communities in the district were situated on large estates of about 7,000 to 11,000 acres in size (Table XXXIX). The nuclei of the early landholdings were originally acquired through land grants, as governments offered land bounties, tax exemptions, and other liberal premiums to encourage the manufacture of iron. As a consequence, between the American Revolution and 1830, the nuclei of some estates were acquired through land grants of 2,000 to 3,000 acres.[82]

The land grants, tax exemptions, and other concessions indicate that there was an industrial consciousness in the Upland South District, though its impact had mixed results. According to Swank, there is no evidence that the liberal programs increased iron production in South

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[82]Swank, History of the Manufacture of Iron, p. 213; Cappon, "Iron-Making in North Carolina," pp. 332 and 336; Cappon, unpublished manuscript, pp. 28-29, 47, and 132; Nave, p. 101; Samuel C. Williams, "Early Iron Works in the Tennessee Country," Tennessee Historical Quarterly 6 (March-December, 1947), pp. 34-40; Hunt, pp. 179, 189, and 196; Fink, pp. 51-52.

TABLE XXXIX

SIZE OF THE IRON PLANTATIONS IN THE UPLAND SOUTH DISTRICT

Furnace, Firm, or Ironmaster	Size of Landholdings (in Acres)	Approximate Date
East Tennessee		
Tellico Iron Company	30,000	antebellum
East Tennessee Mining and Mfg. Co. (2 furnaces)	40,000	1850's
Washington Iron Mfg. Co.	30,000	1839
Pactolus I.W.	3,000	1795
Green County Iron Co.	5,564	1869
A furnace in Union County	4,000	infer postbellum
Carter furnace	12,000	postbellum
Maxwell furnace	13,000	postbellum
Butler	3,000	postbellum
Roane Iron Co.[a]	20,000	after 1867
Oakdale I.W.[a]	4,139	1870's
Rhea Iron Company[a]	5,000	c. 1880
South Carolina		
Hill's I.W.	15,000	1795-1801
S.C. Manufacturing Co.	25,000	antebellum
Nesbitt Iron Manufacturing Co.	8,000	1830's
North Carolina		
High Shoals Manufacturing Co.	15,000	1840-1854
Alexander Brevard[b]	8,000	1815
Mt. Tirzah Forge[b]	7,883	1855
Alabama		
Shelby I.W.	6,000	1862
Brierfield	7,000	1866
Old Oxford	825	1862
Furnace on Choccolocco	800	1850

Sources: Carter Z. Patten, "A History of the Mansion on the Tellico River," Tennessee Historical Quarterly (December, 1951), pp. 366-369; Cappon, unpublished manuscript, pp. 135-136, 139, 182-183, and 168; Fink, pp. 54-55 and 59. Chamberlain, p. 6; Foster, Part II, p. 10; Hunt, pp. 180 and 196; Killebrew, Introduction to the Resources, p. 235; Killebrew, Iron and Coal, pp. 13, 17 and 67; Armes, pp. 88, 177, 179, and 204-206; Vandiver, 1948, p. 15; Vandiver, 1950, p. 10; State Archives, North Carolina, Alexander Brevard Papers; Lander, pp. 341, 343, 339 and 348; Warren, pp. 67-68; Safford, Geology of Tennessee, p. 455; University of North Carolina, Southern Historical Collection, William P. Bynum Papers; Brevard and McDowell Papers.

[a]Coal and coke furnaces. [b]May be the same forge.

Carolina,[83] the opportunity of acquiring free land undoubtedly luring novice ironmen into ventures destined for failure. On the other hand, Cappon points out that land grants provided the stimulus for exploitation of mineral resources in the western Piedmont.[84] The prosperous iron business of the Brevard and Graham families in Lincoln County, North Carolina, was aided by the acquisition of land from the state.[85] While the impact of land bounties and tax exemptions is difficult to measure, the valuable ore and timberland and favorable legislation undoubtedly were partly responsible for an increase, at least for a generation, of industrial activity in the Upland South District.[86]

The Economic Components of the Furnace Community

At some furnaces a diversity of enterprises was developed, including a forge, rolling mill, foundry and machine shop, grist mill, saw mill, woolen mill, and tannery.[87] As a rule, however, only two or three enterprises were operated in conjunction with the furnace, usually a forge, rolling mill, farm(s), or grist mill.

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[83]Swank, History of the Manufacture of Iron, p. 213.

[84]Cappon, "Iron-Making in North Carolina," p. 336.

[85]"Land Grant from North Carolina No. 042 10 November, 1795"; "Inventory of Lands Belonging to A. Brevard and Co. taken January, 1806 and July 15, 1803"; "John Davidson to Alexander Brevard and Joseph Graham, Deed," October 11, 1804, University of North Carolina, Southern Historical Collection, Brevard and McDowell Papers; Cappon, unpublished manuscript, pp. 29-30.

[86]Cappon, "Iron-Making in North Carolina," p. 336.

[87]Chapman, p. 99; Lander, p. 348; Swank, History of the Manufacture of Iron, pp. 217-218; Armes, pp. 66, 77, 94, and 204-205; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850 and 1860; Frank E. Vandiver, p. 15.

Forward integration. One of the principal economic components of the furnace community was secondary iron manufactures, such as a forge and/or rolling mill, which was linked in a productive chain with the furnace. During the mid-1850's, an estimated 20% to 25% of the furnaces in the Upland South District were operated in conjunction with a forge or rolling mill.[88] Forward integration was evidently more common in Alabama and South Carolina than it was in east Tennessee, North Carolina, and Georgia.[89] Since firms in South Carolina were incorporated, it is possible that integrated firms were a way to justify the stockholders' capital investment and at the same time manufacture a variety of ironware for the plantation trade. On the other hand, individuals and families were operating the furnaces in Alabama where forward integration was also designed to make secondary manufactures for the local plantation trade.

It is possible that the need and economic conditions to promote forward integration did not arise in areas of east Tennessee and North Carolina, since bloomery forges there produced a large share of the district's bar iron, while in Georgia ironmasters were making castings and hollowware for the agricultural trade and selling pig iron to secondary manufacturers in Columbus, Rome, and Atlanta.

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[88]These figures were inferred after a careful study of ownership patterns. Lesley, pp. 74-83 and 194-195; Lander, p. 349; Armes, pp. 80-81.

[89]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850 and 1860; Safford, A Geological Reconnaissance, pp. 51 and 55-56; Cappon, unpublished manuscript, pp. 43 and 135-136; Lesley, pp. 76-78, 192-192, 246, and 448; "Agreement H. S. Manufacturing Co. between H. Fulenwider and Co., 27 July 1840," University of North Carolina, Southern Historical Collection, William P. Bynum Papers; Swank, History of the Manufacture of Iron, pp. 217-218.

The compatibility of agriculture and iron making. In addition to the secondary iron manufactures, another component of the iron plantation was the furnace farm(s). The compatibility of agricultural regime and iron making may be seen in the coordination of the two sectors of production. In North Carolina, the ironmaster-planter operated the furnace so that (1) iron making would not interfere with cotton and/or corn seasons, (2) labor could be shifted to the industry when free from agriculture, (3) ironware was manufactured in time to meet the spring and fall needs of the farmer and planter, and (4) the volume of stream flow was sufficient to generate the power to operate the furnace.

To coordinate farming and iron making, two seasonal patterns were apparently practiced. In the first, the furnace blast was begun about the first of the year and continued until late spring or early summer, producing ironware suitable for spring work in agriculture.[90] Waterpower was greatest during the spring, and more plantation slaves were available at that time than in the busy harvest season of cotton picking, baling, and hauling.[91] In the second, the blast was begun in September and continued until the following April, a pattern which was also favored by available labor, market demands, and waterpower. The ironmaster-planter was able to manufacture ironware for the fall and

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[90]Cappon, "Iron-Making in North Carolina," p. 339.

[91]J. G. DeRoulhae Hamilton, editor, The Papers of William Alexander Graham (Raleigh: State Department of Archives and History, 1957), pp. 170, 179, and 240; Letter, Joseph Brevard, to Capt. Alexander Brevard, February 26, 1805, State Archives, North Carolina, Brevard Papers; Cappon, "Iron-Making in North Carolina," pp. 338-339; Cappon, "Iron-Making in North Carolina," pp. 339-340.

spring markets, yet the blast ended in time to shift labor to the plantation and/or furnace farms for the new crop season.[92]

Another advantage of coordinating agriculture and industry on the same estate was the opportunity to raise feed and foodstuffs for the furnace community.[93] In addition, the ironmaster-planter and pioneer industrialist were also involved in trade with the yeoman farmer and planter, thereby promoting agricultural settlement and development.[94] Since furnaces in the Upland South District were situated near farms and plantations and ironware was often considered legal tender, the ironmaster had little difficulty in obtaining foodstuffs at relatively low prices.[95]

In contrast to the compatibility between the agricultural regime and the iron industry, there is evidence that the agrarian ideal which permeated southern society hampered the growth of a business class.[96]

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[92]Cappon, unpublished manuscript, p. 339; Hamilton, pp. 170, 179, 188-189, and 240.

[93]Hamilton, p. 170; Cappon, unpublished manuscript, pp. 43 and 175; Lander, p. 350 and 352-53; "Stockholders Journal," May 3, 1841, University of North Carolina, Southern Historical Collection, William P. Bynum Papers; Killebrew, Iron and Coal, pp. 18-19; Nave, pp. 103-104; Killebrew, Tennessee: Its, p. 165; Chamberlain, p. 2; Letter, September 4, 1848, Knoxville Public Library, Shields Papers; Hunt, p. 194; "Pactolus Iron Works, 1811-1828," University of North Carolina, Southern Historical Collection; Cappon, "Iron-Making in North Carolina," p. 340; Frank E. Vandiver, "Josiah Gorgas and Brierfield I.W.," Alabama Review 3 (January, 1950), p. 16.

[94]Letters, Sam Shields to Sampson Bobo, May 20, 1848 and September 4, 1848, Knoxville Public Library, Shields Papers.

[95]Lesley, pp. 464, 467-468; Killebrew, Iron and Coal, p. 17.

[96]Chapman, p. 101; A. D. Foster, "History of Tennessee Industry," Tennessee Industry, Vol. 1, Part II (March, 1931), p. 11; Eaton, p. 244.

Writers have claimed that a primary reason for the decline of the iron industry was the revival of high prices for Southern agricultural staples.[97] On the other hand, the industry was also hampered when agricultural interests were depressed, since stockholders and ironmaster-planters were unable to meet their financial commitments to the iron industry.

The Carolina Piedmont is the area of the Upland South Iron District where these conclusions are most applicable. The long depression in the South Atlantic cotton region following the Panic of 1837 affected the planters' ability to support the iron business, causing the failure of some firms.[98] Cappon pointed out that since the iron industry was financially and functionally subsidiary to the plantation system in the Carolina Piedmont, the industry failed to reach out beyond the limited local market and never realized its full potential.[99] However, as argued in the concluding section of this chapter, it is doubtful whether the ironmaster-planter of the Carolina Piedmont could have successfully developed the iron trade much beyond the local market because of competition in the overlapping trade areas.

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[97]Chapman, p. 101; Eaton, p. 242.

[98]Lander, p. 344; Eaton, p. 235; Cappon, unpublished manuscript, p. 168.

[99]Cappon, unpublished manuscript, p. 107c; Cappon, "Iron-Making in North Carolina," p. 344.

The Pattern of Iron Trade in the Upland South District

Compared to the other southern iron districts, the iron production of the Upland South was relatively small. There were two peak periods of production during the antebellum era, one in the late 1840's and the other in the mid-1850's, when the furnaces in the Upland South produced between 7,000 and 8,000 tons. Until the 1840's, the factors limiting production were the dependence on agricultural needs, the underdevelopment of secondary manufactures, and the cost and difficulty of transportation to marketplaces in the Ohio Valley and Midwest. When pig iron was shipped to marketplaces in the Ohio Valley, it had to compete with iron from the Western and Hanging Rock districts.

With the underdevelopment of secondary manufactures in the district, a large share of the furnace production was in the form of hollowware and castings for trade with the yeoman farmers, planters, and other settlers. As late as 1850, ironmasters in east Tennessee were manufacturing 805 tons, or 27%, of their production into hollowware and castings, casting the balance into pig iron.[100] This pig iron was primarily consumed by the forge, rolling mill, and foundry and machine shop. Forges and rolling mills connected with some furnaces were also manufacturing bar iron, nails, and other agricultural implements and tools for the agrarian economy.[101] However, as a small secondary iron

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[100]United States Bureau of the Census, unpublished census manuscripts, 1850.

[101]"Stockholders Journal," University of North Carolina, Southern Historical Collection, William B. Bynum Papers; Letter or unpublished manuscript, no date, Duke University, W. I. Crandall Papers, pp. 1-4;

manufacture began to develop in the Upland South, ironmasters made more pig iron and fewer castings and hollowware.

In 1850, pig iron production in the Upland South was about 4,000 tons, and the consumption by forges, rolling mills, and foundry and machine shops was nearly equal to production (Table XL). This balance in production and consumption was probably maintained through the mid-1850's as furnaces in the Upland South produced the lion's share of pig iron fabricated in the interior of the district.[102] After 1856, pig iron production began to decline; by 1860, pig iron consumption was perhaps greater than production, the deficit apparently being made up by unsold stocks of iron, reuse of old metal, and imports from other districts.

Pattern of Iron Trade: The Antebellum Period

From the furnaces in east Tennessee the ironware was transported in wagons and boats to towns throughout east Tennessee, Kentucky, Virginia, Georgia, and Alabama, including such places as Kingsport, Jonesboro, Knoxville and Kingston, Tennessee, Saltville, Virginia, and Huntsville, Muscle Shoals and Florence, Alabama.[103] The ironmasters sold a portion

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"Pactolus Iron Works, 1811-1828," University of North Carolina, Southern Historical Collection, pp. 1-2; Hunt, pp. 178, 185-186, 188-189, and 195; Chamberlain, p. 24; Cappon, unpublished manuscript, p. 51; Killebrew, Iron and Coal, p. 67; Fink, pp. 49-55; Nave, p. 104; "Pactolus Iron Works, 1811-1828," University of North Carolina, Southern Historical Collection.

[102] Bowron, p. 495.

[103] Hollowware and castings were hauled in a six-mule team wagon to marketplaces and returned with merchandise received in exchange for iron. Letter or unpublished manuscript, Duke University, W. I. Crandall Papers, pp. 1-4.

TABLE XL

PRODUCTION AND CONSUMPTION OF PIG IRON IN THE UPLAND SOUTH DISTRICT, 1850-1870
(IN TONS)

	1850			1860			1870		
	Prod.	Cons.	Diff.	Prod.	Cons.	Diff.	Prod.	Cons.	Diff.
Alabama	552	2,511	-1,959	1,742	1,762[b]	-20	6,273	1,780[d]	+4,493
East Tennessee	2,190[a]	518	+1,672	2,796	3,871[c]	-1,075	13,002	4,029	+8,973
Georgia	900	540	+360	1,100	2,869[c]	-1,769	1,220	12,700	-11,480
North Carolina	400	192	+208	none	658[c]	-658	1,422	1,088	+334
South Carolina	no entry	169	-169	none	276[c]	-276	180	727	547
TOTALS FOR THE DISTRICT	4,042	3,930	+112	5,638	9,436[c]	-3,798	22,097	20,324	+1,773

Sources: U.S. Bureau of the Census, Seventh Census, "Report of the Superintendent of the Census for December 1, 1852" (Washington, D.C.: Robert Armstrong, 1853), pp. 156-158; Eighth Census 1860, Vol. III (Washington, D.C.: Government Printing Office, 1865), pp. clxxix and clxxx; Ninth Census 1870, Vol. III (Washington, D.C.: Government Printing Office, 1872), pp. 601, 605-607; U.S. Bureau of the Census, unpublished census manuscripts, "Products of Industry" in 1850, 1860, and 1870 for Alabama and Tennessee; DeBow's Review, Vol. 18, p. 114.

[a]The total production was 2,995 tons, but 480 and 325 tons were castings and hollowware, respectively.

[b]The manuscript entry for S. Kate and Co. listed 4,000 tons, but the cost data did not corroborate that tonnage. As a consequence, this writer believes the entry should be 400 tons, which is used here.

[c]Estimated.

[d]Estimated by taking 75% of the value of raw materials divided by $40.00.

of the pig iron to secondary manufacturers in east Tennessee, shipping the surplus pig metal down the Tennessee River on flatboats to Georgia and Alabama and forwarding smaller quantities to the Ohio Valley and Lower South.[104]

During the 1840's and 1850's, furnaces with some potential were erected in proximity to the Etowah Valley in northwestern Georgia.[105] Since the furnaces possessed easy access down the Coosa River into Alabama and were situated on the periphery of the Georgia plantation district, the ironmasters directed their trade toward agricultural needs.[106] They also supplied pig iron to Etowah, a local rolling mill near Cartersville, and shipped pig metal to secondary manufacturers in Atlanta, Rome, and Columbus.[107]

In Columbus, Georgia, two foundry and machine shops were manufacturing castings and machinery for steamboats, with Columbus Iron Works beginning a few years later.[108] In Rome, the Rome Foundry and Machine Company on the upper Coosa River was chartered by the

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[104]The boats from upper east Tennessee were designed to carry 25 tons to Florence, Alabama, then to the Ohio Valley. Foster, Part I, p. 8; Swank, History of the Manufactures of Iron, p. 224; "Pactolus Iron Works, 1811-1828," University of North Carolina, Southern Historical Collection, p. 3; Cappon, unpublished manuscript, pp. 49-50 and 135-136; Fink, pp. 49-53; Hunt, pp. 186 and 188; Letter or manuscript, Duke University, W. I. Crandall Papers, p. 3; United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850; Killebrew, Iron and Coal, p. 36.

[105]Cappon, unpublished manuscript, p. 172.

[106]Cappon, unpublished manuscript, pp. 172-174.

[107]Lesley, p. 246.

[108]Cappon, unpublished manuscript, p. 178.

mid-1850's. Finally, Gate City rolling mill in Atlanta had the capacity to fabricate 12,000 tons of iron for southern railroads, offering iron and coal entrepreneurs another large market.[109] About 1859 Atlanta also had a number of retail stores selling ironware and nails, six hardware and cutlery firms, and four large foundry and machine shops, two of which were connected with the railroad.[110]

In Alabama the inhabitants were almost entirely dependent upon ironware from the Atlantic states until the development of the industry in three areas of the state, including the Coosa Valley, Cahaba Valley, and northwestern Alabama. Since northern Alabama was separated from the ore deposits of central Alabama (Coosa and Cahaba valleys) by rugged terrain, consumers in Florence, Huntsville, and other places were primarily dependent on receipts of ironware from northwestern Alabama and Tennessee.[111]

The ironmasters in the Coosa and Cahaba valleys, including those in Shelby, Talledega, Calhoun, Cherokee, Tuscaloosa, and Bibb counties, supplied ironware to the planters and farmers in central and southern Alabama.[112] The ironware was hauled in wagons, crude rafts, and

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[109]Lesley, p. 246; Cappon, unpublished manuscript, p. 178.

[110]Cappon, unpublished manuscript, p. 177.

[111]By the late 1850's, ironmasters there also shipped ironware southward to Columbus, Mississippi, where it was sold to farmers and planters at the same high prices as Swedish iron. Cappon, unpublished manuscript, pp. 68-69 and 184-185; Armes, pp. 30 and 96-97; Woodward, p. 199.

[112]The Cahaba Valley area was dominated by forge production for the plantation trade. Armes, pp. 65-66, 70, 78-79, 80-83, and 91-94; Cappon, unpublished manuscript, pp. 180-183.

flatboats to such marketplaces as Wetumpka, Montgomery, Washington, Prattville, Selma, Marion, Tuscaloosa, and other places in the Black Belt of Mississippi, with some forwarded by steamboat to Mobile.[113]

By 1852 ironmasters in the Coosa Valley were also shipping pig iron to foundries in Columbus and Rome, Georgia, where the metal was selling at a higher price than pig iron from Georgia and Tennessee because it produced a better result.[114]

At midcentury the secondary manufacturers in northern and central Alabama were fabricating nearly two-thirds of the state's pig iron into wrought iron, machinery, mill castings, and gin castings, the balance supposedly used by manufacturers in Mobile.[115] Since pig iron consumption in Alabama exceeded the state's production, the deficit was made up by imports into Mobile and receipts of iron from Tennessee and Georgia.

Locational Change in Production: The Demise of the Carolina Piedmont and the Rise of East Tennessee, Georgia and Alabama

In North Carolina and South Carolina, the course of the rivers favored the Piedmont and Tidewater regions as markets, causing

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[113]Cappon, unpublished manuscript, pp. 180-182; Armes, pp. 61, 64-66, 71, 73, 78-80, 91-96, and 99; Letter, Sam S. Marshall to J. A. Jackson, February 7, 1859, University of Kentucky, Buckner Papers.

[114]Armes, pp. 65-66 and 80-81; Cappon, unpublished manuscript, pp. 181-183.

[115]United States Bureau of the Census, unpublished census manuscripts, "Products of Industry," 1850; United States Bureau of the Census, Seventh Census, "Report of the Superintendent of the Census" (Washington, D.C.: Robert Armstrong, 1853), p. 158.

ironmasters in the Carolina Piedmont to direct their trade toward Charlotte, Camden, Columbia, Charleston, and Augusta.[116] While iron prices were relatively high in the interior, prices declined toward the Tidewater Region and became more uniform because of competition from northern and foreign iron.[117] The merchant-importer in Charleston, South Carolina, would ship ironware up the Catawba River as far as Camden every spring to supply the plantation trade. Piedmont ironmasters were shipping ironware by wagon and river to the same marketplaces, which created competition in the overlapping trade area.[118] The ironmaster-planter had the advantage over the merchant-importer in the interior and in the overlapping trade area when rivers were too low to prevent shipment inland.[119] However, when ironware was shipped inland, it

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[116]Letters, Thomas S. Tarts to Dr. Shields, September 4, 1848 and May 20, 1848, Knoxville Public Library, Shields Papers; Cappon, "Iron-Making in North Carolina," pp. 337-341; Lander, pp. 352-354; Lesley, p. 189; Cappon, unpublished manuscript, pp. 33 and 43; Letters, J. Brevard to Alexander Brevard, June 18, 1797 through July 28, 1810, State Archives, North Carolina, Brevard Papers; Letter, R. H. Morrison to John D. Graham, July 21, 1836, State Archives, North Carolina, Brevard Papers.

[117]Even with the benefits of improved river and steamboat transportation, the cost of marketing was more severe than any one single factor of production. Lesley, pp. 464-465; Cappon, unpublished manuscript, pp. 49, 72, 107a, 107b, 166, 170, and 195-196.

[118]See Alexander Brevard Papers, State Archives, North Carolina for a detailed description of the problems in the iron trade. Cappon, "Iron-Making in North Carolina," pp. 338-339; Cappon, unpublished manuscript, p. 43; Lander, p. 352.

[119]Letters, Joseph Brevard to Alexander Brevard, June 18, 1797, September 6, 1797, December 27, 1798, and January 1, 1801, State Archives, North Carolina, Brevard Papers; Lesley, pp. 464-465; Cappon, "Iron-Making in North Carolina," pp. 335, 338-339, and 343-345; Cappon, unpublished manuscript, pp. 42-44, 107a, 107b, 107f, 161, 164-165, and 188; Armes, p. 97.

satisfied the plantation needs, leaving less opportunity for the sale of home manufactures. In addition, the ironware produced by the developing secondary manufactures in Charleston and Augusta also entered the competition, further reducing the prospects for the iron industry of the Carolina Piedmont.[120]

As a consequence of this competition, there was a relative decline of the iron production in the Carolina Piedmont in the 1850's and by 1860 the industry was nearly extinct. Although the principal reason for the demise was competition in the overlapping trade area, other secondary causes included poorly developed transportation, depletion of timber resources, emphasis on agriculture, poor management, and related financial difficulties.[121]

Impact of the Railroad

Closely connected with competition in the iron trade was the development of railroads, which would supposedly enable the Carolina ironmasters to compete with northern and foreign iron.[122] While the railroad could have aided the backcountry ironmaster in South Carolina, rail lines did not reach Greenville, Spartanburg, and Yorkville until the 1850's, by which time the ironmaster-planter was struggling to hold local trade.[123] While railroad construction began early in North

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[120]Lander, p. 354.

[121]Eaton, p. 235; Chapman, p. 101; Lander, pp. 354-355; Cappon, unpublished manuscript, pp. 72 and 168; Foster, Part 2, pp. 11-12.

[122]Lander, p. 354; Cappon, unpublished manuscript, p. 164; Cappon, "Iron-Making in North Carolina," pp. 344-345.

[123]Lander, p. 354.

Carolina, it advanced slowly; when railroad facilities reached the Piedmont in the 1850's,[124] it was too late to reverse the waning production. The railroads extended the range of trade for northern and foreign iron makers who apparently gained more than the ironmasters of the Carolina Piedmont.[125]

The opportunity that ironmasters of the Carolina Piedmont enjoyed in the 1830's and 1840's was lost to the ironmen of east Tennessee, Georgia, and Alabama, where transportation facilities to the Ohio Valley and Midwest were superior.[126] The Western and Atlantic Railroad gave the furnaces of northwestern Georgia access to rail transportation, enabling some ironmasters there to transact trade in Chattanooga and Knoxville, as well as marketplaces in the Ohio Valley.[127] The railroad apparently encouraged the expansion of pig iron production in northwestern Georgia, since the furnaces produced nearly 3,000 tons a year during the mid-1850's.[128] The prominence of Chattanooga as an

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[124]Cappon, unpublished manuscript, pp. 163-164; Cappon, "Iron-Making in North Carolina," p. 344.

[125]Cappon, unpublished manuscript, pp. 164-165; Cappon, "Iron-Making in North Carolina," p. 345.

[126]Cappon, "Iron-Making in North Carolina," p. 347; Cappon, unpublished manuscript, p. 196; Robert H. McKenzie, "Reconstruction of the Alabama Iron Industry 1865-1880," Alabama Review 25 (July, 1972), pp. 186-187.

[127]Lesley, pp. 76-78; Cappon, unpublished manuscript, pp. 172 and 174-176.

[128]Lesley, pp. 76-78; Cappon, unpublished manuscript, pp. 172 and 175-176.

iron center was also due to the superior transportation facilities and excellent bituminous coal in the vicinity.[129]

Safford noted that the lack of a suitable market was limiting production in the eastern ore region of east Tennessee, a problem that the railroad would remove by either encouraging the development of secondary manufactures or providing access to marketplaces outside the district.[130] The proprietors of Pleasant Valley furnace held a similar viewpoint, believing that the railroad would create a new era of production.[131] While the railroad evidently encouraged the expansion of Pleasant Valley furnace, by 1860 iron production in east Tennessee was similar to that of 1850; consequently, railroad developments were apparently too late to alter the pattern of production and trade during the antebellum period. The circumstances were undoubtedly similar in Alabama. Nonetheless, during the postbellum period, the history of the development of iron, coal, and railroads in Alabama, Tennessee, and Georgia are inseparable.

Rise of the Postbellum Industry

The iron industry of Tennessee, Alabama, and to a lesser extent, Georgia, underwent a remarkable period of growth during the postbellum period (Table XXXVI, page 275, and Figure 43, page 284). Iron production

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[129]Swank, History of the Manufacture of Iron, p. 226; Cappon, unpublished manuscript, p. 138.

[130]Safford, A Geological Reconnaissance, pp. 32 and 38-39.

[131]Lesley, p. 246; Fink, p. 55; Cappon, unpublished manuscript, p. 134.

in east Tennessee, Alabama, and Georgia rose to over 20,000 tons in 1870; but by 1880 production had risen to over 120,000 tons, charcoal iron comprising about 40,000 tons of this production. While charcoal iron production in Tennessee, Alabama, and Georgia increased to over 165,000 tons between 1880 and 1889, it represented a declining share of total production as pig iron made with coal and coke rose to 950,715 tons.[132]

Although pig iron consumption in the Upland South District was nearly equal to production in 1870, production soon exceeded local consumption. As a consequence, ironmasters sought new markets, the Midwest and North, for their surplus pig iron. In 1873, 16,500 tons of pig iron were transported on the Tennessee River between Florence, Alabama, and the Kentucky state line, undoubtedly destined for secondary manufacturers in the Ohio Valley and Midwest.[133] By 1879, 80% of the pig iron used by rolling mills in Louisville, New Albany, and Terre Haute was supposedly shipped from the Upland South.[134] During the 1880's ironmen were also supplying markets in the North with pig iron largely used for foundry purposes. In conclusion, to maintain the new, enlarged scale of production characteristic of the postbellum period,

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[132]The 1880 and 1889 production given here includes the entire state of Tennessee.

[133]Killebrew, Introduction to the Resources, p. 285.

[134]It is possible that part of this pig iron may have been shipped from the Western Iron District. "Scrapbook of J. B. Killebrew No. 1," August 29, 1879, State Archives, Tennessee, Killebrew Papers.

iron makers in the district were almost entirely dependent on marketplaces in the Midwest and North.[135]

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[135]A thorough study of the charcoal iron industry between the Civil War and early 20th century is badly needed. Armes, pp. 66 and 303; McKenzie, pp. 183, 186, and 190; Killebrew, Iron and Coal, pp. 11-12, 17, and 53-54; Killebrew, Tennessee: Its, p. 125; P. N. Moore, "Report on the Iron Ore in the Vicinity of Cumberland Gap," Geological Survey of Kentucky (Frankfort: Yeoman Press, 1884), p. 13; Sanborn, pp. 39-40; Foster, Part 2, p. 13; Directory of the Iron and Steel Works (A.I.S.A., 1887), pp. 38, 40, 41-43, 46-47, and 171.

CHAPTER VII

SUMMARY AND CONCLUSIONS

According to Clement Eaton, a number of small industries concentrated in towns, usually located along the fall line, was the typical industrial pattern in the antebellum South.[1] A pattern just as typical, however, was that of the numerous rural furnaces, forges, and rolling mills in the southern iron districts. These furnaces and integrated firms were among the largest southern business enterprises in terms of capital investment, employment, value of products, and size of landholdings.

The outstanding characteristics of the southern charcoal iron industry were its wide dispersion, rural location, rapidly changing pattern, close relationship with agricultural settlement and development, use of slave labor, and spatial variation in cost and consumption of raw materials.

The widely dispersed charcoal iron industry of the southern iron districts produced a significant proportion of the nation's pig iron, and experienced a rapidly changing pattern of production. Between 1830 and 1840, production in the southern iron districts rose from 26,100 to 84,087 tons, a 17% annual rate of growth, compared to only 6% for the rest of the nation. On the other hand, while the annual rate of growth for the nation was about 8% during the 1840's, production in the

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[1]Clement Eaton, The Growth of Southern Civilization (New York: Harper and Row, 1961), p. 241.

southern iron districts slowed to an annual rate of only 4%. Consequently, at midcentury the 125,960 ton production of the southern iron districts represented a declining share of the nation's pig iron production, dropping from 29% in 1840 to 22% in 1850.

Although the pig iron production of the southern iron districts represented a declining share of the U.S. production during the 1840's, the causes and timing of the demise were different for each southern district. While the decline of the southern iron districts was caused by a number of interrelated processes, it has been the purpose of this study to examine the role that competition in the iron trade and depletion of timber resources played in the demise. The hypotheses tested are (1) the depletion of timber for charcoal shut some local ironworks down, but it did not cause the demise of the industry on a regional scale; and (2) the changing patterns of production, particularly the decline, can be largely explained by the inability of southern ironmasters to compete for markets. The third hypothesis tested in this study is that the existence of the southern charcoal iron industry is partly explained by the compatibility between the agricultural regime and the iron industry.

In Lesley's Iron Manufacturer's Guide . . ., C. E. Smith correctly observed that the decrease in charcoal iron production was directly proportional to the accessibility of the iron districts to the seaboard and to foreign iron.[2] What he omitted from his evaluation was the fact

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[2]John P. Lesley, The Iron Manufacturer's Guide to the Furnaces, Forges, and Rolling Mills of the United States (New York: John Wiley, 1859), p. 752.

that competition from Pennsylvania anthracite iron was also a primary factor in the demise.

The Virginia District and the Carolina Piedmont of the Upland South District were the most accessible areas to the seaboard and were the first areas of the Southern Iron Region to experience a decline. In the Virginia District, production plummeted from 22,163 tons to 11,646 tons between 1850 and 1860 due to (1) competition from cheaper northern iron, (2) a diminution in iron prices, (3) a rise in cost of hiring slaves, and (4) the displacement of the rural forge by secondary manufactures in urban areas. The more remote mountain furnaces, depending on markets in Richmond, Fredericksburg, Philadelphia, Baltimore and other seaboard marketplaces, were apparently the first to fail, but one by one, furnaces were closed as cheaper Northern iron undersold slave-made Virginia iron in the Old Dominion.

The plight of the industry in the Carolina Piedmont was similar, as ironmasters there were facing competition from Virginia, Northern and foreign iron. The most accessible marketplaces in the Carolinas were in the Piedmont and Tidewater regions, prompting ironmasters to direct their trade toward Charlotte, Camden, Columbia, Charleston, and Augusta. Meanwhile, merchants in Charleston, South Carolina, shipped ironware up the Catawba River as far as Camden every spring to supply the plantation trade. Thus, a principal reason for the decline was the competition in the overlapping trade areas, though other secondary causes included poorly developed transportation, depletion of timber resources, emphasis on agriculture, poor management, and related financial difficulties.

While the industry was declining in the Virginia District and the Carolina Piedmont, production was being expanded in the Western and Hanging Rock districts to meet the rising demand for charcoal iron in the Ohio Valley and Midwest. In 1854, peak iron production was achieved in the Western Iron District when furnaces there manufactured 49,419 tons. Subsequently, there was a slow absolute decline which became more acute after 1857, with production plummeting from 42,858 tons in 1857 to 26,640 tons in 1860. Since manuscript records are presently inadequate to document the reasons for the decline, it is hypothesized that there is a correlation between the demise of the Western Iron District and the rise of production in the Hanging Rock and Missouri iron districts.

The secondary manufacturers in the Ohio Valley and Midwest were the primary markets for the Western, Hanging Rock, and Missouri iron districts, and competition in the pig iron trade supposedly caused the demise of the Western Iron District. Similarly, blooms from the Western Iron District were also facing competition in the Ohio Valley, and rolling mills were increasingly using pig iron in place of blooms. In addition, at least nine furnaces in the district failed because of problems in mining, exhaustion of ore, and excessive distance to the ore banks, indicating that problems in supplying ore were another factor in the demise. Finally, the high cost of transportation from the more distant rural locations also reduced the profit margin, with the more remote Tennessee section of the district the first to experience a decline in production, followed after 1857 by the Kentucky section.

Meanwhile, the Hanging Rock District was experiencing a production increase of nearly 17,000 tons between 1854 and 1857, which, along with

the rise of the Missouri Iron District, more than offset the decline of the Western Iron District. The 1850's were an active period for the erection of new furnaces in the Hanging Rock District, causing production to rise from 56,491 tons in 1850 to an antebellum peak of 96,000 tons in 1857. This 8% annual rate of growth was higher than that of the rest of the nation, and most of the new capacity was in the Ohio section of the district.

After 1857, however, there was an absolute decline in production, and by 1860 the furnaces in the Hanging Rock District produced only 84,170 tons. Even though charcoal iron production rose to 103,816 tons by 1870, the Hanging Rock District experienced a relative decline compared to the rest of the nation's iron industry, including the charcoal sector.

This absolute decline in the late 1850's and the relative decline during the postbellum period can be largely explained by the inability of ironmasters to compete for markets, first in Pittsburgh and later in other Midwestern cities. The causes of the Hanging Rock District's demise were (1) the direct and indirect competition from cheaper domestic (anthracite pig iron) and foreign iron; (2) the expansion of the railway network that allowed anthracite iron to enter the Pittsburgh trade and established the basis for the development of pig iron made with bituminous coal and coke; (3) the rise of pig iron made with bituminous coal and coke in the latter 1850's, which provided new competition; (4) the fluctuating and periodic decline in iron prices; and (5) the rise in cost of raw materials, labor, and supplies.

Although a number of causes were responsible for the decline of the southern iron districts, competition in the iron trade was the overriding factor. The primary and secondary data overwhelmingly support the hypothesis that the demise can be largely explained by the inability of ironmasters to compete for markets.

The second hypothesis tested in this study is that the depletion of timber shut some local ironworks down, but it did not cause the demise of the industry on a regional scale. To be sure, charcoal iron making was clearly a fuel intensive industry, with the typical furnace annually consuming the cordwood from 100 to 300 acres. At this rate of consumption, it is not surprising that depletion of timber has been widely given as a cause of the industry's demise. Yet it is clear that competition in the iron trade rather than any serious shortage of timber at the regional scale was the principal cause of the demise. The evidence that timber depletion was not the primary cause of the demise includes the following facts. First, the landholdings of the iron plantations were usually large enough to provide sufficient quantities of cordwood to have sustained the industry through the antebellum period. In addition, the majority of furnaces were erected after 1830, and were on landholdings large enough to supply cordwood through the rather brief period of decline. Second, the absence of references in the manuscript records to difficulties in supplying cordwood also strongly suggests that wood depletion at the regional scale was not a problem. Third, the modest increase in cost of charcoal during the 1850's also indicates that there was a plentiful supply of timber. If

charcoal had been in short supply during the period of decline, the shortage should have been accompanied by a sharp rise in cost. Finally, during the period that iron production was declining, Lesley, Safford, and other 19th century commentators were confident that the timber supply was abundant. These conclusions support the hypothesis that the depletion of timber was a cause for the failure of a few furnaces at specific sites, but it was not a principal factor in the demise at the regional scale during the antebellum era.

It is obvious that use of the charcoal technology placed limits on growth. Ironmasters in southern Lawrence and Scioto counties, Ohio, and in the Carolina Piedmont apparently had difficulties in supplying cordwood. Although reports concerning wood depletion in the Carolina Piedmont are contradictory, Ernest Lander presents a convincing argument that timber depletion was a factor in the demise of the South Carolina iron industry,[3] with the circumstances in the North Carolina Piedmont undoubtedly similar.

In the Hanging Rock District, the furnaces in southern Lawrence and Scioto counties were erected near the Ohio River during the 1820's and 1830's. Since the estates of these furnaces were smaller than the average furnace landholding in the district, wood depletion eventually became a problem. Lagrange furnace was abandoned in 1856 for lack of timber, and the timber supply at Franklin and Etna furnaces was surely near exhaustion. The ironmaster at Union furnace, last operated in

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[3]Ernest M. Lander, "The Iron Industry in Ante-Bellum South Carolina," Journal of Southern History 20 (August, 1954), pp. 354-355.

1854, was waiting for second growth timber to mature before beginning a new blast. In contrast, Steam furnace, built in 1817 and rebuilt in 1854 in Greenup County, Kentucky, was operating on second growth timber, which illustrates the potential for a long-term, sustained operation of the charcoal furnace.

Although depletion of timber caused these furnaces either to shut down temporarily or permanently, the timber supply at the regional scale was sufficiently abundant so as not to cause a regional decline. A number of furnaces were built in the Hanging Rock District during the 1840's, and 30 of the 59 furnaces in operation during the 1850's were built after midcentury. The majority of these furnaces were situated on the periphery of the older, established area, the capacity of which more than offset any relative decline in production caused by depletion of timber in southern Lawrence and Scioto counties.

To provide cordwood for the fuel intensive industry, ironmasters of the southern iron districts held sizeable estates, averaging from 5,000 to over 10,000 acres. Besides gathering raw materials on these large estates, some ironmasters maintained furnace farm(s), providing all or part of their feed and foodstuffs. Conducting the iron business and agriculture on the same estate and/or the trade relationship between the pioneer industrialist (including the ironmaster-planter) and the farmer and planter suggests a reciprocally beneficial arrangement.

However, historians have commonly asserted that the agrarian ideal which permeated southern society undoubtedly hampered the growth of business and industry. While this was perhaps the case with the growth

of secondary iron manufactures, it does not apply to the development of the charcoal iron industry. Ironmasters successfully developed furnaces, forges, and rolling mills in the southern iron districts; and their interchange with the farmer and planter seems partly to contradict the premise that the agricultural regime hampered the growth of industry. This observation led to the final hypothesis of this study; that is, that the success of the southern charcoal iron industry is partly explained by its compatibility with the agricultural regime.

The successful trade relationship between the pioneer industrialist and farmer and the suitability of conducting agriculture and iron making on the same estate may be seen in the following. First, the furnace farms were another feature of backward integration as they either partly or wholly supplied the furnace community with foodstuffs. Second, the ironmaster was able to efficiently use labor by coordinating its application between the agricultural and industrial sectors, thereby taking advantage of seasonal patterns. He operated the furnace so that (1) iron making would not interfere with the cotton and corn seasons, (2) labor could be shifted to the iron industry when free from agriculture, (3) ironware was manufactured in time to meet the spring and fall needs of the farmer and planter, and (4) the volume of stream flow was sufficient to generate the power needed to operate the furnace.

Third, there was a successful interaction between the pioneer industrialists (including the ironmaster-planter) and the farmers and planters, involving the hiring of slaves, the trade for agricultural commodities and the sale of ironware. The furnace communities

collectively generated an enormous demand for food and provisions, which fostered the expansion and prosperity of nearby agricultural regions. A substantial amount of corn, bacon and pork, beef, roughage, and other commodities was needed to supply the draft animals, workmen, families, and others in the furnace communities. It is obvious that the iron industry promoted the settlement and development of the evolving corn-livestock region, as the Scioto Valley was the principal area of supply for the Hanging Rock District. To a lesser extent, the iron industry had a similar impact on the agricultural development in the Western, Virginia, and Upland South iron districts.

The agrarian population was also a primary market for pig iron, bar iron, tools, castings and hollowware manufactured by the furnace and forge. In addition, some farmers sold raw materials to the ironmasters and had their land cleared in exchange for the cordwood. The farmer also found seasonal employment in the iron industry. Finally, the farmer and planter contributed to the industry's labor force by hiring their surplus slaves to the ironmaster.

Although agriculture and iron making were usually complementary, agriculture occasionally hampered the iron business. The production and cost of pig iron were affected by high prices for agricultural commodities, poor crop yields, and delays in the receipt of feed and foodstuffs. The Carolina Piedmont was the principal area of the southern iron districts where agriculture was apparently detrimental to the iron business. The stockholders of the furnaces, forges, and rolling mills were often planters, and when cotton cultivation did not

fair well they were unable to honor their financial commitments to the industry. On the other hand, during periods of prosperity in farming, stockholders and ironmaster-planters directed their investment and bondsmen toward agriculture, which apparently offered more certain profits at less risk than iron making. During periods of agricultural prosperity in the Virginia District, ironmasters also had to compete for slave hirelings and were forced to pay higher prices for manpower, which contributed to the demise of the industry.

While agriculture evidently hampered the development of the iron industry in the Carolina Piedmont, the primary cause of the decline in production was more likely competition in the iron trade than the industry being financially and functionally subsidiary to the plantation system. In other parts of the southern iron districts it is clear that the existence of the charcoal iron industry is partly explained by its compatibility with the agricultural regime.

In addition to the compatibility of agriculture and iron making, a hallmark of many successful furnaces was the use of an elaborate barter system, which allowed the ironmaster to operate on limited capital. The barter involved (1) workmen making purchases at the company store in exchange for their labor, (2) deferred payments for slave hirelings until the end of the year, and (3) the purchase of goods from commission merchants who subtracted the purchase from the sale of ironware.

In conclusion, besides promoting agricultural settlement and development, the charcoal iron industry fostered the growth of other facets of the economy. Commission merchants, ironmongers, bankers, and

others in the developing urban-industrial centers provided the rural ironmaster with financial, wholesale, and other services. The development of secondary iron manufactures contributed to an increase in size of these towns and provided a market for pig iron. Finally, the shipment of ironware, agricultural commodities, and other goods promoted the improvement of transportation facilities to handle the new and enlarged trade.

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