The Relationship between Agricultural Development and Industrial Growth 1660-1880: A Case Study of The Black Country

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Abstract

This dissertation examines the link between agricultural growth and industrial development in Britain, using the Black Country as a case study. This involves looking at a how industry developed in the Black Country and considering what factors facilitated this development and how far agriculture was one of these.

This focuses on an investigation into the role of the knowledge economy, and the idea that as the importance of science became more recognised, people who understood how to apply science to agricultural, and later industrial, situations were able to influence the direction that these economies took. This investigates the actions of "revolutionary players" such as James Loch and James Keir, discovering how far they utilised the same knowledge economy that had been used to develop agriculture, as they drove industry forward.

Primary sources include the works of Robert Plot and James Keir who provide accounts of the Black Country during the seventeenth and eighteenth century. Personal correspondence of some Black Country land agents which show exactly how these men were involved in industrial development and provide an insight into their role in the knowledge economy, are also used. A wealth of information has also been taken from nineteenth century printed sources on the coal and iron trades, which provide accounts of the Black Country economy at this time.

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Abbreviations

BAH: Birmingham Archives and Heritage

SRO: Staffordshire Record Office

MS: Manuscript

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Introduction

The history of industrialisation in Britain has been told innumerable times. Historians have written generally about economic and population growth and new industries stemming from breakthroughs in mechanisation. Recently, historians such as Inkster and Morrell have sought to redefine the period by considering the idea that industrial change was inherently linked to social change. For them, the traditional historiographic tendency to define the Industrial Revolution in economic terms is insufficient. Throughout *Metropolis and Province*, consideration is given to the idea that "a social approach [to the industrial revolution] can incorporate the material of the former approach within its basic argument".[1] Inkster and Morrell argue that "socio-psychological forces, and the associated educational-scientific-technological factors in the Industrial Revolution, which cannot any longer be explained simply in economic terms of supply and demand" were at the root of industrial change. This thesis takes its roots in this idea, that these social changes, the growth of education and of the Literary and Philosophical Societies were underpinned by a growth of scientific consciousness across the country.

Metropolis and Province considers the opinions of Thackray in *Natural Knowledge in a Cultural Context* and Berman in *Science and History* in order to analyse the role that society played in the growth of the industrial revolution. They reflect on the importance of the spread of science throughout society in the period between 1780 and 1850. Their piece is built on developing an understanding of the "wider scientific movement"[2] that was percolating through society. Their conception of the Industrial Revolution calls on Ashton's idea that there was "much coming and going between the laboratory and the workshop [during the industrial revolution]".[3] This suggests that they see the Industrial Revolution as a process of evolution, where changes were wrought based on scientific experiments. It is the intention that this thesis will explore this scientific fascination, and consider its importance to the Industrial Revolution. This will build on the idea that the Industrial Revolution was the result of a series of gradual changes at a societal level in an attempt to investigate the possibility that there was a link between the agricultural revolution of the seventeenth and early

[1] I.Inkster and J. Morrell, *Metropolis and Province: Science in British Culture, 1780-1850.* (Hutchinson: London, 1983) p. 13
[2] ibid. p. 14
[3] T.S. Ashton *The Industrial Revolution 1760-1830,* (Oxford University Press: Oxford) p. 16

eighteenth century and the industrial growth of the late eighteenth and early nineteenth. The hypothesis is that there is a causal link between the agricultural and industrial revolutions which stems from the processes behind the agricultural revolution.

Metropolis and Province claims that the Industrial Revolution was dependent on society's adoption of science and the recognition that it had the potential to push the British economy forward. Through groups such as the Lunar Society, the Literary-Philosophical societies and the Mechanics Institutes science became a pre-requisite to the social and institutional change that was central to the growth of industrial Britain. These institutions underpinned the spread of scientific knowledge in the eighteenth and nineteenth centuries, creating a culture where the generation of ideas and experimentation were encouraged. Inkster and Morell argue that it was inconceivable that an economic perspective adequately defines Industrial Britain as it fails to account for the percolation of scientific thought throughout society, which is necessary because, as they argue "if social systems undergo basic change, then so too do our and the actors perceptions".[4] These perceptions and actions are as important as the physical changes to the economy. From here, we can see how a model was created where the spread of knowledge was inherent within society. *Metropolis and Province* presents the Industrial Revolution as the point at which scientific study and experimentation began to impact tangibly on society. As such, it should be looked on as a spectrum, rather than a revolution.

Science is shown to be something that was inherently social; it is from this that this work takes its starting point. The underlying theme of the piece is that a change was taking place in which science was the primary currency. In regarding ideas "as tools with which social groups may seek to achieve their purposes in particular situations"[5] they build on the idea that the middle classes began to recognise that science held the key to greater power and social standing, an idea that would later be built upon by Martin Wiener. This is a fundamental discussion, and one which will be at the centre of this piece. The thesis will examine the idea that a development of scientific knowledge during the period 1700-1850 underpinned the growth in both the industrial and agricultural sectors. This will involve looking at a multitude of factors with the aim of uncovering how far knowledge was a fundamental growth factor, and whether there were other changes which can be considered more important to industrial growth.

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[4] Inkster and J. Morrell, *Metropolis and Province: Science in British Culture, 1780-1850.* (Hutchinson: London, 1983) p. 14
[5] Ibid.

The ideas at work in *Metropolis and Province* are supported by Eric Hopkins in his piece, which takes Birmingham as a case study of a town in industrial development in the period 1760-1840. In expounding that "society in Birmingham was subjected to all the strains of expanding urbanization which were manifested generally in industrial towns and the response of Birmingham's middle classes to emerging social problems was in many ways typical of what happened elsewhere",[6] Hopkins suggests that "economic growth was accompanied by social change".[7] Furthermore, this claims that this was necessarily a "gradual and undramatic change to more modern means of production".[8] Hopkins's study shows that there are inherent social changes that need to be made before the economy was ready to be considered "industrial". He refers to changes in class consciousness that lead to "class co-operation rather than class conflict"[9] as industry began to usurp agriculture as the most important sector of the economy. To combine these two modern works is to theorise that there were social changes taking place in the period leading up to the arrival of Britain as the foremost industrial nation in the world which cannot possibly have been considered revolutionary in their formation. The scientific culture spreading throughout society as outlined by *Metropolis and Province,* coupled with Hopkins's idea that society had a change in ideology, suggest that British society was undergoing significant and wholesale change during this period. I would argue that these changes can be traced back further than the eighteenth century, by studying the growth of the Industrial economy in the Black Country. This presents a concept which leaves room for the idea that knowledge and science were developing at the same time as the industrial and agricultural revolutions. The aim will be to discover the extent of their influence. Hudson suggests that merely considering the changes made to industry is insufficient. He argues that one must look "beyond the narrow confines of manufacturing industry and include changes in the economy across the board from agriculture to finance and industrial trade".[10] This suggests that there is a modern conception of the debate that argues that a wider study of societal changes is needed to fully understand the Industrial Revolution. Hudson goes on to argue that there developed a "nexus between capitalist employers and wage dependent employees",[11] it is from this point of view that one can begin to explore the relationship with agriculture and the importance of knowledge. Hudson suggests that across all areas, there developed a linear system of management which aided the passing of

[6] E. Hopkins, *The Rise of The Manufacturing Town: Birmingham and the Industrial Revolution,* (Sutton Publishing: Stroud, 1998) p. 1
[7] Ibid.
[8] Ibid.
[9] Ibid.
[10] P. Hudson, The Industrial Revolution,(Arnold: London, 1992) p. 3
[11] Ibid. p. 12

knowledge and skills along it, and subsequently throughout society. As society began to embrace colleges, education and intellectual and Lit.-Phil. societies the spread of knowledge became even easier. This piece will examine how far this was dependent on the growth of science and knowledge and how important the link can be considered to be. The actual methods by which knowledge was transferred require in-depth further study. However, it is possible to see that society was progressing to a point where the recognition that knowledge was key, and changes were being made, to ensuring that as many people as possible had access to new discoveries and understanding.

One of the industrial centres of the United Kingdom during the period 1750-1850 was the Black Country. This is an area which benefitted from a wealth of mineral resources not seen anywhere else, the exploitation of which was a direct cause of industrial growth. This required a new understanding of the necessary scientific processes and lead to a massive change from a small, subsistence based industrial economy to a booming industrial centre of Europe as mining took off. For this reason, the Black Country will be used as a case study by which to measure the themes under consideration throughout this piece. In order to understand the growth of industrialisation in the Black Country, it is first important to understand the region itself and the raw materials that lead to industry becoming so prevalent here. This will allow us to better understand why the spread of knowledge became important as people sought to utilise these resources. From this we can also see how, in living in a society that was so dominated by the output of these natural resources, that understanding them became a way of life and we begin to recognise why the spread of knowledge became so much faster as people began to recognise its importance and took up learning and understanding more readily in order to progress in their society.

James Keir's 1793 article "Mineralogy of the South-West part of Staffordshire" details the abundance of minerals in the region, describing the main seam as being "twenty-eight square miles".[12] The location of the coalfield is the subject of much debate. Elihu Burritt, writing nearly eighty years later than Keir in 1869, puts the Black Country as being "a circle of twenty miles in radius of Birmingham town hall",[13] with Keir suggesting that the mining was focused around "Wolverhampton…Bilston and Wednesbury…Dudley, Oldbury, Albion and Smethwick",[14] these are the locations which feature most often in primary source definitions of the Black Country. A breakdown of the mineral content of the different strata beneath the

[12] J. Keir, "Mineralogy of The South-West Part of Staffordshire" in S. Shaw, *The History and Antiquities of Staffordshire* (Nichols: London, 1793), p. 116
[13] E. Burritt, *Walks in The Black Country and its Green Boarder-Land* (Sampson Low: London, 1869), p. 5.
[14] J. Keir, "Mineralogy" in *The History and Antiquities of Staffordshire.* p. 116

Black Country shows that the "thick" coal, which provides the most effective fuel, was located in the Permian rock formations beneath the districts of Dudley, Walsall and Sedgely, with the richest seam, the ten yard, or thirty-foot seam running beneath the Dudley district.

It is also important to understand the culture of the West Midlands and the Black Country and the role that this played in the development of industry in the area. Fundamental to this culture were the Literary and Philosophical societies which began to highlight the importance of science throughout the region. Elliott has discussed the importance of the Derby Philosophers to the recognition of science across Britain and has argued that the success of thinkers such as Herbert Spencer was "primarily stimulated by his immersion in this culture".[15] Elliot shows how Spencer, Wedgewood and their contemporaries created a culture across Britain where science was at the centre of change and development, and was revered as such by the population. Lit.-Phil. societies began to promote science as a method of social improvement and they evolved as a "public platform for science and scientific education".[16] In exploiting the political and religious connections that ran through Europe and the USA the members of Lit.-Phil. societies put science at the centre of a network of people who could both utilise and develop science. From here it became apparent that these societies were one of the most important manifestations of British enlightenment culture as they galvanised the population on a wave of scientific exploration and understanding. Between the 1760s and 1790s the Derby Philosophical Society was at the forefront of this and was becoming increasingly central to the development of scientific thought in the Black Country, they held lectures, engaged in new research and developed new scientific instruments. The natural resources and latent industrial potential of the Black Country made this region an object of great interest to them. Plumb has referred to this as an "age of stability"[17] where the political and economic situation reached the point where focus turned away from the more traditional topics of social change, towards less tangible, cultural manifestations. This facilitated the spread of science and the Literary and Philosophical societies were a product of this. As education became mandatory, public meetings and the modern concept of "the town" came to fruition, it became easier for the ideas that they were exhibiting to be carried into society. The Staffordshire Records show the development of a school in Lilleshall which was managed by public donations – showing a collective desire to develop knowledge across the region. Subscriptions from 1827 show that parents of children attending the school paid "twenty nine

[15] P. Elliott, *The Derby Philosophers: Science and Culture in British Urban Society, 1700-1850* (Manchester University Press: Manchester, 2009), p. 12.
[16] Ibid. p 10.
[17] J. H. Plumb, *The Growth of Political Stability in England, 1689-1725* (Macmillan: London, 1725)

pounds and three shillings for their child's instruction and the national school".[18] The document gives an important insight into the lives of the people of Lilleshall and shows how far the power and resources of the Sutherland estate were felt. Previous to this, in 1815, a free grammar school was developed at Breewood by Dr. Matthew Knightley. His intention was the same, to make education and the spread of knowledge accessible to everyone. That these sorts of establishments were being set up by and for local people in Staffordshire is a fundamental turning point, showing a unified belief among society, driven by the local estate, that learning and the development of knowledge were of essential importance to the growth of the economy. The Staffordshire General and Commercial Directory[19] shows that in 1794 a private school was developed by the Merchant Taylor's company in Wolverhampton that was expressly designed to develop the business nous in this region; another significant investment in education and acknowledgement that this was the way to effectively educate society with the correct skills to further the economy. This is, effectively an investment in the spread of knowledge. Locke's *Thoughts Concerning Education* details the importance of this transmission. He suggests that "the manners and abilities of men is owing more to their education than to anything else"[20]. Locke wrote at the end of the seventeenth century and was looking to push Britain in to the enlightenment. His recognition of the importance of the transmission of knowledge is key because it shows an awareness that this was the root to improvement. We can see that Locke's ideas began to catch on and the publishing of texts like his, were a significant part of the dissemination of the importance of education and scientific understanding. He goes on to claim that mans education "must be something woven in to the principles of his habitat"[21], this is a concept which will be discussed later on, but can be seen in the redevelopment of the modern town.

On a wider level, this represents a point at which society made a step forwards. By developing institutions such as this Black Country towns instantly became more unified in a single goal and were more focused on a particular development and towns – in a modern sense – were beginning to develop with this in mind. This shows recognition that social structure was to play an important part in the development of the economy and that change was needed that reflected this. As such, we see the increased development of civic buildings – showing that there was a recognition that a more closely knit society was important if the economy were to develop effectively. Civic buildings represent a progression in thought that

[18] Staffordshire Record Office - D593-V-10-95 (67/1414)
[19] Staffordshire General and Commercial Directory, (South Staffordshire: 1818), p. 193
[20] J. Locke, *Some Thoughts Concerning Education,* (A. & J. Churchill: 1693) p. 33.
[21] Ibid. p. 44

is the focus of Stobart and Raven's piece as they show that the town was growing in a manner which was designed to be more amenable to the growth of the economy. As industry grew there was also a growth in amenities as areas became more populated and towns became more structured and gradually moved in line with what we would recognise today. In essence, the Black Country as we know it began to form. This significantly increased the ease with which knowledge and new practices could be transferred because society, literally, moved closer together. Couple this with the growth of education and printed media and this becomes a time when the transference of knowledge was easier than ever before. The Black Country was a prime example, its growth the result of industrial changes and the area developed a structure and culture in this light.

Like so much else in the seventeenth and eighteenth centuries, the culture of towns and cities in the Black Country began to progress beyond recognition. We began to see the growth of numerous brick and stone private and public buildings, denoting and encouraging a parallel acceleration in the variety and intensity of urban sociability. With this sociability came the reconsideration and ultimately redevelopment of public mores as political, economic and cultural developments like the Literary and Philosophical Societies began to evolve within this infrastructure. Such developments made the passing of information easier and people began to raise questions about previously indoctrinated beliefs. It is from here that science was granted an opening.

These changes lead to the growth of a town mentality, evidenced by the development of civic buildings, meeting halls, libraries and adult educational centres, and developments in the royal mail. These are outlined by Pigot's Directory, which shows that a social change was taking place, making the passage of information far easier than it previously had been. These are examples of Locke's idea that learning and the transmission of knowledge needed to become part of people's habitat. It shows that people were realising that this was an important concept and society was beginning to evolve in this light. It also suggests that the spread of printed texts across society was having an effect. Locke claimed that his book would become a "public discourse"[22] and that he was writing with the intention of doing a service to his country. Showing that he was of the belief that this was essential to British development. These thoughts were heightened in the Black Country because of the geological make up of the region. The fact that the region was coming to terms with the mineral potential of the ground, and developing techniques to profit from this, meant that the it was a

[22] J. Locke, *Some Thoughts Concerning Education,* (A. & J. Churchill: 1693) p. 1

region more receptive to the spread of scientific though because it gave people some tangible results to look for.

I would argue that one should look at the Black Country as a collection of economies bought together by the need to exploit this resource. Further, that industrialisation developed from this coming together and was therefore dependant on an infrastructure that enabled these economies to be brought closer. At the same time one must consider the importance of the idea that towns were physically developing into places where people were more connected. Society was becoming much more closely-knit and knowledge more easily transferred between groups as towns changed, so too did their dynamics and the transition of knowledge was much more fluid. These were coupled with the publication of numerous texts, such as Keir's *Dictionary of Chemistry* or Locke's *Thought's Concerning Education*, which put knowledge at the centre of society's mind. As these texts became more widely circulated Keir and others like him, made knowledge and science more accessible while Locke made people realise that education and the acquisition of knowledge was important, and allowed for a better quality of life. This created a partnership where knowledge was seen to be both accessible and important – making its spread throughout the region much easier.

My hypothesis is that the spread of knowledge meant that both agriculture and industry developed as a result of the same forces. The aim is to see how effectively knowledge could spread, and how far this dynamism can be said to be causal.

The growth and importance of the knowledge economy is shown because in the eighteenth and nineteenth centuries - in the agricultural and industrial economies -people with specific skills, knowledge and expertise began to take charge of certain situations. For example there were land agents, such as James Loch, whose understanding of mining ensured that they were employed to look after some of the nation's biggest landed estates in the nineteenth century, while Robert Plot refers to "land doctors"[23] being used in seventeenth century farming. This shows the beginnings of a knowledge economy, as new knowledge and understanding provided those who held it with a greater ability to profit from their land, from this point on middle classes sought to understand science as they recognised that this held the key to furthering a capitalist society, making them richer and more powerful. I would argue that it was this that leads to the inventions that facilitated industrialisation. It is clear that living in a

[23] R. Plot, *The Natural History of Staffordshire* (At The Theatre: Oxford, 1686), p. 340

business-focused economy imbued some people with an entrepreneurial spirit and understanding, which did not exist in a society where subsistence was the focus. The development of the education system during this period included the wider acceptance by tradesmen and entrepreneurs of apprentices and students. The rise in apprentices ensured that the dissemination of scientific and trade knowledge was made far easier and we can begin to see how the network by which knowledge was passed began to grow.

In light of massive population growth in the second third of the eighteenth century it is apparent that experimentation became more important as works such as Arthur Young's *Tours of England* became more widely recognised as holding the key to expansion. They provided examples of how published texts were disseminating knowledge through the population. The development of fertilisation and crop rotation shows that there was greater thought going in to the process by which crops were grown. There is a definite movement towards more professional practices, and a consideration of the chemical make-up of the soil and the crops themselves.

High-farming is a process which is often taken to represent the introduction of science into the agricultural economy. It is easy to see a definite progression as farmers began to pay greater attention to the manner in which they tended their crops. From around 1760 and the accession of George III we can identify changes driven by the likes of Young and Jethro Tull and Lord Townshend in transport, stock breeding, fertilisation and the capitalisation of farming. As these men implemented more sophisticated methods, Britain was able to feed a population that had almost doubled from the same amount of land. The scientific understanding that is used to fertilise crops appropriately and the engineering ability required to introduce fen drainage were substantial and they provided farmers with evidence of how best they could utilise these new discoveries to their advantage.

Peter Jones argues that the Black Country was a product of "spatial and economic integration"[24] which suggests that the agricultural and industrial economies integrated to form a regional economy, supporting a developing Britain and ensuring that certain regions could draw on all their available resources. I would build on this to suggest that one of these resources was the spread of knowledge and the subsequent embracing of science. James Keir

[24] P. Jones. *Industrial Enlightenment: Science, Technology and Culture in Birmingham and The West Midlands: 1760-1820* (Manchester University Press: Manchester, 2008), p. 23

recognised that in the eighteenth century scientific knowledge was accessible to all men.[25] Dr. Priestley and others including Keir himself were influential in the progression of industry.[26] This is linked to the explorations of Robert Plot in the seventeenth century whose *Natural History of Staffordshire* considers the role of "rural learning"[27] and the acquisition of knowledge in the agricultural sector. During the nineteenth century the region was dominated by industry and the intricacies of the formation of an industrial economy are present. However, the Black Country also had a reasonable agricultural economy in the seventeenth century. The West Midlands also had a number of landed estates whose owners and agents had a strong impact on the use of land in the area and were members of the Lunar Society who were influential in the spread of knowledge.

Central to the debate will be a definition of industrial and agricultural development. Industrial development is roughly defined as the growth of manufacturing and production across Britain, stemming largely from the boom in the use of coal as a fuel in the eighteenth century as outlined by Raybould[28] using records from the Dudley estates. Added to this are subsequent expansion of transport nodes and the technology and mechanisation which have become synonymous with the period in question. Agricultural development is taken to mean the progression from a subsistence based agrarian system, which was at the root of Britain's organic seventeenth century economy,[29] towards the capitalist model based on the landowner-tenant system. Following this movement, people sought to increase the productivity of land in order to support a growing population using a reduced percentage of the workforce who were aided by technological advances and an improved set of practices. These practices were based on understanding botany and high farming, "rural knowledge"[30] and the parliamentary enclosure process. Marshall takes rural knowledge to be the increased understanding among yeoman farmers of the processes by which they were able to increase productivity and quality in the period of expansion. Marshall refers to practices being taught as schoolboys learnt the science of farming in informal specialist schools and colleges.[31] This was fundamental to the spread of knowledge across the region and is central to the recognition of the ability of

[25] J. Keir, *A Dictionary of Chemistry* (T. Cadell & P. Elmsley: London 1776), p. iii
[26] Ibid. p. iv.
[27] R. Plot, *The Natural History of Staffordshire,* p. 339.
[28] T.J. Raybould, *The Economic Emergence of The Black Country* (David & Charles: Newton Abbott,1973), p. 1

[29] E. A. Wrigley, *Continuity, Chance and Change: The Character of The Industrial Revolution in England* (Cambridge University Press, Cambridge 1991), p.55

[30] W. Marshall, *The Rural Economy of The Midland Counties* (London: G. Nicol, 1790), p. 118

[31] Ibid. p.128

knowledge to influence the economy. It also raises the issue that rural knowledge provided the initial realisation that knowledge lead to power over the direction of the economy and was accordingly at the root of the eighteenth century enlightenment, so strongly associated with the West Midlands and Birmingham.

This piece will aim to couple this notion with a tenet expounded by Stobart and Raven, which takes an Annalist perspective by suggesting that the development of a town or city depends on a variety of constants including geography and geology, leading to the notion that "regional space was not only the geographical site of action but also the social possibility for engagement in action".[32] This meant that the components of a region combined to facilitate social actions or changes. Stobart and Raven argue that regions are "dynamic networks of towns and individuals", each of which plays an important role in the "shaping and development process…as they appear as constants in the structuring of urban and industrial change".[33] This is important because it suggests that a region is dependent on the people within it, showing that the knowledge and understanding that they bring is vital. In raising the idea of a "network", this also shows that the formation of an economy is dependent on the input of various areas, each contributing different components to the whole, rather than one static geographic area. This is fundamentally linked to the ideas of Inkster, Morrell and Hudson and the suggestions that there was a massive change in social ideology that ensured that all society was more focused on the importance and spread of knowledge. From here we can see the importance of geography as towns and their evolution played a central role in facilitating the knowledge transferral. This is important in considering the Black Country because it was a network of neighbouring towns, brought together by industry.

Secondary sources vary greatly in their perspective of the link between the industrial revolution and its agricultural cousin. The divide appears to stem from the era and historical framework in which the text was produced. E. L. Jones, writing in 1973, argued that the growth in a landowner-tenant capitalist system of farming allowed agriculture to move away from the organic economy that it once was. According to Jones "profit-minded landowners",[34] such as Viscount Dudley of the Dudley Estate in the West Midlands, were

[32] J. Stobart & N. Raven (eds.) *Towns, Regions and Industries: Urban and Industrial Change in The Midlands, c. 1740-1840* (Manchester University Press: Manchester, 2005), p. 8

[33] Ibid. p. 9

[34] T.J. Raybould, *The Economic Emergence of The Black Country* (David & Charles: Newton Abbot, 1973), p. 182

responsible for ensuring that agriculture was able to adjust to operating within this new economy.[35] This is a view also exhibited by Wrigley[36] who provides examples of how enclosure prompted the growth of a capitalist agricultural economy and a new workforce. According to Wrigley, the progression in agriculture and increased output per acre ensured that more time and labour could be devoted to the fledgling industrial society that would soon become part of the phenomenon generally regarded as the Industrial Revolution, rather than being trapped in a cycle in which all the resources of the agricultural economy were devoted to the production of the essential means of survival. James Keir wrote about the diffusion of knowledge and science throughout society.[37] This provided the new techniques and methodology which facilitated this change. However, Mokyr suggests that "the Malthussian theory of food shortages is one of the most egregious mistakes in the history of economic thought as far as the West is concerned",[38] such dichotomy is indicative of the study of the link between the agricultural economy and industrial growth. Mokyr takes an economic approach to the discussion by looking at the issues of output per capita across society coupled with population and wage evidence to show how the agricultural revolution had happened. He calculates that an increase of 193% in British was food output was necessary to support the growing population which was increasing output per capita by 65%.[39].Mokyr calls on Craft's gradualist approach to show how output necessarily grew and also attempts to look at the manner in which society was undergoing institutional change. He notes how the number of periodicals concerning the development of farming increased radically over a period from the end of the seventeenth to the middle of the nineteenth century. At the beginning of the eighteenth century, there was, on average, one periodical published per year on the topic, a hundred years later, this figure had tripled. Even more importantly, over the same period, the number of societies dedicated to the subject of improvement had risen from 35 to 600. This shows a massive increase in interest in the subject of improvement and the acceptance that this was the route to the necessary growth. This statistic shows that as society was changing, the spread of knowledge and the sharing of ideas were at its heart as these tenets were recognised as providing the dynamism that would push the country forward. As Mokyr put it,

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[35] E. Jones, *Agriculture and the Industrial Revolution* (Western: Bristol, 1974), p. 10

[36] E. A. Wrigley, *Continuity, Chance and Change: The Character of The Industrial Revolution in England* (Cambridge University Press: Cambridge, 1991)

[37] J. Keir, *A Dictionary of Chemistry* (T. Cadell & P. Elmsley: London 1776), p. iii

[38] J. Mokyr. (ed.), *The Economics of the Industrial Revolution* (Allen and Unwin: London, 1985), p. 20

[39] J. Mokyr, *The British Industrial Revolution: An Economic Perspective,* (Westview Press: Oxford, 1993) p. 230.

aside from the per capita statistics, "the other elements that seem to indicate profound changes in the period 1770-1850, are the blossoming of intellectual writing and the institutional changes being wrought".[40] Improvement was fast becoming what Mokyr has called a "mark of enlightenment and sophistication".[41] He suggests that knowledge was becoming fashionable, which was aiding the spread of learning throughout society. This is a major part of the institutional changes that were taking place in British society that were facilitating the growth of knowledge and a greater understanding of science and the role that it had to play in the development of British industry and agriculture.

This is intrinsically linked to Inkster and Morrell's idea that the industrial revolution "cannot be explained simply in economic terms of supply demand".[42] I would argue that to this end, there must be an appreciation of the idea that this was part of a cultural and institutional change that created a societal shift with knowledge, a mark of fashion and standing, at its centre. The socio-cultural element of change is important. In one sense, to reject this, is to suggest that there was a more highly developed class system during than there actually was in the seventeenth century. There was the public laudation of the value of science to industry taking place at the same time as the institutional changes made its dissemination possible. This combination gave a new dimension to society meaning that the institutional changes society was seeing in the industrial revolution forced a new perception of science to the fore. This, in turn promotes a "non-rigid definition"[43] of scientific subject matter, suggesting that the spread of scientific knowledge has an intangible quality to it that means it can be hard to define outside of being a topic inherently running through society by way of discussion and permeation of ideas. This relates to the social and cultural institutional changes that took place and the fact that these lead to science becoming a part of the social consciousness of the nation. Science became culturally important and fashionable among the upper classes, and an object of interest for the dissenting churches. Added to this, the increased publishing of texts made scientific discoveries more readily available to British citizens. The reorganisation of towns and the development of civic buildings and meeting rooms bought society generally closer together and made the discussion and dissemination of ideas easier, this was key to knowledge developing an intangible presence at the heart of society as people began to recognise its importance. Ultimately, science became fashionable and that gave it this

[40] Ibid. p. 232.
[41] Ibid.
[42] I.Inkster and J. Morrell, *Metropolis and Province: Science in British Culture, 1780-1850.* (Hutchinson: London, 1983) p. 12
[43] Ibid.

presence at the heart of society and inspired discussion of it as people felt compelled to show a grasp of it.

Of all the economic historians mentioned above, it is Joel Mokyr who takes the most pragmatic approach to his work. For him, the discussion of the agricultural and industrial revolutions has often taken a "post hoc ergo propter hoc"[44] form, stemming from the fact that so much changed between the mid-seventeenth and late nineteenth centuries. As a result, he distances himself from either of the two common schools of thought and suggests that we study each of the causal links before drawing any conclusions. It is from this position that I will begin my research.

I intend to use evidence taken from the Black Country to analyse these theories, using the work of Raybould, who has produced a history of the Dudley estates, and D.M. Palliser[45] who has charted the geographical history of the county of Staffordshire from the Middle Ages through the industrial revolution. Also used are eighteenth and nineteenth century writers who studied the growth of industry in the Black Country. Authors such as Richard Meade,[46] Edward Hull[47] and T. E. Lones[48] have focused on how industry was able to develop in the Black Country and have all chosen to concentrate on the role that coal and iron played in this. James Keir and Robert Plot provide detailed accounts of how the Staffordshire economy functioned in the seventeenth and eighteenth centuries. Keir in particular gives an insight into the mindset of a Black Country industrialist in the eighteenth century.

Chapter One will study the geology and geography of the Black Country. The area was built on coal and iron mining and production and so a study of the formation of this industry is essential. This chapter will look at the importance of Birmingham and the towns and villages which make up the Black Country and provided the mineral resources which were so important when combined with the development of a knowledge economy in the area. This is

[44] J. Mokyr. (ed.), *The Economics of the Industrial Revolution*, p.19
[45] D.M. Palliser, *The Staffordshire Landscape* (Hodder and Stoughton: London, 1976)

[46] R. Meade, *The Coal and Iron Industries of The United Kingdom* (Crosby Lockwood: London,1882)

[47] E. Hull, *Coal Fields of Great Britain: Their History, Structure and Resources* (Edward Stanford: London, 1873

[48] T.E. Lones, *History of Mining in The Black Country* (The Dudley Herald Press: Dudley, 1898).

an example of Rostow's model of economic development which Raybould applies to the Black Country and suggests that "one or more substantial economic sectors develop on a high growth rate and the impulses to growth are exploited through emergence of a political, social and institutional framework".[49]

Chapter Two gives a synchronic view of the Staffordshire economy in the seventeenth century according to Robert Plot, taking into account his study of agriculture and primitive industrial society. By looking at what he accepts as the social, scientific and economic norm, and comparing this with the views of Keir one hundred years later, this chapter aims to look at the changes in understanding and analyse how they occurred. This chapter will look in detail at Plot's *Natural History of Staffordshire* and Keir's *Dictionary of Chemistry* in order to make a comparison between two periods. This chapter takes the spread and development of knowledge at its root. The two texts not only show the state of scientific, industrial and agricultural knowledge in their respective eras but also that an influential group were attempting to disperse knowledge throughout society.

Chapter Three, will look at the role certain individuals played in the development of industry in the Black Country. Estates represented a significant part of the Black Country economy and this section will examine how they were run. The aim is to establish how landowners and their agents developed industry here and how far the growth of the knowledge economy played a role in their work. This chapter will study the work of Raybould as well as looking specifically at the estate records and accounts which provide evidence of the impact that they were having on the area around them. I will also be studying the work of a number of local historians such as David Brown who has studied the estates as well as the industrial growth of the Black Country. The aim of this chapter will be to look at how far the growth of the Black Country was supported by events in the local area and to look at specific events in one locality and tract the impact that they had on society and industry.

[49] W.W. Rostow (ed.), *The economics of take-off into sustained growth: proceedings of a conference held by the International Economic Association* (Macmillan: London, 1963). p. 11.

Chapter 1:

Geological and Geographical Explanations for Industrialisation in the Black Country

This chapter looks at whether the natural endowment of mineral resources was sufficient to explain the Black Country's industrial growth and what other factors combined with mineral wealth to facilitate this growth.

William Hutton's *History of Birmingham*[50] shows how the canal network revolutionised industry in the Black Country and significantly decreased the price of coal and iron, while increasing the resources available to all components of the region, thus representing a huge opportunity for industrialists to profit. Matthew Boulton dedicated much time to campaigning for the growth of canals throughout the region culminating in the 1770 canal network that connected the Black Country with markets in Birmingham. This suggests that industrialists were beginning to feel the need to connect different areas. This theory is backed up by Keir's suggestion that "Birmingham…Dudley, Wednesbury, Bilstone, Wolverhampton and Stourbridge owe their foundation and prosperity"[51] to the coal seam, and Pitt's assertion of an "inestimable mineralogy of the area"[52] which was essential to industrial growth. The idea of a mutually dependent region was central to the growth of the Black Country.

In order to look at the development of the Black Country economy, it is important to have an understanding of what the Black Country parishes were like in the years before industrialisation. Studying writers from the seventeenth century through to the present day gives us an impression of how the Black Country fits with the concept of the region. The picture painted by nineteenth century sources is that before industry, the Black Country was effectively a "barren"[53] region populated by "little groups of smiths and miners scattered across the district".[54] The economy was largely based on small nail workers working from their own homes with poor quality iron. These accounts contrast with the vast and expansive

[50] W. Hutton, *History of Birmingham* (Birmingham: Thomas Pearson. 1795), p. 402.
[51] J. Keir, "Mineralogy of The South-West Part of Staffordshire" in S. Shaw, *The History and Antiquities of Staffordshire* (Nichols: London, 1793), p. 116

[52] W.Pitt, *A Topographical History of Staffordshire,* (J.Smith: Newcastle-Under-Lyme: 1817) p. xxv
[53] C. Beaumont, *A Treatise on The Coal Trade* (Crowder and Robinson: London, 1789), p.

[54] W.Hawkes-Smith, *Birmingham and South Staffordshire* (London: Charles Tilt, 1838), p. 5.

nature of the industry that dominated the Black Country once it became mechanised in the nineteenth century and industry became focused on mass production and markets.

The Black Country was a region typical of seventeenth and eighteenth century Britain where the lords of the manor owned the majority of the land and the commoners farmed for subsistence, which is why it was an area where the industrial workers only "went some way to balancing the number of agricultural workers".[55] As coal and iron began to take hold, the production side of industry moved to the outskirts of the Black Country as the mining industry and blast furnaces became focused centrally near the coal reserves to reduce transport costs. Pitt claims that this is because by 1817, people had "perfected the art of pit coal"[56] showing a direct correlation between the growth of industry and the spread of knowledge, and also alluding to the idea that a process of trial and error and experimentation was key. In understanding the type of economy that existed in the Black Country before industrialisation began to take hold, we can see that there was a distinct growth of the economy and that this growth was heavily dependent on geography and geology. We can see from this, the sort of changes that were necessary to form the Black Country economy that we recognise today and that these changes were central to unlocking the potential of the mineral resources.

Peter Jones describes the region in the 1700s as an "unrecognised collection of metalworking towns and villages".[57] A diversion from the main trade routes was required if produce were to be sold outside of the "interminable villages…which were scarcely more than agricultural or at best proto-industrial"[58] and thus benefit from the "miracle"[59] that was the growing Birmingham markets which provided an outlet for the produce. It is important to consider the potential that the Black Country held. By 1850 it was synonymous with industrialisation and one of the manufacturing centres of Europe, exporting extensively across the continent and the rest of Britain. This suggests that the changes made during the eighteenth and nineteenth centuries were of paramount importance to the emergence of the Black Country as an industrial powerhouse because it was these changes that allowed the potential of the mineral resources to be realised.

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[55] G.C. Allen, *The Industrial Development of Birmingham and The Black Country* (London: George Allen & Unwin), p. 11
[56] W.Pitt, *A Topographical History of Staffordshire,* (J.Smith: Newcastle-Under-Lyme: 1817) p. 155
[57] P. Jones, *Industrial Enlightenment,* p. 24.
[58] Ibid. p. 30.
[59] B. Faujas de Saint-Ford, *A Journey Through England and Scotland to the Hebrides in 1784* (Glasgow: 1907), p. 346.

A concept which is central not only to the study of the geology of the Black Country but is of paramount importance to the study of development in industry overall, are the resources of coal in the Black Country, notably the "ten-yard seam". As Burritt[60] has suggested this seam is widely regarded as being the main factor behind the industrial success of the Black Country and an examination of it is central to understanding how industry in the region developed. Any study of the development of industry in the region must look at the development of the ten-yard seam. In order to look at the link between industrialisation and agriculture in the area effectively, one must see if there is a link between the agricultural economy and the exploitation of the ten-yard seam.

The seam was an area of particularly dense and profitable coal, of higher carbon content than other strata. It was the product of the complex geology of the region, as outlined by Keir[61], consisting of no Carboniferous limestone or Millstone grit and, where the coal was immediately below the surface at a depth of around one hundred and twenty metres, not only pure and rich, but also easily accessible. The ten-yard seam is regarded by many nineteenth century authors to be the root of the Black Country's industrial growth with Beaumont referring to the "wealth and importance"[62] which came from lying close to mines. Furthermore, Burritt refers to the fact that the ten-yard seam was home to coal, iron-ore and limestone "packed together in alternate layers in almost the very proportion requisite to the furnace to give the proper flux to the iron".[63] The seam is made up of several different layers of coal each distinct from the others, which combined to give a type of coal that was incredibly useful in the iron smelting process as it provided a highly efficient fuel. This gave the Black Country a potential natural source of immense wealth which has been descried by Pitt as "abunds of coal of great value"[64] and notes the fact that the Black Country was "celebrated for it's valuable mines".[65] This resource remained untapped until society was in a position where it had a sufficiently strong economy and infrastructure to profit from the coal. It is here that the knowledge economy becomes important as people learnt about the potential that coal and iron held in their chemical content, and understood how to utilise this.

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[60] E. Burritt, *Walks in The Black Country and its Green Boarder-Land,* p. 3

[61] J.Keir, "Mineralogy" in *The History and Antiquities of Staffordshire,* p. 116.
[62] C. Beaumont, *A Treatise on The Coal Trade,* p. 2
[63] E. Burritt, *Walks in the Black Country,* p. 3
[64] W.Pitt, *A Topographical History of Staffordshire,* (J.Smith: Newcastle-Under-Lyme: 1817) p. 36
[65] Ibid. p. 153

The ten-yard seam was one of six workable coal seams in the Dudley district in the mid-nineteenth century, stretching from the Whyley Colliery near West Bromwich towards Kingswinford and Dudley. The coal seam was unique in Great Britain as nowhere else was so "great a volume of coal available at so shallow a depth".[66] This enhances the idea that the Black Country was predisposed to industrial success and was more advanced than most of the rest the country when it came to industrial capabilities, making it a perfect location in which to test the theory that mineral resources were useless without the right economy in which to exploit them.

With a ready supply of relatively efficient fuel and raw iron-ore, the Black Country had all the ingredients for industrial success. What the historians do not focus on is why, despite Dud Dudley's efforts and such a wealth of resources, it was not until the late eighteenth century that coal and iron became a productive resource. This was because at this time, a knowledge economy had not developed which embraced the understanding of the science behind coal and ironstone. Science was not, at this point, recognised as being the solution to many problems, such as utilising coal on a large scale. It will be examined in chapters two and three that once science was embraced, both industry and agriculture were able to develop.

Mining from the South Staffordshire coalfields was in itself a massive source of income and revenue. However, arguably more importantly, through this study we begin to see that this mining allowed for the growth of blast furnaces and the subsequent spread of the industry across the Black Country as outlined by Pitt's study of Staffordshire which states that "not only the coal trade increased but also the number of blast furnaces. And the business done at each one was much extended".[67] The rest of this chapter will analyse the changes which took place in the Black Country economy, these include population growth, the onset of war and increased trade and the access to a skilled workforce. The mining of coal and iron-ore began to increase dramatically in the mid-eighteenth century, and was soon matched by the smelting of iron in blast furnaces, once the technology had been developed sufficiently to make the concept financially viable. A study of the production output of the region for both coal and iron shows that growth begins to gather pace at the end of the eighteenth century. Raybould shows that that pig-iron production in the Black Country increased from 2,000 to 4,500 tons

[66] M.W. Greenslade & J.G. Jenkins (eds.), *A History of The County of Stafford: Volume II* (Oxford: Oxford University Press, 1967), p. 68.
[67] W.Pitt, *A Topographical History of Staffordshire,* (J.Smith: Newcastle-Under-Lyme: 1817) p. 160

per annum between 1717 and 1788[68], a growth of 125%. This is dwarfed by the growth between 1827 and 1854 where production rose from 216,000 tons to 743,000 tons as the Crimean War stimulated growth even further. This trend shows the growing importance of mineral resources to the economy. With this level of growth, it is easy to see why many writers have alluded to the idea that the Black Country only came into existence as a place in which to process the product of its mines and to fuel the growing industrial nation. As such it becomes easy to see that without the mineral resource production, the Black Country economy would not have existed as we know it. In 1788, the region was home to just six blast furnaces, this grew steadily to 181 in 1860, the peak of the mineral revolution. Fuelling this increase in production was an equal increase in the amount of coal mined in the region, this rising by over 1,000% from 50, 000 tons in 1785 to 1.6million tons in 1805 and 4.1million tons in 1875.[69] This ensured that the district was producing more iron than practically any other region in the country. Employed in these mines and furnaces were some 36,000 people in 1850,[70] with the Black Country being home to around ten times this as the coal and iron industries turned a previously barren landscape into one of the foremost industrial districts in the United Kingdom.[71] This shows the extent to which mineral resources came to dominate the Black Country economy and explains why Burritt describes a region focused purely on mining and production. These statistics highlight the scale to which the Black Country was dependent on profit from mineral resources, as has already been discussed, this profit was reliant on the ability to trade the product of these resources across the region and so, was totally reliant on the capitalist market infrastructure that facilitated this. At the same time, we see that without the development of science and understanding of how to utilise coal and other minerals, the Black Country would not have developed.

Central to understanding the geography of the Black Country is knowledge of the surrounding area. This encompasses a brief study of Birmingham and the markets and trade that it offered. Birmingham developed into one of Britain's major industrial cities, with national and international trade flowing in and out. This represented a major outlet for the coal and iron produced in the Black Country and subsequently can be said to have had a significant influence on demand here. This shows the reliance of different areas on a region where each component contributed different aspects to the whole economy. It is no

[68] T.J. Raybould, *The Economic Emergence of The Black Country,* p. 11.
[69] R. Meade, *The Coal and Iron Industries In The United Kingdom,* p. 158-160.
[70] R. Meade. *The Coal and Iron Industries,* p. 166.
[71] C. Beaumont, *A Treatise on The Coal Trade,* p. 2

coincidence that we begin to see the accelerated expansion in the Black Country following the growth of Birmingham as a major international market centre. To have such a bustling metropolis in close proximity gave the Black Country a major outlet for its produce as well as access to international markets, which saw the region sending iron to America.[72]

The introduction of turnpike roads, as shown by James Jaffray[73], was of fundamental importance in exploiting the potential of being part of a wider, more accessible region where the Black Country had access to a whole range of new environments and structures which would change the course of growth. Birmingham was home to the class that Peter Jones refers to as "the intelligentsia"[74] who were responsible for more patents over the period 1760-1849 than the people of the other important centres of production in the country. It was two members of this class, Watt and Boulton who founded the Soho manufactory, which was a fundamental outlet for Black Country produce. This shows that residents of the West Midlands were more accepting of the importance of science and innovation than much of the rest of Britain; this is potentially because they benefitted from the mineral resources of the Black Country coalfields. The proximity of the Black Country to a town such as Birmingham is a major geographical factor in its industrial success as it provided those assets which the Black Country was not able to provide for itself.

As Thirsk has put it, "Of the 66 years between 1750 and 1815, Britain was at war for 41",[75] this suggests that a significant response was required of the nation's industrial and agricultural economies as demand increased significantly. As Cronin[76] has argued; war has been considered as the most influential agent of economic change in Britain, such was the scale of its impact. Production was massively increased, as coal and iron were fundamental to the production of weapons and tools for the troops. Towns and cities such as Birmingham were increasingly focused on this. This meant a massive source of revenue for the Black Country, which was dependent on the region outside its boundaries for trade and was thus required to use these areas to form an industrial economy. The wars gave an impetus to both agriculture and industry to stop relying on imports and begin to increase their ability to manufacture themselves so that they could become self sufficient as Britain began a fractious relationship with much of the rest of the world.

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[72] E. Burritt, *Walks In The Black Country,* p. 137.
[73] J. Jaffray, *Hints for a History of Birmingham* (Birmingham: 1856).
[74] P. Jones, *Industrial Enlightenment,* p. 40.
[75] J. Thirsk (ed), *The Agrarian History of England and Wales: Volume VI 1750-1850*, (Cambridge: Cambridge University Press, 1989), p. 200.
[76] J. E. Cronin, *The Politics of State Expansion* (London: Routledge, 1991)

According to Allen,[77] Birmingham provided two-thirds of the weaponry required by the British forces in this period with iron from the Black Country mines. There was, subsequently, a massive rise in the exports of iron into the city providing the dynamism for the Black Country to form more trade links with Birmingham. The development of canals in the 1760s and 1770s were fundamental in this as they reduced transportation costs and still further bought together the dynamic concept of the region. Without these links with Birmingham or the ability to sell the produce, the Black Country would not have access to the trade that expanded the economy.

The increased ability to market the product of the mines as well as a growth in the demand for iron and subsequently for coal meant that there was a distinct impetus for the Black Country to develop its methods of production and transportation. As Jones suggests, "the natural endowment argument will only take us so far",[78] which is where there appears to be a gap in the historical explanations of the nineteenth century writers and where the importance of knowledge becomes apparent. Thus, we begin to see the development of a mutually dependent region as outlined by Stobart and Raven.[79] Observations given by the likes of Barthelemy Saint-Ford[80] and Alessandro Volta[81] suggest that in the late 1700s coal was considered sufficient to create an economy on its own and the concept of a dynamic trading region was not yet on the horizon. This shows that while the West Midlands was given a natural push towards industrialisation, the area was still lacking the dynamism which would turn it into a blossoming industrial economy, even when people did realise the potential that coal and mineral resources held as fuels. Jones suggests that the success of the Black Country that we recognise was built on the ability of the components to interact as a region, and the embracing of the knowledge economy.

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[77] G. C. Allen, *The Industrial Development of Birmingham and The Black Country 1860-1927* (Allen and Unwin: London, 1929), p. 33.

[78] P. Jones, *Industrial Enlightenment,* p. 24
[79] J. Stobart & N. Raven, *Towns, Regions and Industries,* p. 8.
[80] B. Faujas de Saint-Ford, *A Journey Through England and Scotland*, p. 346.
[81] G. Pancaldi*, Volta: Science and Culture in the Age of Enlightenment,* (Oxford: Princeton University Press, 2003), pp. 160-162.

Stobart and Raven's theory is that "regional space is not just the geographical site of action but also the social possibility for engagement in action",[82] and they argue that the region was a construct made from geographical space and "dynamic networks of towns and individuals".[83] The Black Country provides a perfect example of how this concept works. Where agriculture developed because it was central to basic human needs and subsistence, industry was not necessarily human nature, it required a concerted effort by enlightenment thinkers to press forward in an era when the majority of the population were focused only on subsistence. Therefore industry is reliant on innovation coming from entrepreneurs looking to push the nation forward into the industrial age; and the Black Country needed an infrastructure which complemented this. The dynamism of which Stobart and Raven speak came from people who recognised the potential of the area and knew that science was the key to unlocking it.

This chapter has tried to show that lying dormant within the Black Country, there was the potential for industrialisation. In its proximity to Birmingham there was massive potential for marketing the product of the region. Together with this there was the abundance of natural minerals, unmatched anywhere else in the world, which provided the potential to develop industries that would be at the centre of British industrialisation. This suggests that for some time, there had been potential in the Black Country for massive industrial success. Despite the advances that Dud Dudley made in the early seventeenth century his method was ineffective and unproductive and the process was "not made commercially successful until many years after [his] death".[84] One argument suggests that Dudley failed in his attempts to capitalise on the potential of coal because he did not fully understand how to process and mine it because scientific knowledge was not yet that advanced.

I would suggest that dynamism was brought about by the development of the knowledge economy which saw people who held scientific knowledge take power over certain areas of society, such as the extraction industries, because they understood how to make it productive. Part of this involved the creation of a dynamic region which enabled the Black Country to profit from the produce of mines by accessing bigger markets. Chapter Three will build on the idea that a combination of middle-class landowning farmers and entrepreneurs recognised the potential that had developed in the Black Country and looked to capitalise on it. This

[82] J. Stobart & N. Raven, *Towns, Regions and Industries,* p. 8
[83] Ibid. p. 9
[84] T.E. Lones, *History of Mining in The Black Country*, p. 7

discusses the idea that the agricultural economy could have been important to the development of industrialisation in the Black Country, and alludes to the schools of thought of historians such as Crafts[85] or Eatwell whose synchronic views would argue that any one point in time is the "product of the entire history of Britain"[86] up to that point rather than those who support the idea of revolutions and breaks with history. Furthermore, it shows that the knowledge economy was influential in the growth of industry, as it could have provided the dynamism that unlocked the mineral potential of the Black Country.

[85] N.F.R. Crafts, 'The assessment: British economic growth over the long run', *Oxford Review of Economic Policy*, 4 (1988), pp. i-xxii.

[86] J. Eatwell, *Whatever Happened to Britain?* (Duckworth: London, 1982)

Chapter 2:

Approaches to the Black Country: Robert Plot and James Keir

Robert Plot's seventeenth century piece *The Natural History of Staffordshire* provides a picture of pre-industrial Staffordshire. Plot makes a series of observations that give an insight into how the economy functioned in his time. In taking a diachronic perspective we can compare these with the Staffordshire of a hundred years later presented by James Keir and look at the changes that have been made in the way the economy functions. We can also begin to piece together why these pieces were written and the role that such texts had to play in the dissemination of science throughout society. A number of issues become clear in Plot's work if we consider how the points that he does *not* make, help create a picture of Black Country development as we look for things which have been omitted from his description that we would recognise as being typical of the Black Country. Obvious features of the region that we recognise that Plot does not are potentially the result of some dynamism that aided economic and industrial development in the area. If we can understand what these features were, then we can begin to understand what provided the dynamism that changed the agricultural economy in the period between the two authors. It is important to consider the fact that both Plot and Keir were publishing scientific texts to be read throughout society. To study their backgrounds and motivations gives us an insight into how science spread throughout society and the importance that was placed upon it. As members of the Royal Society both were influential in directing the course of scientific intelligence at different times. As a society which was formed with the intention of encouraging discussion and exploration of science, the Royal Society was of fundamental importance to the realisation of new knowledge. That members were taking a keen interest in matters of mineralogy and natural history is key as it suggests that there was a realisation among the nation's most eminent scientists that this was a significant topic. Once this was recognised, the Royal Society was a perfect platform through which an understanding of mineralogy and how it was best utilised could be spread throughout society. Through the Royal Society journals and lectures the thoughts, findings and opinions of these scientists was made much more accessible to the British public.

As Professor of Chemistry at Oxford University, Plot was one of the foremost scientists of his era. He was also in a position to transfer his scientific knowledge to an influential group. It is also telling that such an important scientific figure was keen to explore the mineral make

up of the ground as people began to recognise that this was a potential source of great wealth for the nation. Plot had previously published a natural history of Oxfordshire[87] and had moved on to study the Black Country. This is of fundamental importance because it outlines the fact that Plot, a keen chemist, mineralogist and one of the nation's leading scientific teachers, had actively sought to study the mineralogy of the Black Country because he felt that it was an area of natural and scientific importance. Plot was actively looking to study the Black Country, presumably to make a comparison with other areas of the country and publish his results. These will have been read by the learned and powerful middle classes, indicating a desire to spread this knowledge throughout the population. This begins to create a model of how knowledge was spread throughout society as influential scientists began to print their thoughts with the sole intention imparting their knowledge on others.

Keir, was one of the most influential scientists of his generation, having relocated from Scotland to the West Midlands where he became dedicated to the study of chemistry and more importantly the impact that it could have. That he recognised the importance of Macquer's *Dictionnaire de Chimie* and sought to translate it and bring it to the British people is significant because it shows that he recognised chemical understanding as being something which would be the key to change and wanted to bring it to the British masses, it also suggests that he felt it was something that Britain needed. Having run a glassworks during the mid 1770s, Keir opened a chemical works in Tipton in 1780 in partnership with Alexander Blair and so began to capitalise on the spread of science. He then took charge of running Boulton and Watt's Soho foundry in Handsworth before later opening his own mine in Tividale in 1794. These pursuits show that Keir was inextricably linked to the scientific culture of the Black Country and the dissemination of science throughout society as his business interests were dependent on further discovery in science. This provided a significant motivating factor for him to increase society's scientific awareness as this would have a direct impact on the success and growth of his business.

Plot's work makes a series of observations that show us the state of Staffordshire's economy as he saw it. The first of these is that for him the study of geology and mineral resources were unknown, certainly he did not recognise the potential that we know they held. This is in stark contrast not only to Keir's work but also to William Pitt's *Topographical History of Staffordshire,* which, despite being a fundamentally historical account, still focuses on the

[87] R. Plot, *A Natural History of Oxfordshire, (L.Lichfield: London, 1677)*

coal and mineral deposits and the soil structure. This shows that by 1817 the view of minerals was changed. Even though their development was by no means at its peak, Pitt still felt that they played an important role in the history of the region, mentioning them as he does alongside the development of farms and churches. This highlights how opinions and priorities had changed.

The impression that Plot gives by not referring to the mining trade that we would associate with this region shows Staffordshire towns as insular, and not having the knowledge to experiment and discover the potential that the area held. Much of this could be attributed to the fact that the transport, infrastructure and knowledge economy required to create a dynamic region did not exist. Plot's experience as a scientist, and from his studies in Oxfordshire, shows that such potential for scientific expansion was clearly what he was looking to investigate. That it is hardly mentioned suggests that it was essentially unrecognisable from the area in the 1750s which thrived on the results of scientific exploration. I would argue that it was potential for scientific expansion, and the ability to progress scientific thought throughout society that prompted Plot to conduct this study. That he does not mention any trade that could have evolved in to the nineteenth century mineral trade is significant. Plot was presumably looking to map the importance of the mineralogy of the soil structure; the fact that he did not find anything that would later become of paramount importance gives us an indication of where scientific understanding stood in 1686. The fact that he chose to study Staffordshire shows that the mineralogy, or natural history, of the ten-yard seam, was becoming of interest to scientists as they began to recognise that such minerals were potentially very powerful and worthy of greater investigation.

Plot gives focus to the agricultural land which existed in the North of Staffordshire showing that "both moorlands and woodlands [had] goodly cattle, large and fair spread. The warm limestone hills of the moorlands producing a short sweet grass and large oxen".[88] Evidently he recognises potential in the region for different areas to support each other by utilising their respective economic strengths, of which agriculture was clearly one. It also shows that while the mineral resources were there, the understanding of them was limited as they were overshadowed by agriculture. The fact that Plot – one of the nation's leading scientists had no

[88] R. Plot, *The Natural History of Staffordshire* (Oxford: At The Theatre, 1686), p. 107

comprehension of the importance of geology is key. What is also important, however, is that he was making an attempt to understand it, and pass this knowledge along. This indicates the very beginnings of a scientifically conscious society where influential people were trying to pass their knowledge on to society at large. He mentions that limestone was recognised only as being good for feeding. This alludes to knowledge of soil structure but shows that the full potential is not realised. The intention of Plot's study was clearly to uncover how far it was possible that the mineralogy of the soil in the Black Country could possibly have had wider implications for the area, although what they might be, he did not understand.

What is clear from Plot's natural history is that Staffordshire required dynamism and social change from elsewhere in order to become the region that we recognise today. We can see that an agricultural economy did exist in Staffordshire; he also states that the region was "esteemed by many as the best feeding land in England" as the limestone provided such fertility. [89] Plot writes about a healthy agricultural economy in the region, where farmers were keen to "improve their land…by laying ashes on their meddow [sic] as some are of the opinion that this brings more profit to the husbandman than any dung;"[90] showing an appreciation of the scientific importance of fertilisation. He also details the primitive understanding of crop rotation, which seventeenth century Staffordshire farmers utilised in order to produce better crops, suggesting that after wheat "the next crop was usually beans". [91] He speaks about the concept of "rural learning", [92] and the idea that people recognised at this early stage that agriculture was dependent on knowledge and understanding and that successful agriculture depended on learning about soils, plants and the relevant chemistry, which would become what we call botany. He builds on this to suggest that in agriculture "everybody took advice from the most skilful on the matter in hand"[93] which shows that a knowledge economy was progressing in the region where people were developing a level of superiority based on knowledge. This could show that people were beginning to see the benefits of science and it is possible that this provided the dynamism once they were able to apply it to the mining industry.

One hundred years after Plot, James Keir published his *Dictionary of Chemistry*, which proclaimed that knowledge had diffused through society as men of all classes recognised its

[89] Ibid.
[90] Ibid. p. 333.
[91] Ibid. p. 340.
[92] Ibid. p. 336
[93] Ibid. p. 337

importance[94] and scientists who embraced it became influential in the age of industrialism. Keir was one of those influential scientists and the publishing of his book shows the importance that he placed on the diffusion of knowledge. The very fact that an influential scientist such as Keir was publishing this text shows that he recognised that a process of learning was needed. It is easy to see the link between the recognition that knowledge was influential in agricultural growth and its subsequent application to industry. I would argue that investigations into "rural learning" made by Plot's contemporaries were responsible for drawing attention to the soil and the chemical potential that it held.

Plot's account does not include the study of any of the capitalist anchors that came to characterise the agricultural revolution, for example the marketing of goods, or the importance of enclosure. In fact, he actively denounces the importance of enclosure by suggesting that "the healthy-land of this county is seldom inclosed [sic]",[95] showing that this was a development which had not yet begun to take off, suggesting that the benefits were not recognised. It could be argued that enclosure was the spark that was required to change the regional economy because it represented a break with subsistence farming and a move towards capitalism as power was handed to those who had turned "rural learning" in to rural knowledge. Examples like this show the limits of scientific and economic knowledge at the time and highlight the room for development even among the most respected scientists in society.

Plot enhances the idea that the Black Country of the seventeenth century was focused on subsistence and survival, while nineteenth century accounts are focused heavily on the ability of the region to export the product of her mines across the country. Plot shows no concept of marketability or capitalism in the economy as the people of Staffordshire utilised the mineral rich ground to provide food for themselves and their families. While Plot speaks in some detail about farming techniques and methods,[96] he does not focus on the idea that this produce might be intended for sale at market. This tells us that in the seventeenth century, the Black Country economy was static and lacked the dynamism to make the most of its natural resources. I would suggest that this was because it did not have the appropriate knowledge economy at this point. As we can see from James Keir's *Dictionary of Chemistry*, as knowledge and science began to spread and create such an economy, industry began to

[94] J. Keir, *A Dictionary of Chemistry* (T. Cadell & P. Elmsley: London 1776), p. iii.
[95] R. Plot, *The Natural history of Staffordshire* (At The Theatre: Oxford, 1686), p. 342.
[96] Ibid. Chapter IX

follow. I would argue that Plot's concept of rural learning represents the start of the growth of this economy and the beginning of the gradual movement towards industrialisation. As Rostow has argued, economies build on what has gone before them and thus, if industry was going to develop, agriculture could play an important role. This is why the revolution in terms of farming techniques and practices in the early eighteenth century was so vital; knowledge was the common link between the two. By the seventeenth century the knowledge economy had not developed sufficiently to show people the effect it could have on agriculture and thus it is possible that science was not recognised as being able to provide the answers that would allow industry to grow. Science had not yet had a sufficient impact for people to realise that experimentation with mineral resources held the key to unlocking their potential. By publishing his natural histories, Plot was aiming to start spreading scientific knowledge, to use his position to create a society that embraced science and was able to unlock the potential that the ground in Staffordshire held. Being home to the knowledge and business skills of the likes of Watt and Boulton are a part of this. Without the agricultural economy restructuring the economy into one that was focused on markets and profit, there would have been little potential for men like this to make the most of their business talent.

There was some conception in the seventeenth century that smelting and iron production was possible but clearly there was no idea of the commercial potential that it held, evidently a market economy was not in formation as yet and a further spark was needed. What this does show is that the knowledge and understanding of chemical processes and the potential that they held existed but was minimal. Plot shows how people, such as a "Mr Lister", a lecturer to the Royal Society,[97] were developing this new industrial knowledge by introducing it on a smaller scale in local iron works. Plot refers to the "firestone, such as they use in the furnaces"[98] however there is nothing to suggest that he understands the science behind the process or the chemical properties involved. James Keir clearly understands the importance of science and recognises that experiments with quicklime by the likes of Dr. Black and Mr. Cavendish have furthered the progression of industry by embracing science and publishing this knowledge. Keir proclaims that the experiments by Black and Cavendish "concerning the caucity of alkali and quicklime and the effects of adding fixed air to these bodies"[99] were embracing science and playing a role in its rapid development. He also refers to a rapid

[97] Ibid. p. 165.
[98] Ibid. p. 151
[99] J. Keir, *A Dictionary of Chemistry* (T. Cadell & P. Elmsley: London 1776), p. iv

growth over the previous twenty years[100] suggesting that this knowledge and experimental nature would not have been common in Plot's time. All of this leads to the fact that when Pitt wrote in 1817, he had a full understanding of the importance of the mineralogy of the area. We can see a definite progression, from small-scale industry to a society that has become much more focused on science, where trial and error experiments in the quest for knowledge of the ground have driven both agriculture and science forward. It is possible that the "rural learning" which Plot advocates was responsible for the furthering of experiments on the land which in turn lead to experiments by the likes of Black and Cavendish.

Plot's study proves that simply being home to mineral resources was not enough and the Black Country required the infrastructure to make the most of them. Plot makes no mention of areas common in the works of other writers. Instead of focusing on Dudley, Oldbury or Smethwick, he concentrates on northern Staffordshire, the moorlands, because this was where agriculture was strongest and the economy was focused. He shows that Staffordshire did not have different dynamic regions based on trade and production as it did during the nineteenth century era of capitalism and was merely a county conforming to traditional geographic boundaries because science had not spread sufficiently for society to recognise that this was important. Publications such as Keir's *Dictionary of Chemistry* are part of the percolation of these ideas throughout society.

In a society to which transport and trade over significant distances were alien, there was little to be gained from industrial production because for Plot and his contemporaries the market for it did not exist. As the population began to grow and a market economy became essential, priorities shifted and industrialisation became the natural progression as subsistence was no longer viable and thus, agriculture became a secondary economy. The Black Country is far more complicated than is often considered. Although we might understand it geographically as being those places that bordered the coal seam, the economy is far more complicated than this and reliant on connections with other areas. This is shown by the fact that it grew gradually out of the small farming community that Plot understands rather than a revolutionary break with subsistence.

By showing how the same region existed before industrialisation, we can see what changes needed to take place to achieve the picture we have of the industrial Black Country in the nineteenth century. By studying the work of two influential scientists at different times, we

[100] Ibid. p. iii

can also see how far there was a definite movement towards a scientifically educated society in the Black Country. The publication of these works, some 100 years apart, shows that there were significant attempts to ensure the development of a society which would be able to make the most of the potential that the Black Country held in its geology. By releasing these studies, Plot and Keir ensured that not only were people aware of the geology of the area they lived in and the potential it held, but also that there was a means of unlocking it – should they be able to master chemistry. Works such as these two were what began the percolation of science throughout society. In coupling this with the development of the Lit.-Phil. Societies and the evolution of the modern town structure, mading the dissemination of knowledge possible and more accessible, we see both how science was recognised as the route to unlocking certain problems and how this message was conveyed to the population. This allows us to show how the Black Country that we recognise was created and shows us what changes took place. It is also fundamentally important that Keir and Plot were both in positions to ensure that this was done. They took advantage of positions of scientific influence in order to publish accounts and reach out with their knowledge to as many people as possible. It is also fundamentally important that Keir partially translated his dictionary from Macquer's French version, showing that he recognised that this was something that the British population needed to see if knowledge were to disperse effectively and efficiently as was necessary.

The sort of differences that we see between the accounts of Plot and of nineteenth century writers are very much social, or structural, and dependent on the growth of knowledge and the ability to apply this in the correct sphere. The changes were dependent on the growth of scientific knowledge and understanding, which allowed industry to develop. Plot shows that knowledge was beginning to appear as modern science became important to the agricultural sphere. This shows that some hundred years before James Keir highlights the fact that a new industrial society – dependant on science – was beginning to appear, an agricultural economy in the Black Country was developing in the same way.

Chapter 3:

The Impact of Individuals on the Industrialisation of the Black Country

The following chapter will explore the role that individuals played in the development of industrialisation in the Black Country. This section looks at the acquisition of new knowledge and the subsequent diffusion of it throughout society. The chapter looks at how knowledge became more accessible using books such as James Keir's *Dictionary of Chemistry*, and Young's *Farmers Guide*, which were intended to be read by the landed gentry, with the intention of spreading knowledge and an appreciation of science. This is followed by a discussion of how science and knowledge permeated through the agricultural community and played a fundamental role in development here. This is linked directly to the importance of land agents on the aristocratic estates in the region and the fact that, as knowledge spread, the management of estates became a full-time profession such was the level of expertise required. The tripartite system involved management at three levels as landowners employed land agents or tenant farmers to manage their land who in turn employed yeoman farmers to carry out the labour. This was influential as it required tenant farmers to carry out the work requested of them by land agents; therefore these farmers needed a degree of understanding, showing that new knowledge was reaching all levels of society. The chapter will focus on James Loch whose work on the Sutherland estate during the nineteenth century has been well documented. I would argue that Loch is the archetypal land agent from this period and he was responsible for radical change on a number of levels. This chapter examines the culture of innovation that existed in the region and how far knowledge, and the people who possessed it, affected the growth of industry and agriculture. The focus is the idea that the acquisition of scientific knowledge was influential in the growth of industry. The piece then builds on this to examine the application of knowledge in the agricultural economy in order to investigate any similarities in development between agriculture and industry.

In 1776, Keir claimed that "the diffusion of general knowledge and a taste for science over all classes of men in every nation in Europe or of European origin seems to be characteristic of the present age".[101] As this quotation suggests, people were becoming increasingly aware of

[101] J. Keir, *A Dictionary of Chemistry* (T. Cadell & P. Elmsley: London 1776), p. iii. For James Keir see Oxford National Dictionary of Biography: Barbara M. D. Smith, 'Keir, James (1735–1820)',*Oxford Dictionary of*

the potential that scientific knowledge held for understanding the world because "it is only by taking comprehensive views of things and by approximating and comparing all the facts…that we can expect to trace the grand plans of nature".[102] William Marshall emphasised the growing importance of "rural knowledge" to the agricultural economy and agricultural education. This by no means constitutes a definitive causal relationship but does suggest that agriculture and industry were subject to the same powers of development. The manner in which knowledge percolated through the population has already been discussed. A revolution in social make-up made communication easier and people became more receptive to change. The educational reforms which made school compulsory were influential in the spreading of knowledge. To add to this there was the development of "the town" which would "provide meeting spaces for bodies including assembly rooms".[103] This highlights two key points; the first is that it was easier for opinions and ideas to spread throughout society as people became better connected and "community" was given greater importance and as Stobart and Raven have noted "it was recognised in the early nineteenth century that a town was an amalgamation of particular functions"[104] and that "more substantial towns were centres of social organisations",[105] rather than just a town focused on small scale production as Plot would recognise. They suggest that towns had a "much more dynamic and mixed economy"[106] than they had previously had which suggests that there was a multiplicity of ideas at work in towns at this time and the transferral of knowledge was encouraged. The second is that there was recognition that it was important for this dissemination to take place – suggesting that those in positions of power had seen potential. In line with this James Keir refers to the fact that "the progress of chemistry over the last twenty years has been more rapid than was ever made perhaps in any science in an equal period".[107] These are the changes that Hopkins argued, needed to be made if the industry was to develop fully in Britain, which were discussed in the introduction.

National Biography, Oxford University Press, Sept 2004; online edn, May 2007 [http://www.oxforddnb.com/view/article/15259, accessed 29 July 2010.

[102] Ibid. p. xi.
[103] B. Trinder "Towns and Industries: The changing character of manufacturing towns" J. Stobart & N. Raven (eds.) *Towns, Regions and Industries: Urban and Industrial Change in The Midlands, c. 1740-1840* (Manchester University Press: Manchester, 2005), p. 105.
[104] Ibid
[105] Ibid.
[106] Ibid. p. 116.
[107] J. Keir, *A Dictionary of Chemistry* (T. Cadell & P. Elmsley: London 1776), p. iii

Elliot has argued, the radical transformation of towns during the seventeenth and eighteenth century which focused around the building of "brick and stone private and public buildings, encouraged a parallel acceleration in the variety and intensity of urban socialability."[108] This shows that Elliot clearly believes that this was a point in time at which society was best positioned to transmit knowledge. This is coupled with the fact that a period of political stability ensured that people were able to focus on progress and innovation rather than simply on survival and stability. Thus, the scientific revolution became very much a part of the Georgian renaissance. This was particularly prevalent during the 1730s and 1740s at which point the literary and scientific culture in provincial towns, such as Birmingham and the West Midlands, began in earnest. Elliot argues that the "increasing importance of natural philosophy in polite culture is evident in the demand for scientific goods".[109] This shows that social conditions had reached a point where the consumption of scientific knowledge was not only encouraged but was made easier by social conditions at the time. I would argue that both agriculture and industry were able to capitalise on this and that these conditions were fundamental in the development. The aim is to determine whether the link can be considered to have been causal.

As this process unfolds we begin to see the publication of more and more county studies and natural histories, which Elliott refers to as being "manifestations of this interest in natural philosophy".[110] Plot would be a prime example of these but others include Pitt's *Topographical History of Staffordshire* (1817) and Garner's *Natural History of the County of Stafford* (1844). That society was encouraging the publication of these texts is of fundamental importance. Firstly it shows an interest in the region and its geography, encouraging an exploration of its natural science and, presumably, how to capitalise on it. Secondly that these books were being written and distributed throughout society shows that people were being exposed to the ideas of science and natural philosophy. That these two subjects were being passed through society is influential in the spread of knowledge across society and provides evidence that this was taking place and that this knowledge could be absorbed.

Another fundamental factor in this spread were the dissenting churches which had a culture of learning that embraced science. As these churches grew bigger and more influential during the eighteenth and nineteenth centuries, so science was given a new platform through which

[108] P. Elliott, *The Derby Philosophers: Science and Culture in British Urban Society 1700-1850,* (Manchester University Press: Manchester 2009) p. 14
[109] Ibid. p. 23.
[110] Ibid.

to present itself. Benjamin Parker was a key figure in this, notably with his *Philosphical Meditations* of 1734. Through this text he began to consider the "aurora borealis, the position of the planets, [and] the location of minerals".[111] Parker's text was "designed to rectify the prevailing errors in faith, so evident among us."[112] This shows how the dissenting churches began to question the accepted social doctrines and put greater emphasis on science and the spread of knowledge. Dissenting culture encouraged "scriptualism, intellectualism… [and] tended to encourage a broad education which included science"[113] whilst embracing scientific and economic progress across society.

Dissenting schools such as the Findern academy began to carry great influence over their areas as the focused on discussions of chemistry, logic, maths, natural philosophy and anatomy and, importantly, "the importance of Britain's geographical position".[114] All of these were prompted by two key texts from the dissenting churches at the time – John Gregory's *Manual of Modern Geography* and John Locke's *Thought's Concerning Education* both of which emphasised the importance of the recognition of science, and were able to impart this insight to their audience, to great effect.

This was incredibly important to the spread of knowledge. As towns began to develop their urban ideology, they moved closer together and the sharing of thoughts, ideas and information not only became easier, but was also encouraged. Couple this with the influence of the dissenting churches and the publishing of texts by the likes of Parker, Locke and Gregory, and it is easy to see how knowledge was passed around and how science became fundamental to society. The combination of these two key facets creates a robust model for the spread of knowledge as the growth of awareness through the dissenting church was coupled with the ease and openness with which new knowledge was now spread through the developing urban society. That the agricultural and industrial revolutions were gathering pace at this time suggests that people were using this knowledge in these two fields and that society was using the spread of knowledge for economic growth.

Agriculture and industry developed, if not in the same way, then as a result of the same forces, including the growth of knowledge and the culture of enlightenment thought. As

[111] Ibid. p. 25
[112] B. Parker, *Philosophical Meditations with Devine Inferences* (Mary Bridge: Derby & London: 1734) p. A3.
[113] P. Elliott, *The Derby Philosophers*, p. 28.
[114] Ibid.

knowledge was diffused among society and people recognised its importance first agriculture and later industry began to grow and benefit because of it. While the relationship may not be a causal one there are certainly major developments that held important implications for agriculture and for industry and facilitated developments in each, enclosure is the main example of such a development. Enclosure was fundamental to the growth of the agricultural economy and in shifting power towards those who were in a better position to mould the agricultural economy to a capitalist market system. An example of this comes from the Duke of Sutherland's Staffordshire estates. In 1812, control over the enclosures was given to the newly appointed land agent James Loch whose knowledge and technical expertise ensured that the Marquis of Stafford had given him almost total control of the estate. Personal correspondence shows that it was Loch who was in charge of negotiating acts and exchanges of land as well as land use and the implementation of high farming techniques,[115] such was his knowledge and skill set.

Another example of the link between knowledge and growth which agriculture and industry share is in the concept of high farming, an idea which is a common topic among agricultural historians and was central to Arthur Young's discussions.[116] This was an idea which dealt with the implementation in farming of a variety of new techniques which allowed the agrarian system to grow and to achieve the status that was required of it to support the growing national population who were increasingly focused on industrial pursuits. Young describes how farmers became concerned with marling and fertilizing and crop rotation, all of which applied the science of botany in order to produce better quality, saleable crops.[117] Another fundamental introduction was the development of fen drainage systems that allowed fields to be kept better and made the growing of crops easier. *The Farmer's Pocket Guide* was published to aid Farmers in 1825. This guide facilitated the diffusion of knowledge into the agricultural sphere. It provides examples of how farmers began to use exact measurements and thought in depth about the management of their fields and where and when crops were planted in order to produce better results. It also advocated a standardisation

[115] A collecion of Loch's personal letters are held at the Staffordshire Record Office. Letters dated January and May 1813, D593 K/1/3/1 and K/1/3/9 in particular show his role in enclosure and high farming.
[116] A. Young, *Tours in England and Wales: Selected from the Annals of Agriculture*, (Reprinted in 1932 by the London School of Economics: London, originally published in 1771). Examples of references to practices of "high farming" are pp. 31, 290, 228.
[117] Ibid.

of farming practices.[118] This guide was joined by Arthur Young's county studies and the works of Keir and Plot in trying to diffuse scientific knowledge throughout society as, consciously or otherwise, we see the beginning of an effort to spread knowledge throughout society. As knowledge became fundamental to farming improvements, a new demographic of specialist tenant farmers began to appreciate the importance it held and thus through them it was transferred to the apprentice farmers. Who these young farmers were and what it was that they studied is a subject that requires further research. However, the very fact that they existed suggests that knowledge was being diffused. Marshall refers to young boys "placed as pupils with superior farmers at some distance from their fathers residence" stating that "if ever agriculture be brought near perfection this is the class of men who must raise it".[119] This shows that the value of learning and teaching was being embraced in the agricultural community, which is consistent with the views of Plot and Keir that knowledge was becoming important throughout society.

These books were intended to be read by the landed gentry and presumably the knowledge that they presented was meant to be passed on to the next generation. While the evidence presented by Marshall does not prove that there is a definite link, it does show a relationship between knowledge and growth and suggests that the attempted diffusion of knowledge was working. The very existence of apprentice farmers learning the trade suggests that people recognised that knowledge and learning was important if farming was to develop and that foundations were being laid to continue this. Keir is effectively explaining the dawning of a new society in which scientific knowledge and understanding were paramount. His comment on the expansion of science over the last twenty years shows how this new society was dependent on a knowledge economy where those with the greatest grasp of new scientific knowledge, were at the top. By virtue of the fact that he refers to a new society we can see how this knowledge economy would have an impact on all areas of life, both industrial and agricultural, and these two areas were both subject to the same growth pressures as all society was changing. Robert Plot made this point in 1686, some hundred years previously to Keir. The comparison of the two shows that the knowledge economy was formed gradually over the previous hundred years and began to influence agriculture, as this was the dominant economy. Once the appreciation of science grew so industry began to develop because people

[118] W. Young, *The Farmer's Pocket Guide: or, Imperial standard measurer : containing many useful and practical tables, rules and calculations, on subjects of rural economy, husbandry, and agricultural commerce* (Leadbetter, 1825), p. 139.

[119] W. Marshall, *The Rural Economy of The Midland Counties* (London: G. Nicol, 1790), p. 118

saw the influence it was having in agriculture. Knowledge was diffused by individuals such as James Keir in the industrial sphere and by tenant farmers like Loch in the agricultural economy.

Many landowners of the Black Country estates chose to hand over control of their land to land agents or managers who took charge of the day-to-day running of the estate. This became necessary as estates became more and more diverse as enclosure took hold and they became larger and took on both agricultural and industrial pursuits. A typical example is the Dartmouth estate which conforms to Raybould's general theory of estate management that "administrative matters probably took up much more of the landowners time than before [as enterprise grew]"[120] and as a result third party expertise was essential. On the Dudley estate, Richard Smith managed the land between 1836 and 1864 and was regarded as having bought with him an entire network of professional people who managed the land and were employed by the estate, as well as bringing his "unsurpassed administrative efficiency and technical expertise to the conduct of mineral and industrial affairs".[121] Smith was an example of a land agent who, due to his expertise, had turned estate management into a highly skilled profession. Men like him became the fulcrum of their estates as they became more and more complex.

Men such as Smith, the Thynnes on the Dartmouth estates[122], Peter Potter working for the Bradfords[123] and later, James Loch who took charge of the Sutherland estates from 1812-1855, became fundamental to the development of the midlands economy. Managing the region's large estates was no longer a part time job for the landowner, but something that required particular skill and attention. These men were employed with the intention of disseminating their knowledge and expertise among those who worked for them. This is made clear by Graham Mee in *Aristocratic Enterprise* as he details the work on the Fitzwilliam industrial undertakings and shows how the fact that Black Country estate owners employed such people shows that knowledge and understanding were becoming central to the economy. Mee outlines the reasons why landowners employed agents and uses the Fitzwilliam estates as a case study. As he suggests "the owner's natural concern was to

[120] T.J. Raybould, *The Economic Emergence of The Black Country,* p. 12
[121] Ibid. p. 229.
[122] The Thynne family took charge of the Dartmouth estate from 1853 until the twentieth century. Estate records do not show exactly but 1901 is the last recorded date.
[123] Estate Correspondence from the Bradford Estate suggests that Peter Potter took charge in 1820 and was in charge until 1889 by which point he was aided by his sons. Staffordshire Record Office, collection D1287.

secure maximum working relationship with minimum disturbance".[124] He goes on to suggest that as management became more complex and began to span both agriculture and industry, it became impossible for one man to spread himself over multiple divisions and there was "less opportunity for switching labour between occupations"[125] arguing that each area required specialists and required too much input to be combined. Mee argues that a "labour force had to be recruited and a management structure had to be built"[126] which continues the argument that the tripartite system was essential in that it divided the labour and allowed the landowner to manage the different specialisms on the estate – "the land agent, as the landowner's local representative, would traditionally have been expected to adopt the management role".[127] And given his wider knowledge and skills, he would have been in charging of managing the "engineering, marketing, personnel management and organisation skills"[128] of the workforce. This resulted in a significant spread of knowledge as the undertakings increased in size and complexity, men developed day to day skills through a process of learning by doing, through experiment. This was a model which maintained fluidity and allowed knowledge to be simply passed from man to man. Significantly it also generated a knowledge gap between skilled and unskilled workers that made knowledge a powerful commodity and encouraged its use. This is the manner in which the management structure began to proliferate and highlights how the relationship between owner and agent developed and was key to the spread of knowledge.

Land agents such as these were the most influential component of the tripartite system, which became more popular in the nineteenth century. It is clear that if they were responsible for many of the decisions that were made on the estates there were tenant farmers and contractors who carried out their orders. At the same time, these land agents were empowered by the landowners themselves, suggesting that these people recognised something about the state of the economy which showed them that an agent was necessary. It is clear, from the writing of Plot and Keir, that knowledge was diffusing, the Duke of Sutherland recognised that a knowledge economy was developing and sought to educate himself accordingly.[129] It could be argued that this recognition involved the realisation that in order to effectively manage their estates, they needed a professional estate manager to take control, recognising that knowledge was essential to the management of an estate. At the same time, correspondence

[124] G. Mee, *Aristocratic Enterprise: The Fitzwilliam Undertakings 1795-1857* (Blackie: Glasgow & London, 1975). p.xi
[125] Ibid.
[126] Ibid.
[127] Ibid.
[128] Ibid.
[129] Ibid. p. 83

from the Bradford[130] and Sutherland[131] estates shows that while many decisions lay with the agents it was still very much the landowners who injected their capital into the estate and who stood to gain financially from rent increases.

Tenant farmers and contractors completed the tripartite system, as it was they who carried out the work. Evidence suggests that they answered directly to the land agents.[132] These people obviously played a fundamental role in the running of the estates and in the diffusion of knowledge throughout society as understanding filtered down to them through instructions from the land agents. Joseph Reynolds[133] is an example of a contractor who clearly answers directly to Loch and displays a strong understanding of how to manage a mine. In a letter to Loch, Reynolds asks, "in consequence of understanding from George Bishton that he [the Marquis] does not understand the management…[Reynolds] begs leave to present his duty to the Marquis of Stafford…to be considered for another lease of the mines at Kettley"[134] This shows that knowledge was reaching throughout society as people at this level could be more adept at managing mines than the Lords and that land agents such as Loch were given the responsibility of empowering these people.

Arthur Young claims that "the improvements which have been wrought in England have been almost totally owing to the custom of granting leases".[135] Tenants were rewarded for their efforts with longer leases, providing greater financial stability and opportunity to profit. Thus, while land agents were the driving force behind the tripartite system, there is evidence that in all three departments, knowledge was proving influential as a new education in practices began to filter down and provide a more rigid base for the agricultural economy to build on as those who understood best the processes which would further the economy began to rise to the top and began instructing those below them. Here we can see that knowledge was percolating all levels of society and diffusing in the manner that Keir has suggested.

[130] Staffordshire Record Office: Letter from Peter Potter to the Earl of Bradford (D1287/18/21), dated 6th December 1830.
[131] Staffordshire Record Office: Letter from L.M. Unett to James Loch (D593 K/1/3/1) dated 29th January 1813.
[132] Letter from Joseph Reynolds to James Loch dated 21/Jan/1813: SRO D593 K/1/3/1
[133] Ibid.
[134] Ibid.
[135] A. Young. *Political Arithmetic: Containing observations on the present state of Great Britain; and the principles of her policy in the encouragement of agriculture* (W. Nicoll, London: 1774.)

As David Brown has suggested, it was often the case that land agents directed the landowners on where and how to enclose open fields.[136] At the same time enclosers had many different motives for enclosing; most historians have drawn the conclusion that the parliamentary enclosure movement gathered force as landowners saw it as an opportunity for increased profits and control of the land. An example of the control they gained is the Pensnett Chase award in 1784 that allowed the Dudleys to build a 1,000-yard canal branch across the enclosed land in order to expand industrial enterprises. It is too simple to suggest that enclosure was a capitalist device designed purely to give power to landowners so that they could deal with the land as they wished. David Brown has outlined a number of permutations and restrictions that could prevent them from enclosing, such as damages payments and compensations to those who used the common land.[137] However, it was a significant step in this direction and as knowledge spread and industry began to develop on the estates, enclosure came to play a fundamental role in growth. It is possible that much of the impetus to spread industry came from land agents, who were often employed because they were able to show knowledge of the economy, of accounts and of how to manage an estate, which was beyond the landowners themselves. This suggests that the drive to move the economy forward was coming from those who were employed on the estates because of their knowledge and expertise of this very situation.

Turner[138] concluded that enclosure, during the first wave of parliamentary acts from 1780, was undertaken with the intention of improving agriculture, such was the nature of the economy, as enclosure facilitated the improvements which increased rents and profits. It is also clear that enclosure would have a significant role to play in the mining industry. Enclosure began to have an impact and certain mines can be seen to have developed purely because of enclosure, for example that at Cannock Chase on the Anglesey estate. There, enclosures gave the Anglesey's the freedom to open the mine which helped their estate become one of the most profitable in Britain[139] and was at the centre of road and canal developments which were built to access the mine, furthering the spread of industry. Thus, it becomes clearer how enclosure, which was initiated as an agricultural development, came to

[136] D. Brown, *Enclosure and Improvement: An Investigation into the Motives for Parliamentary Enclosure*, Unpublished PhD Thesis, Wolverhampton Polytechnic, 1992, p. 7

[137] Ibid. p. 81

[138] M. E. Turner, *English Parliamentary Enclosure, its Historical Geography and Economic History* (Dawson: Folkestone, 1980).

[139] M. Wood, *The Economic Development of the Dartmouth Estate, Sandwell: 1801-1912,* MA Thesis, University of Birmingham, 2009. P. 51

have a significant role in the growth of industry as landowners recognised the freedom that it could give them, and land agents were given the freedom to expand industrially.

Coal and mineral deposits were often located on loamy soil, which was frequently common and waste. These were often prime areas for enclosure and thus, once enclosure was recognised as a means by which landowners could take control of land, it presented an opportunity to develop mining on these otherwise barren areas. It is possible that these enclosures were used to create mines such as that in Cannock Chase. Following this, miners needed houses and we begin to see the development of communities on the enclosed land as the canals and roads that were facilitated by enclosure also began to appear. We can see then that enclosure, a cornerstone of the agricultural economy also played a subsidiary role in the growth of industry as it allowed landowners to develop this side of their business. While this may not be a causal link it is certainly an important development and it was founded on what David Brown refers to as "the spirit of improvement"[140] and developed because landowners wanted to tackle primitive methods of farming which were still in operation on open land. They did this by enlisting the help of land agents who embodied a progressive culture within a knowledge economy.

New techniques such as marling, draining, fertilizing and crop rotation all combined to ensure that even with fewer workers, farming could still feed the country. We can also see considerable application of science as farmers began to use super-phosphates to fertilize their crops. This shows a significant understanding of the chemistry that Keir was preaching and evidences the spread of knowledge across the agricultural economy. Meanwhile, the development of the plough shows an application of science and engineering that was able to revolutionise the process of farming and significantly reduce costs. These changes were facilitated by the first wave of enclosure and the control that this gave landowners over their fields. The single greatest change that can be seen is the application of convertible husbandry and the understanding of botany that this represents. The use of crop rotation not only shows better application of science but bought better quality crops at greater yields, meaning that farming became much more financially secure and the economy began to grow. These are further examples of the transmission of knowledge throughout society and they show that science was having an effect on all areas of the economy. Not only this, but it shows how Locke's idea of knowledge becoming part of the fabric of society, was also taking hold. This

[140] D. Brown, *Enclosure and Improvement: An Investigation into the Motives for Parliamentary Enclosure*, p. 9.

leads to the suggestion that science had an important influence on both agriculture and industry.

These changes meant that more resources could be dedicated to industrial exploits. As Figs. 5 and 6 show (see Appendix), between 1841 and 1861 the working population of Staffordshire grew by nearly 140,000 people. In 1841, 15% of the 187,605 workers were employed in agriculture with 10% employed in mining. By 1861, the working population had increased to 326,030 people with just 11% employed in agriculture and 13% employed in mining. This change becomes even more apparent if we consider the other industries that developed as subsidiaries to the mining industry; for example the 37, 577 people who were employed in metal manufacturing in 1861 compared to just 11, 543 in 1841. There is also a significant increase in employment in industries that were dependent on the growth of new knowledge from the knowledge economy, for example construction, chemicals and transport. This is where the Black Country began to burgeon, as much as mining presented a massive opportunity for growth; this expansion was matched by the subsidiary industries that flourished around it. This furthered the development of towns as we would recognise them as shops, houses and communities began to develop and in the decade up to 1840 "the trading status of a town was measured by the degree of specialisation of its shops"[141]. This shows that the Black Country economy had progressed over the course of a decade to the point where the influence of mining and industrialisation had lead to development of new communities and more sophisticated measures and models of economic success which focused on a more complex economic structure than simply mining and exporting minerals. In this, we can see a growth in Black Country society of an awareness of complicated economics and how best to use this to develop their own economy. Furthermore, we begin to see towns feature different professions, such as Doctors and Lawyers, educated men who had set up practice in these towns. Their presence meant that there were men able to pass their knowledge on to the local community – to teach and educate people in matters of the law or medicine and that these people were holding positions of increasing power and importance. To study the intricacies of the business history of the Black Country is a study that requires further work, but we can see that as blacksmiths, shopkeepers, publicans, leather workers and all manner of general amenities began to appear, the Black Country economy began to increase exponentially as it attempted to support the mining industry. Kelly's Trade Directory

[141] B. Trinder "Towns and Industries: The changing character of manufacturing towns" J. Stobart & N. Raven (eds.) *Towns, Regions and Industries: Urban and Industrial Change in The Midlands, c. 1740-1840* (Manchester University Press: Manchester, 2005), p. 105.

of 1829 details that "the agriculture and farming stock of this county have, within the last half century, undergone material improvement".[142] The directory also lists the trades in the area, which include "plumbers, painters and glazers, china, glass and earthenware dealers, confectioners, coopers, tailors, and hosiers."[143] This is a range of new professions which numbered a significant percentage of the population and almost all of which were unheard of a generation before. This is supported by evidence from Wolverhampton and Wednesbury, which arguably saw the most industrial development outside of the mining industry. The Staffordshire General and Commercial Directory of 1818, suggests that "Wednesbury is distinguished for its numerous and valuable manufactures.[144] Pitt says of Tipton that by 1817 it had developed a manufacturing trade which produced "shovels, tongs, augers, edge tools, wood screws, awls and fenders."[145] This is a fundamental insight on two levels; firstly, it shows the spread of new industries as a result of the expansion of mining in the area and evidences a spread of skills. The industrial nature of all of these trades shows the impact that mining was having on the region. We can see that the mining industry required significant support and each of these trades would have fed in to it by providing the necessary tools and equipment. At the same time, they created numerous new jobs around the mines that ultimately lead to the growth of towns, villages and new economies. These are evidence of the influence that mining had and the way that its influence was far reaching. On a second, less tangible level, this shows that there was a significant spread of knowledge and education. As these trades increased and "manufactures" became a significant part of the economy, we can see that a whole new skill set was developing and was adding to the economy of the local area. This shows how it is possible that the mining industry was aiding the growth of the British economy through subsidiary trades, the need for which was enhancing the spread of knowledge. This shows the expansion of the region and the fact that knowledge and new skills were constantly developing – simultaneously bringing the community closer together, which eased the transferral of knowledge whilst evidencing the idea that knowledge and developing skills were responsible for growing the economy on a number of different levels – not just through mining and primary industry alone. The Staffordshire General and Commercial Directory also provides evidence for this theory by suggesting that "few towns possess greater local advantage than Wolverhampton for carrying on an extensive trade and

[142] Pigot and Co's Directory of Staffordshire, Pigot and Co, London 1829, p. 701.
[143] Ibid.
[144] Staffordshire General and Commercial Directory, (South Staffordshire: 1818), p 192.
[145] W. Pitt, *Topographical History of Staffordshire,* p. 160

manufacture".[146] This idea is enhanced by the suggestion that "the skill and ingenuity of its mechanics, especially the locksmiths have been known and established".[147] This suggests that the development of the mining industry in Wolverhampton allowed for the development of "trade and manufacture" and lead to a growth of trades such as "heavy ironmongery…used by wheelwrights, cabinet makers, smiths etc…"[148] These were almost a direct consequence of the mineral industry and shows how the natural resources of the region were dictating the growth of the economy and ultimately urging new skills to develop. There is also evidence of a development of "skilled artizans" who began "to build elegant articles in steel, consisting of watch chains, buttons, buckles and sword hilts etc".[149] The directory also notes that "the brass foundry line which employs an almost innumerable number of workmen in [the production of] an almost innumerable variety of brass articles".[150] Thus showing how new skills were developing. Here we can see how the mining industry expanded a market for more consumer goods and desirables. This is key because it is an entirely new market with entirely new skills that was developed for people by the mineral resources industry. Similarly there is evidence that mills that had previously been used for pressing grain were now being used to spin woollen yarn for carpets and clothes,[151] showing a significant change in the economy, away from food production. Instead we can see how there was a developing economy that was catering for new towns that were appearing as a result of the plethora of new industries and new jobs, and a new urban lifestyle focused on the home and quality of life, rather than subsistence.

These ideas furthered by the growth of Mander & Co. a chemical laboratory manufacturing "oil, vitriol, aquafortis and every other chemical preparation connected with medicine, manufacturers and commerce".[152] This is supplemented by the work conducted by James Keir & Co. who began producing "alkali, soap, white lead and red lead"[153], showing that Keir was using his position and knowledge, discussed earlier, to great effect. This is evidence that people were developing their scientific knowledge and applying it to the growth of industry. The existence of both Mander & Co. and James Keir & Co. shows that people were aware that chemical exploitation was key to increased industrial productivity, hence the desire to

[146] Staffordshire General and Commercial Directory, (South Staffordshire: 1818), p. 193
[147] Ibid.
[148] Ibid.
[149] Ibid.
[150] Ibid. p.198
[151] Ibid. p. 200.
[152] Ibid.
[153] W. Pitt, *Topographical History of Staffordshire,* p. 160

apply it to as many areas as possible. This proves that people were taking on board the work of men such as Keir and is evidence that this was having an impact and was actively spreading knowledge throughout society. The very fact that such a company is listed in the General and Commercial directory of the region shows that it was becoming an important institution, one that people were encouraged to take advantage of.

As Raybould has stated, "Rostow's model suggests that one or more substantial sectors develop a high growth rate and the impulses to growth are exploited through the emergence of a political, social and institutional framework".[154] Rostow's "Take off Model" explains that economic growth occurs in five stages, as follows:

1. Traditional society
2. Preconditions for take-off
3. Take-off
4. Drive to maturity
5. Age of high mass consumption

Rostow believed that the social and political structure of society at the time was influential to the growth of new industries and economies and also that economic development followed a linear pattern, with each stage dependent on the completion of the stage before, requiring society to reach a certain point in development before it is ready for the next stage of growth. As Rostow[155] has shown, this was fundamental to the development of a new economy as it was these individuals who, through groups such as the Lunar Society, created a culture of innovation in the West Midlands. Their work was then carried on as Rostow's five stages of development began to progress and opened up new opportunities for expansion – such as more trades for people to learn and expand in to as well as closer communities and better communication which were designed around economic growth. Scientific knowledge was seen as providing the answers that facilitated this development both in agriculture and industry.

This culture of innovation was created by the actions and innovations of men like James Loch, who provide perhaps the greatest example of the development of industry in the Black

[154] T.J. Raybould, *The Economic Emergence of The Black Country,* p. 11.
[155] W.W. Rostow (ed.), *The economics of take-off into sustained growth: proceedings of a conference held by the International Economic Association* (Macmillan: London, 1963).

Country. Loch lived in a period where the dissenting churches were dominant and social change was something of a fashion. As a result, Loch was one of those social engineers who, so strong was his bond with this new developmental society and new knowledge, that he was inherently part of the influential group who were responsible for the developing of a new system of agricultural and industrial management, suggesting that the diffusion of knowledge was somewhat self-perpetuating, becoming part of people's lives. Correspondence from the estates shows that Loch was well versed in the processes by which mines were run and crops cultivated. In 1820, Loch published *An Account of the Improvements of the Estate of the Marquess of Stafford* which detailed the changes that he had made to the agricultural economy on the estate and is yet further evidence of the dissemination of knowledge throughout society. As Loch published his experiences and accounts of how best to improve an estate he instantly shared his skills with the rest of the population. Such was the high regard in which Loch was held among estate owners that his book would have become widely read and increasingly influential. This is another example of someone who has risen to a position of power thanks to their knowledge and skill set. The manner of Loch's ascendance to high society suggests that it was facilitated by his ability to capitalise on the knowledge economy. Loch was a law student, Member of Parliament and industrialist. His work reflects the idea that he recognised the direction in which the economy needed to move and can be used to show the status of learning in the Black Country. It also shows that Loch shared the thirst for knowledge that was common in the Lunar Society and was, according to Keir, spreading during the nineteenth century. His radical clearances on the Sutherland estates show that he was determined to force through change for the benefit of industry in the region. This shows a devotion to ensuring that the necessary growth was achieved in the desired manner. The catalogue to the James Loch records in the Sutherland collection at the Staffordshire Record Office states that "Loch's improvements of the estates were a revision of the estate management"[156] suggesting that for him, a revolution in organisational structure was paramount. The records show that from 1812 onwards there was a significant amount of business outsourced by the Sutherland estates and the recording of invoices and payments becomes much more regulated, including the management of the estate's mines – showing that Loch valued expertise and knowledge and was willing to hand power of them to those he recognised as being able.

[156] *James Loch: Managing the Sutherland Estates.* SRO: D593-K-3-1-1-1

There are negotiations regarding canal and railway acts that show the extent to which Loch was looking to ensure that the estate was able to remain at the forefront of industrial growth and to take the Black Country as a whole with it. A letter written by Loch to a Mr. Fenton in 1825 shows that he had "taken much pains to ascertain the power of the loco-motive engine & the facilities of Railways" and that he had discovered railways to be "a very superior mode of conveyance, if constructed on the proper principle".[157] This letter shows that by 1825 Loch was embracing advances in technology to such a level that he would become "undoubtedly the most important influence in the Stafford family".[158] This also shows the extent to which Loch had used science to reach a position of power and influence. That he saw the railways as being able to "encrease [sic] the wealth and commerce of the Country prodigiously",[159] which shows that he recognised the importance of these developments and was attempting to implement them as widely as possible.

A letter written to Mr. Fenton some ten years previously to the above, in 1815,[160] shows the extent to which Loch researched how best to develop the economy of the Sutherland estates. In investigating the plausibility of railways on the estate he visited different sites before establishing that "the carriage of the stone to London' was precarious using the Leek Canal which was 'often dry in summer and soon frozen in Winter".[161] This shows that Loch was actively seeking out new ways to develop industry on the estate, utilising the newest technologies. What is key is that he was seeking out the benefits over older methods, which shows an understanding of the latest technologies and an appreciation that science and development held the answers to key questions. What we can also see here is a desire to reach the maximum economic efficiency of the estate and the region as a whole by developing new techniques. A subsequent letter in the series from Loch is to a Mr. Burgess,[162] instructing him to build the railway across the Sutherland estate, showing that such important decisions were his to make, as it was he who was charged with researching the technology behind them.

[157] Staffordshire Record Collection D593-K-1-5-21 (84/1643)'

[158] Ibid.
[159] Ibid.
[160] Staffordshire Record Collection D593-K-1-5-4 (2/56)

[161] Ibid.
[162] Ibid.

As Graham Mee has pointed out in *Aristocratic Enterprise*, it could often be the case that the landowner had "limited interest and an early lack of competence in the technical aspects of the collieries management".[163] This suggests that colliery management was so delicate a business that it required significant technical expertise. There is evidence from the Sutherland estates that mine managers were approaching Loch and offering their services, as knowledge became a valuable and competitive commodity in the economy. Joseph Reynolds wrote to Loch in 1813 suggesting that one of the estate workers had told him that the Lord "does not understand the management of mines" and that Loch should consider Reynolds "for a lease on the mines".[164] This suggests that while the Lords owned the land the power lay with those men who understood how to manage it effectively. There is evidence to suggest that it was Loch who took charge of the enclosure acts taking place on the estate and made enquiries about the acquisition of land[165] and was able to negotiate its sale and exchange. There is also evidence that Loch dealt with house building and brick making,[166] important to the growth of industry on the estate. Loch also took charge of improvements on the agricultural side of the estate as his private correspondence suggests that he was responsible for the implementation of drainage[167] and ploughing systems central to the concept of high farming. Aside from the Sutherland estate there is evidence to show that other land agents were given a similar level of power over estates; a letter from Peter Potter to the Earl of Bradford written in 1830[168] gives us details of the duties with which he was entrusted. Potter advises the Earl on the acquisition of land, including costs and the rental structure which should be applied to certain areas of land. In the same letter he tells the Earl of the application of "dung" and "manure" to the fields before "seeding them down with clover and hay seeds",[169] presumably to act as fertilisers and displaying knowledge of botany and science. This letter shows that the level of control that Potter was given was comparable with Loch. Frederick Thynne displayed a similar level of control over the Dartmouth estate with his records suggesting that he controlled the accounts and became "the fulcrum of estate management".[170] Before this the Lord Bradford paid for advice on mining from another agent, Henry Bowman, from whom he

[163] G. Mee, *Aristocratic Enterprise: The Fitzwilliam Undertakings 1795-1857* (Blackie: Glasgow & London, 1975), p. 81
[164] Letter from Joseph Reynolds to James Loch dated 21/Jan/1813: SRO D593 K/1/3/1.
[165] Ibid: Letter from a Mr. Fenton to James Loch dated 18/Jan/1813.
[166] Ibid: Letter from George Bishton to James Loch dated 23/Jan/1813.
[167] Letter from Richard Ford to James Loch dated 19/May/1813. SRO D593 K/1/3/9
[168] Staffordshire Record Office: Letter from Peter Potter to the Earl of Bradford (D1287/18/21), dated 6th December 1830.
[169] Ibid.
[170] M. Wood, *The Economic Development of the Dartmouth Estate, Sandwell: 1801-1912,* MA Thesis, University of Birmingham, 2009. P. 27

sought technical advice on the mineral make up of his estate.[171] The Thynnes became central to the management of mining on the estate as well as several other affairs, showing that across the Black Country, land agents had a massive influence.[172] This shows that certain people, responsible for the management of much of the local economy, were simultaneously embracing the importance of knowledge for the improvement of agriculture and industry and suggests that there is a link in their development. Thus we have a picture where, on one of Britain's biggest estates, the Lord accepted his inability to run the economics effectively and passed control to a man of greater knowledge and skill, furthering the development of the knowledge economy and showing that both agriculture and industry could develop in the same manner.

The same is true of many other land agents, Raybould suggests that during the trust era on the Dudley estates agents such as Richard Mee were given charge of the supervision of all areas of the manorial courts as well as the management of agricultural and mineral exploits.[173] At the same time the 4th Earl Fitzwilliam is quoted as having said on the subject of mines drainage to his chief agent Joshua Biram that "your opinion is better than mine".[174] This suggests that landowners recognised that a knowledge economy was developing and that if their industrial and agricultural exploits were to develop they needed to embrace this. This is furthered by Mee's account of the 5th Earl's thirst for knowledge[175], which resulted in a compulsive desire to read and to study in the hope that this would empower him. There is an overriding sense that knowledge was becoming fundamental to both the growth of agriculture and industry during this period and while that may not show a causal relationship, it displays a link. Both agriculture and industry were being managed by, if not the same people, then people demonstrating understanding and an aptitude for knowledge that suggests that these attributes were fundamental in the dawning of the new society which Keir speaks about.

[171] Staffordshire Record Office: D1287, The Account of Henry Bowman with the Earl of Bradford for the Expenses and Profits of the Mineral and Limestone works at Walsall.

[173] T.J. Raybould, *The Economic Emergence of The Black Country,* p. 225
[174] The Earl is quoted in G. Mee, *Aristocratic Enterprise: The Fitzwilliam Undertakings 1795-1857,* p. 82.
[175] Ibid. p. 83

Conclusion

This thesis has taken its roots in the ideas of historians such as Eric Hopkins who suggested that industrial revolution in the West Midlands was "not based on a massive technological breakthrough, as in the cotton industry but on existing modes of production. [it was] Thus a gradual and undramatic progression".[176] His view is supported by the likes of Gregory Clark who has suggested that there was a potential link between industrial and agricultural development in the period 1700-1850. Clark argues that the "performance of agriculture in Britain has become central to most of the key debates on the Industrial Revolution".[177] Clark's exploration of the economic impact of the agricultural revolution shows that it had a strong impact on the industrial economy because "the population fed by the agricultural sector nearly doubled in the Industrial Revolution".[178] What is clear from Clark's work however is that he is confident that there were two very separate revolutions between 1700 and 1850 rather than a seamless transition from one to the other. This is an idea that has been explored across this piece. Inkster and Morell's *Metropolis and Province* suggests that although they are "many in number and large in volume, the attempts to forge a direct causal link between science and economy…have failed to satisfy economic historians and have neglected a range of data".[179] This is a view typical of modern historians and is one which this dissertation has attempted to explore by looking at certain factors and assessing the strength of their relationship to industrial and agricultural development.

The foundation of this has been the formation of industry in the Black Country with the intention of testing this contrasting hypothesis by looking at certain common themes – notably the importance of the growth knowledge, and the idea that this played a part in both revolutions. W.W. Rostow's "Economic Take Off" model suggests that economies develop in a gradual, linear manner, using five progressive steps. Rostow has called these "Traditional Society" and "Preconditions for Take Off". They suggest that any new economy develops when an existing society encounters a change that sets the foundation for a new economy, making its development both necessary and possible. In the case of the Black Country, we have a situation where the traditional society outlined by Plot as being home to a series of small nail-makers and subsistence farmers was home to the mineral potential of the coal

[176] E. Hopkins, *The Rise of The Manufacturing Town: Birmingham and the Industrial Revolution,* (Sutton Publishing: Stroud, 1998) p. xv
[177] G.Clark, "Agriculture and the Industrial Revolution: 1700-1850" in J.Mokyr (ed.), *The British Industrial Revolution: An Economic Perspective*, (Westview Press: Oxford, 1993) p. 266
[178] Ibid. p 230.
[179] I.Inkster and J. Morrell, *Metropolis and Province: Science in British Culture, 1780-1850.* (Hutchinson: London, 1983) p. 11

deposits. What is being discussed here is what the "Preconditions for Take Off" were and whether or not the agricultural economy and the spread of knowledge were part of it.

This thesis has explored the idea that the spread of a knowledge economy was influential in the development of industry and aimed to uncover any potential link with agriculture. There are examples of a link between the growth of both the agricultural and industrial economies and science; there is also evidence to suggest that the knowledge economy was beginning to develop in the seventeenth century. Knowledge grew out of the traditional society of the time, dominated by agriculture, and thus the knowledge was focused on farming before industry developed and science and knowledge were applied here. This can be seen in Plot's recognition of the importance of a "land doctor"[180] being consulted on matters of botany, showing that he recognises the importance of expertise. One hundred years later, Marshall writes about the educating of apprentice farmers to make the best out of the agricultural conditions[181] and by the nineteenth century, in the industrial sector, men such as James Loch or Peter Potter were at the top of their field because of their skills and expertise. This followed on directly from a period of development during which Robert Plot published his key texts. These were followed in a distinct linear progression which included Pitt and then Garner as each built on his predecessors ideas. These books and the creation of agricultural colleges had the sole intention of allowing knowledge to percolate throughout society. In this way we can see how the transmission of knowledge became part of the fabric of society and was having a direct effect on all areas.

As James Keir suggested, knowledge and science were creating an economy where both agriculture and industry would benefit. This could lead to suggestions that because classic agricultural historians such as Chambers and Mingay and Lord Ernle date the agricultural revolution just before its industrial cousin, that there is evidence of a progression. This is true, however I would agree with Joel Mokyr's idea that this is too simplistic an argument and could be put down to a case of "post hoc, ergo propter hoc".[182] It was the mines managed by the like of James Loch that typified industrial growth in the Black Country. It was these that transformed the South Staffordshire landscape from the tiny villages of metal working families into the Black Country that Elihu Burrit[183] recognised where factories and their smog

[180] R. Plot, *The Natural History of Staffordshire*, p. 340
[181] W. Marshall, *The Rural Economy of The Midland Counties,* p. 118
[182] J. Mokyr. (ed.), *The Economics of the Industrial Revolution*, p.19
[183] E. Burritt, *Walks in The Black Country and its Green Boarder-Land,* p. 3

dominated the skyline. If the Black Country itself was created by these mines and foundries and the towns and villages built up for those who worked in them, then it is the men who developed and applied the knowledge which made these possible who are responsible for the industrial development in the Black Country. I would question whether this is substantial enough to be considered causal.

As David Brown has suggested, industrialists were not aiming for any kind of social or political change, his motivations were exclusively "selfish and commercial".[184] Loch did not have any grandiose ideas of economic development when he took over the role as land agent of the Sutherland estate. He was ultimately motivated by money and power. Keir was motivated in the same way, to utilise his educated and scientifically conscious position to gain power, however in order to do this, he first needed to educate society on the benefits of his skill. These men were at the heart of a social change which had two fundamental layers. The first is recognition of the importance of knowledge, the foundations of which were laid by Locke, Robert Plot and then James Keir, among others. The second is the fact that society evolved to the point where the transferral of knowledge between people were at its centre. As such towns developed to the point where communication was easier and the structure was more amenable to transferral of knowledge and ideas. This modern conception of the town included a much greater focus on education and exploration. At the same time there was the growth of Lit.-Phil. societies and education became a fundamental part of governmental reforms. Literary and Philosophical Societies were central to the spread of knowledge throughout the community because they inspired discussion, education and experimentation. They meant that ideas were filtered through social classes much more easily and people were made much more aware of the work of others and how they could build on it. This is coupled with a dramatic increase in the availability of printed media and a change in the culture and structure of towns that made the transmission of knowledge much easier and made people recognise its importance and also made it easier for people, like Loch, to take advantage of it.

Growth in the agricultural system was merely something that these men made use of, rather than developing. While agricultural change was useful to them, in that enclosure gave greater control, and a market economy developed, it is too insignificant a link to say that it allowed them to achieve their goals of industrialisation for personal gain. That many nineteenth century industrialists were desperate to gain membership to a higher class has been considered by Wiener to be one reason why Britain never underwent a significant social

[184] D. Brown "Matthew Boulton, Enclosure and Landed Society" in *Matthew Boulton: A Revolutionary Player,* p. 61

revolution.[185] They were so keen to achieve this goal that even though they were in a position to make significant changes to society, they didn't because as it was, they knew what they had to achieve to reach this higher class, they capitalised on the knowledge economy and the transmission of knowledge through society and used it for personal gain. Their goals were achieved without a break with traditional society and corresponded to Rostow's model of gradual growth. Therefore the people who were responsible for the British process of industrialisation were far removed from the Marxist notion of change by revolution. Development was achieved "gradually and peacefully"[186] as industrialists recognised that in order to achieve their goals, all they needed was the knowledge to understand the current state of the world, a movement which as Keir wrote, was taking place in the eighteenth century.

This fits with Perkin's description of the industrial revolution which he defines as "a revolution in men's access to the means of life…it opened the road for men to complete mastery of their physical environment".[187] He suggests that the industrial revolution was the point at which man was finally able to fully understand his surroundings as they were at that particular point in time. This came from the growth of a knowledge economy that aided development in both agriculture and industry, as skills and expertise became more important. The knowledge economy was formed as each generation built on the knowledge that went before it, just as Marshall's apprentice farmers built on Plot's land doctors, until finally the understanding was such that land and minerals could be exploited and industry could take off and society changed to reflect this. In essence, it can be said that the preconditions for industrial take-off took place over generations as ideas built on ideas, and science built on existing knowledge. It was this which facilitated the industrial revolution so that come the nineteenth century, all that was needed was for a class of people to have the drive and motivation to apply it. This was the tip of the iceberg of industrial growth and if we consider the whole process by which industrialisation became possible, then Hopkins's idea that a significant breakthrough was not the precursor to revolution, becomes the more prevalent argument.

[185] M. Wiener, *English Culture and the Decline of the Industrial Spirit* (Cambridge University Press, Cambridge, 1981)
[186] D. Brown "Matthew Boulton, Enclosure and Landed Society" in M. Dick (ed.), *Matthew Boulton: A Revolutionary Player,* p. 62

[187] H. J. Perkin, *The Origins of Modern English Society, 1780-1880* (Routledge & Kegan Paul, London), pp3-5.

Appendices:

Fig.1:

Sizes of Notable British Coal-fields

Coal-field	Km sq.
Flintshire (North Wales)	90,650
Denbigshire (North Wales)	121,730
Bristol and Somerset	166,550
North Staffordshire	194,250
Shropshire	240,870
South Staffordshire	240,870
Lancashire	562,030
Durham and Northumberland	1191,390
West Riding	1968,390
South Wales	2345,530

Fig. 2:

The Percentage Growth of Pig Iron Output in the Black Country relative to Overall Output in Great Britain

Year	Black Country	Great Britain
1750-1760	228%	67%
1760-1770	0%	23%
1770-1780	13%	32%
1780-1790	291%	29%
1790-1800	225%	107%
1800-1810	89%	54%
1810-1823	77%	70%
1823-1830	58%	53%
1830-1840	64%	84%
1840-1850	73%	100%
1851-1855	26%	29%
1855-1860	-38%	19%
1860-1866	13%	18%
1866-1870	10%	32%
1870-1871	23%	11%

Fig. 3:

Growth of Coal Output in The Black Country

Year	Output (tons)	Growth (%)
1681-1690	45,000	-
1781-1790	800,000	1677
1816-1817	2,300,000	187.5
1854-1855	5,000,000	117

Fig. 4:

Average output of Iron per blast furnace in the Black Country: 1740-1880.

Year	Number of Furnaces in Blast	Average Output per Furnace (tons)
1740	2	525
1750	2	425
1760	4	697
1770	4	697
1780	4	784
1790	14	875
1800	28	1,178
1810	45	1,676
1823	66	2,024
1830	98	2,169
1839	106	3,266
1840	116	3,509
1851	105	5,714
1860	108	4,327
1866	112	4,755
1870	114	5,162

Data taken from

P. King, *The History of The Iron Trade,* Unpublished PhD Thesis, University of Wolverhampton, 2003.(Workbook Furnace_5A as included in the Section Forge XL of Appendix).

Fig 5:

Population and Employment Data: Staffordshire 1841

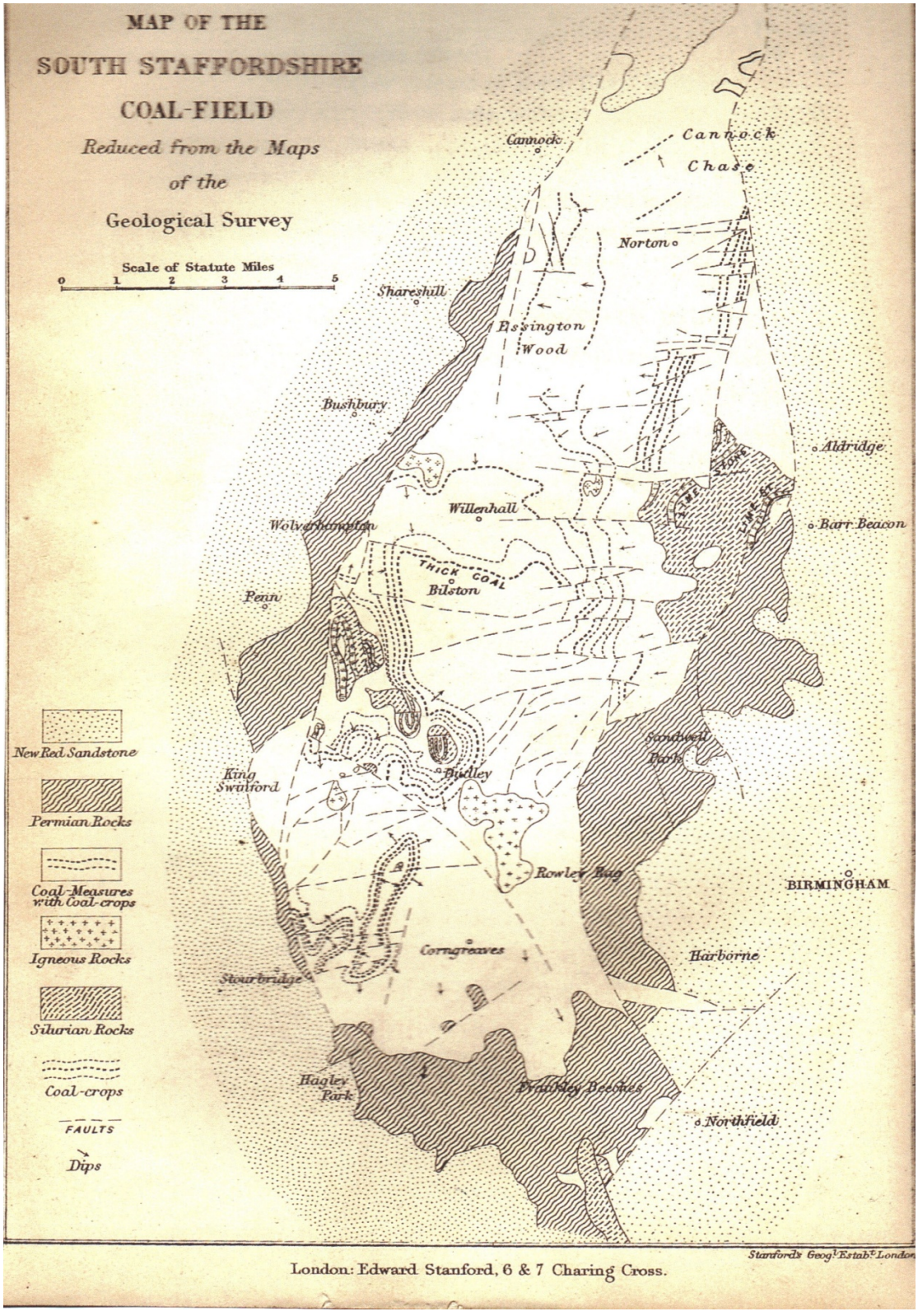
Industry	Number Employed: Males	Number Employed: Females
Agriculture	28,425	933
Mining	19,410	262
Food	4,722	441
Chemicals	557	33
Metal Manufacture	11,543	162
Mechanical Engineering	1,695	11
Instrument Engineering	369	5
Vehicles	1,601	10
Other Metals	6,044	1,594
Textiles	3,193	2,530
Leather	1,917	77
Clothing and Footwear	9,642	2,965
Bricks etc	14,443	6,651
Timber, Furniture	2,609	68
Paper, Printing	407	134
Other Manufacturing	292	96
Construction	11,162	80
Gas, Electricity, Water	53	0
Transport	2,398	84
Distributive Trades	639	319
Professionals	1,977	874
Miscellaneous Services	6,305	20,442
Not Classified	20,389	632

Fig. 6:

Population and Employment Data: Staffordshire 1861

Industry	Male	Female
Agriculture	34,109	2,503
Bricks etc	21,882	11,055
Chemicals	1,458	59
Clothing and Footwear	12,529	12,544
Construction	17,569	18
Distributive Trades	925	724
Food	11,500	1,617
Gas, Electricity, Water	363	1
Instrument Engineering	534	22
Leather	2,192	647
Mechanical Engineering	5,674	27
Metal Manufacture	37,577	786
Mining	42,319	917
Miscellaneous Services	7,003	33,308
Not Classified	22,069	325
Other Manufacturing	254	256
Other Metals	8,705	7,420
Paper, Printing	901	170
Professionals	3,671	2,765
Textiles	4,345	4,415
Timber, Furniture	4,570	239
Transport	10,946	686
Vehicles	2,194	1

Source for fig. 5 and 6: http://www.visionofbritain.org.uk/data_cube_page. Accessed 17/08/2010.

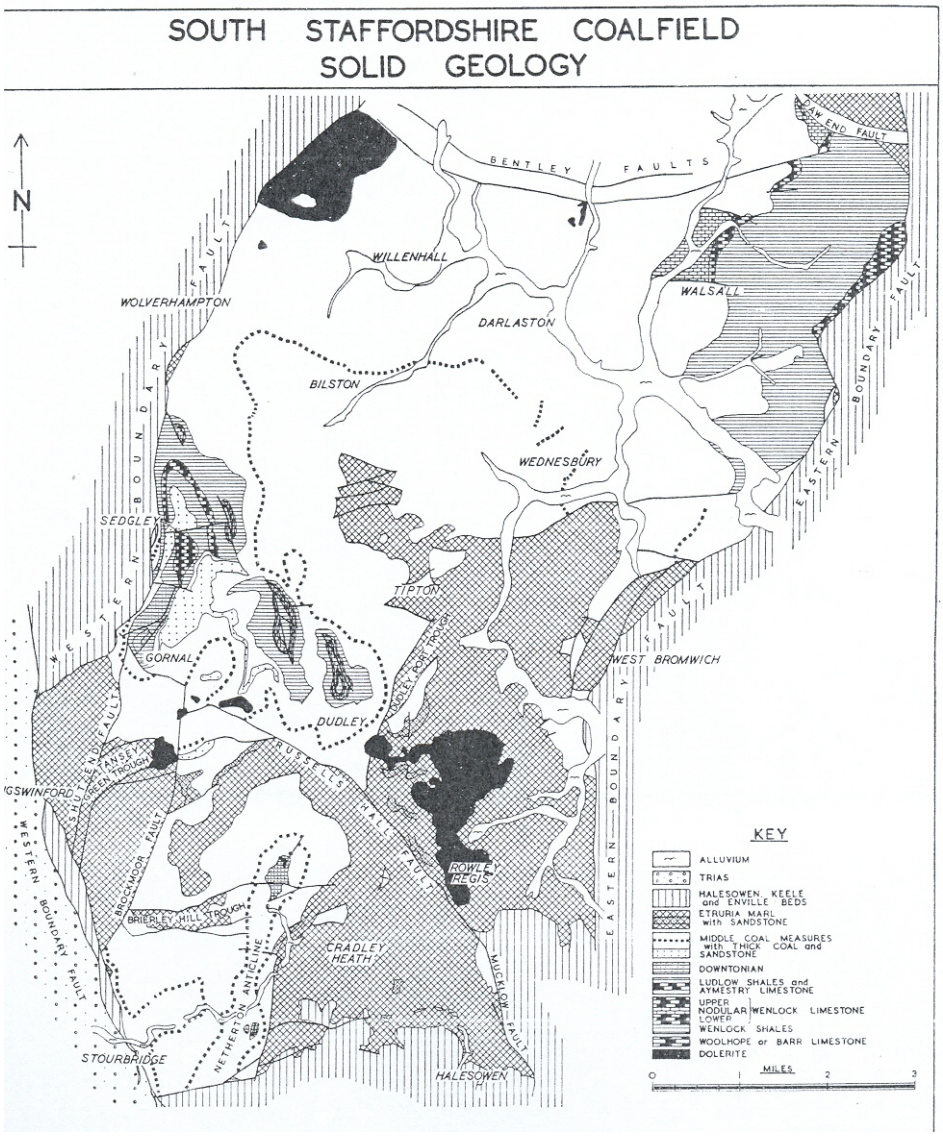


Map 1:

E. Hull, *Coal Fields of Great Britain: Their History, Structure and Resources* (London: Edward Stanford. 1873), p 154

Map 2:

Geology of the South Staffordshire coal-field.



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