Skilled Immigrants and American Industrialization: Lessons from Newport News Shipyard

December 23, 2018

Abstract

In the late nineteenth century, American shipyards sought to begin building modern metal ships, a sector dominated by the British. To do so, they faced a challenge: a shortage of domestic workers with the skills to fabricate large metal ships. Using census of population data, this article describes how one important U.S. shipyard, Newport News Shipbuilding, overcame the shortage of skilled domestic workers in order to assemble an effective labor force. The results show that skilled immigrants, mainly from Britain, played an important role in the shipyard's early life while, over time, native workers were trained to fill skilled occupations.

1 Introduction

The economic impact of immigrants remains an active area of both scholarly and public debate. In recent years, much of the economic analysis of immigration has focused on the impact of low-skilled immigrants on native workers through labor market competition, or the effects that very high-skilled immigrants may have as entrepreneurs or inventors.¹ Yet there is another group of immigrants, the skilled craft workers, that typically receive less attention from economists.

The fact that skilled craft workers are often ignored in economic analysis is somewhat surprising given that historians have documented the important role that skilled immigrants played in the development of American industry. John Lewis and coauthors, for example, describe the role that skilled Welsh workers played in early tinplate manufacturing (see, e.g., Jones & Lewis (2007)). Recent work by Fones-Wolf (2004) on Belgian glass workers provides a second case. While studies of this type are insightful, they are limited by their focus on relatively small and somewhat obscure industries as well as the difficulty in quantifying the effects that they describe.

This article augments and extends previous research on skilled immigrants by documenting the role they played in the development of modern industrial shipbuilding in the U.S. in the late-19th century. The analysis focuses mainly on one shipyard, Newport News Shipbuilding (NNS), which grew from its founding in the late 1880s to become the most important American shipbuilder. Today it continues to be the nation's preeminent shipyard, and the only yard capable of producing the largest classes of Navy ships.

Shipbuilding is an ideal setting in which to examine the importance of immigrant

¹See (Hatton & Williamson, 1998; Hirschman & Mogford, 2009) on the impact of immigrants on natives through labor market competition. For reviews of the modern economic literature on immigration see Kerr & Kerr (2011) and Borjas (2014).

workers. This is clearly an industry of great importance in U.S. history, starting in the colonial era. It is also a sector where access to skilled workers was important. In addition, as I discuss below, the fact that shipyards were often located in smaller towns allows me to take a novel approach to understanding how a new shipyard like NNS assembled the skilled workforce necessary to build large metal ships.

The shipbuilding industry has had a long and volatile history in the United States. Early in the country's history, New England shippards drew on the continent's vast untapped timber resources to supply wooden sailing ships to buyers around the world. However, after 1850 the industry began to decline. The rise of metal shipbuilding shifted production towards Britain, which enjoyed the advantage of initially cheaper iron inputs and more workers with engineering experience.² This early lead allowed Britain to build up a pool of skilled metal shipbuilders that made British shipyards the most productive in the world (Pollard & Robertson, 1979).

Toward the end of the 19th century, the development of the U.S. as a major iron and steel producer lowered the cost of metal inputs, opening up the possibility that U.S. shipyards could begin competing in metal ship production.³ However, young American shipyards still faced important challenges. Chief among these was a lack of workers with the unique and vital skills necessary to fabricate large metal ships.

How did NNS assemble, virtually from scratch and over a relatively short period of time, the skilled workforce necessary to successfully produce large metal ships? In studying this topic, the paucity of available corporate records during these early stages of the firm's life presents a challenge. While firm records give us information

²See Hutchins (1948), Pollard & Robertson (1979), and Hanlon (2018).

³The drop in iron prices was due in part to the discovery of new iron reserves, particularly in the Mesabi Range in Minnesota, which led to the expansion of iron and steel production in the U.S. (Irwin, 2003). At the same time, productivity in U.S. iron and steel production was improving rapidly (Temin, 1964; Allen, 1977, 1981, 1979).

about the senior level of managers, they provide little information about the main body of the workforce, the men who actually built the ships.

To overcome this, this study applies a somewhat novel approach that takes advantage of the fact that Newport News was essentially a company town during the first two decades of the firm's existence. As a result, anyone residing in Newport News and holding a shipbuilding or related occupation was almost certainly working for NNS during these years. This means that the Population Census can be used as a unique window into the firm's workforce. The Census provides details about workers' backgrounds that are typically not included in corporate records. For example, the census provides each resident's occupation as well as background information such as birth place, what year immigrant workers came to the U.S., race, marital status, and household composition. These details can help us understand the origin and composition of the workforce that NNS assembled.

This approach differs from the methods commonly used to study the impact of immigration. Most of the existing work focuses on "mass migration" in the tradition of Hatton & Williamson (1998). Studies of this type rely on aggregated statistics or, more recently, the full-count census records provided by IPUMS.⁴ While much can be learned from this data, the role of skilled craft workers is often swamped by the impact of more numerous less-skilled immigrants. This may lead to an underestimation of the role that skilled workers played in important sectors like shipbuilding. A second important strand of literature focuses instead on the very top group of "elite" workers. The experience of these notable migrants can be traced out in firm records, media reports, or other sources. These workers feature prominently in work on international technology transfer, such as the studies collected in Jeremy (1991)

⁴See Margo (2014) and Abramitzky & Boustan (2017) for recent reviews of this literature.

or the work of Moser et al. (2014). However, this approach also tends to overlook the larger set of skilled workers that I study, a group that brought craft skills rather than technical knowledge. Thus, this study fills in a missing piece in our understanding, by illuminating the impact of skilled craft workers that fall in between the notable elite and the mass body of migrants.

Previewing the results, I will present evidence highlighting the vital role that skilled immigrants played at NNS. Immigrants from Britain, the world's leading ship-building nation, filled key skilled positions, particularly early in the firm's life. These skilled immigrant workers, together with skilled Americans hailing mainly from the Mid-Atlantic region, were employed together with a large pool of unskilled workers, mainly African-Americans, drawn from Virginia and neighboring states. Over time, local (white) workers were trained to take up skilled positions. Thus, my analysis highlights the importance of access to skilled foreign workers for the early development of NNS, as well as how, over time, local workers were trained to fulfill the firm's expanding need for skilled labor.

2 Industry background

The shipbuilding industry has attracted a substantial amount of interest from historians and economists. One topic of study has been the factors behind the rise of British shipbuilding to dominance in the mid-19th century, and the subsequent decline of the industry in the mid-20th century.⁵ Other research focuses on why the U.S. struggled to compete with British shipbuilders, particularly after U.S. iron and steel prices fell to comparable levels around the turn of the century. Harley (1973), for example, examines the persistent survival in wood shipbuilding in the U.S. and concludes that

⁵See, e.g., Lorenz (1991).

it continued because of the existence of locked-in skills specific to wood ship construction. However, even as wood shipbuilding survived, U.S. firms were beginning to move into modern metal ship construction. Protectionism certainly played a role in this process; U.S. shipyards were protected from British competition for ships operating directly between U.S. ports, which provided a small market that was reserved entirely for vessels of U.S. construction.⁶ While this protection propelled the growth of U.S. shipyards, they still faced important challenges in moving into large-scale iron and steel shipbuilding.

Chief among these challenges was the scarcity of skilled metal shipbuilders in the U.S.⁷ The building of large iron or steel-hulled ships required a wide variety of skilled workers, ranging from boilermakers, platers and riveters to ship carpenters, chippers & caulkers, and mechanics.⁸ While many of these skills were also used in other industries, or in wood shipbuilding, other vital skills were specific to metal shipbuilding. For example, the shaping of large metal plates and beams into various irregular shapes was an operation that was central to metal shipbuilding but of limited importance in most other sectors. How fast beams and plates could be formed into the desired shape determined the speed with which a ship could be built, while errors in the process contributed to delays and waste.⁹ Skills of this type, those unique to the industry, were gained through on-the-job experience, often as part of a formal apprenticeship. In Britain, where training systems were firmly established, apprenticeships typically lasted 5-7 years. Unions, a strong force in British shipbuilding but absent in American

⁶Shipyards in the Great Lakes were also protected by natural barriers that made it difficult for large vessels to transit between the Great Lakes and the Atlantic.

⁷See Pollard & Robertson (1979) and Culliton (1948).

⁸It is worth noting that boilermaker is a bit of a misnomer by the period I study, as workers with that title may not have been mainly engaged just in the production of boilers. Rather, boilermakers were involved in fabricating metal sheets and tubes, jobs that made them the most prominent skilled workers in metal shipbuilding.

⁹Thiesen (2006) p. 101-112 provides an excellent description of the various stages involved in metal ship construction and how they were accomplished during the 19th century.

yards like NNS, played an important role in this training process. Only a few elite positions, such as naval architects, marine engineers and draftsmen required more formal education (Pollard & Robertson, 1979).

Several features of the shipbuilding industry contributed to firms' reliance on skilled labor. One important factor during the period covered by this study is that most ships were unique bespoke orders. Occasionally yards would produce two or three of the same design, but typically shipyards worked on a wide range of different ship designs, often at the same time. This variation made standardization difficult and increased the importance of workers with skills that gave them the flexibility to work on very different types of ships.¹⁰

Also, shipbuilders faced volatile demand and a highly competitive market. Shipbuilding was a fragmented industry where many small and medium-sized shippards competing for orders. As a result, Hutchins (1948) described shipbuilding in the late 19th and early 20th Century as, "a market which, except for the influence of national laws and policies, is naturally one of the most highly competitive of all markets..." This competition, together with highly volatile demand, meant that large investments in durable capital were dangerous for shipbuilders and came with the risk of bankruptcy during downturns. As a result, "The principal task of the shipbuilders was to minimize total overhead expenses while maintaining the ability to build large and complex ships at prices that were competitive on the world market" (Pollard & Robertson, 1979, p. 28). Having access to skilled workers helped shipyards manage this volatility, by avoiding heavy fixed capital expenditures. In British metal shipyards in the late 19th and early 20th century, skilled workers made up 70-80% of the

¹⁰These conditions were very different from those experienced during both WWI and WWII, studied by Thompson (2001), where the production of repeated standardized designs allowed shipyards to expand by using lower skilled workers trained to do just one type of task.

workforce (Pollard & Robertson, 1979, p. 153). Newer metal shipyards in places like the U.S. and Germany, lacking similar access to large pools of skilled workers, were forced to substitute by making heavier capital expenditures, which put them at risk of bankruptcy during the inevitable cyclical downturns in the industry (Pollard & Robertson, 1979, p. 28-29, 42).

The importance of skilled workers, together with the fact that skills were mainly gained through apprenticeships and on-the-job experience meant that locations with a longer history of metal shipbuilding maintained a distinct advantage. This led to regional concentrations of ship production in locations where low iron prices had allowed the metal shipbuilding industry to gain an early start, particularly in the areas around Glasgow in Scotland, Newcastle-upon-Tyne and Sunderland in Northern England and Belfast in Ireland.

We know from research by Berthoff (1953) and others that at least some skilled British shipbuilders migrated to the U.S. However, assessing the magnitude of these flows and their importance for American shippards has proven difficult. Most of what we know come from anecdotal sources which, while informative, are difficult to quantify. One aim of this study is to provide us with a better idea of the quantitative importance of these skilled immigrant shipbuilders.

2.1 Origins of Newport News Shipbuilding

Any discussion of the origins of NNS has to start with the company's founder, Collis P. Huntington. Huntington, born in Connecticut in 1821, made his fortune selling supplies to the California gold miners in the 1850s. By the 1860s he had become involved in railroad construction. Together with Leland Stanford, Mark Hopkins and Charles Crocker, he was one of the "Big Four" promoters of the transcontinental rail-

road. By the 1880s, Huntington was a very wealthy man, with ownership stakes in several railroads, including the Central Pacific and Southern Pacific, shipping companies, land companies, and a variety of other businesses. In the late 1860s Huntington had become involved in resuscitating the Chesapeake and Ohio Railroad in Virginia after the Civil War. He became the president of the C&O in 1869. Soon after, he began extending the railroad from Richmond to the Ohio river valley in West Virginia, which gave access to West Virginia's coal country. Next, the railroad turned east for a connection to the sea.

Huntington considered several possible locations for the port connection. These included established cities such as Norfolk and Yorktown as well as rural areas along the Peninsula, a strip of land stretching southeast from Richmond to where Chesapeake Bay meets the mouth of the James River at Hampton Roads. While each location had something to recommend it, Huntington eventually settled on Newport News.

Newport News offered several advantages as a sea terminus for the C&O. First, it possessed an excellent deep natural harbor. Second, the area was almost completely undeveloped, consisting mainly of farmland and a small fishing village. This made it easy for Huntington to buy up the land in order to take advantage of the increase in value that the railroad would bring, which he did through his Old Dominion Land Company. Another advantage of this location was that there were no competing railroad lines on the Peninsula. On the other hand, Huntington had to build the city of Newport News virtually from scratch, provide it with roads, water lines, etc. 11

Newport News did not have a history of commercial shipbuilding nor did the area

¹¹Newport News was also close to the Navy Shipyard in Norfolk, VA, which may have been useful for winning Navy contracts or learning about new metal shipbuilding technologies. Hanlon (2018) provides evidence that there were spillovers from Navy shipyards to other nearby private shipyards.

have a substantial base of engineering or metalworking firms. These are important features for this study. The fact that Newport News was essentially a company town means that it is possible to relate occupations observed in the Census directly to the firm's labor force.

By the early 1880s Huntington's Old Dominion Land Company owned 17,000 acres on the Virginia Peninsula. The C & O rail connection to Newport News opened in 1882. The Chesapeake Dry Dock & Construction Company, which would eventually become Newport News Shipyard and Dry Dock Company, was chartered in 1886. The land for the shipyard was purchased from Huntington's Old Dominion Land Company and construction of the dry dock, piers, and other facilities began in 1887. The initial equipment for the yard were purchased from a defunct New York shipyard, Newburgh Iron Shipbuilding Company, and moved to Virginia. The shipyard began operation in 1888, a year that will play an important role in my analysis.

3 Data

A central challenge in understanding the early workforce of NNS is the paucity of direct information from corporate records. While some records have survived, mainly as part of the extensive Huntington papers, these contain mainly personal correspondences. Among these records, the more concrete challenges faced by the management in Virginia make only an occasional appearance. Newspaper articles also offer some information, but reporters paid relatively little attention to the common workers at the yard. Thus, if we want to understand how the firm assembled a workforce it is necessary to look for other, less traditional, sources of information.

 $^{^{12}}$ Smith (1965) provides a thorough review of the information available from both company records and other sources.

The main source of information drawn on by this study is a set of hand-collected data from the U.S. Population Census of 1900 manuscripts.¹³ I focus on data from the 1900 census in part out of necessity. Records for the 1890 Census, the first one taken after the founding of NNS, have been lost to a fire. However, as we will see, the details contained in the 1900 census can help shed light on the firm's workforce, even going back to the firm's founding in 1888.

To collect these data, I reviewed all of the original census manuscripts for the town of Newport News as well as nearby areas in Hampton and Warwick County, and digitized information on individuals where the data explicitly mention working at the shipyard (as most did) or where their occupations made it likely that they did. This review identified 3,564 individuals employed at the shipyard, nearly all of them men. As a point of comparison, Smith (1965) suggests that employment at the yard was at 6,000 in December, 1899, while a letter from Mr. Smith, the shipyard Superintendent to Mr. Orcutt, the President, indicates that in January 1898 the yard employed 3,316 workers (1,259 mechanics and 2,057 laborers). This range should not be surprising given that employment at shipyards could fluctuate rapidly depending on market conditions. Given this, my data appear to be in line with the range indicated by contemporary evidence.

For the majority of shipyard workers, the occupation information in the census specifically references shipyard work. Even for common laborers, the enumerators in Newport News distinguished shipyard laborers from other laborers. I also include among shipyard workers those in jobs, such as draftsman or mechanic, where it is likely that most of the people holding the occupation were working at the shipyard.

¹³These manuscripts were accessed using the genealogy website Ancestry.com. While census data is available in transcribed form, hand-collecting the data from the original manuscripts allows me to take advantage of additional details that are often unavailable in the transcribed databases while limiting the effect of transcription errors.

It is worth noting that my listing of shipyard workers is likely to miss a relatively small number of shipyard workers in occupations that were also common outside of the shipyard, such as blacksmiths, masons, cooks, etc., which I do not include in my list of shipyard workers. In addition, the many day laborers, stevedores and longshoremen listed in the Census returns for Newport News are not included in my accounting. While a few of these must have been employed at the shipyard, most of them worked at the C&O's port facility.

There are just under 100 unique occupations associated with NNS in the data (after some basic standardization has been done). For analysis, it is useful to divide these into a smaller set of occupation groups. I use the following categorizations: Laborers, including assistants; Apprentices; Office workers, such as clerks, bookkeepers, and accountants; Skilled Craftsmen, a broad category including riveters, iron workers, carpenters, joiners, chippers & caulkers, etc.; Managers; and Specialists, high-skilled workers with skills specific to shipbuilding, such as naval architects, marine engineers and draftsmen.¹⁴ The population census also include background information on each worker including the worker's age, location of birth, whether they were an immigrant, and their year of arrival.

For comparison purposes I also collected data on all foreign-born male workers in Newport News with occupations that signal that they were unlikely to have worked at the shipyard.¹⁵ There were 393 residents who fit this description. A glance at these data reveal that by 1900 the city was incredibly diverse, with residents from

¹⁴The main distinction between skilled craftsmen and specialists is that the former typically acquired their skills on the job or through apprenticeships while the latter may have had some more formal education.

 $^{^{15}}$ E.g., I exclude from this list occupations such as blacksmiths and electricians where some workers were likely to have been employed at the shipyard. I also focus only on male heads of household. The focus on males makes these data more comparable to the data on shipyard workers. The reason I focus on heads of household is to exclude some sons with fathers that worked at the shipyard.

23 different countries: Irish longshoremen, Greek carpenters, Russian grocers, Chinese laundrymen, German brewers, English bartenders, a French hotel proprietor, a Turkish fruit seller, and even an Italian ice cream maker.

To provide a point of comparison, I also construct similar data for three other major American shipbuilding centers. One of these, the Groton-Noank area of Connecticut, remained entirely focused on wood shipbuilding. Thus, as a comparison case this can be used to illustrate the different challenges, and responses, involved in moving into metal shipbuilding. A second comparison case is provided by Bath Iron Works (BIW) in Bath, Maine. BIW differed from NNS in important ways. It was located in the heart of the traditional U.S. (wood) shipbuilding areas, and, because it originated from a producer of metal machinery (thus the name), it had access to a pool of skilled metalworkers. The third comparison location, Lorain, Ohio, was the site of an important Great Lakes metal shipyard owned by the American Ship Building Company. That company had opened a yard in Cleveland in 1888 and then expanded to the Lorain site in 1898. My review of manuscripts for Bath identified 1,204 workers with shipbuilding or related occupations in the seven wards of the city. In Lorain I identify 1,073 shipyard workers or workers with related occupations. ¹⁶ In Groton and Noank I identified 501 men with occupations related to shipbuilding.

It is worth noting that an analysis of the census data for these comparison locations faces limitations relative to what is possible for Newport News. For example, in Bath and Groton-Noank the census enumerators did not separately identify unskilled shipyard laborers from other local unskilled workers. In addition, in Bath, some enumerators wrote "Bath Iron Works" as the occupation for a number of individu-

¹⁶Contemporary sources suggest that the Lorain yard employed 700-1000 workers in early 1898 (Marine Review, 27 January 1898) so my data likely capture most of the yard's workforce. I have not found similar figures for the other two locations.

als without describing exactly what their occupation was. Also, there were multiple shipyards in both Bath and Groton-Noank, so my analysis does not allow me to separately identify the labor force of any particular shipyard.¹⁷ Another issue faced when analyzing Bath is that the town also had a well-developed iron products industry. In Lorain this is even more of an issue, since that town had a steel plant. Thus, in these locations it is difficult to separately identify shipyard metalworkers from metalworkers employed in other sectors except in occupations, such as boilermakers and riveters, which were primarily associated with ship production.

4 Composition of the NNS labor force

Operations at NNS really began in late 1888, with the dry dock ready for use in 1889. The first payroll made by the yard was in December, 1888 (Smith, 1965, p. 12). By April 1889 there were 98 workers employed at the yard (Smith, 1965, p. 16) and by 1900 employment had grown to several thousand. But where had these workers come from?

As a starting point for understanding how NNS assembled a labor force, Table 1 describes the breakdown of workers across broad occupation categories in 1900. By far the two largest occupation groups were unskilled laborers, which made up about 43% of the workforce, and skilled craftsmen, which accounted for about 49%. The very elite worker groups – managers and specialists – were much smaller. NNS also employed a number of apprentices who were learning a variety of skilled trades. 19

 $^{^{17}{}m I}$ do know that in Bath the only major metal ship producer was Bath Iron Works.

¹⁸In fact this number likely understates the true unskilled share since it may not include casual laborers.

¹⁹The share of unskilled workers obtained from the census data roughly matches the share reported for different periods by Smith (1965) based on information from correspondence and surviving ship-yard records. For example, in October of 1889 report 38 laborers out of a total of 97 workers, a

The data in Table 1 suggest that NNS was using a substantially higher share of unskilled workers than the share used in other foreign yards. For comparison, data from Pollard & Robertson (1979) (Table 8.1, p. 153) show that in 1892 unskilled workers made up just 29 and 22 percent of the labor force in English and Scottish shipyards, respectively. In Scotland in 1911 the share was 18\%, and it was 25\% in Northeast England in 1913. This is much lower than the 47.7% of unskilled workers shown in Table 1. This pattern is consistent work by historian such as Pollard & Robertson (1979) suggesting that U.S. shipyards used a greater share of capital and unskilled workers in order to overcome a shortage of skilled workers. However, we should be careful in drawing strong conclusions from the unskilled shares reported in Table 1 because the location of NNS may have given the yard better access to unskilled workers than other American yards. In particular, my data show that the yard relied heavily on African-American workers to fill unskilled positions. More than 1,400 of the laborers employed at Newport News in 1900 were black while whites accounted for just over 200, only 40 of whom were foreign born. This is very different from conditions in other American metal shipyards at this time. In Lorain, unskilled laborers were mainly white and foreign immigrants, mainly from Germany, Poland, Austria and Hungary, accounted for 45% of this group. The need to attract unskilled workers from abroad may explain why the unskilled share in Lorain, which I estimate to be around 26%, is substantially below the share in Newport News, though still higher than in most British yards.

_

share of 39% (Smith, 1965, p. 23). An internal document from 1897 indicates employment of 1259 mechanics and 2057 laborers, an unskilled share of 62%.

Table 1: Number of workers by type

	Number	Share
Laborers	1676	0.477
Apprentices	60	0.017
Skilled craftsmen	1577	0.449
Office workers	45	0.013
Managers/foremen	44	0.013
Specialists	112	0.032

Data from the 1900 Census of Population for workers residing in Newport News, VA and nearby areas and holding shipbuilding-related occupations.

The more intensive use of unskilled labor and advanced machinery does not appear to have made Newport News more productive than British yards. In July, 1897, for example, Mr. Smith, the NNS Shipyard Superintendent, reported that the labor costs required to produce a tramp steamer in Newport News was 40% higher than in England. This higher labor cost reflected the scarcity of skills faced by the shipyard relative to their competitors on the other side of the Atlantic.

The data show stark differences in the origins of NNS workers fitting into the different occupational categories. Among unskilled laborers working at NNS in 1900, 95% were born in Virginia or one of the neighboring states (Kentucky, Maryland, North Carolina, and West Virginia), while men born in these states made up just 54% of skilled craftsmen, 39% of managers and 29% of specialists. Among more skilled groups, foreign-born workers from Britain or other parts of Europe made up a substantial fraction of the workforce: 21% of craftsmen, 13% of specialists, and 20% of managers. British-born workers, for example, made up 15% of skilled craftsmen at NNS and 88% of British workers were in one of the skilled craft occupations, while only 7% were in low-skilled work. The importance of foreign-born workers is

even larger if we focus on more experienced workers, such as those over 30 years of age. Among this group, British workers made up 22% of skilled craftsmen and 16% of specialists. Internal migrants were also important. Migrants from the Mid-Atlantic states accounted for one-third of managers and specialists as well as 16% of skilled craftsmen. Those from New England, the region with the longest history of (wood) ship production, were particularly important in the specialist positions such as draftsman. These findings enrich and quantify available narrative evidence from historians such as Evans (1954) who writes (p. 637), "At the beginning of ship construction and repair in the Newport News plant, skilled mechanics and engineers had to be brought from other sections of the country and from abroad."

To gain more insight into the importance of skilled immigrant workers it is useful to look at their shares in the major shipbuilding occupations present in Newport News. This is done for British-born workers and all foreign-born workers in Table 2 for all occupations with more than 15 workers. These data show that the occupations that were most dependent on British immigrants were riveter and boilermaker. These are the two quintessential skilled occupations of metal shipbuilding. British workers also formed a substantial share of machinists and chippers/caulkers.

The occupations where most workers were native-born include low-skilled occupations like watchman and laborer and those requiring skills that were not specific to shipbuilding, such as clerks and painters. It is worth noting that this table includes workers of all ages. If we instead focus only on workers over age 30, immigrants are relatively even more important. For workers over 30, for example, British-born immigrants make up over half of the chippers & caulkers, 46% of riveters and 37% of boilermakers, as well as more than a fifth of all machinists, ship fitters and draftsmen.

Table 2: Share of British-born and foreign-born workers by occupation, 1900

	Share	Share	Total		Share	Share	Total
Occupation	British	foreign	workers	Occupation	British	foreign	workers
	born	born			born	born	
Boilermaker	0.273	0.318	110	Ship fitter	0.114	0.142	254
Riveter	0.269	0.282	78	Ship joiner	0.100	0.200	90
Chipper/caulker	0.214	0.229	70	Clerk	0.080	0.080	25
Machinist	0.158	0.260	442	Iron worker	0.075	0.113	53
App. machinist	0.150	0.200	20	Draughtsman	0.066	0.143	91
Stat. engineer	0.138	0.241	29	Driller	0.058	0.100	52
Coppersmith	0.136	0.455	22	Foreman	0.054	0.189	37
Rigger	0.125	0.625	32	Patternmaker	0.045	0.091	22
Bolter, ships	0.125	0.188	16	Laborer	0.007	0.015	1592
Pipe fitter	0.122	0.146	41	Painter	0.000	0.063	16
Ship carpenter	0.118	0.225	169	Watchman	0.000	0.000	18

Data from U.S. Population Census of 1900 for residents of Newport News, VA and nearby areas. Table includes all shipyard occupations with more than fifteen workers.

Table 3 looks at the fifteen most important skilled occupations in Newport News and compares occupation shares there to the shares in Bath, Lorain, and Groton-Noank. Note that the comparison to Groton-Noank is particularly useful here, since it can help us identify those occupations that were specific to metal shipbuilding. Based on this comparison, occupations can be divided into several types. Some, such as machinists, ship joiners, and stationary engineers (engine operators) appear to have been important regardless of the type of shipbuilding.²⁰ Other occupations were concentrated only in metal shipbuilding centers. These include ship fitter, boilermaker, riveter, and pipe fitter. Many of these occupations were small or completely absent in Groton-Noank. Referring back to Table 2, it is notable that these occupations tended

²⁰Chippers/caulkers also appear to be important in both types of shipbuilding, but this is probably somewhat misleading because while the term caulker appears in both metal and wood shipbuilding, it means something very different in these two settings.

to have high shares of foreign workers. Moreover, of the foreign workers in these occupations, a large share came from Britain. For example, 86% of the foreign-born boilermakers were British as were all of the foreign-born riveters in Newport News.

There are also some occupations that were clearly associated with wood shipbuilding only. This is mainly true of ship carpenter, an occupation that made up almost 60% of the skilled workforce in Groton-Noank but only 8.5% in Newport News and 4.9% in Lorain. It is also worth noting the large share of iron workers and stationary engineers in Bath and Lorain compared to the other locations. This likely reflects the fact that, in addition to shipbuilding, these locations also had other metal-goods firms.²¹

Table 3: Comparing important skilled occupations in different locations

		No. emp. in	Share in	Share in	Share in	Share in
	Occupation	Newport	Newport	Bath, ME	Groton-	Lorain
		News	News		Noank	
1	Machinist	431	22.66%	11.96%	10.78%	21.06%
2	Ship Fitter	247	12.99%	2.74%	_	5.78%
3	Ship Carpenter	161	8.46%	29.15%	59.88%	4.94%
4	Boilermaker	102	5.36%	4.57%	0.40%	4.38%
5	Draftsman	91	4.78%	2.74%	0.40%	0.28%
6	Ship Joiner	90	4.73%	2.33%	3.39%	0.19%
7	Riveter	71	3.73%	1.99%	_	6.15%
8	Chipper/Caulker	65	3.42%	3.74%	4.99%	0.84%
9	Iron Worker	41	2.79%	10.54%	2.99%	4.01%
10	Driller	50	2.63%	0.25%	_	0.56%
11	Pipe Fitter	47	2.47%	_	_	1.49%
12	Rigger	28	1.47%	2.08%	0.60%	0.47%
13	Stat. Engineer	27	1.42%	3.24%	2.00%	7.55%
14	Coppersmith	22	1.16%	0.50%	_	_
15	Patternmaker	22	1.16%	1.33%	0.40%	0.75%

Data from U.S. Population Census of 1900.

²¹We also see a low share of draftsmen in Lorain compared to Newport News. It may be that the designs for ships built in Lorain were still being drawn up at the company's older yard in Cleveland during this period.

To see whether the importance of British-born workers observed in Newport News was also found in other new American metal shipyards, it is useful to compare NNS to the data from Lorain. This comparison, in Table 4, suggest that British-born workers were just as important in key shipbuilding occupations in Lorain as they were in Newport News.

Table 4: Comparing British-born shares in key shipbuilding occupations

	British-born share	British-born share
Occupation	in Newport News	in Lorain, OH
Boilermaker	0.273	0.319
Riveter	0.269	0.182
Ship fitter	0.114	0.274
Foreman	0.054	0.278

Data from U.S. Population Census of 1900.

Thus far the results show that foreign-born, and particularly British-born workers, made up an important part of the skilled labor force in Newport News in 1900, particularly in those occupations specific to metal shipbuilding like riveter and boilermaker. While these findings are important, we are particularly interested in the impact of skilled workers earlier in the shipyard's life. It is possible gain additional insight into this by using information on how long immigrant workers had been in the country in 1900.

Figure 1 provides a histogram of immigrant workers at NNS sorted by the number years that they had been in the U.S. in 1900. The key feature in this graph is that there was a large spike in shipyard workers who entered the country exactly twelve years before 1900. This corresponds exactly with the opening of NNS. It is difficult to explain this distinctive spike in year 12 other than as a result of the opening of the Newport News Shipyard. Thus, this pattern that these foreign workers either came to

the U.S. specifically to work at NNS, or that many of the foreigners with shipbuilding skills coming to the U.S. in that year opted to go to Newport News. It is worth noting that the figure also shows spikes in years such as 15, 20 and 30, consistent with recall bias, however this cannot explain the spike at year 12.

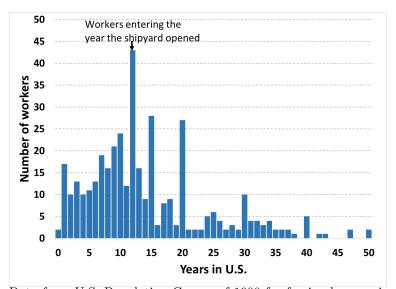


Figure 1: Number of foreign NNS workers by years in the U.S.

Data from U.S. Population Census of 1900 for foreign-born residents of Newport News, VA holding shipbuilding occupations.

The spike in year twelve in Figure 1 suggests that around 20-30 more NNS shipyard workers entered the U.S. in that year than we would expect given the levels in other nearby years. The occupations of the immigrant workers that arrived in the U.S. in 1888-9 essentially covered the range of skills needed for metal shipbuilding: 9 machinists, 6 riveters, 2 boilermakers, 4 ship fitters, 2 ship joiners, 2 draftsmen, 2 chipper & caulkers, a coppersmith, a millwright, a rigger, etc. Compare these to employment in the yard in April of 1889 given by Smith (1965) based on firm records: out of 98 workers the yard employed 17 workers with skills specific to metal shipbuilding (boilermakers, machinists, platers, and caulkers) and 23 others skilled

workers, foremen or managers, and 58 laborers. These facts suggest that NNS likely drew a substantial portion of its initial skilled workforce from abroad.

Another sign of the importance of the 1888-89 immigrant cohort can be found by looking up individuals listed as foreman at the shipyard in 1900 from a list given by the Newport News Daily Press (Smith, 1965, p. 109-10). The three foremen overseeing the key metal shipbuilding trades at his time were Arch Shankland, the Foreman Riveter, William McCallum, the Foreman of Plumbers and Pipefitters, and Charles White, the Foreman Anglesmith. Looking these up in the Census shows that all three were born in Scotland. Shankland immigrated to the U.S. in 1888 at age 28, McCallum came in 1887 at age 31, while White came in 1886 at age 24. All of them would have been old enough to have completed an apprenticeship before coming to the U.S. This pattern is particularly striking given that most of the other foremen on the list, who oversaw tasks that were less unique to metal shipbuilding, were born in Lorain, where the shipyard superintendent William W. Watterson, was also born in England, where he worked as a shipbuilder before coming to the U.S. at age 23.

The timing of immigration of shipyard workers in Figure 1 can be compared to the timing of entry for foreign-born residents of Newport News working in other (non-shipyard) occupations. Figure 2 plots number of years in the U.S. for these other foreign workers. Comparing this graph to Figure 1 we can see that, unlike shipyard workers, there is no concentration of foreign non-shipyard workers who arrived in the U.S. twelve years ago. This suggests that the pattern displayed by foreign workers in Figure 1 is driven by the opening of the shipyard and not simply a result of overall migration patterns.

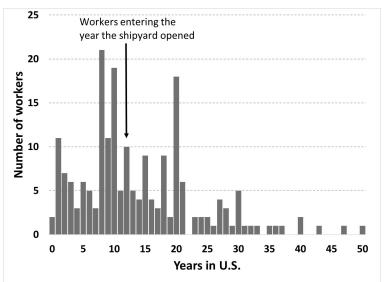


Figure 2: Years since migration for foreign-born non-shipyard workers

Data from U.S. Population Census of 1900 for foreign-born residents of Newport News, VA holding non-shipbuilding occupations.

To quantify the number of excess shipyard workers that arrived in the U.S. in 1888 compared to the pattern observed for non-shipyard workers resident in Newport News I run some simple linear regressions. Specifically, using a data set containing both foreign shipyard and foreign non-shipyard workers, I aggregate workers based on their number of years in the U.S. and then run regressions looking at whether there was an increase in workers who came to the U.S. twelve years ago, the year that work began at NNS. The results of this exercise are presented in Table 5. All regressions in Table 5 include fixed effects by arrival year and a fixed effect for shipyard workers. Thus the immigration timing for NNS shipyard workers is being compared to the timing observed for the relevant comparison group.

Columns 1-2 of Table 5 compare the number of shipyard workers present in Newport News in 1900 that arrived in the U.S. the year the shipyard opened compared to other foreign-born workers in Newport News. These results indicate that there was an excess of 25-27 arrivals of immigrant shipyard workers in 1888, compared to what we would have expected given the immigration pattern observed for non-shipyard workers. Given that there were 98 workers on the NNS payroll in April of 1889, this tells us that roughly one quarter of the total shipyard workers at that point were likely to have been immigrants. Since only around half of the shipyard workers were skilled, as many as half of the skilled workers in the shipyard early on were likely to have been foreign. Moreover, even among skilled workers, only a subset, about 17 workers, had skills to the metal shipbuilding industry. Thus, it is reasonable to conclude that in the early days of the shipyard the majority, and perhaps the entirety, of workers with skills specific to metal shipbuilding were recent immigrants. Columns 3-4 show that roughly similar results are obtained if we instead compare the arrival time of foreign shipyard workers at NNS to the foreign shipyard workers employed at Lorain, which had not yet opened in 1888.

Even for those foreigners who came to the U.S. before the shipyard opened, the Census supplies some interesting clues about their path to Newport News. Earl Simon, for example, was a 36-year-old ship joiner in the 1900 Census. From the Census we can see that he was in Scotland at age 23, where he had a son, and then he moved to the U.S. at age 24. He had a second son at age 26 while living in Pennsylvania, before coming to Newport News. This type of trajectory appears to be typical. Another example is Alfred Bull. Born in England in 1854, Bull moved to the U.S. at age 18 and had children in Pennsylvania in 1888 and 1891 before coming to Newport News, where he worked as boilermaker. Given that Pennsylvania was the most important metal shipbuilding state in the U.S. in the 1880s and 1890s, these patterns suggest that these workers may have moved to the U.S. to work at the Pennsylvania shipyards, and then relocated later to work at the new NNS shipyard.

Table 5: Testing the difference in immigrants in the year NNS opened

Dependent variable: Count of immigrants by arrival year						
Comparison group:	Non-NNS foreign workers in Newport News		Foreign shipyard workers in Lorain			
	(1)	$(1) \qquad \qquad (2)$		(4)		
NNS workers × year NNS opened	27.03*** (0.922)	25.14**** (2.054)	20.11*** (0.872)	21.20*** (2.058)		
NNS workers	0.971 (0.922)	3.155 (1.946)	-1.114 (0.872)	0.665 (4.180)		
NNS workers \times arrival year		0.677 (0.760)		-0.379 (1.045)		
NNS workers \times arrival year sq.		-0.0787 (0.0522)		0.0117 (0.0645)		
NNS workers \times arrival year cub.		0.0017* (0.0009)		-2.35e-06 (0.00112)		
Year-of-arrival effects	Yes	Yes	Yes	Yes		
Observations R-squared	$72 \\ 0.896$	$72 \\ 0.924$	$72 \\ 0.919$	$72 \\ 0.923$		

^{***} p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. Data set used in Columns 1-2 includes all foreign-born NNS shipyard workers who arrived in the U.S. in the 35 years before the census and all male foreign-born head-of-household residents of Newport News who arrived in the U.S. in the 35 years before. Data in Columns 3-4 includes all foreign-born shipyard workers at NNS or in Lorain who arrived in the U.S. in the 35 years prior to 1900.

Immigrant shipyard workers were more experienced when they arrived than other immigrant workers in Newport News. This can be seen in Figure 3, which plots the age at migration for immigrant shipyard workers in Newport News and other non-shipyard immigrant workers. These data show that those foreigners who worked at NNS were much more likely to have migrated in their late 20s or early 30s than foreign workers outside of NNS.

0.25

O.2

O.15

O.05

O.4

Age at immigration to U.S.

Figure 3: Age of migration for NNS and other foreign workers in Newport News

This figure plots the share of workers falling into each age bin based on when they immigrated to the U.S. The first series covers immigrant workers in Newport News with shipbuilding occupations. The second series covers all other immigrant male household heads in Newport News with non-shipyard occupations. Data from 1900 Census of Population.

Immigrant shipyard workers in Newport News, as well as in Lorain, were much more likely to hail from major European metal shipbuilding nations than other immigrant workers during this period. This fact is illustrated by the comparison in Table 6, which shows the top fifteen countries of origin for different groups of immigrants. We can see that immigrants working in shipyard occupations in Newport News hailed

primarily came from just a few locations – England, Scotland, Ireland and Germany – the major European metal shipbuilding centers. Together, these four locations of birth make up almost three-quarters of all of the immigrant shipyard workers. As a point of comparison, Britain (England, Scotland and Wales), Ireland and Germany accounted for, respectively, 14%, 13% and 23% of all migrants to the U.S. from 1870-1900 (United States Bureau of the Census, 1975). Thus relative to national immigration trends, English and Scottish workers were substantially overrepresented among the shipyard workers in Newport News. A similar pattern is visible in Lorain, shown in the right-hand column, where English and Scottish workers together made up 29% percent of all foreign workers. We also see many immigrants from Germany and Poland in Lorain. Many of these, particularly the Poles, were unskilled laborers. Note that relative to national rates, German workers were not over-represented in either Newport News or Lorain.

The origins of the shipyard workers contrast with the origins of the foreign residents of Newport News working in non-shipyard occupations, shown in the second column of Table 6. While England, Ireland and Germany are also important among this group, the shares are spread much more evenly across origin countries. The differences are particularly stark for England and Scotland. Overall, the pattern for non-shipyard workers is much closer to the patterns exhibited at the national level. A further contrast is provided by comparing to the main immigrant groups in Groton-Noank. In that area, as in many wood shipbuilding centers, the foreign population was dominated by Canadians. Many of these had immigrated fairly recently from the declining wood shipbuilding towns of Nova Scotia and New Brunswick to the wood shipbuilding centers of the U.S. These U.S. wood shippards were partially protected from competition from British metal ship producers thanks to government regula-

²²See, e.g., United States Bureau of the Census (1975).

tions banning the use of foreign-built ships to ship between U.S. ports. In contrast, as part of the British Empire, Canada could not offer similar protections to its local shipbuilders, resulting in a far steeper decline in that industry in Canada than in the U.S. (Hanlon, 2018).

Table 6: Top ten countries of origin for different groups of workers

Newport News shipyard wkrs.		N.N. other foreign wkrs.		Groton-Noank shipyard wkrs.		Lorain, OH shipyard wkrs.	
Country of birth	Share	Country of birth	Share	Country of birth	Share	Country of birth	Share
England	0.262	England	0.158	Canada	0.776	England	0.215
Scotland	0.186	Germany	0.147	England	0.057	Germany	0.203
Germany	0.147	Ireland	0.124	Scotland	0.050	Poland	0.148
Ireland	0.143	Russia	0.110	Ireland	0.048	Canada	0.130
Canada	0.062	China	0.107	Norway	0.016	Ireland	0.080
Sweden	0.039	Scotland	0.062	Sweden	0.014	Scotland	0.075
Wales	0.034	Canada	0.062	Germany	0.009	Wales	0.043
Hungary	0.030	Italy	0.042	Italy	0.007	Austria	0.032
Austria	0.023	Austria	0.040	Russia	0.005	Hungary	0.025
Denmark	0.016	Poland	0.023	Finland	0.002	Switz.	0.011

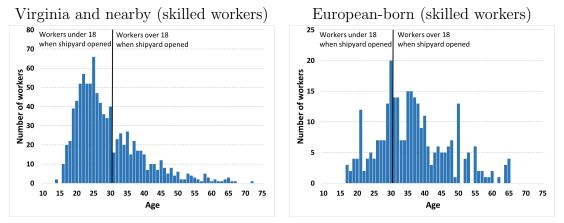
Data from U.S. Population Census of 1900.

The census data also provide evidence that, while NNS initially drew heavily on foreign workers, it soon began training local workers to move into higher-skilled positions. Evidence for this can been seen in Figure 4, which describes the age distribution of local workers (from Virginia or nearby states) and foreign workers in skilled shipbuilding occupations in Newport News. For native-born workers, in the left panel, we see that in 1900 there were many more shippard workers just below the age of 30 than just above age 30. This is exactly the age that would have been moving into the labor force at the time that the shippard opened. This suggests that local workers who had not yet entered the labor force when the shippard opened were

substantially more likely to take up shipyard work than those who were already of working age.

This pattern contrasts sharply with what we see for European-born workers, in the right panel. The most important feature in this figure is the high level of European-born workers in their late 30s. Workers in this age category would have finished their apprenticeship period – typically 5-7 years in British yards – around the time that NNS was opening. There are also relatively few European-born workers under age 29 but many more around 29-32. Workers around 29-32 would have been moving into the labor force around the time that NNS opened. This suggests that the shipyard may have attracted Europeans who were just moving into the labor force when the shipyard opened, but that the yard did not continue to attract similar workers in later years. It is worth noting that the double-peaked age pattern shown for foreign shipyard workers in Figure 4 does not appear in the age distribution of other foreign residents of Newport News, nor does it appear for the wood shipbuilding workers of Groton and Noank.

Figure 4: Age distribution of local-born workers and European-born NNS workers



Data from U.S. Population Census of 1900 for residents of Newport News, VA and nearby areas holding shipbuilding occupations.

A more direct way to look at this effect is to study how the share of native-born workers in skilled occupations varied across age cohorts. Figure 5 does this for those occupations most closely associated with metal shipbuilding: boilermakers, riveters, coppersmiths, and ship fitters (including apprentices). This figure shows that in Newport News, native-born workers made up almost all of the workers in their early 20s in these occupations but that for older age cohorts a substantial fraction of the occupations were filled by foreign workers. This pattern suggests that immigrant workers were initially important in these occupations but that over time they were being replaced by native-born workers.²³ For comparison purposes I have also included the same data for Lorain in this graph. The same patterns appear there, which suggests that foreign workers were playing an equally important role in the Great Lakes shipyards during this period.

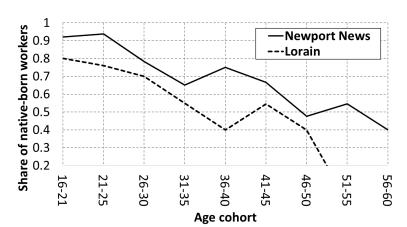


Figure 5: Share of native-born workers in key metal shipbuilding occupations

This figure plots the share of native-born workers in the occupations most closely associated with metal shipbuilding: boilermakers, riveters, coppersmiths, and ship fitters, including apprentices in each of these occupations. Data from 1900 Census of Population.

²³An alternative explanation is that native-born workers were more likely to drop out of these occupations as they grew older, but this seems unlikely.

The data in these figures augment historical evidence showing that NNS began training local workers to fill skilled positions soon after the yard opened. For example, we know that the first apprenticeship at NNS began in 1889 and the first completion certificate was issued to Norwood Jones in 1894 after a four-year program (Smith, 1965, p. 22). In the 1900 Census data, 60 workers are listed as apprentices in skilled occupations. Out of this group, 55 (91%) were native-born Americans, with most born in Virginia or Pennsylvania. The few foreign-born apprentices were the sons of shipyard workers.

To summarize, the census data tell us a number of useful facts about how NNS assembled a workforce despite the scarcity of skilled local workers. In particular, we have seen that the shipyard depended heavily on attracting skilled workers from abroad, particularly from Britain, the world's leading shipbuilding country. There is evidence that these skilled foreign workers were particularly important early in the firm's life, and particularly in those occupations most closely associated with metal shipbuilding, while over time native-born workers were trained to fill these positions. This suggests that early access to foreign workers may have eventually led to increases in both unskilled and skilled employment among native-born workers. There is also evidence that the shipyard substituted towards unskilled workers, relative to British yards, consistent with facing a scarcity of skilled workers.

5 Discussion

This study shows that immigrant workers made a substantial contribution to the emergence of Newport News Shipbuilding, the most important new industrial ship-yard to emerge in the U.S. during the late-19th century. Immigrants, hailing primarily

from Britain, provided key skills early in the firm's life, while over time there is evidence that native-born workers were trained to fill skilled occupations.

Why did these skilled immigrants leave British shipyards that were near the peak of their dominance? The answer must be the higher wages offered by American yards. These were regularly remarked upon by contemporary sources, such W.I. Babcock of the Chicago Shipbuilding Company who wrote in the *Marine Review* (2 September 1897) that wages on the Clyde were just 55 1/2 percent of the wages paid in U.S. yards but that U.S. yards might still compete with the British due to their "much greater use of labor-saving machinery," "larger and more modern yards," as well as the absence of unions in U.S. shipyards. These wage differentials attest to the shortage of skilled workers in American yards, a feature further confirmed by the relatively greater reliance on labor-saving machinery.

A second natural question is, how did American shipyards like NNS go about attracting British workers? Answering this question turns out to be difficult. Almost no company records on recruiting practices have survived from this period. I also failed to find evidence that the firm advertised through the media. One way workers may have found out about higher wages in the U.S. is through British newspaper reports. The Glasgow Herald (14 September 1899), for example, described piece rate earnings for skilled artisans of \$2-\$2.50 per day at NNS. These would have looked attractive to workers in British where, according to data from Pollard & Robertson (1979) (Table 9.5), skilled piece rate earnings were typically around \$1.70 per day. Informal networks and private communications were likely to have also been quite important. While direct evidence on these channels is difficult to find, such networks have been shown to influence migration patterns in a variety of contexts.

Of course, there remains the counterfactual question of whether the modern ship-

building industry would have developed in the U.S. during this period in the absence of access to skilled immigrant workers. This paper should not be interpreted as claiming that, without access to foreign workers, metal shipbuilding would not have emerged. However, the higher wages in U.S. shipyards, and the fact that American yards substituted towards labor-saving machinery and unskilled workers, compared to leading British yards, tells us that U.S. firms faced a relative scarcity of skilled workers even when access to skilled immigrant workers was possible. Given the number of skilled immigrant workers employed by firms like NNS, had U.S. firms not had access to immigrant workers the shortage of skills would have been even more acute. Surely, then, the ability to attract foreign skilled workers likely lowered the firms cost early in their development, though it is impossible to know by exactly how much.

Finally, what can we say about how these migrant flows affected native-born workers? In the short run, the impact of the availability of skilled immigrant workers on employment of skilled native-born workers is ambiguous, though over time there is evidence that native-born workers were trained to fill skilled positions. While skilled foreign workers may have taken some jobs from American workers in the short-run, it is also possible that, by allowing shipbuilding to grow, they expanded overall skilled and unskilled employment. In any case their effect was not strong enough to eliminate the substantial wage premium that skilled workers in America enjoyed. In the end, the greatest threat to skilled wages was not immigration, but rather the constant introduction of new labor-saving machinery induced by the high wages faced by American shipyards.

References

- Abramitzky, R, & Boustan, LP. 2017. Immigration in American Economic History. *Journal of Economic Literature*, **55**(4), 1311–45.
- Allen, R.C. 1977. The Peculiar Productivity History of American Blast Furnaces, 1840-1913. *The Journal of Economic History*, **37**(3), 605–633.
- Allen, R.C. 1979. International Competition in Iron and Steel, 1850-1913. The Journal of Economic History, 39(4), 911-937.
- Allen, R.C. 1981. Accounting for Price Changes: American Steel Rails, 1879-1910. Journal of Political Economy, 89(3), 512-528.
- Berthoff, RT. 1953. British Immigrants in Industrial America, 1790-1950. Harvard University Press.
- Borjas, G. J. 2014. Immigration Economics. Cambridge, MA: Harvard University Press.
- Culliton, James W. 1948. The Shipbuilding Business in the United States of America. The Society of Naval Architects and Marine Engineers. Chap. Economics and Shipbuilding, pages 1–13.
- Evans, Cerinda W. 1954. Collis Potter Huntington. Newport News, VA: The Mariners' Museum.
- Fones-Wolf, K. 2004. Transatlantic Craft Migrations and Transational Spaces: Belgian Window Glass Workers in America, 18801920. *Labor History*, **45**(3), 299–321.
- Hanlon, W Walker. 2018 (February). The Persistent Effect of Temporary Input Cost Advantages in Shipbuilding, 1850-1911. Mimeo.
- Harley, C. K. 1973. On the Persistence of Old Techniques: The Case of North American Wooden Shipbuilding. The Journal of Economic History, 33(2), pp. 372–398.
- Hatton, TJ, & Williamson, JG. 1998. The Age of Mass Migration. Oxford University Press.
- Hirschman, C, & Mogford, E. 2009. Immigration and the American Industrial Revolution from 1880 to 1920. Social Science Research, 38(4), 897–920.
- Hutchins, John G.B. 1948. The Shipbuilding Business in the United States of America. The Society of Naval Architects and Marine Engineers. Chap. 2: History and Development of the Shipbuilding Industry in the United States, pages 14–60.
- Irwin, Douglas A. 2003. Explaining America's Surge in Manufactured Exports, 1880-1913. The Review of Economics and Statistics, 85(2), pp. 364-376.
- Jeremy, DJ. 1991. International Technology Transfer: Europe, Japan and the USA, 1700-1914.
 Edward Elgar Publishing Limited.

- Jones, B, & Lewis, RL. 2007. Gender and Transnationality among Welsh Tinplate Workers in Pittsburgh: The Hattie Williams Affair, 1895. *Labor History*, **48**(2), 175–194.
- Kerr, SP, & Kerr, WH. 2011. Economic Impacts of Immigration: A Survey. Finnish Economic Papers, 24(1).
- Lorenz, Edward H. 1991. An Evolutionary Explanation for Competitive Decline: The British Shipbuilding Industry, 1890-1970. *The Journal of Economic History*, **51**(4), pp. 911–935.
- Margo, RA. 2014. The Economic History of Migration: The Pre-WWI USA as Lens. Edward Elgar Publishing. Pages 42–64.
- Moser, P, Voena, A, & Waldinger, F. 2014. German-Jewish Emigres and U.S. Innovation. *American Economic Review*, **104**(10), 3222–55.
- Pollard, S., & Robertson, P. 1979. *The British Shipbuilding Industry, 1870-1914.* Cambridge, MA: Harvard University Press.
- Smith, Edward O. 1965. History of the Newport News Shipbuilding and Dry Dock Company.
- Temin, P. 1964. Iron and Steel in Nineteenth-Century America. Cambridge, MA: The MIT.
- Thiesen, William H. 2006. Industrializing American Shipbuilding. University Press of Florida.
- Thompson, Peter. 2001. How Much Did the Liberty Shipbuilders Learn? New Evidence for an Old Case Study. *Journal of Political Economy*, **109**(1), pp. 103–137.
- United States Bureau of the Census. 1975. Historical statistics of the United States, colonial times to 1970. US Department of Commerce, Bureau of the Census.