

**Railroads, Factor Channelling and Increasing Returns:  
Cleveland and the Emergence of the American Manufacturing Belt**

‘Explanations of the urban-industrial growth process need to focus on the early stages of the process’  
(Meyer, 1990, 731)

## 1. Introduction

Since De Geer’s classic paper in the 1920s (De Geer, 1927), the emergence and persistence of the American Manufacturing Belt (AMB) have attracted the attention of several generations of economists and economic geographers (Harris, 1954). Early work on developing regions (Perloff et al., 1960) was followed by that of Pred and others (e.g. Muller, 1977; Pred, 1965, 1966, 1973) whose interests lay primarily in the development of systems of cities. Building on these studies, Meyer (1983; 1989; 1990; see also 2003, chapter 9) wrestled with different hypotheses about the emergence of the Belt and his earlier ideas (though not his later findings) became one of the empirical foundations for Krugman’s seminal work on the New Economic Geography (NEG) (Krugman 1991a, 1991b, 1991c, 1998). Most recently, in an impressive econometric study, Klein and Crafts (2011) examined alternative factors contributing to the *persistence* of the Belt into the 20<sup>th</sup> century. However, they clearly state that their study does not address the processes involved in the *emergence* of the Belt, owing to lack of data prior to 1880. Since Meyer has argued that the main structure of the Belt was already in place before this date (Meyer 1989, 936; 1990, 733), the factors important for AMB emergence may therefore differ from those that enabled it to persist.

For Krugman, the key mechanism responsible for AMB emergence was economies of scale or increasing returns at the level of the manufacturing plant, aided by falling transportation costs over an extended period of time (Krugman, 1991c). His main concern is to provide a simple over-arching model and for empirical support, he relies on the authorities indicated above. However, to anticipate the later, more detailed discussion, other studies indicate that scale economies did not become pervasive in manufacturing until well after the emergence of the AMB, high transport costs may have protected nascent Midwestern industry from eastern competition, and the benefits of falling freight rates may have been offset by lack of integration of the railroad network prior to 1880. Also a recent assessment of data quality in the published US Manufacturing Censuses prior to 1890 suggests they

may not be the reliable sources of evidence that earlier studies of the AMB have taken them to be (Healey, 2014).

Both theoretical postulates and previous empirical findings are therefore more contentious than might at first appear. This study analyzes the timing of industrial development, transport network expansion and the introduction of technological innovations, in order to discriminate between alternative and incompatible explanations of AMB emergence and test the assumptions of the NEG model. It uses a wide variety of new data sources, including manuscript manufacturing and population census schedules, city directories, railroad annual reports, 19<sup>th</sup> century newspaper articles, and data on company incorporations. Such sources provide a much finer spatio-temporal and indeed firm-level ‘granularity’ than has been the case in previous work. This level of detail is fundamental to a deeper understanding of the economic-geographical processes in question.

## **2. Critique of Past Hypotheses of Belt Emergence**

Prior to Meyer’s investigations in the 1980s, the traditional explanations of AMB emergence revolved around the westward spread of industrialization from the Eastern Seaboard, which initially brought agricultural processing, followed by market-oriented industries. Iron and steel developed later to utilize newly found coal and iron ore deposits (McCarty, 1940; Meyer, 1983). Meyer’s papers progressively refine hypotheses about Belt formation, utilizing census evidence to track industrial concentration. He begins with regional industrial systems, which successively emerged in each newly settled region. Broadly based regional manufacturing sectors arose prior to 1860 to serve regional markets and ‘simultaneously’ producer durables sectors developed in support of these activities (Meyer, 1983, 145-6). Producer durables include iron foundries and machine shops, as well as railroad repair shops, though little evidence pertaining to the latter is presented (Meyer, 1983, 154-5). Bespoke production methods in this sector precluded significant scale economies, necessitating a regional market orientation. Subsequently, national market industries emerged. Though the precise mechanisms are unclear, progressive penetration of national markets by regionally oriented industries, enabled successful firms to exploit scale economies and convert themselves into national market industries,

leading to progressive specialization of urban-industrial complexes. This ‘well-articulated’ specialization was in place by 1880, i.e. the AMB had emerged fully-fledged before this time.

Subsequent work (Meyer, 1989), using the published manufacturing census tabulations, indicated that the Mid-West region substantially increased its share of employment in the AMB 1860-1880, especially during the 1860s. Railroad expansion in the 1850s had made markets more accessible to firms, especially those located in rail hub cities. However, prior to 1880 the lack of an integrated rail network impeded access to inter-regional markets. In both cases his evidence is limited, covering only 1855-1860 (Meyer, 1989, 928, footnote 26), or absent. He attributed the 1860s growth surge to several factors. Firstly, eastern firms were unable to reduce costs low enough through scale economies, to offset transportation costs and dominate national markets before 1870, except in a few sectors, such as textiles. Secondly, as a result, Midwestern industrialists had a window of opportunity to develop their own factories, often using eastern-built machinery, as long as high transportation costs protected them from eastern competition. Thirdly, by 1870 the Midwestern iron and machinery sectors had reached a ‘scale and efficiency comparable to eastern factories’ and so could compete directly with them thereafter (Meyer, 1989, 934). The relative importance of regional and sub-regional metropolises as a group did not change 1860-1880, because railroad network expansion reduced their early advantages as rail hubs, in terms of market accessibility. Yet he still took the view that many of the reasons for industrial change in the Midwest during the period remained unclear and more investigation of the relative impact of scale economies in Midwestern and eastern industrial sectors was needed.

Finally, Meyer grappled with the defining characteristics of the industrial metropolis, which he contrasted with the specialized industrial city. He examined major Belt metropolises and concluded that they had a key role as ‘controllers and co-coordinators of exchange’, with a focus on finance, wholesaling and transportation (Meyer, 1990, 732). Both exchange related and local/regional consumer manufactures in these cities generated a demand for intermediate goods firms, especially those in the producer durables sector (primary and fabricated metals and machinery). This latter sector was pivotal to the ‘industrial niche’ of the Midwestern industrial metropolis, but not to eastern cities.

Midwestern metropolises concentrated on this niche as industry expanded from regional to inter-regional markets. However, they had no peculiar economic advantages in the manufacture of national market goods, so their later growth merely kept pace with other specialized industrial centers, rather than outperforming them (Meyer, 1990, 737, 744-745). Finally, following Atack (Atack, 1985a; 1985b; 1987), he noted that scale economies spread from a few firms in the ante-bellum period to encompass most industries 1870-1890, but manufacturing did not concentrate further in metropolises during that time. This contradicts the NEG model where increasing returns is the mechanism that enables concentration to take place. Meyer concluded that 'metropolises were at or near their peak of relative importance as industrial centers in the nation' by about 1870, not during the later period of 'large-scale urban industrial growth' (Meyer, 1990, 734,743).

Much of this argument centres around the relative concentration of manufacturing employment in specific industries, rather than on the relative or absolute magnitudes of change in manufacturing employment overall. It also implicitly relies on consistent inter-censal data reporting. However, it does not adequately explain some important differences in the development paths of major cities. For example, there is a major contrast between the relative ascent of Cleveland up the urban hierarchy 1850-1900 in both manufacturing and population terms, and the relative decline of Cincinnati, which ranked third nationally as a manufacturing centre in 1860. This decline does not fit Meyer's thesis, because Cincinnati had an important concentration of exchange supporting industries (defined as printing/publishing and transportation) as late as 1880, that should have stimulated producer durables manufacturing (Meyer, 1990, 741, 743).

In relation to the role of transportation, both Meyer, in his earlier papers, and Krugman and his co-authors (Fujita, Krugman and Venables, 1999) start from the premise of pre-existent towns, providing services to their agricultural hinterlands. Transportation improvements are secondary and more an outcome of the development process than a causal factor in it. In his later work, not referenced by Fujita et al., Meyer (1990) recognizes the transportation sector as a contributor to the 'support of exchange', but transport costs *per se* are not a key part of the argument. This difference in the significance of transportation to the overall explanatory framework has major theoretical and

practical implications. Unlike Meyer, NEG approaches downplay the importance of the *sector*, and relegate its effects to the role of transport *costs*. These in turn are handled using Samuelson's 'iceberg' modeling approach (Samuelson, 1954; McCann, 2005), where 'a fraction of a good shipped simply melts away or evaporates in transit' (Fujita, Krugman and Venables, 1999, 7). This deliberately obviates the need for explicit modeling of the transportation sector, but it is more than a convenient simplification. Use of the 'iceberg' approach with the Dixit-Stiglitz model of monopolistic competition crucially makes the whole NEG approach mathematically tractable, as Krugman repeatedly emphasizes. A good deal of both the theoretical and empirical validity of the NEG approach as an explanatory model of AMB emergence therefore hangs on whether or not the transportation sector itself makes an important contribution to AMB development.

Both Meyer and Krugman depart from traditional explanations of AMB emergence by ignoring or minimizing the significance of access to factor endowments, such as coal and oil, whereas others such as Kim include them at a very coarse geographical scale (Kim 1995), though the latter's findings have been criticized by Klein and Crafts (2011, 3). However, if transport networks are required to access to factor endowments, it is hard to justify ignoring the latter. Natural resource cargoes may be shipped long distances from the mine or well, before being unloaded at a port or rail hub for local processing, or traded and re-shipped by land or navigable water for processing elsewhere. Transportation possibilities may themselves be constrained or controlled by the specific geography of transportation networks or business/financial linkages governing ownership of mineral deposits, processing works and indeed railroad companies. Especially in earlier years when transportation networks were not well developed, these constraints could be very significant, to the point where the term 'factor endowment' seems inappropriate, since, in geological terms, endowment without exploitation is merely lithology. The term 'factor channelling' is introduced here to describe these processes. It implies flows of raw materials were directed to chosen locations in a planned and managed fashion, sometimes contrary to the economic logic of transport cost minimization. As transportation infrastructure became more ubiquitous over time, such processes would be harder to sustain, without collaboration or collusion between transportation and processing firms. While they are

scarcely fundamental new insights, these points still serve to problematize the processes of securing and assembling natural-resource-based raw materials for manufacturing purposes in specific locations, which have been largely ignored in the existing quantitative literature on the AMB.

Furthermore, during this early period, the mere existence of coal and iron ore deposits, or indeed oilfields, did not imply active exploitation, since the respective extraction industries were still in their infancy (Crowell, 1995; Eavenson, 1942). Likewise, in the absence of active exploitation, no assumptions can be made about the accessibility of such deposits to the transportation network. In some cases, pre-existing canals or railroad lines might fortuitously traverse locations later found to be resource-rich, or be deliberately routed across known but undeveloped deposits. An example would be the construction of the Cleveland and Pittsburgh Railroad, which reached the coal deposits around Salineville, Columbiana County, Ohio in 1852 and led directly to mines being opened in that district (Coal Trade Journal (CTJ), 1880a). In other cases, new railroad construction might be called for specifically to reach new mining regions and gain a share of an expanding traffic, e.g. the building of the Columbus and Sunday Creek Valley Railway to tap the coal trade of the Hocking Valley region in Ohio (CTJ, 1879b; Mould, 1994).

A counter-argument from theory would be that higher availability of raw materials and lower cost should go hand in hand, mediated by the price mechanism, as assumed by Klein and Crafts (2011) in their post 1880 analysis. However, during the earlier period, published price circulars and quotations frequently failed to reflect a complex reality of irregular supply, short-term price hikes and even wholesale unavailability of factors of production, regardless of price. In the case of coal, miners' strikes, flood damage to railroads, or shortages of rolling stock could all induce coal 'famines'. In an era when average coal prices were not necessarily declining in real terms (e.g. in Cincinnati 1863-83), such adverse circumstances could wipe out manufacturers' profit margins. The only real protection against such business risks was to locate in a city served by several coal carrying railroads, as one Columbus booster argued (CTJ, 1879c; AGWRR, 1865b, 14). The case of Cincinnati was particularly complex, since until the 1890s the city remained partially dependent on irregular river transport of coal, as the expanding railroad network alone still could not keep the city supplied during protracted

periods of low water (Report of Committee of Investigation 1889, 82). Thus accessible, reliable and low cost supplies of bulk fuel and other raw materials, constituted a key aspect of locational decision-making by prospective primary manufacturing concerns and their financial backers during the period of interest.

### 3. A New Explanatory Framework

The major contradictions between the explanatory claims of Meyer and Krugman identified above for the first time, and their omission of potentially important processes involved in AMB emergence, will now be addressed by the development of a new explanatory framework. This has three main strands. The first examines the interrelationships between natural resource exploitation and the transportation sector, including factor channelling processes, as driving forces of economic expansion. The second explores the key role of the transportation sector in stimulating urban industrial employment. This stimulus involved both direct and indirect effects. *Direct* effects included employment in railroad construction, traffic operations and repair shops. These shops, in turn, fostered wider manufacturing employment *indirectly*, in foundries and parts supply companies, while the railroads themselves required rails. The third major strand of the analysis evaluates the evidence both for the existence and timing of increasing returns in different industrial sectors, including transportation, although the latter was not considered by Krugman. Scale economies are only found in the iron and steel sector and only from the 1880s onwards, too late to contribute to AMB emergence. In oil refining, *economies of size*<sup>1</sup> rather than scale predominated, while on the railroads, transportation specific *economies of traffic density* prevailed. The last of these were large enough to initiate an era of progressive real terms freight rate reductions, commencing with sharp declines during the Civil War itself. Such reductions were eventually sufficient to widen markets for manufactured goods, but the time lags identified here indicate that the effect also came too late to foster AMB emergence.

This framework challenges the NEG model on two counts. Firstly, it argues that the transportation sector and access to natural resources, often *via* factor channelling, were the key drivers of AMB emergence, not increasing returns. Secondly, this implies that use of the iceberg model is not

---

<sup>1</sup> Economies of size exist where larger firms can negotiate bulk purchases of inputs for lower unit cost whereas economies of scale are defined 'strictly in terms of the homogeneity of the production function' (Atack, 1987, 185, note 28)

a modelling convenience, but an incorrect specification of the problem, as it ignores the key transportation sector. Unfortunately, if this model is inapplicable, much of the analytical basis of NEG collapses or becomes intractable. In a broader contemporary theoretical context, a recent critique of NEG models has also highlighted the need to look more closely at transportation, among other factors, and specifically at the limitations of the iceberg model, if NEG research is to move forward (Behrens and Robert-Nicoud 2011). However, these points are not stressed in trenchant earlier critiques of NEG (Martin and Sunley, 1996; Martin 1999). This suggests the present study may have implications beyond the specific problem of AMB emergence.

The new framework is developed mainly in the context of a case study of the rise of industrial Cleveland before 1880. There are several reasons for this. Firstly, Cleveland was one of the fastest growing cities in the AMB in terms of population and manufacturing employment (Table 1), both within the period of interest and beyond, rising from a population of 17,034 in 1850 to 381,768 by 1900 (Robison, 1887; Kennedy, 1896; Rose, 1950; Meyer, 1990). Key growth processes would presumably find full expression in such a case study, although doubtless all major cities also had individual historical or geographical factors that influenced their expansion (or contraction) in a ‘path-dependent’ manner (Guinnane, Sundstrom and Whatley, 2004; Martin and Sunley, 2006). Secondly, Cleveland had significant employment in the transportation and iron and steel industries as a proportion of overall male employment (Table 1), yet manufacturing did not dwarf all other types of economic activity as in the specialized manufacturing cities of Newark, NJ and Worcester, MA. Thirdly, although the 1860 manuscript manufacturing census schedules have not survived for the city, it has a wealth of accessible newspaper-derived sources of information, and a number of industrial and city directories covering the period of interest. These allow a much more detailed (and accurate) picture of its industrial development to be reconstructed than would have been possible using published census sources alone.

**Table 1.** Manufacturing Employment Growth in Major US Cities 1870-1880

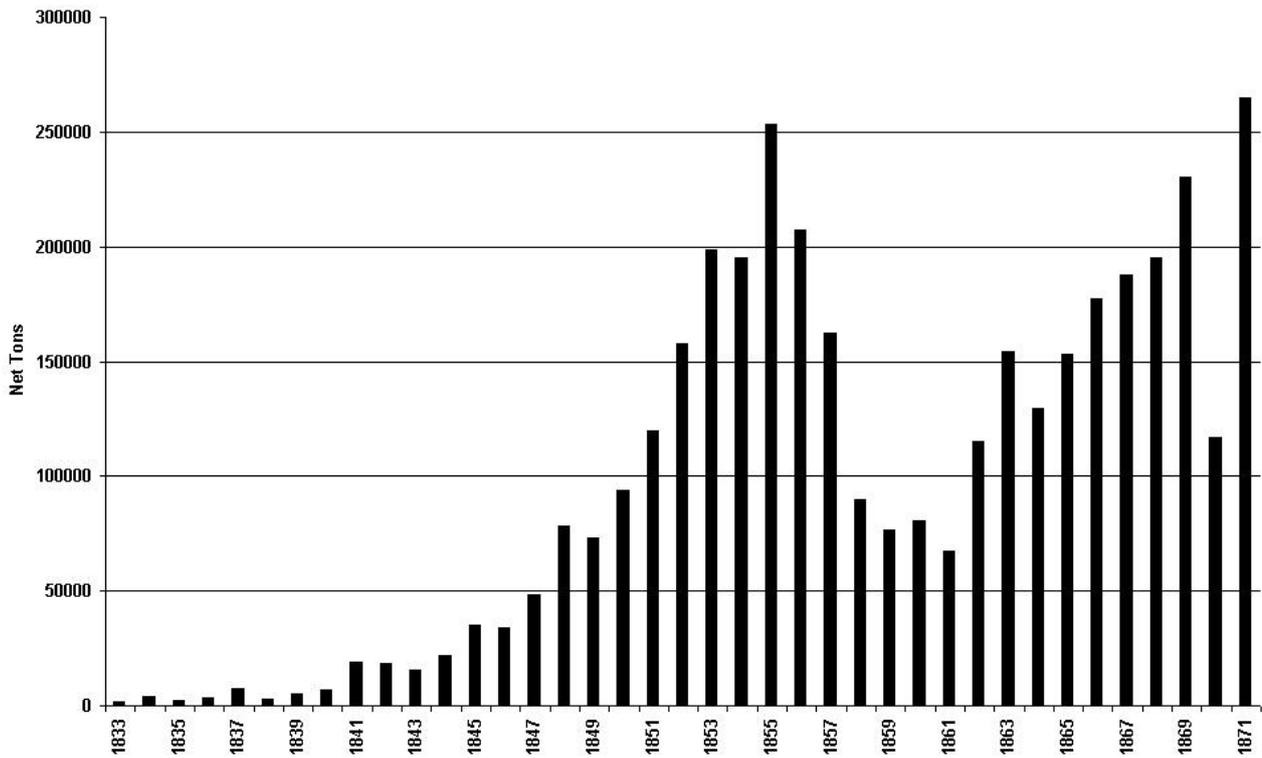
	1870	1870	1880	1880	1870	1880	1870-1880
	Total		Total		RR and Iron/Steel Male	RR and Iron/Steel Male	Growth Rate of
	Manufacturing		Manufacturing		Employees as % of Total	Employees as % of Total	Manufacturing
City	Employment	Rank	Employment	Rank	Male Employment	Male Employment	Employment
Milwaukee	9254	22	18252	16	4.97	4.88	97.23
Providence	12240	16	23769	12	3.86	3.45	94.19
Chicago	40541	4	76811	4	3.80	4.84	89.46
Cleveland	13874	13	26148	11	11.28	10.28	88.47
Jersey City	9252	23	17388	18	4.38	5.23	87.94
San Francisco	20932	10	36578	9	1.04	1.69	74.75
Pittsburgh	12289	15	20832	14	13.00	13.67	69.52
Rochester	10819	18	17910	17	6.93	4.60	65.54
Philadelphia	105633	2	171451	2	3.57	3.27	62.31
Detroit	10389	19	16733	19	3.33	5.53	61.06
Brooklyn	57530	3	92635	3	1.51	1.63	61.02
Troy	7517	27	11954	24	11.10	16.89	59.03
Indianapolis	6913	28	10262	27	10.72	7.71	48.44
Buffalo	15834	12	23271	13	4.97	7.25	46.97
Worcester	9082	24	13314	22	6.05	6.54	46.60
New York	145228	1	212844	1	1.62	1.83	46.56
Albany	9374	21	13556	21	7.09	6.56	44.61
Baltimore	35535	7	49915	7	3.39	3.13	40.47
Washington DC	9494	20	13260	23	0.62	0.97	39.67
Cincinnati	33971	8	47284	8	3.76	3.23	39.19
Boston	38971	5	53880	5	2.37	2.84	38.26
St Louis	38184	6	52682	6	3.61	5.36	37.97
New Haven	8555	25	11626	25	5.18	6.26	35.90
Louisville	12485	14	16596	20	4.26	5.75	32.93
Newark	22823	9	29979	10	2.43	3.20	31.35
Richmond	6520	29	8442	29	4.05	4.75	29.48
Syracuse	7864	26	9427	28	5.94	5.41	19.88
New Orleans	16071	11	19104	15	1.44	1.23	18.87
Charleston	4928	30	5130	30	2.35	3.10	4.10
Allegheny City	11917	17	11557	26	9.24	10.09	-3.02

Sources: U.S. Census Office (1872a), Table XXXII; U.S. Census Office (1883a), Table XXXVI and calculations based on data in those tables, which are derived from occupational statistics in the population census, not the inconsistent manufacturing census returns (see later text). The railroad (RR) employees considered are trainmen only, so relative proportions are more important than absolute percentage values, which are underestimates of total railroad employment. RR trainmen are specifically separated from non-railroad manufacturing workers in this tabulation.

## **4. Transportation and Natural Resource Exploitation**

### **4.1 The Ohio and Erie Canal and the Great Lakes trade**

The earliest major impetus to the commercial development of Cleveland and nearby coal deposits was the choice of the town as the lake terminus of the Ohio and Erie Canal, completed in 1832 to Portsmouth on the Ohio River (Ohio State Archaeological and Historical Society (OSAHS), 1905). The Pennsylvania and Ohio canal, completed in 1840 to its junction with the Ohio and Erie in Akron provided a through water route to Youngstown and Pittsburgh (Rose, 1950, 169) An important trade in wheat, flour and to a lesser extent corn, arose during the 1830s, much of it for onward shipment by lake. However, corn shipments by canal had already peaked by 1847, followed by wheat and flour in 1851 and 1852 respectively, too early for the coming of the railroad to be identifiable as the reason. Newspaper accounts blamed widespread crop failure at the time (Annals of Cleveland (AoC), 1850, 23). Declining grain cargoes were replaced by burgeoning coal shipments, whose tonnage overtook that of all three agricultural staples combined by the early 1850s (OSAHS, 1905, 175-6). The most accessible early coal supplies for Cleveland until the mid-1840s came from mines developed close to the Ohio and Erie Canal near Akron. Subsequently, additional sources of canal supply came from Massillon to the south and from near Youngstown to the east, on the Pennsylvania and Ohio Canal (Wiggins and Company, 1872). Coal tonnages increased rapidly, reaching 93,914 short tons by 1850 and peaking at 253,576 tons in 1855 (OSAHS, 1905), before railroad competition and canal mismanagement led to a sharp fall in shipments (AoC, 1857, 24-27). This decline was reversed during the 1860s and shipments still exceeded 200,000 tons at the end of the 1870s, but declined thereafter (Figure 1).

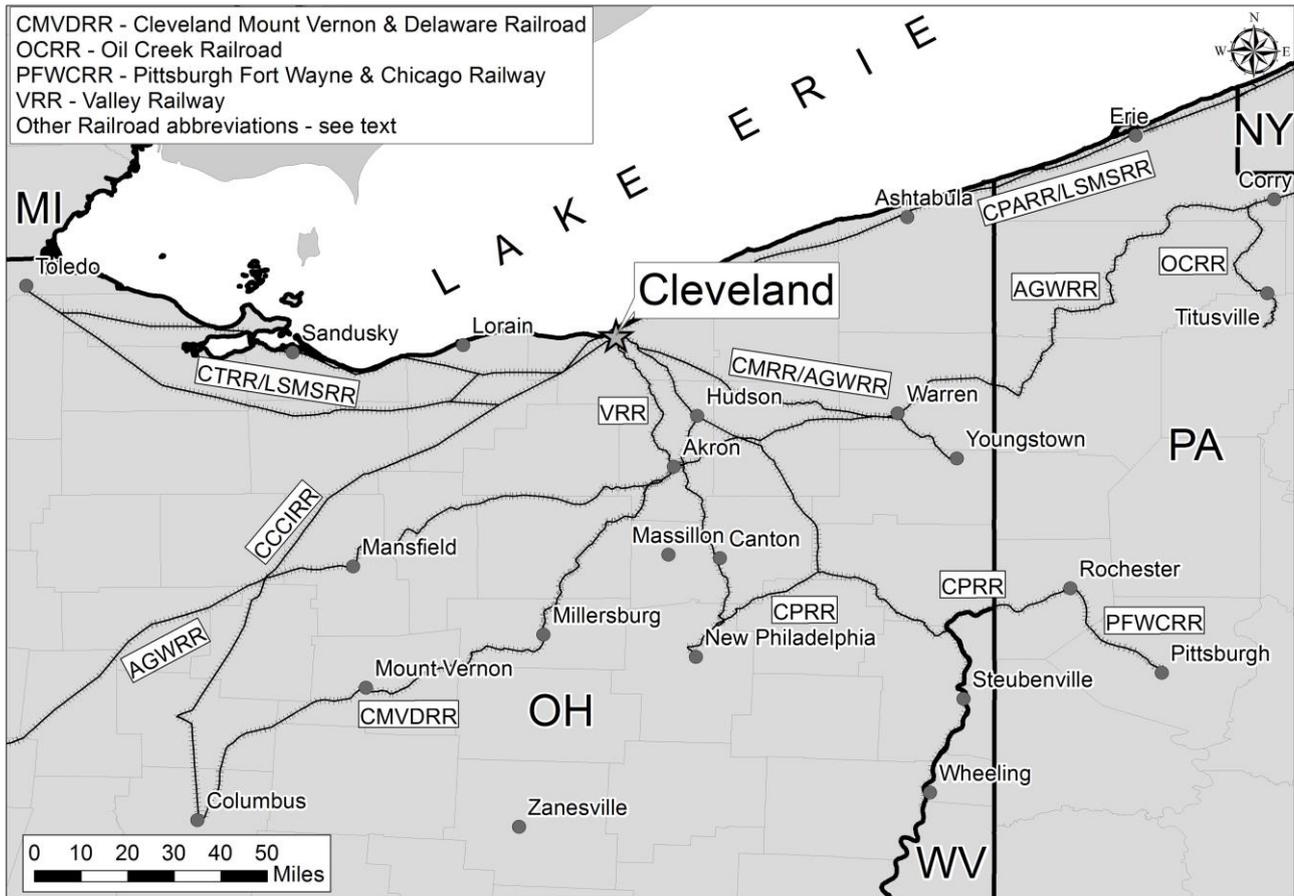


**Figure 1.** Canal Shipments of Coal to Cleveland 1833 – 1871

#### 4.2 Railroad Developments and Coal Shipments

Winter closure of Cleveland harbour and the canal, meant the railroad was essential to the expansion of regular year-round trade. The city’s first railroad, the Cleveland, Columbus and Cincinnati RR (CCCRR), opened in 1851 (Cleveland Board of Trade (CBoT) for 1865, 5-6). The Cleveland, Painesville and Ashtabula RR (CPARR) followed in 1852. Running eastwards from the city, it linked to Buffalo and New York (Wiggins and Company, 1872, 13). A western connection to Toledo was made by what became the Cleveland and Toledo RR (CTRR) when it completed its first track to Grafton on the CCCRR, 25 miles south-west of Cleveland in 1853 (CTRR Annual Report (AR), 1854, 4). The CTRR and the CPARR later merged into the Lake Shore and Michigan Southern RR (LSMSRR) (LSMSRR AR, 1870). The Cleveland and Pittsburgh RR (CPRR) had a complex construction history, but key stages included traversing the Salineville coal district to the Ohio River in 1852, building the Tuscarawas branch to New Philadelphia in 1854, which gave access to a second important area of coal deposits, and eventual completion to Rochester, PA in 1859, where it joined onwards connections to Pittsburgh (CPRR AR, 1852, 5; Driggs, 1878, 93f.). The last 1850s railroad to enter the city was the Cleveland and Mahoning

(CMRR), completed to Youngstown in 1856 (CMRR AR, 1857, 3). The geography of these railroads (ignoring branches) is shown in Figure 2.



**Figure 2.** Major Railroads Serving Cleveland circa 1880

The CPRR and the CMRR, which was leased to the Atlantic and Great Western Railroad (AGWRR) in 1863, rapidly became Cleveland’s major railroad suppliers of coal (AGWRR, 1864, 22). In 1865, they respectively shipped over 160,000 and 140,000 tons to the city and nearby Newburgh, as compared to approximately 150,000 tons by canal. These shipments provided almost all of the 460,000 tons received in total. By 1869, the CMRR shipped 320,000 tons, and the CPRR reached nearly 522,000 tons in 1871, so the two railroads increasingly dominated the city’s coal trade (CBoT for 1865, 13; for 1869, 13; CPRR AR, 1865, 1871).

A second development phase began in the 1870s with agitation for new lines to reach reliable sources of cheap coal, as supply limitations over largely single-track railroads, overcrowded terminal facilities and miners’ strikes had interrupted trade after 1865 (AoC, 1871, 661; Report of Special

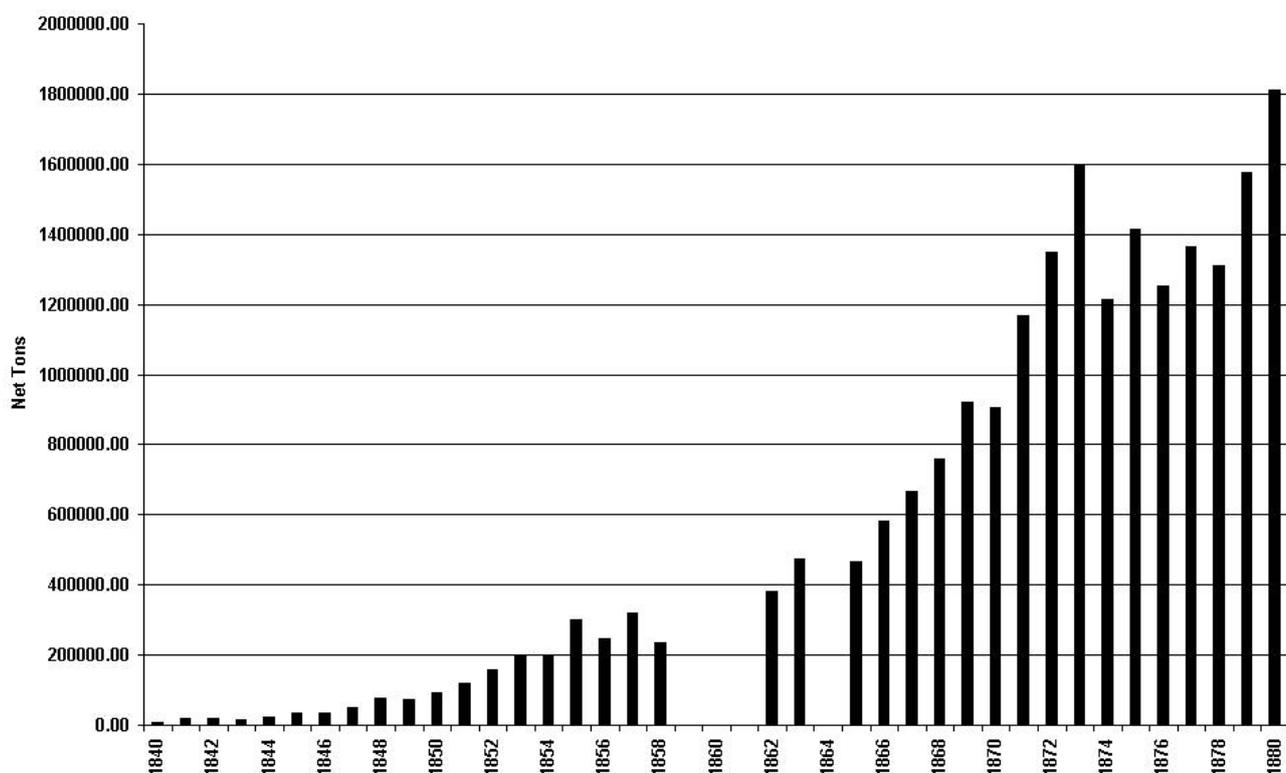
Committee (RSC), 1874, 14; CBoT for 1870, 18). The first of these new lines, the Lake Shore and Tuscarawas Valley Railway (LSTVRR), eventually by-passed Cleveland for the nearby lake port of Lorain (Rose, 1950, 404), but about half its coal traffic during the 1870s was transferred to the Cleveland, Columbus, Cincinnati and Indianapolis Railroad (CCCIRR), successor to the CCCRR, at Grafton for onward shipment to Cleveland (LSTVRR, 1871; Ohio, Commissioner of Railroads Report (OCRR) for 1876, 263; CCCIRR AR, 1876, 29). Like the predecessor lines to the LSMSRR, the CCCIRR had not been a substantial coal shipper during the 1860s (CPARR AR, 1861, 1864, 1867; CTRR AR; CCCRR AR), but by 1880, the combination of the Grafton trade and other coal loaded at Columbus from the Hocking Valley coalfield enabled it to bring more than 275,000 tons into Cleveland (CBoT for 1869, 13; CCCIRR AR, 1880, 35). This latter coalfield began to expand rapidly about 1870 (Crowell, 1995). The second new line, the Valley Railway, was chartered in 1871, opened in 1880 and extended in 1883 to reach mines in the vicinity of Akron and Canton. By 1888, coal shipments exceeded 350,000 tons (Reese, 1880; OCRR for 1888, 1018-1026). The clear rationale for this railroad was to provide cheaper coal for the city and its mills. For example, the Newburgh Rolling Mill was urged to invest in the line to facilitate low cost coal delivery at only \$2.50 per ton (AoC, 1872, 693). Or, more generally, as a sagacious correspondent of the *Cleveland Leader* put it in March 1872:

‘The coal trade of Cleveland is one of the most important elements in its prosperity. Not only do our manufacturers depend on it, but the price at which it can be furnished for manufacturing purposes causes either a small or a great future’ (AoC, 1872, 693).

However, not all coal received was for local consumption. Much was shipped on to other lake ports, especially Chicago. In 1865, of the 214,837 tons of coal shipped, half went there (CBoT for 1865, 9, 11). The range of coals received made Cleveland an attractive marketplace for coal buyers, even though residents mainly used Mahoning coal (CTJ, 1880b). The railroads also consumed a very substantial tonnage for fuel. Thus, the AGWRR used 121,830 tons in 1870, much of it carried on its CMRR branch (OCRR for 1870, Vol II, 33).

In summary, Cleveland’s coal trade experienced relatively steady growth in the 1850s until the 1857 Panic, then further increase during the Civil War years and a sustained growth surge between 1866 and the 1873 Panic. This can be seen in Figure 3 despite the early data gaps. The canal share of tonnage

fell from 30.3% in 1862 to 25.2% in 1870, with further declines thereafter. Rapid growth was followed by stagnation during the post-1873 depression (Fels, 1959). The surge prior to this was Cleveland specific. In Cincinnati, coal consumption barely increased 1865-68 (Saward, Annual for 1883, 39). Until the 1870s, the business relied on relatively proximate resources within a radius of about 100 miles. Four of the major regional railroads were specifically constructed to channel coal to the city, while the remaining roads had traditionally provided more general transportation services, with coal traffic a later addition. Unlike western roads, often controlled by Eastern Seaboard capital (Johnson and Supple, 1967), most Cleveland railroads were predominantly promoted by local capitalists. Over time, however, they progressively fell under the sway of interests allied with the Eastern Trunk Lines. In addition to fuelling manufacturing, the coal business generated much additional employment in railroad transportation. It also supported office workers in the commission houses, dock labour, lake vessel crews and shipbuilding workers. So the interplay between the coal mining and the transportation sectors was a key theme in the development of Cleveland.



**Figure 3.** Cleveland: Total Coal Receipts 1840 – 1880

### **4.3 Channelling of Iron Ore Traffic**

In addition to coal, iron ore also reached Cleveland in progressively growing quantities. Although Cleveland entrepreneurs (Havighurst, 1958) were major instigators of this trade, prior to the 1870s little of this ore went to ironworks in the city. Instead, by 1871, 56% of the nearly 400,000 tons received were shipped eastwards by the CPRR (CPRR AR, 1871) and to Pittsburgh in particular. For example, in 1870, 71,026 tons were shipped to the Superior iron furnaces in Pittsburgh (CPRR AR, 1870), whereas only 13,198 tons was delivered to the Newburgh furnaces in the 18<sup>th</sup> ward of Cleveland. Likewise, almost all the ore shipped by the CMRR/AGWRR in 1866 went eastwards, i.e. largely to the Mahoning Valley (AGWRR, 1865b, 39; 1866, 47).

The main direct benefits of the iron ore trade in Cleveland therefore initially accrued to the transportation and port/shipping industries, and the commission merchants. The iron manufacturers who benefitted were mainly in Youngstown or in Pittsburgh, not Cleveland. However, from a factor channelling perspective, the extent of control of the ore trade by Cleveland men, as opposed to merchants in Chicago or Detroit, was very considerable. For example, Selah Chamberlain, a founder of the Cleveland Iron Mining Company, which supplied Superior ore, was also construction contractor for the CPRR and later a director of the railroad (CPRR AR, 1852; Swineford, 1876). All the Superior ore companies had sales offices in Cleveland and 70 iron furnaces in the wider region arranged their ore contracts through Cleveland agents. Of these furnaces, 45 received their ore through the port in 1868, 15 had Cleveland shareholders and 9 were directly controlled from the city, so indirect financial returns on the ore trade were also accruing to Clevelanders through a variety of means (CBoT for 1867, 21; for 1868, 20).

### **4.4 Expansion of Iron Ore Consumption for Local Pig Iron Manufacture**

Pig iron manufacture was not important in Cleveland until 1864 when the Cleveland Rolling Mill Company (CRMC) built two blast furnaces at Newburgh to use Superior ore. The Cleveland Iron Company (CIC) built the Proton furnace in 1869, but suspended operations in mid-1878. The CRMC then leased this furnace and built another near it in 1879, before adding a fifth furnace (the Central) in 1882. Other small works were in Bedford and Newburgh (AoC, 1858, 240; 1866, 249; CDL, Feb. 3, 1866; AISA

1876, 49; Ohio, Bureau of Labor Statistics, 1878, 87; AISA 1882, 65; Ohio, Geological Survey, 1884, 450, 456). By 1870 pig iron production in the city was 18,575 tons, less than half the tonnage of iron rails rolled. The CPRR brought 13,000 tons of iron ore and nearly 65,000 tons of coal to the CRMC at Newburgh, while the figures for the CIC were 13,000 and nearly 45,000 respectively. These works consumed nearly all the ore used in the city, a mere 6% of the tonnage received at the port (Wiggins and Company, 98; CPRR AR, 1870; U.S. Census Office, 1870). The direct contribution of the iron ore trade to Cleveland's manufacturing development was therefore limited prior to 1870 and in tonnage terms it did not match coal until 1890 (Cleveland Chamber of Commerce, 1912, 223). Prior to this coal dominated, because 50% of receipts were consumed locally, rather than trans-shipped (Macfarlane, 1873, 672). Nevertheless, for the railroads, iron ore was a valuable back haul commodity once Superior ore traffic grew. By 1874, extensive docks on the Cuyahoga River, capable of handling 300,000 tons per annum were devoted to iron ore by the AGWRR (Tyler, 1874, 83). Likewise, CPRR dock investments were justified by the 'unquestionable demand for the same by the requirements of the business. When stockholders visited the docks they found a stockpile of 150,000 tons of iron ore (RSC, 1874, 14-15). Hence, growing supplies of coal and iron ore drove the expansion of commerce related to the handling of raw materials. With coal, cheap reliable supplies aided both local firms and the railroads. The latter also benefitted from acquisition of prime river and lakeside properties for dock expansion, until growing stockpiles of coal and ore led to space constraints on future developments, beginning in the late 1860s.

#### **4.5 Channelling Crude Oil to Cleveland**

The discovery of oil in 1859 near Titusville, in north-western Pennsylvania (Dolson, 1959; Giddens, 1938, 1947), initially had very limited impact on Cleveland, owing to the absence of railroad connections from the oilfields. While tracks that passed near these oilfields reached the competing port of Erie in December 1859 (Rosenberger, 1975; Springirth 2010, 33; Sunbury and Erie Railroad, 1860, 20), the AGWRR could not ship oil until it reached Corry, north of Titusville in 1861 (AGWRR, 1866, 67). This made eastwards oil shipments possible to New York via connections with the Erie Railroad, but the Oil Creek Railroad, connecting Corry to Titusville, was not completed until October 1, 1862. This road was effectively owned by one of its prime movers, W.S. Streator of East Cleveland, a director and former

construction contractor of the AGWRR (AGWRR, 1864, 3; Maybee, 1940, 13-14; Joblin, 1869, 316). The AGWRR lease of the CMRR in October 1863 and the rapid laying of a third rail so broad gauge cars could enter Cleveland by November 1863, constituted the final link required to channel crude oil to the city (AGWRR, 1866, 68). Westward oil shipments to Cleveland over the AGWRR soared thereafter to more than 500,000 bbls by 1866 (AGWRR, 1865a, 24; 1866, 47). Crude oil largely reached Pittsburgh by river (Giddens, 1948), and Philadelphia via the Sunbury and Erie RR. By 1869 oil receipts at Cleveland reached 1,121,700 bbls to overtake shipments to Pittsburgh. They nearly doubled again in 1870 and three-quarters were carried over the Erie, by then the lessor of the AGWRR, underlining the dominance of the latter over the city's crude oil traffic (Ohio, Secretary of State, Annual Report for 1869, 217; Maybee 1940, 37, 224; Derrick's Handbook, 1898, 143).

Unlike coal or ore, which were partially used or processed in the city, nearly all the crude sent west to Cleveland was shipped eastwards again after refining, largely for export. Some oil was sent by lake direct for Liverpool (AoC, 1867, 404; 1868, 387). In transportation cost terms, Cleveland was not an obvious location for a major refining centre, since it was further west of the Oil Regions than Erie and Pittsburgh and thus more distant from the eastern seaboard markets. Its emergence as a refining centre was due to factor channelling, since it was the specific railroad construction and leasing strategy of W.S. Streator and his AGWRR associates that enabled crude oil to reach the city in quantity from an early date. Although these men were mainly interested in the growth of railroad traffic (in-bound crude oil and outbound refined), their actions enabled other Clevelanders to invest in the Pennsylvania oil 'boom' of 1864-6. Out of 44 oil companies with Cuyahoga county offices incorporated in Ohio during the 1860s, 24 planned to drill in Pennsylvania, mostly along Oil Creek (Ohio, Secretary of State (1852 -)).

## **5. Railroads and the Growth of Urban Industrial Employment**

Since factor channelling was a key motivation for new railroad projects in Cleveland, the broader economic stimuli these provided must now be examined. The effects included direct railroad employment, both in transportation services and in the repair shops, indirect backward linkages to support industries, such as rolling stock and rail manufacture, and the forward linkages to the oil refining sector. The temporal and geographical contexts of these linkages must also be investigated, to identify when and how

benefits accrued to the Cleveland region, rather than elsewhere. In the absence of any systematic input-output estimates or waybill statistics of the kind used by Klein and Crafts (2011) for much later dates, evidence had to be assembled from a wide range of sources from 1850 onwards. These comprised newspapers, company and state annual reports, city directories, and manuscript materials, including manufacturing census schedules and state incorporation records.

### **5.1 New Estimates of Direct Railroad Employment**

Railroad employees can be divided into shop-men and those involved in train service, including depot staff, and track maintenance. Shop-men lived near their work, train service employees (e.g. conductors and brakemen) mostly lived at termini or divisional endpoints, while depot and maintenance workers were necessarily spread along the line. Railroad-related employment growth in any specific town or city therefore depended on the number of lines serving the settlement, rates of traffic growth, and whether the settlements were divisional endpoints and the sites of railroad shops. Cleveland, as the lake terminus of a number of railroads, was fortunate to meet all these requirements.

The CCCRR established an 'engine shop' in the city by 1850 (AoC 1850, 33), a roundhouse and car shop by 1854, and by 1857 their machine shop complex was large enough for the company to build its first locomotive. In the latter year, they took over the locomotive works of the Cuyahoga Steam Furnace (CSF) company (see below) and further major expansion took place into the 1860s (AoC 1855, 479; 1857, 272; 1862, 581-2; 1864, 233; CCCRR AR, 1857, 1859, 1860, 1864; Joblin, 1869, 398). The other roads quickly followed, beginning with the CPRR which commenced building and repairing cars at its new main shops in 1852 (CPRR AR, 1852). By 1861 these shops employed 155 men (Cleveland Morning Leader (CML), 19 Feb. 1861). The CPARR started its car shops in 1853, adding additional machine shop capacity in 1856-7, while the CTRR moved its car shops from west Cleveland to Norwalk in 1857 (AoC, 1857, 272; CTRR AR, 1856/7, 24). By mid-1858 the CPARR shops employed 70 men, increasing to 167 by 1862 (AoC, 1858, 448; CML, 21 Oct. 1862). Lastly, the CMRR established its Cleveland shops in 1857-8 with a workforce of 50, which increased thereafter as motive power and rolling stock expanded (AoC 1858, 449; AGWRR, 1864).

Taken together these figures suggest about 300 shop-men for the CPARR, CMRR and CPRR at the beginning of the 1860s, while the CCCRR, which had the largest shop complex, probably contributed at least 150-175 more for a total of 450-475 shop-men. Later figures for Cleveland railroads indicate an average of 95.7 other railroad workers to every 100 shop men (calc. from Table VI in U.S. Census Office 1883b, 261f.). Using this multiplier would give 431-455 additional other workers, most of whom would have lived in Cleveland. To these must be added CTRR trainmen resident in the city, suggesting about 900 railroad workers in total. Analysis of all 5,800 industrial and transportation workers identified in the city directory gives a similar result, which includes 84 CTRR men (Cleveland Directory, 1861).

These calculations are necessary, because railroad shop employment is not reported in the 1860 manufacturing census. The 1870 equivalent fares better but a check on the manuscript schedules shows the shops of the LSMSRR (formerly CPARR shops) were omitted (U.S. Census Office, 1865, 1870, 1872b). Allowing for this gives an approximate tally of 1360 shop-men and using the above multiplier for 'other workers' with an allowance for former CTRR, now LSMSRR workers, gives an 1870 estimate of at least 2,750 railroad men. In the 1880 tabulations, railroad shops are again omitted, but availability of the full count 1880 population census has allowed employment estimates to be made (Minnesota Population Center, 2008). This dataset accurately reports railroad specific trainmen, but not the railroad affiliations of shop-men in generic trades, such as machinists and blacksmiths (Healey, 2011). Using the shop-men/other workers ratio in reverse gives a total estimate of 3,832 railroad workers (1,874 other workers identified in the census + an estimate of 1,958 shop-men). Further details of the calculation of all these estimates can be found in (Healey, 2014). These new employment estimates are soundly based on available evidence and are broadly comparable between census years. In contrast, the published manufacturing census figures fail to identify the major direct contribution of railroad shops to industrial employment in Cleveland (and many other AMB cities) prior to 1880. This point has been missed by Meyer, who incorrectly made intercensal comparisons of railroad employment derived from the printed manufacturing census in his 1989 and 1990 studies (Meyer 1989, 930; 1990, 743). This is very problematic, since transportation employment forms part of his 'exchange support' category, which is critical to his argument about the role of cities in exchange. These new estimates indicate a significant

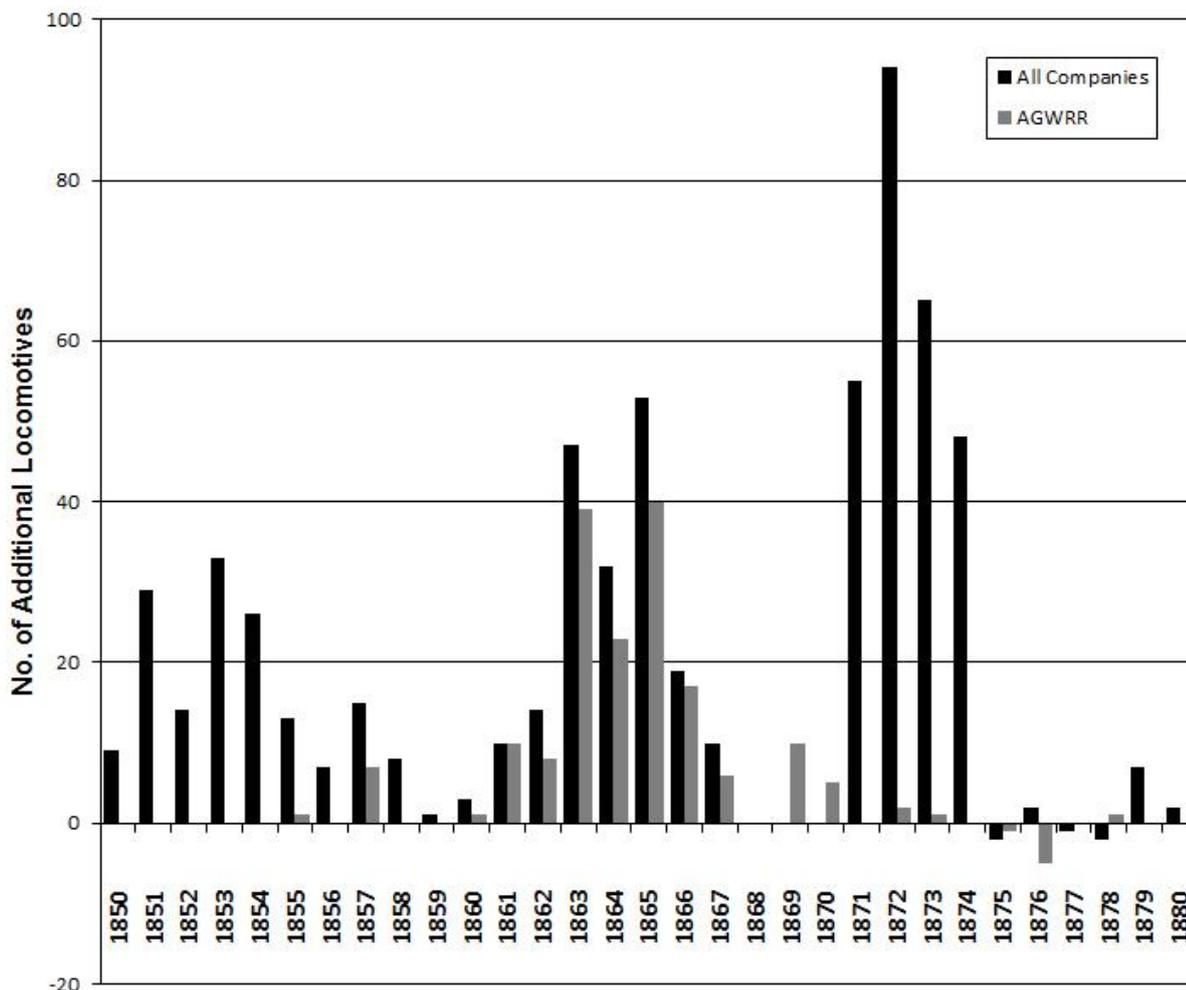
established employment base before the Civil War, rapid growth in the industry 1860-70 and significant but slower expansion in the following decade.

## **5.2 Railroad Shops and the Manufacture of Locomotives and Rolling Stock**

Railroad shops performed two distinct types of work. The first was adding to the company's transportation assets and infrastructure, by building rolling stock and some engines, and also ironwork for depots and bridges. The second was repair and maintenance of locomotives and rolling stock. The significance of the second is much more widely recognized in the literature than the first. For example, Fishlow makes only anecdotal mention of locomotive or freight car manufacture in the shops of the largest companies, but notes the general contribution of repair work at railroad shops to wider processes of economic growth (Fishlow 1965, 130-1, 152f.).

Analysis of the early reports of all the Cleveland railroads allows the complex and time varying contribution of the shops to the local/regional economy to be understood properly for the first time. The first important distinction was between the 'start-up' phase of a railroad's life and its subsequent normal operations. During start-up there was heavy demand for significant numbers of new locomotives and hundreds or even thousands of freight cars over perhaps 3-4 years. Subsequently, requirements were much reduced until growth in traffic necessitated further additions to motive power and rolling stock. Thus expansionary business cycle stages, which encouraged the formation/construction of new railroads, also exerted a positive multiplier on the shops through the need for new capital equipment, while business downturns dampened both effects, leading to very marked cycles in expenditure on engines and cars, even at a relatively local level. This can be seen initially in Figure 4 which shows annual additions to the stock of locomotives owned by all the Cleveland roads in operation before 1870, based on almost complete data. The surge during the early 1850s reflects the startup period of most of the railroads. The AGWRR is shown separately on the graph because its main construction and startup phases took place during the Civil War when very few other new railroad projects were advancing in Ohio. Its startup demand 1863-6 exceeded 100 engines, necessitating contracts with multiple engine builders *and* the leasing of an entire locomotive works in New Jersey to meet its requirements (AGWRR, 1864). Some totals for the years 1868-70 are intentionally omitted because of the distorting effects of company mergers at this time (the

AGWRR is unaffected). Post 1870, the increments are meaningful, though not wholly comparable in magnitude with earlier data, because new companies such as the LSMSRR and CCCIRR absorbed additional major railroads over and above their Cleveland predecessors, which constitute the figures for earlier years. Available data suggest only modest numbers of new locomotives during the omitted transitional period. Setting aside the AGWRR startup, the graph shows that Civil War did not provide a major stimulus to new locomotive orders for existing railroads. Also, a surge in new locomotive building at the beginning of the 1870s evaporated after the 1873 Panic, not to return before 1880.



**Figure 4.** Incremental Additions to the Stock of Locomotives: Cleveland Railroads 1850-1880

Examination of locomotive rosters from the annual reports shows that most early engines were made in the major national centres of locomotive manufacture in New England, New Jersey and Philadelphia (Baldwin and Norris). However, more than half of the entire output of the CSF in Cleveland went to Cleveland roads (52 out of 100 engines). The contention that larger railroads standardized on

engines from the same producer for maintenance efficiency is only partially supported (Fishlow, 1965, 154). The CCCRR had certainly obtained 33 of its 42 engines from CSF by 1857, while the CPRR concentrated on Baldwin locomotives. However, the AGWRR had 8 suppliers, in addition to its own leased works, and the CPARR had 4 major and 5 small suppliers. The CSF was a small supplier to both roads. Locomotive building in the CCCIRR shops began in 1868. In the following 12 years, 47 out of 63 of the company's new engines were built in its own shops, many in Cleveland, where the facilities included the former CSF locomotive works, the remainder at Galion, OH and Indianapolis. Several other companies manufactured some of their own engines, e.g. AGWRR (3), CPRR (6) and LSMSRR (14), in the period 1867-1873. Of these, all of the CPRR and many of the LSMSRR engines were most probably made in Cleveland where the companies had major engine repair shops. The AGWRR locomotives were built at the Kent, OH shops (AGWRR, 1875, 336-7).

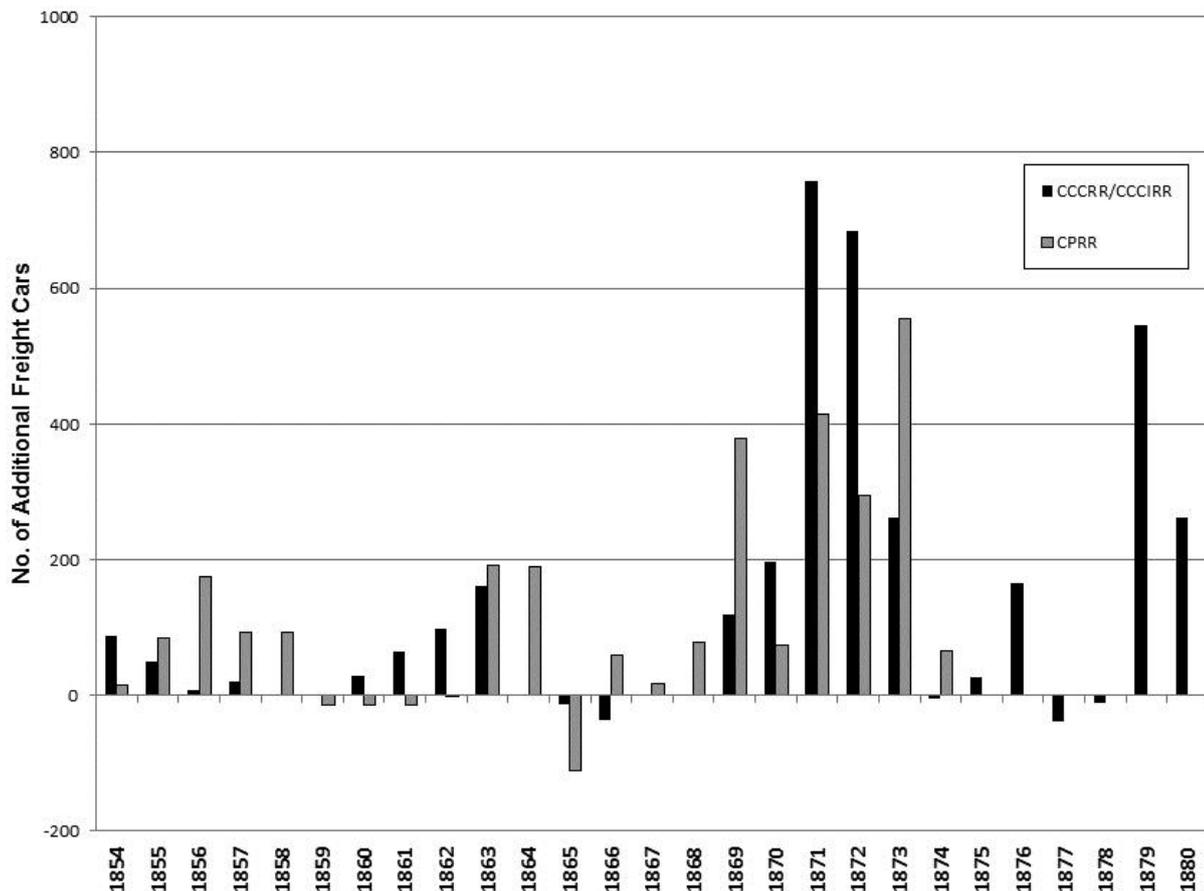
Rolling stock and locomotive manufacture had some similarities, but also important differences. Comprehensive data for all Cleveland railroads are not available, but Figure 5 shows freight car additions by the CCCRR/CCCIRR and the CPRR for most of the period. The 1850s startup phase can be seen, followed by a second surge during the Civil War, although rolling stock expansion occurred earlier for the CCCRR, a general freight carrier, than the CPRR, a coal and iron ore carrier. Despite the small data gap in 1867-8 for the CCCRR, which expanded to become the CCCIRR in the second of these years, the surge in new car demand 1869-73 is apparent. Major additions were then postponed until 1879, although the CPRR added no new freight cars 1875-1880. The later startup of the AGWRR does not affect these figures, so the second two cycles reflected responses to increased traffic demands. Nearly comprehensive data is, however, available for all the Cleveland railroads for the Civil War era 1860-66 (Table 2). This contextualizes the more limited company coverage on the graph. It also shows the startup freight car requirements for the AGWRR, which was opened progressively during the early 1860s, so the vast majority of its 3000+ cars in 1866 had been built since 1860 (apart from those it inherited from the CMRR). The road made only a minor contribution to the car construction surge in the late 1860s. Its car total peaked at 3,475 in 1870 before declining back to 2,480 in 1880 following protracted financial problems (AGWRR AR, various years; OCRR, 1867-80). The other roads added more than 1500 cars

1860-1866, a nearly 80% increase over the 1860 level of approximately 2000 cars. With the AGWRR, the Cleveland roads therefore added a large total of about 4,500 cars during this period.

**Table 2.** Total Freight Cars Owned By Cleveland Railroads 1860-1866

Year	AGWRR	CCCR	CPARR	CPRR	CTRR
1860	N/A	464	420	775*	356
1861	N/A	528	462	760	362
1862	N/A	626	535	758	393
1863	1370	787	813	950	479
1864	2528	788	927	1140	636
1865	2955	774	871	1029	630
1866	3141	737	1012	1088	752

\* This individual value estimated by interpolation between earlier and later reported values  
 Source: Annual Reports of the respective companies



**Figure 5.** Incremental Additions to the Stock of Freight Cars: CCCRR/CCCIRR and CPRR 1854-1880

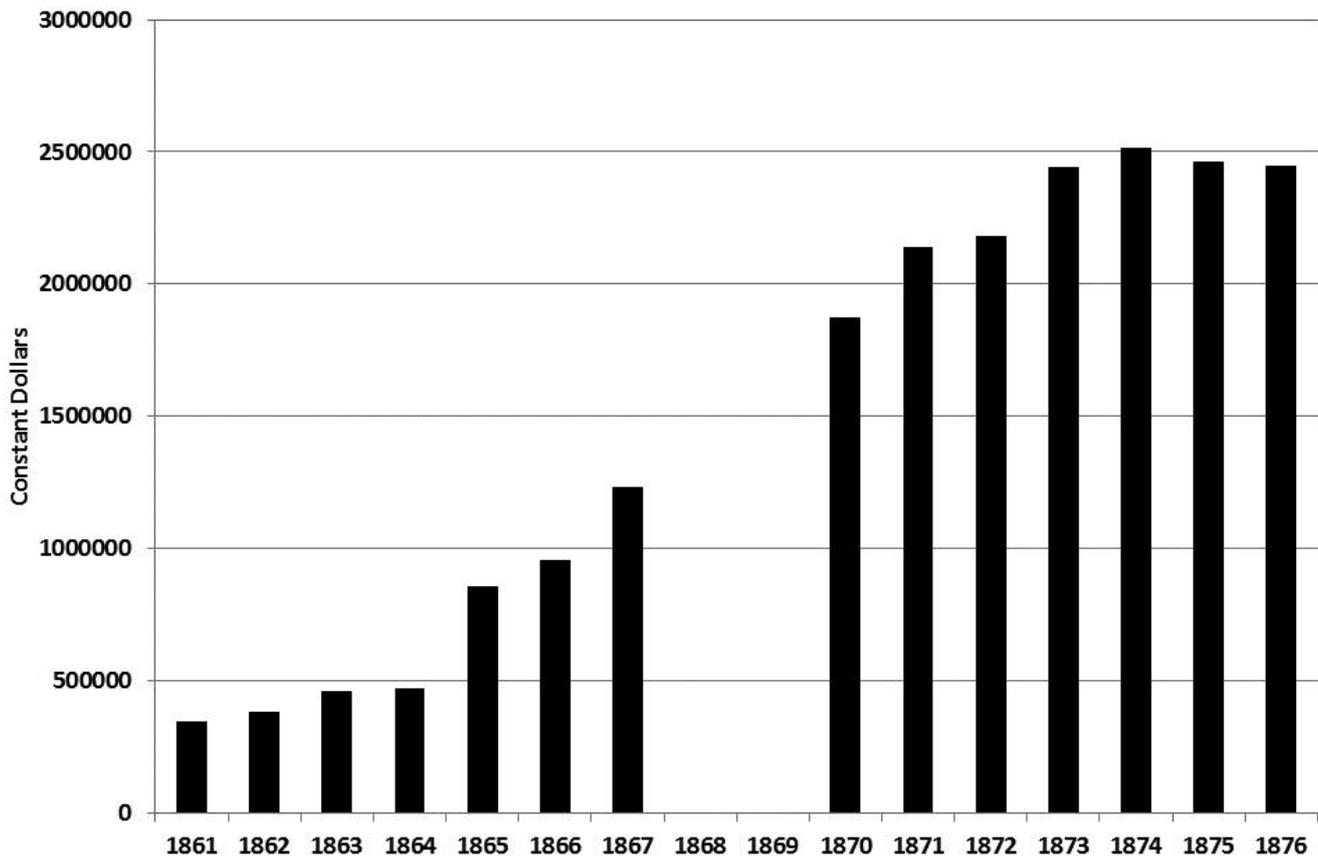
From the outset, the geography of freight and passenger car manufacture differed markedly from that of locomotives, a point not recognized in the literature. While the latter were largely built by east coast firms, cars were being built in quantity in major interior railroad cities from the beginning of the

1850s, both by railroad shops and by independent companies. However, it is hard to generalize across companies and over the three main phases of car construction, namely in the 1850s, during the War and from the late 1860s onwards. For example, the first 228 freight cars running on the CPRR in 1852 were built in the company's shops in Cleveland (CPRR AR, 1852). Similarly, in 1854 some 83 freight and 11 passenger cars were built in the city at the shops then jointly worked by the CCCRR and the CPARR (CCCRR AR, 1854). During the War, however, only 25% of CPRR cars were shop built and the equivalent figure for the CCCRR was only 10%. Yet all of the CTRR's 279 new cars during this period were built at its Norwalk shops. Hardly any cars were built at the AGWRR repair shops prior to 1866. Instead, it was compelled to lease the Ramapo Car Works in New York State to build some its cars, because all other makers, in Cleveland (see below) and elsewhere, were 'full of orders' (AGWRR, 1864, 43). The third post-War phase was characterized by substantial in-house construction for all roads other than the ailing AGWRR. For example, the LSMSRR built 2330 cars at its shops in Cleveland and elsewhere 1870-2, the CPRR 675 cars 1867-71, nearly all in Cleveland, and the CCCIRR 1559 cars, a majority of its new rolling stock 1868-1880, at its Cleveland and Indianapolis shops. In management terms, the primary task of the shops was always to keep equipment in good repair, so cars were only built when spare or expanded capacity permitted it, though it was up to a third cheaper to do this in-house than by external contract (Annual Reports of the AGWRR, CCCRR, CCCIRR, CPRR, CTRR and LSMSRR, relevant years).

Although repair costs are not consistently reported in the 1850s, from 1861 close estimates can be provided of expenditure under this heading, as shown in Figure 6. Minor problems arise from changes in reporting years and occasional lumping of costs, but the broad thrust of the findings stands. However, on the figure, the gap in 1868-9 represents the period when railroad systems expanded substantially in geographical terms, by absorbing new companies. This means that the data from 1861-7 are comparable between themselves, as are the data 1870-6, but the two groups of years should be read separately. Despite these caveats, the key difference to the earlier figures on new capacity is clear. While equipment additions were strongly cyclical, repair costs were proportionate to the size of the overall equipment pool. They were largely unaffected by cyclical factors, either in the railroad sector or the national economy. So

railroad shops were essentially recession-proof industries during the period and cities like Cleveland that possessed multiple large shops, were doubly insulated from wider economic vicissitudes. Cyclical car and locomotive construction in the shops when railroad traffic was booming provided additional limited-term employment above the baseline of repair work, but long-standing skilled shop-men could still count on regular employment during business downturns. This would have greatly increased the attractiveness of Cleveland, especially to immigrants, as a place to live and work.

Cyclical expansion would be further enhanced by the presence, not just of railroad shops, but also of independent locomotive manufacturers, already discussed, and car builders. In 1850 Witt and Harbeck (Harbach), who were construction contractors on the CCCRR, commenced car building in the city. The Wason Car Works followed in 1851 (AoC, 1850, 340; 1851, 332; 1852, 398). This grew rapidly and by 1855, its cars ran on all the railroads serving Cleveland and farther afield (AoC, 1855, 486, 487). While evidence from the mid-1850s is scarce, references to Witt and Harbeck cease after 1855 and it is likely that Wason was succeeded by Morrill and Bowers in 1856-7 (AoC, 1856, 486; 1857, 104). They remained the sole Cleveland car builder until after the War. Most importantly, their workforce of at least 70-80 men had been almost entirely devoted to the making of 1800 freight cars for the AGWRR throughout the War years (CML, Aug. 3, 1863; Cleveland Daily Leader (CDL), Feb. 16, 1866). They apparently ceased trading as the demand for rolling stock collapsed in 1866-7, to be replaced by McNairy and Claflen, who diversified from bridge-building into car manufacture. Limited employment of 25 men on car building in 1867 grew rapidly as demand expanded again in the late 1860s. They quickly became one of the largest factories in the city, employing 4-500 men on car and railroad bridge building by 1870-1, figures incorrectly reported in the census. They built cars and bridges for local and regional railroads (e.g. 200 cars for the CPRR in 1869), as well as cars for the Union Pacific, southern railroads and street railways across the country (CBoT for 1867, 23; for 1868, 29; for 1870, 37; CPRR AR, 1869; U.S. Census Office, 1870, 1872b, 712; Wiggins and Company, 1872, 110).



**Figure 6.** Shop Repair Costs: Cleveland Railroads 1861-1876

The siting of multiple railroad shop complexes in Cleveland therefore provided both a general manufacturing and employment stimulus through a combination of steadily growing repair work, and several additional cyclical surges of activity in rolling stock manufacture, both within the shops and in the works of independent car builders. Repair work also increased in complexity to encompass conversion of passenger engines to freight and from wood to coal-burning, to save buying new engines (AoC, 1863, 444; CTRR AR, 1864). Local locomotive manufacture, inside and outside the shops, was important in the 1850s. After a lull during the War years, it re-emerged as a significant local manufacturing activity in the late 1860s at the CCCIRR shops, while other roads mainly purchased engines from Eastern Seaboard suppliers.

### 5.3 Railroad-Related Manufacture and Backward Linkages

The classic studies by Fishlow (1965) and Fogel (1964) have examined this topic, but only at an aggregate national level and little is known about such linkages at an urban/regional level. Fortunately, in the Cleveland case, analysis of numerous newspaper reports describing systematic visits to railroad shops and manufacturing plants in the city over a number of years, allow a semi-quantitative picture of railroad-related linkages to be assembled. Many reports state the specific firms from which inputs were obtained and where outputs were sent. Some provide limited detail, many others give precise figures for inputs/outputs and further information about contractual relationships. Additional data are derived from railroad annual reports. Checks against trade directories and the manuscript census indicate that nearly all the major firms and many of the smaller firms are represented. Many of the relationships described were clearly long-term, so the data are not isolated snapshots of commercial activity. Since space precludes a listing of all the linkages between named companies, these have been condensed into two informal ‘input-output’ tables (Tables 3 and 4), the first for the 1850s and the second for 1860-73. The concept of industrial ‘sector’ has been interpreted liberally to allow inclusion of data about geographically distinct market areas. Minor linkage evidence is marked as ‘m’, major evidence as ‘M’. Multiple references to the same type of inter-sectoral linkage involving different named companies are deemed to be major evidence, a single reference is deemed minor. Major linkage also results from a known significant quantity of input/output being described, e.g. 50+ railroad cars manufactured is somewhat arbitrarily taken to be a significant level, as is evidence of a contractual relationship, with other product quantities in proportion to relative value. Hence the tables summarize the information in the previous section and extend it to the indirect backward linkages of suppliers to both the railroad shops and independent car manufacturers. These linkages are found in conjunction with the columns for car wheels (CW), cars (RC), locomotives (L), Engines and Machinery (EM), castings (CA) and eventually bridges (BR). Other columns will be examined in later sections. Sectors represented in Cleveland (CL) or in other locations (O) are also distinguished. The ‘other’ category is omitted, if no reports mentioning it were found.

Table 3 shows the first stages of indirect linkage development. Strong linkages involving multiple firms connected the CW sector to the italicized generic sector for ‘Cleveland Railroads’ as a whole.

Specific strong linkages identified for the CCCRR and CPARR shops reflected the long-term contracts with Sizer's foundry. Another strong link between the CA and RC sectors shows foundries were supplying castings to the independent car building sector. Silas Merchant's foundry also supplied large quantities of iron pipes to Chicago (heading 'other cities'), so customers extended beyond railroad-related sectors. The machinery sector (EM) was not well-developed, but neither were there reports of large quantities of machinery sourced in the east.

In the later period (Table 4), CW supply linkages to the shops and car builders remained very strong, and shipments also went beyond Cleveland. The CA sector had greatly expanded, becoming a major supplier to the AGWRR and CPRR shops, while also filling substantial orders from the primary iron (PI) sector (including rolling mills) and from general machinery. This reflected the steady growth of the latter sector from small beginnings in the 1850s. General machinery itself was now strongly linked to the PI sector, providing engines and equipment for the ironworks and supplying the CPRR shops and others. Finally, the new bridge-building sector obtained its iron locally and supplied bridges to regional railroads and the LSMSRR. These two tables therefore show an emerging industrial economy in Cleveland, in which the railroad shops played a key role, stimulating linked manufacturing, which in turn fostered the growth of support industries and raw materials providers. This is the reverse of the causal links between the shops and manufacturing claimed by Meyer. From a solid local base, these same firms later expanded their markets regionally and in some cases, nationally. [Tables 3 and 4 here]

**Table 3.** Input-Output Matrix for the 1850s

1850s	Origin Sector																	
	<i>Cleveland RR Shops</i>					PI	PI	CW	RC	RC	L	L	EM	EM	CA	CA	BR	BR
Destination Sector	CCCR	CMRR	CPARR	CPRR	CTRR	CL	O	CL	CL	O	CL	O	CL	O	CL	O	CL	O
<i>Cleveland (CL) Railroads</i>						M		M										
CCCR	M								m		M	M						
CMRR									M		m							
CPARR											M	M						
CPRR				M					M	m	m	M	m					
CTRR					M						m	M						
<i>Other (O) RRs</i>									M		M		m					
CCCR Shops								M										
CMRR Shops																		
CPARR Shops								M										
CPRR Shops																		
CTRR Shops																		
Primary Iron Manuf (PI)																m		
Car Wheels and Axles (CW)																		
Railroad Cars (RC)									m							M		
Locomotives (L)									m									
Engines and Machinery (EM)																		
Castings (CA)																		
Bridges (BR)																		
Oil Refining and Shipping																		
Oil Drilling																		
Other Cleveland Manufacturers																		
Manufacturers East and South																		
Manufacturers West (incl. OH)																		
Cleveland City (incl. Street RRs)						M			m							m		
Other Cities																M		

Sources: See Text

**Table 4. Input-Output Matrix for the Period 1860-73**

1860-73	Origin Sector	RR Shops by company ----->						PI	PI	CW	RC	RC	L	L	EM	EM	CA	BR
Destination Sector	Cleveland RR	AGWRR/	CPARR/	CPARR/	CPARR/	CPARR/	CL	O	CL	CL	O	CL	O	CL	O	CL	CL	
	Shops (unspec.)	CMRR	CCCRR	LSMSRR	CPRR	CTRR												
<i>Cleveland (CL) Railroads (unspec.)</i>	M						M		m								m	
AGWRR/CMRR	m									M	M		M				M	
CCCRR			M							m	M		M					
CPARR/LSMSRR				M							M		M				m	
CPRR					M					M	M		M					
CTRR						M						m	m					
<i>Other (O) RRs</i>							M		M	M		m		m		m	M	
AGWRR/CMRR Shops																	M	
CCCRR Shops									M									
CPARR/LSMSRR Shops									M									
CPRR Shops									M					M		m		
CTRR Shops (not Cleveland)									M									
Primary Iron Manuf (PI)					m									M		M		
Car Wheels and Axles (CW)																		
Railroad Cars (RC)							M		M								m	
Locomotives (L)																		
Engines and Machinery (EM)							M	m									M	
Castings (CA)								m										
Bridges (BR)							M										m	
Oil Refining and Shipping														M		M		
Oil Drilling (not Cleveland)														M		M		
Other Cleveland Manufacturers														M		M		
Manufacturers East and South							m							M		m		
Manufacturers West (incl. OH)							M							M		m		
Cleveland City (incl. Street RRs)							M			m						M	M	
Other Cities										m							M	

Sources: See Text

## 5.4 Rail Manufacture

The first two rolling mills in Cleveland were opened in 1856 and 1858 with long-term contracts to re-roll rails for the local railroads. Most of these recycled rails were of British origin and this feedstock was supplemented by iron brought from Youngstown, Wheeling and Pittsburgh (American Iron Association, 1856-58, 152; AoC, 1855, 213; 1858, 243; CCCRR AR, 1853, 4-5). In 1864, when its first two blast furnaces were constructed, the Newburgh and Lake Shore Mills of the CRMC produced 2,128 tons of new rails, and re-rolled 18,173 tons of old rails (Daddow and Bannan, 1866, 695). The Cleveland railroads with rerolling contracts laid about 11,500 tons of rerolled rails in that year, excluding the CMRR (no data), so local demand absorbed much of the CRMC output. This demand continued until 1876, when steel rails became more important. The expanded CCCIRR and LSMSRR began major programmes of replacing iron rail with steel around 1870, while continuing to lay about 10,000 tons per year of rerolled iron between them, but the CPRR persisted with rerolled iron rails until 1876, when it too finally switched wholesale to steel. Laying of new iron continued as long as rerolled, but the annual tonnages were usually only about 30% of the latter (Annual Reports of the CPARR, CCCRR, CPRR, CTRR, various years). The AGWRR situation differed, because all its original iron laid in 1863-4 came from Britain (AGWRR, 1864), so it had no requirement for locally re-rolled rails until the late 1860s. From 1872-8 it laid 40,000 tons of rerolled iron, ceasing thereafter. Laying of steel rail was concentrated in 1872 (9,600 tons) and 1878 (5,410 tons) (OCRR, AR, various years). Analysis of a previously unreported inventory of rails in use on the entire AGWRR system in 1874 (Table 5) reveals the linkages between this railroad and its network of suppliers (AGWRR, 1875). For 86% of nearly 60,000 tons of rails, it also gives the year they were laid. The table shows that the British rails from 1863-4 and the original CMRR track had nearly all been rerolled or renewed by 1874 by mills in the USA. Three-quarters of this work had been undertaken by the two Cleveland companies. The remaining work was spread among eastern suppliers. Prior to the mid-1870s, almost all steel rails were Welsh imports, although some steel-capped rails were obtained from Trenton, NJ and Elmira, NY. While annual rail *output* figures by firm in Cleveland are not available during the 1870s, at the CRMC rail-making *capacity* expanded from 26,000 tons per annum in 1864 to 42,000 tons in 1876 (of which 22,000 were steel rail-making capacity, implying a reduction in iron rail

capacity), 58,000 tons in 1878 and 120,000 tons in 1882. It had a further 40,000 tons of railroad and bar iron capacity at its leased Cleveland Iron Works, though average output of the latter was only 20,000 tons by 1874, up from about 17,000 tons in 1869, of which 13,000 were rails (Daddow and Bannan 1866, 695; U.S. Census Office, 1870; AISA 1875, 82; AISA 1876, 100; AISA 1882, 135). Since the Cleveland railroads alone purchased about 21,000 tons of new and rerolled rails and 11,500 tons of steel rails in 1874 (though the LSMSRR may have obtained some steel rails from Chicago), local demand continued to help sustain the Cleveland rail mills during this period as they expanded to make the city one of the leading iron and steel centers of the Mid-West, and to serve national, as well as regional demand. For example, by 1868 CMRC was supplying the ‘Pacific Railroad’ and in 1875 it was awarded its largest ever contract, to supply 23,500 tons of iron and steel rails for the new Cincinnati Southern Railroad (AoC, 1868, 285; 1875, 276; Lovett, 1875; Coulter, 1922). Details of the competing bids show the company could hold its own against East Coast, Pittsburgh and Chicago suppliers by this date (New York Times, 1875). This evidence gives specific substance to Meyer’s general argument about the shift from regional to national market capability in the 1870s, at least in this industrial sector. Rail manufacture and re-rolling also demonstrate import replacing multiplier effects of the kind described by Jacobs (1970), but on a transatlantic scale. [Table 5 here]

**Table 5.** Suppliers of Rails in Use on the Atlantic and Great Western Railway in 1874

Supplier	Rail Type	Tons	Per Cent
Alliance Iron Co. (Ohio)	Iron	1537.94	2.60
Cleveland Iron Co.	Iron	19356.38	32.68
Cleveland Rolling Mill	Iron	11666.75	19.69
Cleveland Rolling Mill	Steel	90.57	0.15
Dowlais Iron Co. (Wales)	Steel	1482.38	2.50
Elmira Rolling Mill	Iron	638.57	1.08
Elmira Rolling Mill	Steel Capped	859.63	1.45
Ebbw Vale Steel Co. (Wales)	Steel	9310.55	15.72
English Unspecified	Iron	4077.72	6.88
Superior Rolling Mill (Pittsburgh)	Iron	2136.66	3.61
Trenton Iron Works	Steel Capped	2783.92	4.70
Valley Rolling Mill (Youngstown)	Iron	4064.3	6.86
Other Suppliers/Unattributable	Iron	1233.35	2.08
Total		59238.72	100.00

Source: Calculated from data in AGWRR (1875, 47-111).

Employment in primary iron, and later steel manufacture, followed a similar trajectory to capacity growth, though data are relatively sparse. In 1858, CRMC employed 125 workers out of an estimated total of 650 ironworkers ‘in and about Cleveland’ (Annals, 1858, 241). By 1866, the CRMC workforce had increased substantially to 5-600 (Annals, 1866, 249-250) and by 1880 to 1,500 employees (AISA 1880b, 135), owing in part to the lease of the Cleveland Iron Company. The latter had been less successful, in growth terms, since both 1866 and 1870 reports indicate a workforce of about 250 (CDL, Jan. 29<sup>th</sup> 1866; U.S. Census Office, 1870).

### **5.5 Construction and Maintenance of Railroad Infrastructure in the City**

The new railroads entering the city 1850-7, each with their own shops and roundhouses, created large scale construction activity on a continuing basis. There was extensive development and repeated modification of terminal piers, both on Lake Erie and on the old Cuyahoga River bed, where coal docks were built by the CPRR and the AGWRR (AGWRR, 1864, 22; RSC, 1874; see also Merchant, 1850; Hopkins, 1858; Lake, 1874). Further major projects in the 1860s included a new CCCRR shop complex and the 600 feet long Union Passenger Depot opened in 1866, which required 100 construction workers (AoC, 1866, 653-4). New mills and ironworks linked to the railroad sector continued to be built and expanded until the mid-1870s. In total, these projects required hundreds of men, over extended time periods.

### **6. Oil Refining - Forward and Backward Linkages**

The channelling of crude oil to Cleveland enabled forward linkages to the new refining industry to develop rapidly. Scofield and Company, among others, were already ‘doing a heavy business’ by 1863 (AoC, 1863, 330), when a successful local merchant called John D. Rockefeller entered the refining sector (Joblin, 1869, 422). Between 1864 and 1866 the number of refineries increased from 20 to nearly 50, representing an investment of \$3 million (CBoT for 1865, 15; for 1866, 27; AoC, 1866, 409f.). When Standard Oil was incorporated in 1870, quarterly revenues of the Cleveland refiners were \$4 million (AoC, 1870, 508). Setting aside its complex history in the following decade (see Hidy and Hidy, 1955; Tarbell, 1904), by 1880 Standard Oil alone was capitalised at \$3.5 million, and its fluctuating workforce of 1850-2600 men made it ‘one of the largest manufacturing establishments in the State’ (Ohio, Bureau of

Labor Statistics, 1879, 220; U.S. Census Office, 1880). It also controlled more than 90% of refined shipments from the city.

A comparison of the national shares of refining capacity between the leading centres of Cleveland, Pittsburgh and New York reveals a rapidly shifting geography. In 1866, Pittsburgh held the largest share of 41.6% to Cleveland's 21%. By 1870 the positions were reversed, as Cleveland's share peaked at 38% while that of Pittsburgh had fallen to 20%. Subsequently New York gained the ascendancy. Its share increased from 25% in 1870 to 45% in 1880, while the Pittsburgh and Cleveland shares declined markedly, albeit against a background of increasing national output (CTJ, 1877; CTJ, 1879a; Maybee, 1940, 224; Ohio, Secretary of State Annual Report for 1869, 217; Pennsylvania, Bureau of Statistics, 1874, 260-1). These changes were neither the outworking of impersonal economic forces nor the effects of geographical inertia. Rather they resulted from the ruthless and, it was argued, illegal activities of the Standard Oil Company in setting up freight rate structures with the railroads that selectively favoured its own operations, especially those in Cleveland. The resulting excess profits were used to buy up ailing competitors and dismantle their works in Pittsburgh and elsewhere, while the company expanded its New York and Cleveland refineries (Report of Committee of Investigation, 1889, 115, 232-4).

While channelling of crude initially enabled Cleveland to develop as a refining centre, this trend was later reinforced by Rockefeller's ceaseless quest for business efficiency. However, the subsequent rapid expansion of refining into the early 1870s, when Cleveland interests controlled price levels in the *entire* US market (AoC, 1870, 507; 1871, 458), was very largely the result of deliberate manipulation of both freight rates and ultimately the geography of the refining industry itself, to serve the monopolistic objectives of Standard Oil.

The refining industry also had important backward linkages to the coal industry, metal fabricating and barrel manufacture (cooperage). One ton of coal was used for every 25 barrels of oil refined (U.S. Census Office, 1884, 188). For example, in October 1874, Standard Oil alone used 8,000 tons of bituminous and 3,000 tons of anthracite coal in Cleveland (AoC, 1874, 355). Such large coal shipments added substantially to railroad employment. A number of metal fabricators made oil tanks and stills for city refineries, in addition to engines and driving pipe for wells on Oil Creek (Table 4). In 1866, some

300,000 barrels were made, again largely for the oil refiners, at 200 different 'shops' in the city, which employed about 500 men (CBoT for 1866, 30). Similarly, when Rockefeller had 100 refinery workers, he was also indirectly giving work to another 7-800 barrel-makers (Joblin, 1869, 422). By 1878, Standard Oil was making its own barrels. This partially explained the large increase in 'refining' employment at the company from about 100 men to 2500 during the 1870s (Ohio, Bureau of Labor Statistics, 1878, 220).

## **7. The Railroad as the Key Driving Force of Cleveland's Economic Development 1850-1870**

In 1860-1 the railroad sector was overwhelmingly the largest industrial employer in the city, more than twice the size of primary iron manufacture (including general castings), which had 433 workers in the census. Railroad shops initially engaged in the manufacture of cars, and later locomotives, in addition to repair and rebuilding work. Both shop and train service employee numbers continued to increase during the 1860s, as a result of both general traffic expansion, much of it related to coal, iron and oil, and expansion of shop and depot facilities in the city. In 1870 there were an estimated 2750 railroad workers and just over 2000 in primary metal manufacture, since CRMC was omitted from the 1870 census. A further 550 people were employed in the manufacture of stoves, general machinery, engines and boilers (U.S. Census Office, 1870; U.S. Census Office, 1872b, 712). An 1871 report, based on a firm-by-firm enumeration (Wiggins and Company, 1872, 106), gave about 3,000 workers in primary iron manufacture, but output had increased by 50% since the previous year, so employment would have grown also. On this basis, the railroad sector was still just leading at this date. Primary iron manufacture was developing steadily, though more than half of 1870 output was still destined for the local and national railroad sector, in the form of rails, spikes etc. (CBoT, 1865, 13-14; Wiggins and Company, 1872, 106). Secondary metal fabrication was also becoming a significant employer, but was still less important than the railroad-linked manufacturing sector described in section 5.3. Reliable estimates for oil refining are difficult because of a 60% under-enumeration of firms, based on comparison of city directory and census data. Perhaps 600 men were directly employed and a similar number in refining-linked cooperage, because by this time barrel use was being replaced by railroad tank car shipments. This combined grouping ranked third in the city.

By 1880, railroad employment growth had slowed, to give an estimated total of about 3,800 workers. Meanwhile, the primary iron and steel total had risen to 4,038 men and 460 boys. These figures include CRMC. Foundry and forging work accounted for another 2,670 workers and three other groupings of secondary iron manufacture including nails, bolts and screws; bridges; and miscellaneous ironwork employed 5-600 additional workers each (U.S. Census, 1883b, Table V, 323). Judging by the firm names in the manuscript schedules, any census under-reporting is limited. Thus primary iron and steel had finally surpassed the railroad sector by 1880. After 1870, secondary metal fabrication expanded rapidly, based in part on backward linkages to the local iron, oil and railroad industries, though much pig iron still came from the Mahoning Valley. Even with Standard Oil, refining-related employment still ranked third in the city behind the railroads.

The transportation sector, with its multiple railroad shops, was therefore the key driving force in early manufacturing development in Cleveland and the leading employer until well after the Civil War. The sector channelled coal and crude oil to the city's homes, factories and refineries, and distributed lake-supplied iron ore, both to local and more distant furnaces. By neglecting the transportation sector entirely, the NEG model necessarily fails to explain the key direct and indirect stimuli the sector provided to manufacturing employment growth prior to 1880.

The identification of the railroad as a key factor in AMB emergence also re-opens a host of old debates from Marx onwards, about railroads and economic growth (Marx, 1930; Rostow, 1960; Fogel, 1964; Atack et al., 2010) and the role of transport innovations in long waves, which do not feature in NEG models. Though Kondratieff cycle promoters (Schumpeter, 1939; Freeman and Louçã, 2001), deniers (Solomou, 1987) and modifiers (Tylecote, 1992) abound, the enthusiasts find common ground in broad generalizations which lack specific evidence about causal links and temporal sequences. For example, Rostow argues that railroads led to the development of the coal industry, whereas factor channelling suggests the causality is in the reverse direction. Likewise, despite noting the role of railroads in stimulating the engineering sector, references to the fundamental role of railroad shops are almost entirely lacking, and there is no understanding of the specific geography of the shops that focused development in selected locations, which were 19<sup>th</sup> century analogues of the nodes in Castell's present-day 'space of

flows' (Castells, 2009). Even Fishlow and Fogel, the most scrupulous of evidence-based scholars, lacked data on the shops, which prevented tracing of their direct and indirect effects on population and manufacturing growth. The present analysis is a first step in rectifying this deficiency in past studies.

## **8. Increasing Returns and AMB Emergence**

Since the railroad has been found to be the key driver of manufacturing development, at best a supporting role is left to the NEG mechanism of increasing returns to scale. Even this must now be tested on evidence not only from the key manufacturing sectors, but also from the railroad sector where the possibility of such increasing returns was not considered by the NEG theorists.

It will be found that a much more nuanced treatment of increasing returns is required, e.g. based on economies of size rather than economies of scale. Also, the extent of increasing returns varied between sectors and in manufacturing, they developed too late to contribute to AMB emergence.

Census inconsistencies and omissions render a statistical approach infeasible, so evidence on physical industrial plant sizes and technology derived from non-census sources will be utilized.

### **8.1 Economies of Scale in Railroad Operations**

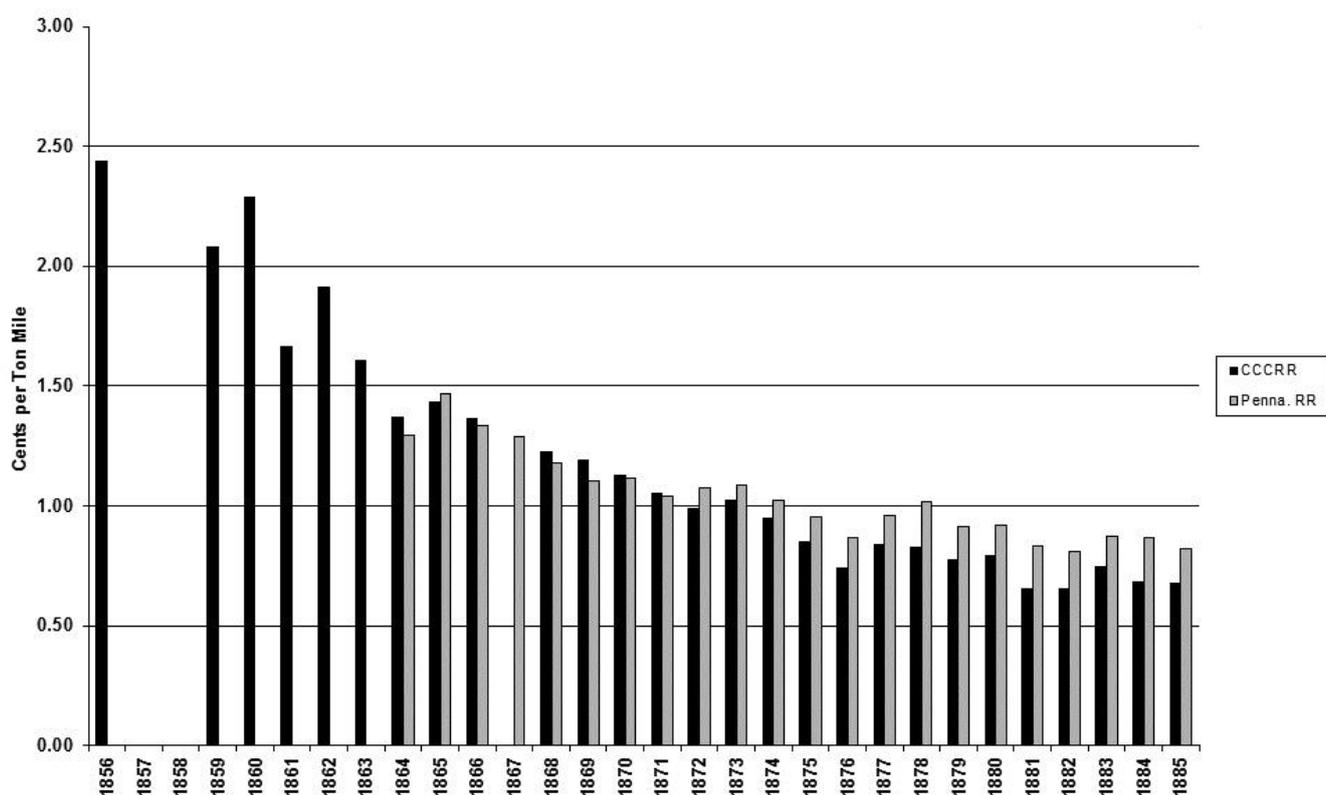
Possibilities for scale economies, both in the port and transportation operations of railroads must now be examined. For example, by 1874 the AGWRR alone was handling 800 cars a day for the Cleveland docks trade (Tyler, 1874, 84), so cargo transfers to and from schooners required a significant workforce. Small hoisting engines, which reduced unloading times for a 300-ton cargo from four days to one, replaced the trusty wheelbarrow in 1867. The bucket elevator was first deployed in Cleveland in 1882, but the massive Hulett automatic ore unloaders, which revolutionized bulk transfer from vessel to railroad cars (Hulett Automatic Unloaders, n.d.; Miller, 1983) were not installed until the 20<sup>th</sup> century. Manual unloading had cost 50 cents per ton, hoisting engines 18 cents, and the Huletts only 5 cents. Thus, prior to 1880, the modest steam-powered hoist was the most important innovation that expedited dock-based commerce. Increased throughput on the docks certainly contributed to the fourfold increase in CPRR iron ore traffic and the near trebling of coal traffic 1866-73 (RSC, 6, 12). Yet, since major economies of scale in port operations had to wait for the Hulett Unloaders they were therefore the consequence, not the cause of the virtuous circle of this component of the city's growth.

Although cities competed to host railroad shops, once established the latter were not really in competition with one another, in the normal manufacturing sense. Also, no contemporary reports claiming major economies of scale in the operation of shops have been found. Size was more related to expected volume of throughput, in terms of repairs to rolling stock and motive power. Over the long-term, measured in decades, technological improvements in locomotives *on average* allowed longer freight trains to be run and car sizes to increase (Fishlow, 1966, 603-4). However, the marked and not necessarily coincident cycles of motive power or rolling stock acquisition documented earlier, meant there could be extended periods when no locomotives or cars, or both, were purchased. For example, after the Civil War the CCCRR was still running the same engines as in the mid-1850s, though the number of cars had more than doubled. Until engine capacity was reached, adding more cars per train allowed more freight to be moved and more efficient use of equipment. Exactly this happened during the Civil War, when there were few new locomotives and minimal changes to the mileage of tracks both on the CCCRR and in Ohio (CCCRR AR, 1860, 9; 1862, 10-11, 13). In railway economics terminology this demonstrates increasing returns to *traffic density* with the network held constant, a well-established phenomenon, rather than to the overall *scale* of operations, where constant returns have generally been found to apply (Jenks, 1944; Graham et al. 2003). This is also the first evidence to support Fishlow's general hypothesis of dramatic declines in capital-output ratios on the railroads during the Civil War, as a result of increased traffic on a largely static network (Fishlow, 1966, 630-1).

## **8.2. Freight Rates and Manufacturing Development**

Increased returns to traffic density imply real terms freight rate reductions through more efficient use of transportation equipment. To test this, despite the extreme scarcity of freight rate data per ton-mile prior to the Civil War (cf. Fishlow, 1965, 334), figures for the period 1856-1885 have been compiled for the CCCRR and compared with the benchmark series of the Pennsylvania Railroad (Schotter, 1927), which begins in 1864. These rates have also been converted to constant dollars, unlike previous studies (e.g. Earle, 1987), thereby eliminating the inflationary influence of the War and its aftermath. The resultant graph shows that the average rate on the CCCRR declined by 54% from 2.44 cents to 1.13 cents 1856-70, followed by a slower 40% reduction in 1870-85 (Figure 7). By the early 1880s competitive

pressures forced rates down faster than cost reductions could be made, leading the Board of Directors to complain about the resulting squeeze on operating margins (CCCIRR AR, 1881, 9). These rate reductions should have stimulated manufacturers to expand their markets, the range of products offered and after a time lag, plant sizes (but see below). The largest real reduction in a short period was that of nearly 1 cent/ton-mile in 1860-64 when the economic stimulus of the War caused freight ton-miles to double. The reduced rates were largely maintained after the War, even though freight traffic declined for several years thereafter (CCCRR AR, various years).



**Figure 7.** Annual Average Freight Rates on the CCCRR and Pennsylvania Railroad 1856-1885

Other Civil War era data for the CPRR and CMRR confirm the CCCRR rate findings (CPRR AR, 1863, 1864; AGWRR, 1866, 63) suggesting they were quite pervasive, at least across Ohio and Pennsylvania. While the onset and time trajectory of this progressive transport cost stimulus is now clear, the timescale of the response in terms of increased manufacturing activity is not. The longer the time lag, the less the contribution to AMB emergence before 1870. Evidence on total output of railroad iron and castings in the city suggests that any effects from a stimulus of this kind were certainly not apparent

before 1868-9 (CBoT for 1868,1869) and this is further supported by evidence below on company incorporations.

### **8.3 Scale Economies in Iron and Steel**

As the oldest and best capitalized mill in the state, the CRMC should have demonstrated scale economies if these could be achieved (New York Times, 1879; MacKeigan, 2011). The company expanded through a combination of new investment in blast furnaces, take-overs, vertical integration, technological innovation and product diversification. Their two 1864 blast furnaces, which used raw bituminous coal from Youngstown, were 50' high. They were subsequently rebuilt to a height of 60' in the early 1870s. The 1869 Proton furnace of the CIC was also 60' high. It was later rebuilt at 70', to match the second furnace on the same site, built by CRMC in 1879 (the 1882 Central Furnace was 75' high) (CDL, Feb. 3, 1866; AISA 1873, 36; AISA 1876, 49; Ohio, Geological Survey, 1884, 456). These findings are critical to the question of scale economies, because Walsh's study of the Pennsylvania iron industry up to 1870 failed to demonstrate increasing returns and even suggests decreasing returns in furnaces using bituminous coal for fuel (Walsh 1975, 157). The early Pennsylvania furnaces in his dataset were of similar height to those in Cleveland pre-1870. Not until 1868 did British metallurgical studies first prove that extremely large furnaces (70' +) were required to obtain both 14% scale economies and better quality iron (Cochrane, 1869). This provided the first scientific rationale for building such furnaces, an innovation adopted in the USA during the 1870s (Gruner, 1874) and apparent in the Cleveland data given above. Industry-wide achievement of scale economies was therefore not possible in primary iron manufacture until new very large furnaces were built in the 1870s.

Examples of other strategies include the early take-over of the rail mill on the lakeshore prior to 1863 and a wire mill at Newburgh in 1868. Coal and ore mining operations were also added over time (AoC, 1867, 282; Comley and D'Eggville, 1875, 406). In 1867-8 CRMC became the first Ohio adopter of Bessemer technology when it installed two 5-ton converters. This was increased to 4 by 1873, but then reduced to two 6-ton converters by 1878, which were upgraded to 10-tons by 1882. Three 7-ton Siemens-Martin open hearth steel furnaces were installed in 1876-8. Two 15-ton furnaces were added by 1882. (AoC 1868, 286; AISA 1873, 6; AISA 1878, 113; AISA 1880a, 35; AISA 1880b, 135; AISA 1882, 135).

Despite clear evidence of innovation here, the change to larger, more efficient equipment beyond the initial technological advances took place in the late 1870s. This was *after* the company had become a major player in national markets, so it cannot be argued that increasing returns were a prerequisite for this to happen.

In secondary iron manufacture, as noted earlier, Meyer argued for an absence of scale economies and a regional market orientation (Meyer 1983, 155-6). Though elements of specialization by firms began to develop progressively, there is a dearth of evidence on precise timing (Rosenberg 1963) or on possible implications for increasing returns. To address this deficiency, a new dataset has been developed, which contains legal details of all the several thousand companies incorporated in Ohio 1860-1873. Except for data limitations in 1871, it gives each firm's location, its products and the maximum permitted capital stock (Ohio, Secretary of State, 1852 - ). Not all industrial activity is tracked, since small concerns were often not incorporated and occasionally, larger firms only incorporated when they had become well-established. Also, the maximum capital stock permitted by law and the actual amounts paid in would differ, especially shortly after incorporation, but comparison with newspaper and other sources suggests the capital stock figure reflects medium-term investment intentions.

Based on these data, the leading Ohio counties in terms of the total maximum capital stock of new primary iron and steel manufacturers, non-railroad producer durables companies and machinery firms incorporated in the period were Cuyahoga (Cleveland) and Hamilton (Cincinnati), with figures of \$10.04 million and \$4.84 million respectively. Producer durables here cover foundries and metal fabricating works. Given that the population of Hamilton County was double that of Cuyahoga in 1870, the reversal of investment ranking is very marked. While similar numbers of companies were involved, the average capital stock of Cincinnati companies was much smaller (\$118K) than in Cleveland (\$223K). Table 6 shows the year-by-year totals and averages in the two counties for the above categories 1862-1873. There were no relevant incorporations in 1860-1. Since capital was usually paid in over a period of time, constant dollar conversion is not appropriate. In both counties, new incorporations are very limited during the Civil War, but increase immediately thereafter. A second wave occurs in the late 1860s but this peters out in Cincinnati, while growth is more sustained in Cleveland. In neither case is there an upward trend in

average intended firm size, so the growth in Cleveland up to 1873 is primarily based on increasing numbers of companies, not on increasing company size. It should be noted that none of the averages are composed of a small minority of very large firms and a majority of tiny firms. These important new findings show the shorter-term dynamics of industrial development that cannot be identified from the census. Firstly, they show that augmentation of the manufacturing base of Cleveland by larger incorporated companies was very limited until after the Civil War. Secondly, sustained increases in new capacity did not become well established until after 1870. So Meyer's finding that relative industrial concentration may have peaked by the 1870s in AMB cities seems questionable in the Cleveland case. Thirdly, there was no standard pattern across cities, as the divergent development paths of Cleveland and Cincinnati indicate. Finally, the evidence strongly supports Meyer and Atack's claims that scale economies in manufacturing, as evidenced by average company size in iron manufacture, were not well developed as late as the 1870s, and therefore were not a major factor in AMB emergence, contradicting Krugman's argument. Neither, it seems, did transport cost reductions filter through into new manufacturing investment early enough to make a contribution.

**Table 6.** Total and Average Maximum Capital Stock (in '000s) of Newly Incorporated Primary Iron and Steel and Producer Durables Manufacturers in Cuyahoga (Cleveland) and Hamilton (Cincinnati) Counties, Ohio 1862-1873

	Cuyahoga		Hamilton		Hamilton	
Year	N	Total Capital Stock	Average Capital Stock	N	Total Capital Stock	Average Capital Stock
1862	2	160	80	0	0	0
1863	1	500	500	2	175	88
1864	1	200	200	1	50	50
1865	1	100	100	3	520	173
1866	4	685	171	8	935	117
1867	6	1900	317	2	400	200
1868	5	490	98	4	350	88
1869	3	660	220	3	850	283
1870	1	100	100	5	695	139
1871						
1872	6	855	143	9	580	64
1873	13	2175	167	4	285	71

## 8.4 Scale Economies in Oil Refining

After the Civil War a 'large capital' was already needed for oil refining because of small margins and trade fluctuations (CDL, Jan. 4, 1866). Montague argues, without giving a source, that a capital of \$500K was required to realize production efficiencies in the pre-1870 period (Montague 1903, 8), but no such well-capitalized refineries have been found, either in the 1870 census or in the comprehensive lists of larger companies reported in the newspapers, prior to the \$1 million incorporation of Standard Oil in 1870 (CDL, various issues, Jan. 1866). Standard, however, was a merger of the smaller operations of J.D. and W. Rockefeller and others, which comprised a large number of small refining stills on multiple sites, rather than a large integrated plant that dwarfed its smaller competitors. J. D. Rockefeller discussed the early industry, not in terms of productive efficiency, but in terms of the problems of financing the large lake and canal shipments of oil required to obtain the most favourable transportation rates (Rockefeller 1909, 20). Given Standard's later obsession with low railroad rates to market, confirmed by examination of Rockefeller's correspondence with his managers over a number of years (Porter, 1992), where no reference to scale economies has been found, this is a much more convincing early rationale for large capital requirements than Montague's unsubstantiated claim about productive efficiency. Though Standard increased its market share from 4% in 1870 to 95% in 1878 (Montague 1903), this was by means of economies of *size* (and other less reputable means, as noted earlier), not economies of *scale*, to drive down transportation costs below those of competitors. Post 1880, examination of anti-trust investigations against Standard also found no evidence of refining economies of scale unavailable to competing firms (Jones 1929, 63).

## 9. Conclusions

The NEG model of AMB emergence is driven by increasing returns and neglects the role of factor endowments. It relies on the iceberg cost model for tractability, but this approach prevents consideration of employment and linkage processes involving the transportation sector. Detailed investigation of development processes in a number of industrial sectors has shown that the current NEG approach cannot withstand empirical scrutiny. These processes had a number of interconnected strands. Firstly, a close interrelationship between natural resource exploitation and the expansion of the railroad network was

identified, leading to the new concept of ‘factor channelling’, where specific strategies of known individuals with strong railroad company links, rather than impersonal market forces, focused natural resource streams on specific locations, with only limited regard for transport cost considerations. Secondly, the first major phase of these developments during the 1850s provided a key direct employment stimulus at this time, especially in urban centres such as Cleveland, where multiple railroads sited repair shops. This large effect has been missed in earlier studies because of unrecognized shortcomings in census data. Thirdly, both railroad shops and natural resource processing industries encouraged by factor channelling, stimulated secondary manufacturing, whether in producer durables or, for example, cooperage for oil refineries, thereby generating further employment growth. The result was not a classic Marshallian industrial district (Marshall 1920, Sunley 1992) comprising small concerns, because the shops were large and the nexus of a railroad-industrial complex. However, in respect of the Marshallian emphasis on external economies in the form of a pool of skilled labour, the effect was similar in either case. The concentration of skilled employees in the shops and foundries provided a fertile breeding ground for new manufacturing methods, as patent filings by Clevelanders indicate (Lamoreaux, Levenstein and Sokoloff, 2007). Fourthly, these direct and indirect effects of transportation and factor channelling on wider economic development first became important in the 1850s and 1860s, early enough to explain industrial expansion before the 1870s when Atack and Meyer argue scale economies began to become important. Fifthly, scale economies could only be identified for iron and steel from the late 1870s onwards. In oil refining, economies of size, not scale, were found, while on the railroads, economies of traffic density initiated progressive reductions in real freight rates, but the lagged effects of these did not become apparent until the end of the 1860s. Apart from long-run rate declines, these findings do not support the simple assumptions of the NEG model. They indicate a more complex model specification than merely increasing returns is required; and one where the transport sector is accurately represented.

Several specific directions for future research also suggest themselves as a result of the present study. Firstly, and most obviously, further empirical work in support of improved model specifications needs to expand the range of case study cities, looking at factor channelling processes, the effect of varying industrial mixes on growth rates and the differential timing and impact of scale, size and other

types of economies in a range of industrial sectors. Pointers in this direction can already be seen in previous studies, e.g. Wilson briefly mentions the importance of railroad shops and car manufacture in Chicago before the Civil War (Wilson, 2005) and Fishlow (1965, 155) makes a similar point about 1850s Detroit. Secondly, the evidence presented here showing the strongly cyclical nature of railroad-related manufacturing, which peaked in the early/mid 1850s, but collapsed at the end of the decade, raises important questions about the reliability of Fogel's key assertion that the railroads made a very limited contribution to overall value-added in manufacturing up to 1860. This assertion, based on 1860 manufacturing census data, albeit with a correction for missing railroad shops, has been accepted without question, even by one of his sternest critics (David, 1969). However, the census returns necessarily reflect the virtual cessation of railroad-related manufacturing in 1859/60 and do not reflect the activity of the 1850s as a whole. Wider confirmation of the cyclical trends reported here is needed from a range of example railroads, followed by a detailed re-examination of Fogel's calculations. Thirdly, factor channelling implies the concerted actions of possibly overlapping groups of influential economic actors. It therefore provides a link to more sociologically-based explanations of regional development related to the formation of urban and regional elites (Ingham, 1978). Further analysis of company incorporation data in conjunction with identification of interlocking directorates, especially between the railroad and financial sectors, is a very promising avenue for future work in this area. Finally, 19th century railroad presidents were acutely aware of the need to secure long-term, steady growth of traffic to justify the large investments made in track construction, rolling stock and terminal facilities. Fostering development of manufacturing and mineral resource exploitation in settlements and locations tributary to their lines was therefore a key priority. Very little work has been undertaken on the role and relative success of railroad managers and investors in establishing the context for future geographical inertia. That such activities were important cannot be doubted, one clear example (and a further instance of factor channelling) being the rise of the Toledo coal trade to compete with Cleveland from the 1880s onwards. This development stemmed largely from the strategic construction of the Columbus, Hocking Valley and Toledo Railroad and the business activities of interests allied to it.

Wherever possible, these avenues of further work should engage with surviving company records, in addition to the types of printed sources used here, as census data in isolation lack the accuracy, consistency and temporal resolution to identify many of the dynamics of interest.

## References

AISA. (1873) *Classified List of Rail Mills and Blast Furnaces in the United States. Prepared by James. M . Swank*. Philadelphia: American Iron and Steel Association.

AISA. (1875) *Annual Report of the Secretary of the American Iron and Steel Association to December 31, 1874*. Philadelphia: Chandler.

AISA. (1876) *The Ironworks of the United States: A Directory of the Furnaces, Rolling Mills, Steel Works, Forges and Bloomaries in Every State. Centennial Edition*. Philadelphia: American Iron and Steel Association.

AISA. (1878) *The Iron and Steel Works of the United States: Corrected to March 1, 1878*. Philadelphia: American Iron and Steel Association.

AISA. (1880a) *Statistics of the American and Foreign Iron Trades in 1879: Annual Report of the Secretary of the American Iron and Steel Association presented to the Members, May 20, 1880*. Philadelphia: American Iron and Steel Association.

AISA. (1880b) *The Iron and Steel Works of the United States: Corrected to March 15, 1880*. Philadelphia: American Iron and Steel Association.

AISA. (1882) *Directory to the Iron and Steel Works of the United States: Corrected to July 25, 1882*. Philadelphia: American Iron and Steel Association.

American Iron Association (1856-58) *Bulletin of the American Iron Association*. Philadelphia: American Iron Association.

Annals of Cleveland (1936-) *Annals of Cleveland, Works Progress Administration in Ohio. Years 1850-1876*, 27 vols, (approx. 17,000 pages of typescript). Cleveland: WPA, District Four.

Atack, J. (1985a) *Estimation of Economies of Scale in Nineteenth Century United States Manufacturing*. New York: Garland.

Atack, J. (1985b) Industrial structure and the emergence of the modern industrial corporation. *Explorations in Economic History*, 22: 29-52.

Atack, J. (1987) Economies of scale and efficiency gains in the rise of the factory in America, 1820-1900. in P. Kilby (ed) *Quantity and Quiddity: Essays in U.S. Economic History*. Middletown, CN: Wesleyan University Press.

Atack, J., Bateman, F., Haines, M. and Margo, R.A. (2010) Did railroads induce or follow economic growth?: urbanization and population growth in the American Midwest, 1850–1860. *Social Science History*, 34: 171-197.

Atlantic and Great Western Railway (1864) *First Annual Report of the Central Board of Management of the Atlantic and Great Western Railway Companies to the Stockholders for the Year ending December 31st, 1863*. Buffalo: Wheeler, Matthews and Warren.

Atlantic and Great Western Railway (1865a) *Second Annual Report of the Atlantic and Great Western Railway Companies to the Stockholders and Bondholders, for the Year Ending December 31st, 1864*. New York: Hosford and Ketcham.

Atlantic and Great Western Railway (1865b) *Report to the Directors in London of the Atlantic and Great Western Railway by Thomas W. Kennard, May 15th 1865*. London: John King and Company.

Atlantic and Great Western Railway (1866) *Reply to the Statements of James McHenry and Others, in Relation to the American Management of the Atlantic and Great Western Railway, together with the Fourth Annual Report of the Atlantic and Great Western Railway Co., Ten Months, Ending October 31, 1866*. Meadville, PA: Republican Printing House.

Atlantic and Great Western Railway (1875) *Report and Inventory of the Atlantic and Great Western Railway to J. H. Devereux, Receiver, 9<sup>th</sup> December, 1874*. n.p.

Behrens, K. and Robert-Nicoud, F. (2011) *Tempora Mutantur: in search of a New Testament for NEG*. *Journal of Economic Geography*, 11: 215-230.

Castells, M. (2009) *The Rise of the Network Society, Vol. 1* (2<sup>nd</sup> Edition). Hoboken, NJ: Wiley-Blackwell.

Cleveland and Mahoning Railroad (1853 - ) *Annual Report for the Year 1852 etc.*

Cleveland and Pittsburgh Railroad (1851 - ) *Annual Report for the Year 1850 etc.*

Cleveland and Toledo Railroad (1854 - ) *Annual Report for the Year 1853/4 etc.*

Cleveland Board of Trade (1866 - ) *Annual Report of the Trade, Commerce and Manufactures of the City of Cleveland, for the year 1865 etc. Reported to the Board of Trade by J. D. Pickands.* Cleveland: Fairbanks, Benedict and Co.

Cleveland Chamber of Commerce (1912) *Annual Report of the Cleveland Chamber of Commerce.* Cleveland: Chamber of Commerce.

Cleveland, Columbus and Cincinnati Railroad (1852 - ) *Annual Report for the Year 1851 etc.*

Cleveland, Columbus, Cincinnati and Indianapolis Railroad (1869 - ) *Annual Report for the Year 1868 etc.*

Cleveland Directory (1861) *J. H. Williston and Co.'s Directory of the City of Cleveland to which is added a Business Directory for 1861-62.* Cleveland: Ben Franklin Print.

Cleveland Directory (1866) *Cleveland Leader City Directory, for 1866-67, together with a Business Directory.* Cleveland: Cleveland Leader Publishers.

Cleveland Daily Leader (1865-6) Daily Issues October 1865 – August 1866. Digital versions available from <http://chroniclingamerica.loc.gov>.

Cleveland, Painesville and Ashtabula Railroad (1861 - ) *Annual Report for the Year 1861 etc.*

Coal Trade Journal (1877) "Petroleum production". *Coal Trade Journal*, January 24, 1877.

Coal Trade Journal (1879a) "The petroleum industry". *Coal Trade Journal*, January 29, 1879.

Coal Trade Journal (1879b) "Columbus and Sunday Creek Valley Railway". *Coal Trade Journal*, February 19, 1879.

Coal Trade Journal (1879c) "Columbus manufactures - our fuel supply". *Coal Trade Journal*, March 19, 1879.

Coal Trade Journal (1880a) "The coal business at Salineville, Ohio". *Coal Trade Journal*, January 21, 1880.

Coal Trade Journal (1880b) "Cost of making pig iron in Hocking Valley, Ohio". *Coal Trade Journal*, February 4, 1880.

Cochrane, C. (1869) On the further utilisation of the waste gas from blast furnaces, and the economy of coke due to increased capacity of furnace. *Proceedings, Institution of Mechanical Engineers*, 21-76.

Comley, W. J. and D'Eggville, W. (1875) *Ohio: the Future Great State. Her Manufacturers and a History of her Commercial Cities, Cincinnati and Cleveland*. Cincinnati and Cleveland: Comley Brothers Manufacturing and Publishing Company.

Coulter, E. M. (1922) *The Cincinnati Southern Railroad and the Struggle for Southern Commerce, 1865-1872*. Chicago: The American Historical Society.

Crowell, D. L. (1995) *History of the Coal-Mining Industry in Ohio*. Columbus: Ohio Dept. of Natural Resources, Division of Geological Survey.

Daddow, S. H. and Bannan, B. (1866) *Coal, Iron and Oil*. Pottsville, PA: B. Bannan.

David, P. A. (1969) Transport innovation and economic growth: Professor Fogel on and off the rails.

*Economic History Review, New Series*, 22(3), 506-525,

De Geer, S. (1927) The American Manufacturing Belt. *Geografiska Annaler*, 9: 233-359.

Derrick's Hand-Book (1898) *The Derrick's Hand-Book of Petroleum: A Complete Chronological and Statistical Review of Petroleum Developments from 1859 to 1898*. Oil City: Derrick Publishing Company.

Dolson, H. (1959) *The Great Oildorado - The Gaudy and Turbulent Years of the First Oil Rush: Pennsylvania 1859 - 1880*. New York: Random House.

Driggs, G. (comp) (1878) *Corporate History, Mortgages, Principal Leases, Agreements, Deeds and Papers of the Erie and Pittsburgh Railroad Company etc. Vol. B*. Pittsburgh: Stevenson, Foster and Company.

Earle, C. (1987) Regional economic development west of the Appalachians. In Mitchell, R. D. and Groves, P. A (Eds.) *North America: the Historical Geography of a Changing Continent*. London: Hutchinson.

Eavenson, H. N. (1942) *The First Century and a Quarter of American Coal Industry*. Pittsburgh: Privately Printed.

Encyclopedia of Cleveland History (1997a) *Collinwood Railroad Yards*. On-line at <http://ech.case.edu/ech-cgi/article.pl?id=CRY>, accessed 15 April 2012.

Fels, R. (1959) *American Business Cycles, 1865-1897*. Chapel Hill: University of North Carolina Press.

Fishlow, A. (1965) *American Railroads and the Transformation of the Ante-Bellum Economy*.

Cambridge, MA: Harvard University Press.

Fishlow, A. (1966) Productivity and Technological Change in the Railroad Sector, 1840-1910. In Brady, D.S. (ed) *Output, Employment and Productivity in the United States after 1800*. Washington, DC: NBER.

Fogel, R. W. (1964) *Railroads and American Economic Growth: Essays in Econometric History*.

Baltimore: Johns Hopkins Press.

Freeman, C. and Louçã, F. (2001) *As Time Goes By: From the Industrial Revolutions to the Information Revolution*. Oxford: Oxford University Press.

Fujita, M., Venables, A. and Krugman, P. (1999) *The Spatial Economy: Cities, Regions and International Trade*. Cambridge, MA: MIT Press.

Graham, D. J., Couto, A., Adeney, W. E. and Glaister, S. (2003) Economies of scale and density in urban rail transport: effects on productivity. *Transportation Research (Part E)*, 39: 443-458.

Giddens, P. H. (1938) *The Birth of the Oil Industry*. New York: Macmillan.

Giddens, P. H. (1947) *Pennsylvania Petroleum 1750 - 1872: A Documentary History*. Drake Well Memorial Park, Titusville, PA: Pennsylvania Historical and Museum Commission.

Giddens, P. H. (1948) *Early Days of Oil*. Princeton: Princeton University Press.

Gruner, M. L. (1874) *Studies of Blast Furnace Phenomena*. Translated by L. D. B. Gordon. Philadelphia: Henry Carey Baird.

Guinnane, T. W., Sundstrom, W. A. and Whatley, W. (eds) (2004) *History Matters : Essays on Economic Growth, Technology, and Demographic Change*. Stanford: Stanford University Press.

Harris, C. D. (1954) The market as a factor in the localization of industry in the United States. *Annals of the Association of American Geographers*, 44: 315-348.

Havighurst, W. (1958) *Vein of Iron : the Pickands Mather Story*. Cleveland : World Publishing Co.

Healey, R. G. (2011) A full-scale implementation of the NAPP 1880 U.S. Census data set using dimensional modeling and data-warehousing technology. *Historical Methods*, 44 (2): 95-105.

Healey, R.G. (2014) Under-enumeration, inconsistency and bias in the US Manufacturing Census 1860-1880: case studies from the American Manufacturing Belt. Submitted to *Historical Methods*.

Hidy, R.W. and Hidy, M.E. (1955) *Pioneering in Big Business 1882-1911: History of the Standard Oil Company (New Jersey)*. New York: Harper and Brothers.

Hopkins, G. M. (1858) *Map of Cuyahoga County, Ohio*. Philadelphia: S.H. Matthews.

Hulett Automatic Unloaders (n.d.) *The Hulett Automatic Unloaders Online*. Available at <http://www.clevelandmemory.org/glihc/hulett/index.html>. Accessed March 1, 2012.

Industries of Cleveland (1879) *Industries of Cleveland. Commerce and Manufactures for the Year 1878*. Cleveland: Richard Edwards.

Ingham, J. N. (1978) *The Iron Barons: a Social Analysis of an American Urban Elite, 1874-1965*. Westport, Conn. : Greenwood Press.

Jacobs, J. (1970) *The Economy of Cities*. London: Cape.

Jenks, L. H. (1944) Railroads as an economic force in American development. *Journal of Economic History*, 4: 1-20.

Joblin, M. (1869) *Cleveland, Past and Present: its Representative Men: Comprising Biographical Sketches of Pioneer Settlers and Prominent Citizens, with a History of the City*. Cleveland: Maurice Joblin.

Johnson, A. M. and Supple, B. E. (1967) *Boston Capitalists and Western Railroads : a Study in the Nineteenth-Century Railroad Investment Process*. Harvard Studies in Business History, No.23. Cambridge, Massachusetts: Harvard University Press.

Jones, E. (1929) *The Trust Problem in the United States*. New York: Macmillan.

Kennedy, J.H. (1896) *A History of the City of Cleveland: Its Settlement, Rise and Progress 1796-1896*. Cleveland: The Imperial Press.

Kim, S. (1995) Expansion of markets and the geographic distribution of economic activities: trends in U.S. regional manufacturing structure, 1860-1987. *Quarterly Journal of Economics*, 110: 881-908.

Klein, A. and Crafts, N. (2011). Making sense of the Manufacturing Belt: determinants of U.S. industrial location, 1880-1920. *Journal of Economic Geography, Business and Economic Geography Virtual Issue*: 1-33, doi: 10.1093/jeg/lbr023.

Krugman, P. (1991a) Increasing returns and economic geography. *Journal of Political Economy*, 99: 483-499.

Krugman, P. (1991b) *Geography and Trade*. Cambridge, MA: MIT Press.

Krugman, P. (1991c) History and industry location: the case of the manufacturing belt. *American Economic Review Papers and Proceedings*, 81: 80-83.

Krugman, P. (1998) Space: the final frontier. *Journal of Economic Perspectives*, 12: 161-174.

Lake, D. J. (1874) *Atlas of Cuyahoga County, Ohio, from Actual Surveys by or under the Direction of D.J. Lake, C.E.* Philadelphia: Titus, Simmons and Titus.

Lake Shore and Michigan Southern Railway Company. (1871 - ) *Annual Report for the Year 1870 etc.*

Lake Shore and Tuscarawas Valley Railway. (1871) *First Report of the President and Directors of the Lake Shore and Tuscarawas Valley Railway Company to the Stockholders, November 14th, 1871.* Cleveland: Leader Printing Company.

Lamoreaux, N., Levenstein, M. and Sokoloff, K. L. (2007) Do innovative regions inevitably decline? Lessons from Cleveland's experience in the 1920's. *Business and Economic History On-Line*, 5, <http://h-net.org/~business/bhcweb/publications/BEHonline/2007/lls.pdf>.

Licht, W. (1983) *Working for the Railroad: The Organization of Work in the Nineteenth Century*.

Princeton: Princeton University Press.

Lovett, T. D. (1875) *Report on the Progress of Work, Cost of Construction, etc., of the Cincinnati*

*Southern Railway*. Cincinnati : Wrightson and Co.

MacFarlane, J. (1873) *The Coal Regions of America: Their Topography, Geology and Development*. New

York: D. Appleton and Company.

MacKeigan, J. A. (2011) *"The Good People of Newburgh": Yankee Identity and Industrialization in a*

*Cleveland Neighborhood, 1850-1882*. M.A. Thesis. Cleveland: Cleveland State University.

McCann, P. (2005) Transport costs and new economic geography. *Journal of Economic Geography*, 5,

305-318.

McCarty, H. H. (1940) *The Geographic Basis of American Economic Life*. Westport, CN: Greenwood

Press.

Marshall, A. (1920) *Principles of Economics: an Introductory Volume*. London : Macmillan.

Martin, R. and Sunley, P. (1996) Paul Krugman's Geographical Economics and its implications for

regional development theory: a critical assessment. *Economic Geography*, 72: 259-292.

Martin, R. (1999) The new 'geographical turn' in economics: some critical reflections, *Cambridge Journal*

*of Economics*, 23: 63-91.

Martin, R. and Sunley, P. (2006) Path dependence and regional economic evolution. *Journal of Economic Geography*, 6: 395-437.

Marx, K. (1930) *Capital*. London : Dent 1930.

Merchant, A. (1850) *Map of Cleveland and Ohio Cities*. Buffalo: Press of Jewett, Thomas and Co.

Meyer, D. R. (1983) Emergence of the American Manufacturing Belt: an interpretation. *Journal of Historical Geography*, 9: 145-174.

Meyer, D. R. (1989) Midwestern industrialization and the American Manufacturing Belt in the nineteenth century. *Journal of Economic History*, 49: 921-37.

Meyer, D. R. (1990) The rise of the industrial metropolis: the myth and the reality. *Social Forces*, 68: 731-752.

Meyer, D. R. (2003) *The Roots of American Industrialization*. Baltimore : Johns Hopkins University Press.

Miller, C. P. (1983) Archaeology in the USA: documenting the Pennsylvania Railway ore dock at Cleveland, Ohio. *World Archaeology*, 15: 148-160.

Minnesota Population Center (2008) *North Atlantic Population Project: Complete Count Microdata. Version 2.0 [Machine-readable database]*. Minneapolis: Minnesota Population Center.  
(<http://www.nappdata.org>).

Montague, G. H. (1903) *The Rise and Progress of the Standard Oil Company*. New York: Harper and Brothers.

Mould, D. H. (1994) *Dividing Lines: Canals, Railroads and Urban Rivalry in Ohio's Hocking Valley, 1825-1875*. Dayton, OH : Wright State University Press.

Muller, E. K. (1977) Regional urbanization and the selective growth of towns in North American regions. *Journal of Historical Geography*, 3: 21-39.

New York Times (1875) "Bids for Railroad Iron". *New York Times*, February 2, 1875.

New York Times (1879) "A Huge Business Transaction". *New York Times*, October 24, 1879.

Ohio, Bureau of Labor Statistics (1877 - ) *First etc. Annual Report of the Bureau of Labor Statistics Made to the General Assembly of Ohio*. Columbus: State Printer.

Ohio, Commissioner of Railroads (1868 - ) *Annual Report of the Commissioner of Railroads and Telegraphs to the Governor of the State of Ohio for the Year 1867 etc.* Columbus: State Printer.

Ohio, Commissioner of Statistics (1857 - ) *First etc. Annual Report of the Commissioner of Statistics to the General Assembly of Ohio*. Columbus: State Printer.

Ohio, Geological Survey (1884) *Report of the Geological Survey of Ohio, Vol. 5, Economic Geology*. Columbus: Brand.

Ohio, Secretary of State (1852 - ) *Articles of Incorporations, Vols. 1-8*. Microfilm Series 1080. Columbus: Ohio Historical Society.

Ohio, Secretary of State Annual Report (1854 -) *Annual Report of the Secretary of State to the Governor of the State of Ohio*. Columbus: State Printer.

Ohio State Archaeological and Historical Society (1905) *History of the Ohio Canals: Their Construction, Cost, Use and Partial Abandonment*. Columbus: Ohio State Archaeological and Historical Society.

Pennsylvania, Bureau of Statistics (1874) *First Annual Report of the Bureau of Statistics of Labor and Agriculture for the years 1872-3*. Harrisburg: Benjamin Singerly.

Perloff, H. S., Dunn, E. S Jr., Lampard, E. E. and Muth, R. F. (1960) *Regions, Resources, and Economic Growth*. Baltimore, MD: Johns Hopkins Press.

Porter, G. (Ed.) (1992) *Papers of John D. Rockefeller, Sr., Part 1: Business Correspondence*. Microfilm edition (13 reels). Bethesda, MD: University Publications of America.

Pred, A. R. (1965) Industrialization, initial advantage, and American metropolitan growth. *Geographical Review*, 55: 158-185.

Pred, A. R. (1966) *The Spatial Dynamics of U.S. Urban-Industrial Growth, 1800-1914: Interpretive and Theoretical Essays*. Cambridge, MA: MIT Press.

Pred, A. R. (1973) *Urban Growth and the Circulation of Information: the United States System of Cities, 1790-1840*. Cambridge, MA: Harvard University Press.

Reese, J.S. (1880) *Guidebook for Tourists and Travelers over the Valley Railway from Cleveland to Canton*. Canton, Ohio : J.S. Reese.

Report of Committee of Investigation (1889) *Report of Committee of Investigation in the Matter of Trusts, or Pools, Appointed under S.J.R. No. 25*. Columbus: Westbote Company, State Printers.

Report of Special Committee (1874) *Report of Special Committee Appointed by the Stockholders of the Cleveland and Pittsburgh Railroad Co. at the Annual Meeting January 7th 1874*. Cleveland: Fairbanks, Benedict and Co.

Robison, W. S. (1887) *History of the City of Cleveland: its Settlement, Rise and Progress*. Cleveland: Robison and Cockett.

Rockefeller, J. D. (1909) *Random Reminiscences of Men and Events*. New York: Doubleday, Page and Company.

Rose, W.G. (1950) *Cleveland: The Making of a City*. Cleveland: World Publishing Company.

Rosenberg, N. (1963) Technological change in the machine tool industry, 1840-1910. *Journal of Economic History*, 23: 414-443.

Rosenberger (1975) *The Philadelphia and Erie Railroad: Its Place in American Economic History*. Potomac, MD : Fox Hills Press.

Rostow, W. W. (1960) *The Stages of Economic Growth: a Non-Communist Manifesto*. Cambridge: Cambridge University Press.

Samuelson, P. A. (1954) The transfer problem and transport costs, II: analysis of effects of trade impediments. *The Economic Journal*, 64: 264-289.

Saward, F. E. (1875-) *The Coal Trade*. (Annual Publication for the year 1874 etc.). New York: F. E. Saward.

Schotter, H.W. (1927) *The Growth and Development of the Pennsylvania Railroad Company*. Philadelphia: Allen, Lane and Scott.

Schumpeter, J. A. (1939) *Business Cycles: a Theoretical, Historical, and Statistical Analysis of the Capitalist Process; Vol. I*. London: McGraw-Hill.

Solomou, S. (1987) *Phases of Economic Growth, 1850-1973: Kondratieff Waves and Kuznets Swings*. Cambridge: Cambridge University Press.

Springirth, K.C. (2010) *Northwestern Pennsylvania Railroads*. Mount Pleasant, SC: Arcadia Press.

Sunbury and Erie Railroad (1860) *Ninth Annual Report of the Board of Managers to the Meeting of the Stockholders of the Sunbury and Erie Railroad, held February 13, 1860*. Philadelphia: Crissy and Markley.

Sunley, P. (1992) Marshallian industrial districts: the case of the Lancashire cotton industry in the inter-war years. *Transactions of the Institute of British Geographers, New Series*, 17: 306-320.

Swineford, A. P. (1876) *History and Review of the Mineral Resources of Lake Superior, Embracing an Account of the Earliest Discovery and Settlement of the Iron and Copper Districts etc*. Marquette: The Mining Journal.

Tarbell, I. M. (1904) *The History of the Standard Oil Company*. 2 Vols. New York: McClure, Phillips and Co.

Tylecote, A. (1992) *The Long Wave in the World Economy: the Present Crisis in Historical Perspective*. London : Routledge.

Tyler, Captain (1874) *Report on the Erie Railway, and its Connections*. London: Harrison and Sons.

U.S. Census Office (1865) *Manufactures of the United States in 1860; Compiled from the Original Returns of the Eighth Census under the Direction of the Secretary of the Interior*. Washington: GPO.

U.S. Census Office (1870) *Manuscript Returns of the 1870 Census of Manufactures*. State of Ohio (part). Microcopy T1159 Roll 45. Washington: NARA.

U.S. Census Office (1872a) *Vol. 1, The Statistics of the Population of the United States, embracing the Tables of Race, Nationality, Sex, Selected Ages, and Occupations. Compiled from the Original Returns of the Ninth Census (June 1, 1870) under the Direction of the Secretary of the Interior by Francis A. Walker*. Washington: GPO

U.S. Census Office (1872b) *Vol. 3, The Statistics of the Wealth and Industry of the United States. Compiled from the Original Returns of the Ninth Census (June 1, 1870) under the Direction of the Secretary of the Interior by Francis A. Walker*. Washington: GPO.

U.S. Census Office (1880) *Manuscript Returns of the 1880 Census of Manufactures*. State of Ohio (part). Microcopy T1159 Roll 93. Washington: NARA.

U.S. Census Office (1883a) *Vol. 1, Statistics of the Population of the United States at the Tenth Census (June 1, 1880)*. Washington: GPO.

U.S. Census Office (1883b) *Vol. 2, Report on the Manufactures of the United States at the Tenth Census (June 1, 1880)*. Washington: GPO.

U.S. Census Office (1883c) *Vol. 4, Report on the Agencies of Transportation in the United States including the Statistics of Railroads, Steam Navigation, Canals, Telegraphs, and Telephones*. Washington: GPO.

U.S. Census Office (1884) *Vol. 10, Production, Technology and Uses of Petroleum and Its Products by S. F. Peckham; The Manufacture of Coke by J.D. Weeks; Building Stones of the United States, and Statistics of the Quarry Industry for 1880*. Washington: GPO.

Walsh, W. D. (1975) *The Diffusion of Technological Change in the Pennsylvania Pig Iron Industry, 1850-1870*. New York : Arno Press.

Wiggins and Company (1872) *Cleveland as it is: a History of Cleveland and Statistical Exhibit of the Trade, Commerce and Manufactures of the City of Cleveland for the year 1871*. J. Wiggins and Co. compiler. Cleveland: G. S. Newcomb Printing Company.

Wilson, M.R. (2005) *Railroad Supply Industry*, entry in on-line Encyclopedia of Chicago History <http://www.encyclopedia.chicagohistory.org/pages/2387.html> Accessed May 5, 2012.