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Racial Diversity and Team Performance: Evidence from the American Offshore Whaling Industry

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ABSTRACT:

In this paper we contribute to the literature on diversity and team performance by exploiting unique data from the natural experiment of American offshore whaling industry during the period between 1807 and 1912. Teams are represented by the crew operating onboard of whaling vessels and performance is measured by the value of the output captured during voyage. Combining information from multiple data sources, we document the existence of a U-shaped relationship between racial diversity and team performance. The nonlinear effect was transmitted by conflicts and skill complementarity among the whalemen. Crews adapted to diversity over time, as the effect shifted from being negative to negligible and then positive between short, medium, and long term voyages.

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1. Introduction

Economists have long recognized the externalities that stem from population diversity. These effects depend on the tradeoff between the benefit and the cost of diversity on socio-economic outcomes.[1] With the increasing globalization and racial integration of labor markets, a central question in the economics and management literature is how this tradeoff influences teamwork and team performance. In team production, greater diversity can have a positive impact on performance by facilitating creativity and complementarity in skills (Lazear, 1999a; Haas, 2010) especially when the task performed requires superior abilities (Hamilton et al., 2003). On the other hand, negative impacts can arise if higher diversity is associated with intergroup distrust or taste-based discrimination, which can lead to conflict and lack of coordination (Hjort, 2014) or if language barriers lead to communication problems (Marx et al., 2021).

Previous studies provide useful evidence for conceptualizing the performance effects of diversity at the team level.[2] Taken together, three general possibilities emerge regarding the net

[1] For a review in economics Alesina and La Ferrara (2005), Alesina et al. (2016), Ozgen (2021), and Harrison and Klein (2007) in management.

[2] Existing empirical studies find contrasting results depending on the source of diversity that is analyzed. For example, while diversity in skills is positively associated with productivity, diversity in ethnicity and age decreases it (Parrotta et al., 2014). Or even when linguistic and religious diversity negatively impact productivity, genetic diversity has a positive effect (Dale-Olsen and Finseraas; 2020). Studies focusing on national diversity on team outcomes find positive effects when a diverse pool of knowledge within a diverse team facilitates mutual learning (Hoogendoorn and van Praag, 2012), or skill complementarities improve team performance in sport as long as the foreign players come from the same country (Kahane et al, 2013). Experimental evidence indicates that homogeneous teams of workers at the same hierarchical level (horizontal diversity) perform better than diverse heterogenous ones, while diversity between supervisors and supervisees (vertical diversity) improves team performance (Marx et al., 2021). Additionally, homogenous teams perform better when team members have different skill sets while heterogeneous teams do better when members have overlapping skills (Lyons, 2017). Finally, recent evidence in the psychological literature indicates that over time individuals adapt to diversity (Ramos et al., 2019), develop a common language in coordinating their tasks (Selten and Warglien, 2007), distrust and conflict dissipate, and when that happens benefits from diversity outweigh its costs (Bai et al., 2022).

effects of diversity. First, the net effect could be positive at all levels of diversity if the realized benefits in team creativity and skill complementarity always dominate the cost of diversity generated by conflict and communication problems. Conversely, the net effect could be negative at all levels of diversity if the costs always exceed the benefits. As the final possibility, the net effect could be non-linear, depending on the level of diversity. For example, the costs could dominate the benefits at low levels of diversity, but the relationship could be reversed at high levels of diversity as benefits eventually exceed costs.

In this paper, we contribute to the literature on diversity and performance by studying the causal effect of racial diversity on team productivity in the American offshore whaling industry during the period between 1807 and 1912. From colonial settlements into the twentieth century, whaling was an important industry in America, thanks to the process of industrialization and urbanization that raised the demand for oil used for lubrication and illumination and for baleen used in the production of various consumer products. Crews were multiracial. Operations on the vessel required a significant amount of teamwork and cooperation by the crew, which consisted of a combination of high and low skill workers with well identified roles and ranks. In this context, we document the existence of a nonlinear effect of racial diversity on team performance, where teams are represented by the crew operating onboard of whaling vessels and performance is measured by the value of the output captured during the voyage. We do this by examining how racial diversity was mediated negatively through conflicts and positively through skill complementarity, which are the transmission channels responsible for the nonlinear shape of the estimated relationship. In addition, we examine the crew's adaptation to diversity over time by studying diversity's effect on performance across voyages of different length.

The history of the American whaling industry offers an ideal setting to examine the impact of racial diversity on team performance by providing appropriate data and unique advantages for identification. A significant benefit from focusing on this industry is the availability of extremely rich data on the crew and the production process of whaling voyages. Customs records include the name, age, birthplace and residence of each voyage's crew members, which can be linked with census enumeration schedules and other external sources to determine their race. In addition, the crew lists include a visual description (skin complexion, hair, and eye color) of the whalemen, recorded for identification at customs, which can also be used as proxy for race in our analysis. Finally, the records provide detailed data regarding the performance of each voyage, such as the dates of departure and arrival, vessel characteristics, and output.

Estimating the effect of diversity on team performance is challenging mainly due to difficulties of data availability, causal identification, and model specification. In particular, researchers had to address the potential endogeneity of the relationship between diversity and performance. In our setting, the historical experience of the whaling industry provides an excellent natural experiment to identify the causal effect of racial diversity on team performance. Many of the usual endogeneity concerns raised by the selection of racial composition or the choice of inputs do not apply in the context of the whaling industry. Crucial for our empirical strategy, each whaling voyage was an independent operation, which required making many important managerial decisions before its start. This included decisions regarding the destination of the voyage, its physical capital (e.g., vessel size and rigging, equipment and provisions), and most importantly the crew. The racial composition of the crew was plausibly exogenous because members were recruited (as good as) randomly before the voyage for their specific skills and could not be changed in response to shocks to performance.[3] Targeting a less productive worker based on race could be costly in the absence of a significant wage gap between white and non-white crewmen (Craig and Fern, 1992). There is no evidence to suggest that recruiting agents employed by the industry were actively seeking diversity for a higher moral, social, or economic objective. Their correspondence, for example, shows that in times of labor shortage they were always busy trying to staff their vessels randomly with the next person that showed up to sign on. When there was a surplus of applicants, as was the case during the economic crises of 1837 and 1857, they were screening based on suitability for open positions and fitness for the difficult life on a whaling voyage, rather than deliberately choose among potential recruits based on certain racial or ethnic characteristics to enhance diversity (Creighton, 1995: Chapter 3).[4] Any diversity that resulted was thus driven by the supply of available labor rather than endogenously through a process associated with performance.

To conduct our empirical analysis, we draw on a large number of data sources. We determine the race of each crew member by combining the hair and complexion data available from the

[3] Mid-voyage changes to the crew were made only if necessitated by an unexpected illness, desertion, or death.
[4] For examples of contemporary and recent accounts of how agents recruited whaling crews, see also Gilje (2004: 15-24), Hohman (1928: Chapter 6), and Nordhoff (1856: Chapter 1).

archival records of the whaling industry with information from the Seamen's Protection Certificate Database, the U.S. Federal Census enumeration schedules, and various sources on the names of native Americans employed in the whaling industry. By determining the fractions of members in various racial categories, we calculate the standard index of fractionalization for each voyage as a measure of diversity to estimate the effect of racial diversity on total revenue. In our empirical specification crew diversity affects performance in a quadratic form. We exploit the richness of the data by including in the analysis various voyage characteristics and a number of fixed effects that address omitted factors. In particular, we include a fixed effect for the captain, as the performance of the team depends on its management, especially in handling the implications of racial diversity. In the whaling industry, the role of the captain and his ability in managing the crew and hunting whales were vital to the success of the voyage.

With this strategy we provide evidence for the existence of a U-shaped relationship between racial diversity and team performance. This relationship is precisely estimated and robust across different specifications. We find that while an initial increase in diversity induces a sharp decline in the value of output, higher levels of racial heterogeneity yield substantial gains. Even though endogeneity concerns are minimal in the case of whaling crews, we cannot completely rule out the possibility of an endogenous relationship between racial diversity and team performance due to such things as measurement error (e.g., in race assignment from complexion data) and selection effects in crew recruitment by the managers or in self-sorting to ports and vessels by the workers. To address remaining endogeneity issues, we follow the literature (Parrotta et al., 2014; Alesina et al., 2016; Dale-Olsen and Finseraas, 2020) by instrumenting racial diversity with pre-existing regional diversity at the home port measured with a time lag. The results of the IV model confirm the robustness of our OLS findings. The IV estimates indicate that a 10 percent increase in diversity would be associated with a decrease in revenue by 0.8 percent for a very homogenous crew, and a 4 percent decrease in for a very diverse crew for a 10 percent decrease.

To understand the reasons for the U-shaped relationship between diversity and performance, we examine two channels of transmission that potentially worked in opposite directions and additionally investigate how crews adapted to diversity over time. First, we analyze the negative effect of diversity by focusing on conflicts arising during voyages, Taste-based discrimination between groups may have led to a lack of trust and poor cooperation among crew members, causing social conflicts. Although our records do not have direct information regarding incidents of conflict during voyages, we can infer this information indirectly from the remarks entered in official records. Specifically, we use incidents of the premature departure and the accidental death (e.g., due to drowning) of crew members as proxies for conflict during voyage. The results show suggestive evidence that more heterogenous crews experienced greater numbers of conflicts. Second, for an analysis of the positive impact of diversity, we examine skill complementarity among the crew in sighting, striking, and trying whales. Since skill complementarity might vary across subgroups of the crew, we distinguishing among the categories of crew according to hierarchy and skill. The results indicate that racial diversity among the skilled members of the crew (skilled maritime and artisan and service personnel) had a positive effect on striking and trying whales.

In addition, inspired by the observation made by Lazear (1999b) that diverse groups of individuals have strong incentives to assimilate more quickly, we investigate whether the effects of diversity varied over time. We explore this possibility by comparing the impact of diversity between similar voyages that differ only by their duration. Because crew members were compensated by a share of the value of the output at the end of the voyage, they had strong incentives to maximize compensation by coordinating efforts. Although conflicts could arise during the initial stages of a voyage due to discrimination and distrust as well as difficulty of communication, rational workers would progressively realize the negative effects of conflict on their performance and eventually learn to set aside their differences, develop a common language,[5] and collaborate toward a common goal. This would allow for the positive contribution of diversity to eventually outweigh the initial cost. We test for this expectation by examining the relationship between diversity and performance during the short (less than 12 months), medium (12-24 months), and long (over 24 months) term voyages separately. Our results indicate that diversity negatively affected revenue in short voyages, had no effect for voyages of medium length, and had a strong positive effect in long term voyages. These results

[5] In a coordination task, when communication is difficult ir no common language is available, a simple language can emerge (Selten and Warglien, 2007).

demonstrate that crews overcame the initial costs from diversity over time, allowing benefits to arise.

We are the first, to our knowledge, to document the existence of a nonlinear U-shaped causal relationship between racial diversity and team performance at the firm level and to uncover the transmission channels responsible for this shape. Although a vast economics and management literature exists regarding diversity's effects on performance, the findings have been confined mostly to a linear relationship or to nonlinear effects in limited contexts. Specifically, the empirical evidence regarding nonlinear effects of diversity has come from studies based on macroeconomic units, sports teams, and experimental studies.[6] We contribute to this literature by providing microeconomic evidence from the firm level competition that took place in the historical natural experiment of the whaling industry for over a century.

Our analysis is also related to the psychological literature on the time-dependent group level effects of diversity. Researchers have recently found that increasing diversity reduces perceived group differences over time.[7] As time passes, conflicts decrease, task coordination increases, and the positive contribution of diversity in terms of background and cognitive ability outweigh its costs (Ramos et al., 2019). Our results regarding the changing effects of diversity over the short, medium, and long time periods contribute to this literature by showing that the time-dependent

[6] In recent macroeconomic analysis, Ashraf and Galor (2013) and Galor (2022) argue that genetic diversity produces both social costs and benefits, with a hump-shaped rather than linear overall effect on development at the country or ethnic group level. Alesina et al. (2016a) also find concave pattern for a relationship between genetic diversity income or GDP per capita. Alesina et al. (2021) find a U-shaped association between the share of immigrant and pro-redistribution attitudes. There are obvious differences, however, between these macroeconomic settings and productivity analysis of industries, which make it questionable to generalize these results at the microeconomic firm level. At the micro level the evidence has been limited to sports teams and experimental data. Using data from the Spanish and the English association football leagues, Tovar (2020) finds nonlinear U-shaped effects on team performance when diversity is defined as the number of players from the predominant nationality. Brox and Krieger (2022) similarly use data from German sports teams to find evidence of a hump-shaped relationship between birthplace diversity and team performance. The external validity of these results is questionable for business firms in general at the micro level because of the special characteristics of sports competition, such as endogeneity concerns that arise from the repeated interactions of competing units and the likelihood of continual changes in unit memberships. In the management literature, based on laboratory studies Earley and Mosakowski (2000) find evidence of a U-shaped relationship between national diversity and team performance. The results of experimental studies with non-random participants who interact briefly or intermittently are also limited because of differences in group dynamics and team production.

[7] Bai et al. (2020) and Ramos et al. (2019) observed that after an initial period where diversity is met with distrust, over time people adapt to diversity, negative effects dissipate, and positive outcomes emerge.

effects of group diversity apply not just to changes in the personal values and preferences of individual group members but to the total revenue generated by a productive team as a whole.

2. Historical Overview of the American Offshore Whaling Industry

The early American commercial whaling industry had its beginnings in the inshore hunting ventures of the colonists in the Northeast in the seventeenth century. The industry soon developed boat whaling techniques of short-term duration (a few weeks) on vessels that grew in size over time. An important technological innovation that allowed long-term hunting in significantly extended areas was the transfer of the tryworks from shore to sea, installed right on the deck of the offshore whalers. This made it possible for American whalers based in the Northeast to hunt whales in not just the North Atlantic, but all over the globe, in voyages that could last several years.[8]

American whaling based on various ports in New England experienced a tremendous rise during the period of peace following the War of 1812. The industry kept growing through the first half of the century, dominating the world in terms of both the number of vessels and the total revenue from various whaling products. As seen in Figure 1, the total number of voyages that originated from New England ports reached a peak of about 150 per year just before the civil war. The industry also grew in terms of vessel size, new hunting grounds were discovered, and more operational ports were established (Davis, et al., 1997: 38-44). At its height during the middle of the nineteenth century, the industry was of great economic significance to New England and the United States as a whole. Thanks to the process of industrialization and urbanization, there was high demand for whale oil used in lubrication and illumination. The whale baleen (plates of cartilage for filter-feeding system) was also in high demand as a flexible yet strong material, used in the production of various consumer products like corsets and umbrellas. In value of output during this period, whaling is estimated to be the fifth among U.S. industries (Davis, et al., 1997: Ch. 4). After the Civil War, however, the industry entered a period of sharp decline and eventual disappearance. The reasons include the destruction caused by the

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[8] For early accounts of the industry's history, see Hohman (1928), Nordhoff (1856), Starbuck (1877), and Tower (1907). See also Busch (1994), Creighton (1995), Davis, et al. (1997), and Dolin (2007) for various modern perspectives.

war, rising wages in other industries that attracted skilled workers, increasing cost due to decreasing whaling population, and rising importance of other regions (Davis, et. al., 1988). Overall, however, scholars attribute the contraction of the industry to supply-side pressures that prevailed over the reduction of the population densities of targeted whales (Davis, et al., 1997: Ch. 4).[9]

2.1 Decision-making in a Whaling Voyage: Firm, Agent, and Captain

Economic historians of American whaling have typically viewed each voyage as a separate firm.[10] As estimated by Davis et al. (2007: 381-2), over three-quarters of ownership groups of vessels lasted only a single venture. Even for groups that continued multiple ventures, each voyage was practically a separate firm because it typically required the choice of a new destination, provision of new supplies (e.g., food and drink), refitting of the vessel with new equipment (e.g., sails, harpoons, whaleboats), and recruitment of new crew and management. The duration of voyages could vary significantly from one venture to the next depending on visited hunting grounds, success of the campaign, and navigation decisions taken for the most part by the captain. Because of high turnover and variability between ventures, the firm had to be liquidated anew virtually after every voyage.

Owners of a vessel typically hired an agent to plan and manage the voyage, though the agent could also be a part owner. The agent's role involved most aspects of the voyage, including recruiting the captain to manage the operation at sea, gathering investors to finance the venture, and handling various business matters regarding the purchase of supplies, payment of bills, sales of products, and distribution of proceeds. The plans for the voyage began with the choice of hunting grounds. This implicitly determined the type of vessel, specifically its rigging and its capacity or tonnage, and the size of the crew needed to operate it. Distant grounds required longer voyages with bigger vessels (e.g., ship or a bark), which consequently involved hiring additional crew with specific expertise, such as a carpenter or a blacksmith. It was normally the

[9] Indeed, technological innovation was the leading factor for the declining demand for whaling products. The development of kerosene, together with other cheap petroleum distillates, replaced whale oil as an illuminant and lubricant (Beaton, 1955), while the invention of steel made whale baleen obsolete (Davis et al., 1988).
[10] See, for example, Davis, et. al. (2007: p. 381) and Hilt (2006: p. 203).

responsibility of the agent to hire the crew and negotiate their compensation. Although the agents sometimes delegated this responsibility to captains or recruiters, they nevertheless closely monitored the process (Hill, 2006; Davis et al., 2007, Ch.10).

Conditional on the choices made by the agent, the day-to-day operational decisions at sea were made exclusively by the captain, who could have a substantial effect on the duration and performance of the voyage. Focused on hunting decisions and crew management, he had absolute powers to choose the necessary means to incentivize the crew and raise effort during the voyage. The success of the voyage could depend critically on the captain's experience, his knowledge of migration patterns of whales, and his navigational and hunting skills, including commanding a lance during the actual hunt. Since the vessels had limited cargo capacity, a skilled captain could fill the hull with oil and bones faster than an unskilled one and thus end the voyage earlier. He could alternatively increase the efficiency of the invested capital by selling cargo at ports along the way, or by transferring it to another merchant ship with available space going back to the same home port (Davis et al., 2007; Ch. 5). The importance of these skills grew over time, as the abundance of whales declined in older hunting grounds and new grounds were sought through longer voyages.

Some voyages picked up seamen *en route* in distant islands, such as during reprovisioning stops in the Portuguese archipelagos of the Azores and Cape Verde, which may present another source of potential endogeneity. If, for example, a captain thought that having diverse crew was beneficial for performance, he could attempt to recruit additional crew after departure for the sole purpose of diversifying the crew. Our review of the historical literature and industry records, however, shows no evidence of deliberate crew diversification by captains during the voyage. It seems that seamen recruitment *en route* was mostly random or aimed at filling positions left vacant unexpectedly. For example, Charles Petty, captain of the vessel Aerial, picked up four new seamen in Fayal in August 1851, three months after departure from Fall River, Massachusetts, to replace the same number of men who had left or were discharged for various reasons. In most cases, replacements were young and inexperienced males eager to sign on to whaling voyages to escape slavery, military recruitment, or miserable conditions at low rates of remuneration (Handsman, et. al., 2021: 300-303). In any case, except unusual circumsytances of unexpected disaster on board, the numbers of new men recruited en route were too small to have significant impact on crew diversity as a whole. The fraction of seamen with such Portuguese descent rose over time, reaching about seven percent by mid-nineteenth century, but by then most of these individuals started voyages in New England ports as residents of the United States.

2.2 Crew Diversity in the American Whaling Industry

A well-known distinguishing characteristic of the American whaling industry was the high degree of racial and ethnic diversity among the crew. A typical mid-nineteenth century crew consisted of not just white men from the dominant demographic of New England towns, but also native Americans from various local tribes and numerous blacks, including runaway slaves, from all parts of the country. In addition, the voyages drew an international mixture of men from a variety of places around the world, including Europe, West Indies, Pacific Islands, and the Azorean and Cape Verde islands in the Atlantic.

Distinctive crew diversity in American whaling has attracted significant attention in the historical literature. In his seminal economic analysis of the American whaling industry, Hohman (1928: 51) observed that "[s]eldom have so many widely assorted specimens of the human family been packed into such small spaces as the forecastles of the latter-day whaleships." Numerous historians have studied the unique features of the racial and ethnic diversity of whaling voyages in the context of broader debates in U.S. history (Raffety, 2008). Noting that blacks constituted as much as one-fifth of American mariners in the early nineteenth century, Bolster's (1997) influential *Black Jacks* argued the crucial importance of seafaring in the history of the black community. Similarly, Shoemaker (2015) focused on the Native Americans of New Bedford area and used various archival records to show how race mattered in various social settings that Indian seamen found themselves in.[11] Finally, a recent special ethnographic report commissioned by the National Park Service has provided a detailed analysis of various racial and ethnic groups in the New Bedford area by tying mariners from these groups to the histories of their communities (Handsman, et. al., 2021).

[11] See also Mancini (2015a, 2015b) for studies of Indian mariners of Connecticut and southern New England in the eighteenth century, based on colonial census schedules, customs records, and tribal documents.

The success of the voyage as an economic enterprise was measured by the ability to maximize the value of the output. Whaling was an intrinsically risky venture for ship owners and crew because of the vulnerability to natural shocks as well as the multiple ways the substantial ethnic and racial diversity that existed among the whaling crews influenced the performance during the voyage. Intergroup distrust or taste-based discrimination could lead to conflicts and lack of coordination, while language barriers prevented to communication with foreign crew members all negatively impacted performance and thus the value of the output. The “society” on board of whaling vessels was more egalitarian than the one found on land (Farr, 1983). Also, the absence of wage differential based on racial or ethnic composition of the crew (Craig and Fern, 1993; Creighton 1995; pp. 76-77) suggests that workers were not discriminated by the employer (the agent), and they were paid based on their ability to contribute to the enterprise. However, this does not exclude that there was discrimination among crew members. In fact, as reported in Creighton (1995; pp. 122-123, pp.159) voyage diaries record accounts of discrimination and conflicts that had racial components. Over time, crew member might have set aside their differences if they found a common purpose. For instance, they might unite against the cruelty of the captain (Creighton, 1995; p. 115) or to maximize output and consequently their economic reward. Indeed, the share payment system also gave workers incentives to coordinate their efforts to maximize their pay and set aside their differences. When that happened, the negative effect due to discrimination and distrust was overtaken by the positive contribution of skill complementarities problem-solving ability, which would positively affect revenues.

3. Data Sources

For our analysis we use data from multiple sources. The first main source from which we draw data is the American Offshore Whaling Voyages database (Voyage database). It is a very rich dataset consisting of detailed information regarding all of the voyages taken by the American whaling industry in the 1800s for which evidence was found (for a description see Lund et al., 2008). There are roughly 15,000 voyages. For most voyages the database includes the port of origin and the declared destination (i.e., hunting grounds), the vessel and its characteristics (e.g., capacity and rig), the dates of departure and return, and whether it ended prematurely due to fire, sinking, condemnation, or other reasons. The database also includes the names of the agent and the captain of each voyage, and the total amount of the catch (whale bone, sperm oil, whale oil) brought back or sold *en route*. Typically, the products were returned to the port of origin aboard the whaling vessel. However, when voyages lengthened, part of the cargo could be transferred to other whaling vessels or freighters to be shipped home (Lund et al., 2008).[12]

The second main source is the American Offshore Whaling Crew Lists database. It includes the crew lists for whaling voyages recorded at the customs houses in New Bedford, Fall River, and Salem, Massachusetts, and in New London, Connecticut. Before a vessel could depart on a voyage the captain had to produce a list of the crew and give an account of any crew members who were not present to customs collector at the port of departure. The original crew list database includes over 177,000 entries for nearly 6,000 voyages. This database includes information on the full name of each crew member, age, and the city of residence and a physical description, i.e., height, skin complexion, hair type and color, eye color. Additional information on the birthplace, citizenship, rank and remuneration, the lay, are sometimes available.

The final database available for the whaling industry is the American Offshore Whaling Logbook database. This includes more detailed information regarding the hunt and the catch from the original whaling logbooks (for a detailed description see Smith et al., 2012).[13] For a subset of the voyages included in the Voyages database, it includes geocoded- and date-specific information regarding the whales seen and captured, and the location of the vessel from the logbooks of 1,381 voyages departing mainly from New England ports.

In addition, we use the information regarding the name, age, and places of birth and residence of the whalemen recorded in Crew Lists to draw external data from the U.S. Census enumeration schedules and other sources on the race and ethnicity of crew members. Following the empirical strategy section below, we will discuss the way we used the data from our sources

[12] Researchers from the World Whaling History project have tracked most of the amounts shipped to the home port (Lund et al., 2008). The product entries in the database are representative to the total output of the voyage (personal communication with Judith Lund, advisory curator and lead researcher on the project, May 2022; and our own investigation).

[13] As detailed in the overview section of the Logbook database, the research projects were conducted by Lt. Cmdr. Matthew Fontaine Maury in the 1850s, Charles Haskins Townsend in the 1930s, and a team from the Census of Marine Life project between 2000 and 2010.

to construct the variables used in the empirical analysis. A detailed discussion of the construction of the main variables is available in Appendix A.

Although the original Voyages dataset includes information for about 15,000 voyages and 119,000 crew members, we do not have complete overlap across the three data sources for all voyages. After merging the data from all sources, the final dataset includes a total of 4,407 voyages made by 1,045 vessels over the period 1807 – 1912.[14] Out of these, only 257 vessels made one single voyage, while more than 50 percent completing at least five voyages, with 10 percent with fourteen voyages or more. On average, over the entire sample, a voyage lasted for a little more than 27 months. It employed a large vessel, a Ship or a Bark, with considerable cargo space, 277 Tons, and a crew of 27 men.

4. Empirical Strategy.

In this section we describe the empirical strategy adopted to investigate the relationship between racial diversity and team performance. We start by outlining how we use a Cobb-Douglas production function and plausibly exogeneous variation in the racial composition of whaling crew and voyage data to estimate nonlinear effects of crew diversity on voyage revenue, a measure of performance. Then, we rely on an instrumental variable strategy to address possible endogeneity of the relationship between racial diversity and team performance.

4.1 Baseline Specification

To investigate the possible effects of labor diversity on performance, we employ the following general expression:

$$Y_{it} = f(K_{it}, L_{it}, S_{it}; \omega_{it}), \tag{1}$$

where Y_{it} is the outcome defining total sales, our measure of team performance, and $f(\cdot)$ is the production function that describes the technology used to produce the gross output, whale products, captured by vessel *i* during voyage initiated from the home port at t.[15] K_{it} denotes the

[14] We keep all voyages for which we have race information for at least 10 crewmen.
[15] In the appendix, section A.4, we also investigate the effect of racial diversity on productivity using the Logbook data.

tonnage of the vessel, a measure of the physical capital employed for the voyage. L_{it} is crew size, measuring labor, and S_{it} denotes the duration of the voyage.[16] As discussed in Section 2.1, the decision on which vessel and rigging to use and the crew to be hired, captain included, are made prior to departure. This implies that capital and labor demands are predetermined relative to the day-to-day decisions made by the captain in response to unexpected luck or disaster faced during voyage. The duration of the voyage is the only flexible input, and it was determined during the voyage. Conditional on predetermined input choices, the objective for the voyage was to maximize output and consequently revenue. Revenue maximization was consistent with the incentives of the crew because each member, including the captain, was paid with a share (a lay) of the net value of the voyage. The term ω_{it} denotes the productivity level observed by the captain during the voyage, when he makes decisions about S, but not observed by us.

Consider the case where the function $f(\cdot)$ is a Cobb-Douglas production function. Adding an unobservable random shock, we obtain:

$$y_{it} = a + \beta^L l_{it} + \beta^K k_{it} + \beta^S s_{it} + \omega_{it} + \eta_{it}, \qquad (2)$$

where the lower-case letters stand for the log values of their upper-case variables. We assume that, conditional on capital and crew size, productivity shocks are determined by several factors. First, crew diversity can generate both costs and benefits that can influence the success of the voyage. Specifically, the ability to capture and extract output from a whale depend on the concerted effort of the entire crew and hence team's performance. Production operations required the employment of some workers with very specialized skill sets as well as close cooperation between officers and crewmen. Hence, management plays an important role. Third, exogenous natural factors influence the spatial distribution of whales, which also impact productivity.[17] For these reasons, we express productivity shocks as a function of these determining factors: $\omega_{it} = g(\delta_{it}; \boldsymbol{\beta}^{\boldsymbol{\delta}}) + \boldsymbol{\mu}\mathbf{X}_{it}$, where the term δ_{it} is diversity, measured by the index of fractionalization calculated as described below in Section 5.1, and $\boldsymbol{\beta}^{\boldsymbol{\delta}}$ measures the

[16] The production process is joint in inputs, i.e., it requires all inputs to produce all outputs, because of the complementarity between whale oil and baleen, it is not possible to distinguish the input allocated to the production of each output. We further assume that prices are homogeneous for the New England region and the market is perfectly competitive.

[17] Annual variation in water temperature across space which influence whales' migration and hence their availability across hunting grounds. We discuss this issue in more details in section A.3.

impact of racial diversity on performance. The term $\mathbf{X}_{it}$ is a vector of factors that can affect team performance.

In our baseline specification the vector $\mathbf{X}_{it}$ includes time fixed effect to control for industry-wide technological change and a dummy variable for each rigging type of the vessel, e.g., bark, ship, etc., which controls for differences in size, maneuverability, and power, that are not captured by cargo tonnage (See Appendix A.3. for vessel types.). It should be noted that in several cases the same vessel could be rebuilt to alter its tonnage or rerigged in a more productive configuration, for instance to improve maneuverability or to extend the potential duration of the voyage and thus allow access to new hunting grounds (Devis et al., 2007; Ch8). To examine the role of management, in our second specification, we add a master fixed effect. Masters (captains) had a major impact on productivity, and for this reason they were highly retributed depending on skill and experience. Including a fixed effect allows us to control for unobservable skill differences between captains, including the ability to manage the crew, to find whales, and lead hunts. We then add fixed effects for the hunting ground visited by the vessel during the voyage interacted by year of departure to control for variation in the availability of whales across oceans and over time. In our final and preferred specification, we add an index of fractionalization based on region of origin of the crew members as a proxy for ethnicity. This allows us to identify the effect of diversity conditional on ethnicity of the crew.

The function $g(\cdot)$ describes how crew diversity affects productivity that could take either a linear or a nonlinear form. Existing studies have generally focused on estimating a simple linear effect of team diversity on productivity.[18] We investigate potential nonlinear effect with a local polynomial regression using as dependent variables the residuals from a regression controlling for the log of tonnage, crew size, and voyage duration, as well as year of departure and rig fixed effects. To capture the nonlinearity in the relationship, we choose to define the function describing how crew diversity affects productivity with a quadratic form: $g(\delta_{it}; \boldsymbol{\beta}^{\boldsymbol{\delta}}) = \beta_1^{\delta}\delta_{it} + \beta_2^{\delta}\delta_{it}^2$. Thus, β_1^{δ} and β_2^{δ} are our parameters of interest.

[18] There are only few examples in the literature of nonlinear effects of genetic diversity or national origin on socio-economic outcomes and sport team performance (Ashraf and Galor, 2013; Alesina et al., 2016a; Galor, 2022; Tovar, 2020). We are not aware of studies documenting racial diversity having nonlinear effect on productivity or other socio-economic outcomes.

4.2 Instrumental Variable Approach

Researchers have faced significant challenges in identifying the causal effect of diversity at the team level because of potential endogeneity of the diversity measure and reverse causality. If workers who sort into the area surrounding the departure ports based on their productivity can lead to non-random assignment of immigrant workers to the different areas. This may generate correlation between the racial heterogeneity of the labor supply for the home port and the productivity of the voyages departing from it. Reverse causality can also be a problem if, for example, higher productivity attracts diverse teams, or if the whaling agent, the team's employer, knows about the benefits of diversity and hire workers accordingly.

As previously discussed, many of these issues do not apply in the context of the whaling industry, but there may be situations when this might not be the case. To remediate the potential endogeneity concerns, we adopt an instrumental variable (IV) strategy established in the literature (e.g., Parrotta et al., 2014; Alesina et al., 2016). Specifically, we rely on an instrument that reflects the potential labor supply, distinguished by race, in the area surrounding the ports from which voyages depart. Considering that transportation in the 19th century was somehow more difficult, especially outside large urban centers, it is safe to assume that most of the whalemen were hired locally. Therefore, the racial composition of the voyage crew is likely to be strongly correlated with racial diversity in the labor supply faced by hiring agents. Moreover, each voyage employed a small portion of the available supply, hence agents were likely to hire whoever was available to ship with their vessel. Based on this consideration, we instrument racial diversity with an index that is constructed using pre-existing population of white (non-white) for the counties nearest to each departing port weighted by the total of white (non-white) whalemen employed in all voyages leaving from that port. The index is computed as follows:

$$\sigma_{jkt} = \frac{population_{jk\,(\text{census year})}}{\sum_j^J population_{jk\,(\text{census year})}} \times \; employment_{jkt}, \qquad (3)$$

where $population_{jk\,(\text{census year})}$ is the population of race j, for j = (white, non-white), recorded in the census as living in the three counties that are closest to port k. Starting with the census of

1790, we use population data from a census with a five to fourteen-year lag.[19] The variable $employment_{jkt}$ denotes the employment of whalemen of race *j* at port *k* for voyages departing in year *t*. So, (3) denotes the sailors of race *j* employed in whaling voyages departing from port *k* in year *t* weighted by the available workers of race *j* and resident in area adjacent port *k* well before departure time *t*. This is then used together with (4) below to calculate the instrument for our fractionalization index. In other words, we calculate the fractionalization of whaling workers as $1 - \sum_j^J \widetilde{m}_{jkt}^2$, where $\widetilde{m}_{jkt} = \sigma_{jkt}/employment_{kt}$ is the *j*-th share, white/non-white, of all sailors located near port *k*. This is the main instrument used for the racial fractionalization index. To this we also add whaling agent fixed effects. An agent is in charge of the planning of the voyage, hiring in particular. Including these fixed effects allows us to control for the agent's preferences with regard with the composition of the hired crew.

5. Measuring Diversity

We use the data to construct indices of racial and ethnic diversity for the crew of each voyage.

5.1 Racial Diversity

Although none of our sources provide comprehensive data regarding the race of all crew members, we can estimate race with a high degree of certainty by combining information from multiple sources. We use a stepwise procedure for this task, starting with sources that include the most direct and definitive information regarding race and continuing with those that provide this information indirectly. Specifically, we determine race in four steps, using information from the enumeration schedules of the 1850-80 U.S. Censuses, the lists of native whalemen compiled by researchers, the physical characteristics of crew members entered in official records, and the information regarding the birthplace and residence of international crew. Since this procedure gives us multiple opportunities to determine the race of each whaleman, we use conservative

[19] For instance, population recorded in the 1850 census is used to predict living population in the years 1855-1864. It should be noted that the census did not record natives and non-residents. Thus, the non-white population reflects essentially only African Americans. Non-white employment instead also includes natives and individual of other races. We believe that a five- to fourteen-year lag provide sufficient time such that diversity in pre-existing labor supply at the port is not correlated with labor demand when hiring decisions were made.

criteria in each step to avoid misidentification. We describe these steps briefly below and provide more detailed information in Appendix A.

The most direct and reliable source regarding race are the enumeration schedules of the U.S. Censuses. We obtained the enumeration schedules of the U.S. Federal Censuses of 1850-1880, which include the names and race (blacks and whites, but not native Americans during this period) of all individual residents. The difficulty in matching the whalemen in our records with the names of individuals recorded in census schedules lies in mistakes and variations in the spellings of names and places of residence. This is essentially the same type of difficulty that historians have faced in matching the same individuals between two or more different censuses. Therefore, we adapted the algorithms that researchers have recently developed to account for the variation in the spellings of names and locations in census records (Abramitzky, Mill, and Pérez, 2020; Berkes, Karger, and Nencka, 2022). For a highly conservative criteria to minimize errors, we used the birthyear (within 2 years), the first and last names, and the state and city of residence of whalemen for the match. This method allowed us to identify the race of 2,902 whalemen with a high level of certainty.

Since the enumeration schedules of the U.S. Censuses of this period did not identify the native Americans, in the next step we turned to the literature on the history of New England natives employed in the whaling industry. Particularly useful in this regard were the databases of native whalemen compiled by Shoemaker (2015) and Handsman, et. al. (2021). Generated from a variety of sources, including oral histories as well as official records, these databases contain valuable information regarding 946 native whalemen. Since some of these individuals went on multiple voyages, we were able to use this information to identify 4,119 native crew members in our lists.

In the next step, we used information regarding the physical characteristics of whalemen available from the archival records of the whaling industry, specifically the American Offshore Whaling Crew Lists database and the Registers of Seamans' Protection Certificates. Although these records do not contain direct information regarding race, they nevertheless have columns for verbal descriptions of skin and hair (for customs purposes), which several historians have previously used to infer race.[20] Building upon their lead, we adopted a conservative procedure, detailed in Appendix A, designed to determine the race of some of the remaining whalemen indirectly by exploiting information contained in descriptions of skin and hair. Matching this information with our records allowed us to infer the race of an additional 78,185 whalemen, again with a high degree of certainty.

Finally, we turned to whalemen for whom the information used in the first three steps was missing. This was clearly the case for international crew who were not enumerated in U.S. Censuses and for whom information regarding skin and hair was somehow not entered in official records. For some of these individuals, the records nevertheless included their birthplace and residence, which can be used to infer race indirectly, albeit possibly with less certainty. Whalemen who were born in certain regions of Africa, West Indies, and Cape Verde Islands, for example, could be considered as being black. Likewise, we could lump together in the "other" category the whalemen who were from the Pacific Islands, East Indies, and Asian or Latin American countries. This strategy yielded estimates of the race of an additional 6,659 whalemen.

Overall, our four-step strategy allowed us to determine the race of 91,865 individuals, over three-quarters of the crew included in our records. We categorized race broadly into four simple categories: Black, Indian, White, and Other (Asian, Hispanic, East Indian, Pacific islander). For each voyage we calculated the well-known fractionalization index as a standard measure of diversity that's been commonly used by researchers in similar analyses. This index is based on the shares of crew members belonging to different race groups (e.g., Parrotta et al., 2014; Alesina et al., 2016). Formally, fractionalization of the crew on board of vessel *i* on voyage *t* is defined as

$$FRAC_{it} = 1 - \sum_j^J m_{it;j}^2, \quad (4)$$

where $m_{it;j}$ is the population share of the j^{th} racial group. This index is a measure of the probability that two randomly drawn individuals within a vessel on a voyage were not from the same racial group.

[20] See, for example, Bolster (1997), Craig and Fearn (1993), Malloy (1990), Pariseau (2015), and Putney (1987).

5.2 Ethnic Diversity

We used a similar procedure to calculate the index of ethnic fractionalization for each voyage. Specifically, we determined the birthplace of each whaleman as recorded in the American Offshore Whaling Crew Lists database and the Registers of Seamans' Protection Certificates. We categorized individuals into 11 broad groups based on the geographic location of their birthplace, namely Africa, Asia, Central America, East Indies, Europe, North America, Oceania, Portuguese Islands, Pacific Islands, South America, and West Indies. For each voyage, we calculated the shares of crew members belonging to these groups and the resulting index of fractionalization based on the formula given in (4) above. Similar to racial fractionalization, the index of ethnic fractionalization is an estimate of the probability that two randomly drawn individuals within a voyage were not from the same birthplace region group.

5.3 Diversity Over Time

We can use the calculated fractions of each category and the overall indices of fractionalization to observe how racial and ethnic composition of whaling voyages changed over time. As seen in Figure 2, overall voyage crews were dominated by white whalemen throughout the entire sample period, 77 percent on average. Black whalemen consisted of 17 percent of the entire crew, and native only 5 percent. However, in the early 1800s native American and black whalemen were also representing a sizeable part of the crew. The white share rose in the early nineteenth century, up to around eighty percent between the 1820s and the 1870s, but eventually declined. The proportion of black whalemen fell below twenty percent until the late 1870s, but then rose considerably afterwards. The change in the ratios of black and white whalemen in the 1870s was likely an outcome of the greater mobility of black men after the civil war.

Figure 3 shows how the two measures of diversity changed over time. After significant fluctuations in the early nineteenth century, the index of fractionalization declined gradually and settled around 0.3 from 1830 to about 1870. Contemporaneously, ethnic fractionalization rose to 0.2 and stayed at that level until the mid-1860s. Both measures of fractionalization grew after the 1860s, as whaling crews became more diverse racially and ethnically. In the following years, while racial diversity remained somewhat constant, ethnic diversity fell sharply after the 1890s.

6. Results

Table 3 contains the results from estimating regression (2) with standard errors clustered at the port and captain level.[21] Our estimates indicate that crew diversity matters in the production process. There are three main findings from our estimates. First, there is evidence of the existence of a highly significant nonlinear effect of diversity[22]. The point estimates for both linear and quadratic term of diversity are strongly statistically significant across all specifications. The baseline specification in column 1 includes the log of tonnage, crew size, and voyage duration, together with rig and year of departure fixed effects. Results indicate that even with a relatively parsimonious specification it is possible to detect a nonlinear relationship between racial diversity and team performance. These estimates imply that a 10 percent increase in diversity[23] for a very homogenous crew, in the 5th percentiles of the diversity distribution (0.067), is associated with a decrease in revenue by 0.3 percent, while a 10 percent decrease in diversity for a very diverse crew, in the 95th percentile of the distribution (0.56), is associated with a 2 percent decrease in revenue.

In column 2 we add master (captain) fixed effects to control for captain differences in skills about managing the crew and leading hunting operations. A change in diversity would also result in a larger change in revenue in this case. That is, a 10 percent increase would be associated with a 0.6 percent decrease for a very homogenous crew, and a 3.7 percent decrease for a very diverse one. This highlights the importance of the role of the captain and his ability to manage the crew. Adding hunting-ground-by-year fixed effects has only a small influence on the estimates while the clustered standard errors become smaller, column 3. These results indicate that the estimates for diversity are remarkably robust to the inclusion of additional fixed effects. Indeed, once we control for his role other factors such as temporal and spatial variation in whale distribution do not play a role. Lastly, we investigate whether we are really capturing the effect of racial

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[21] Clustering at this level allows for the value of output to be serially correlated for voyages leaving from the same port and captains over multiple voyages.

[22] Figure 5 also shows evidence of a nonmonotone relationship between the residuals and diversity. First, we observe an immediate and sharp decline in output value at low level of diversity. Then, as diversity increases output value grows first slightly until there is a sixty percent probability that two randomly drawn crew members were of different race at which point output value raises sharply.

[23] Recall that diversity is measured by fractionalization of the crew which denoted the probability that two randomly selected whalemen are of different race.

composition or ethnicity of the crew. To do this, we add a measure of ethnicity calculated as the fractionalization of the crew based on region of origin, calculated as in section 5.2. This has a negligeable effect on our estimates, which indicates that our estimates are capturing the effects resulting from the variation in the racial composition of the crew rather than variation in the region of origin.

Instrumental Variable Estimates: We address potential endogeneity of the diversity measure by instrumenting fractionalization as described in section 4.2. The last column of Table 3 shows the IV estimates for regression (2).[24] The magnitude of the coefficients is larger (in absolute) value, though the relationship between racial diversity and team performance is consistent with the OLS estimates. The IV estimates of the coefficients are forty percent larger than the OLS estimates for the linear term and thirty percent larger for the quadratic term. This suggests a downward bias of OLS due to the potential endogenous racial composition of the crew or measurement error of race, but the overall U-shape of the relationship is qualitatively the same between the two specifications. The point estimates imply larger effects of diversity on revenue relative to OLS. A 10 percent increase in diversity for a very homogenous crew would be associated with a decrease in revenue by 0.8 percent, while a 10 percent decrease in diversity for a very diverse crew would be associated with a 4 percent decrease in revenue.[25]

The estimated U-shaped relationship between racial diversity and output value plotted in Figure 6 appears to be fairly symmetrical. Starting from a perfectly homogenous crew, increasing crew diversity generates costs until a minimum is reached at fractionalization equal to 0.381 (standard error = 0.057).[26] After that point, increases in the level of racial diversity result in higher revenue. These results suggest that cooperation and teamwork are easier when most crew members belong to the same group, but as more diverse members join conflicts may arise and coordination fails. However, for large enough diversity, groups of a certain size cannot form, workers find incentives to cooperate, to increase their income, and this allows benefits arise and compensate the initial costs. Revenue for the most diverse crew observed in our sample is lower

[24] The F-statistic and the Sanderson-Windmeijer multivariate statistic on the excluded instruments are 50.88 and 181.06, respectively, for the linear term of diversity, and 15.73 and 154.68 for the quadratic term. The F-statistic of joint significance on the excluded instrument is 25.06.

[25] Table A.1 in the appendix shows the full set of estimates.

[26] For the OLS estimates, minimum is reached at a fractionalization equal to 0.350 (standard error = 0.037).

than for the most homogenous one. However, the most diverse crew, e.g., fractionalization index equal to 1, would yield about 12 percent higher revenue than a perfectly homogenous crew, suggesting that at very high diversity, i.e., greater than a fractionalization of 0.762, the benefits arising from diversity overcompensate its costs.

7. Understanding the Mechanisms

We now examine the potential mechanisms contributing to the estimated nonlinear relationship between diversity and performance in the whaling industry. Specifically, we study how both negative, e.g., from reduced trust and cooperation, and positive, e.g., through skill complementarities and creativity, effects may dominate in either direction to reconstruct portions of the U-shaped relationship we estimated with our preferred specification, the IV model. In addition, we estimate the baseline relationship between diversity and performance separately among voyages of varying length to examine adaptation to diversity over time.

7.1 Conflicts

We start by investigating the costs related to diversity by focusing on conflicts during voyage. Conflicts reduce cooperation or coordination among the crew, a negative impact on team performance. Although the records include no direct information regarding conflicts on board, we can infer this information indirectly from annotations entered in Crew Lists. Captains were legally required to report on the whereabouts of their crew and offer an account of what happened if someone did not return (Davis et al., 2007; Ch.3). For instance, if someone was discharged for illness or another cause in a foreign country the local consul had to consent to this action in writing (Davis et al., p.81). Given this, we can use the number of cases in which a whaleman did not return to the home port because he deserted or left, or was discharged, drowned, or was lost at sea.

In our records this information is available in the form of remarks in the Crew List database. The database includes the remarks for only a small fraction of the voyages and not all remarks provide information regarding why a whaleman did not complete the voyage with the rest of the crew. Because we do not know whether the remaining voyages did not experience such incidents or they were simply not reported, we decided to keep only the voyages for which we have information relevant to estimating the effect of racial diversity on the occurrence of conflicts among the crew members. Consequently, this left us with conflict information for less than 10 percent of the voyages, a sample of 422 observations with more than 70 percent of the sample with multiple incidents of whalemen not returning from the voyage. Figure A.2 shows the distribution of the incidents.

We estimate the effects of diversity on conflicts using a regression as close as possible to (2), but where y_{it} is either the numbers of whalemen who deserted or left, or was discharged, drowned, or was lost at sea during voyage of vessel *i* that departed in year *t* and we include only the linear term for diversity. Given the small sample size, we do not include captain fixed effects, in vector $\mathbf{X}_{it}$, and standard errors are clustered at home port level. Table 4 presents the results for the correlations between fractionalization and the four different indicators of conflict. Based on the expectation that diversity's impact on conflict might differ between races, we present the results separately for the whole crew and we also distinguish between the white and non-white crew, as seen in Panels A through C.

Overall, the results support the contention that greater diversity led to rising levels of conflict during voyage, though racial groups experienced these effects differently. The coefficient of "Lost" is positive and highly significant in all panels, indicating that higher levels of diversity is associated with a larger number of crew members being lost at sea in general, and for each racial group. The magnitude of the coefficient for white whalemen, however, is almost three times as much as that for non-white crew members, an indication of greater impact on conflict targeting the former group.

Table 4 also shows that higher fractionalization is positively correlated with the number of discharged whalemen, white and non-white alike. Whalemen were discharged for causes due to their fault, e.g., disobedience and insubordination, or for no fault of them, e.g., sickness. When the discharging was unlawful, complaints could be brought against the captain (examples of such cases can be found in Sprague, 1861). Given the considerable burden, the captain would have discharged any member of his crew only because of an important reason, e.g., critical illness or serious misconduct.[27] The similarity in the magnitudes of the coefficients suggests that increased

[27] About 26 percent of the reported discharged were due to sickness.

diversity had about the same effect on the misconduct of both groups. However, only the correlation for the non-white crew members is more precisely estimated.

We find no convincing evidence that racial diversity affects the number of drownings. Instead, we find that diversity's impact on incidents of whalemen failing to return due to desertion or that simply left the voyage differed between the two racial groups. Diversity is positively with incidents of desertion for whalemen (Panel A and C). This appears particularly strong for non-white whalemen. One reason why crew members could desert was that onshore economic opportunities at the locations visited during the voyages could be more favorable than on the whaling ship.[28] Another was that life on board could become so unbearable for some that they had no choice but leave, and instead join a different crew or just quit whaling altogether. More than three quarters of all desertions were by white crewmen. This is not unexpected considering that they could earn higher wages in shore-based employment, and onshore opportunities for alternative employment were constrained for black sailors (Davis et al., 2007; p.186). So, while the relative wages between onshore-onboard were more favorable to white than non-white crewmen, remuneration onboard of the whaling vessel was more (economically) egalitarian.[29] This suggests that non-white crewmen must have had strong non-economic incentives to abandon the voyage. We speculate that conflicts were the main reason why non-white whalemen abandoned the voyage, probably in search of a less hostile environment. The opposite effect seems to apply for white men. For them, diversity and desertion are negatively correlated, even though the relationship is not precisely estimated. We posit that white whalemen realized the added value of the skills of a more heterogenous crew, which increased the opportunity cost of leaving the voyage. For this to be true, the size of the diverse crew should be large enough to have a significant effect on the opportunity cost.

Overall, these results indicate that racial diversity is correlated with the occurrence of episodes that can be interpreted as symptoms of tension or friction within the crew. Although the results differ somewhat between racial groups, the statistically significant coefficients are all positive, supporting the argument of a strong correlation between diversity and conflict during whaling voyages.

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[28] Desertion implied the entire forfeiture of wages (Davies et al., 2007; p157).
[29] Craig and Fearn (1993) do not find evidence of a considerable wage differential between white and black seamen (or minorities).

7.2 Skill Complementarity

To investigate benefits from diversity we turn to the potential skill complementarity that can arise during whaling voyages. In analyzing the consequences of the globalization of firms, Lazear (1999) has argued that greater diversity in multi-cultural teams might impose cost of communication, but the benefits via skill or information complementarities would be sufficiently high to offset these costs. Moreover, gains from diversity would be higher when teams have skill sets that are disjoint and are relevant to one another. Expanding on this framework, Parrotta et al. (2014) have drawn attention to the way benefits of diversity might depend on the types of tasks and occupational groups. For example, the benefits of skill complementarity might differ between routine and problem-solving tasks and be generated differently between teams of unskilled and highly skilled workers. Marx, Pons, and Suri (2021) have similarly shown in an experimental setting that the cost and benefits of diversity might depend on the nature of team members' relationship to each other in division of labor, specifically whether the diversity is along a vertical or horizontal dimension in hierarchy.

These insights have an important implication for our analysis. It suggests that we should differentiate both among the distinct tasks involved in whaling and among the distinct participation of occupational groups in these tasks. Indeed, the mediating effects of diversity might differ, for example, across different stages of hunting a whale, depending on the relative importance of routine versus problem-solving skills in each task. Likewise, the effects in each stage might differ between groups of horizontal and vertical diversity, for example among a group of similarly unskilled seamen versus among officers whose roles are defined vertically along a rigid hierarchy.

For an empirical analysis of the mediating benefits of racial diversity in whaling, we use data from the American Offshore Whaling Logbook database. As discussed above, this database includes detailed information regarding the hunt and onboard processing of whaling product for a smaller subset of the voyages included in the all-inclusive Voyages database. Specifically, the Logbook database shows for each date the crew's involvement in three essential stages of hunting a whale, whether on that date a whale was sighted, struck, or tried. To examine the relationship between crew's success at these tasks and its racial diversity, we divided the overall crew of a voyage into four distinct groups. The first group consists of the officers, namely the captain (master) and his mates, who have a clear hierarchical relationship. In the next two groups, we separated the skilled members of the crew into distinct categories. Specifically, the second group includes skilled maritime workers, such as boatsteerers, ship keepers, and captain's apprentices. Likewise, the third group consists of skilled artisans and service providers, including coopers, carpenters, blacksmiths, sailmakers, and service personnel like the cook and engineers. The final group consists of remaining unskilled and semi-skilled seamen, such as greenhands, boys, and other ordinary crew members.

After merging these data with the voyage characteristics, the final sample including the logbook data contains 611 observations (Table 2). Summary statistics for tonnage, voyage duration, and crew size statistics are comparable to those included in the Voyage database (Table 1); although the logbook sample seem to include slightly larger vessels undertaking longer voyages. Indeed, the share of Ships, the larger rig, is higher. On average, the crew in these voyages is less diverse than in the larger sample (0.314). Looking at diversity within rank, officers are the least diverse rank, followed by skilled maritime, unskilled maritime, while the most diverse rank is represented by artisans and service personnel.

For this analysis, we estimate a specification as close as possible to (2) but where the outcome variable is either the rate of sighting, striking, or trying whales during voyage of vessel *i* that departed in year *t*. As before, we control of the log of crew size and vessel tonnage, l_{it} and k_{it}, respectively. In addition, we include the rigging of the vessel, differences in master skills, and the spatial and temporal variation in the distribution of whales. Because of the smaller number of observations available in the logbook dataset, instead of including master fixed effects, to control for master skills we include fixed effect for the age of the master. To this we also add ethnic diversity and a set of variables indicating the share of time, during the same voyage, in which the vessel was sailing in each (FAO) fishing zone.[30]

Table 6 shows the results of IV regression analysis of the relationship between crew diversity and success in hunting whales, examined separately for the three tasks of sighting, striking, and trying the whales and the four occupational groups of officers, skilled maritime

[30] To be more specific, these variables are calculated by constructing a set of fishing zone dummy variables for each vessel-location during a voyage for each recorded date of the voyage and take the mean for the voyage.

workers, artisan and service personnel, and ordinary unskilled seamen. The dependent variable is the rate of instances in which a whale was spotted (sighted), harpooned (struck), or processed (tried) during a voyage. The figures show the coefficients and standard errors of the key variable of interest, the index of fractionalization, corresponding to the relationship between each group's racial diversity and task performance. The results are consistent with the mediating benefits of racial diversity via the channel of skill complementarity discussed in the previous literature. As seen in the second and third columns, team diversity had a positive impact on striking and trying whales among the skilled occupational groups (maritime, artisan, and service personnel), indicating that the benefits of greater diversity via skill complementarities in these tasks were sufficiently high among skilled whalemen to offset any costs of communication. Moreover, the coefficient of fractionalization index is negative and statistically insignificant for the ordinary seamen, indicating that gains from diversity are not realized when teams have skill sets that are similar (i.e., non-disjoint) and not relevant to one another, consistent with Lazear's (1999) argument.

Interestingly, the coefficients of the effect of fractionalization index on striking and trying whales are statistically insignificant for the officers. As noted above, the officers comprise a vertical occupational group with a hierarchical structure, contrary to the horizontal relationship among the skilled maritime, artisan, or service personnel groups. The difference in the significance of the effects of diversity between the officers and the two skilled groups, therefore, is consistent with the argument of Marx, Pons, and Suri (2021) that benefits of diversity can vary substantially between vertical and horizontal diversity.

The results of diversity's effects on sighting whales are also interesting. The coefficient of fractionalization index is statistically insignificant among both the skilled and unskilled groups, indicating that horizontal diversity had no effect on sighting whales. This is not very surprising since this task does not require extensive teamwork or collaboration among the crew. What seems somewhat surprising is that the negative and significant coefficient of fractionalization index for the officers. This indicates that greater vertical diversity among the officers resulted possibly in greater costs in communication than benefits in skill complementarity.

7.3 Adaptation to diversity

The preceding discussion showed the mediating effects of diversity through negative correlations with conflicts and positive correlations with skill complementarity. Put together, these arguments support the main finding of a U-shaped relationship between racial diversity and team performance. For a different empirical approach to understanding this shape, in this section we explore how team members adapted to the negative effects of racial diversity over time. This approach is based on the observations of Ramos et al. (2022) and Bai et al. (2022), who argued that people adapt to diversity over time due to repeated contact with outgroup individuals. Consequently, as societies become more diverse, distrust and conflict dissipate, and positive outcomes emerge.

A whaling voyage presents a quasi-experimental setting that offers the conditions that would allow us to test this hypothesis. Voyages typically involved long periods of forced interaction among the crew in close quarters. As described in Davis et al. (2007; section 2.6) crewmen lived and worked in tight areas, as most of the space on the vessel was taken up by cargo and supplies. For sleeping, unskilled crewmen (seamen and greenhands) shared the small, dark, and fetid forecastle. Skilled crewmen, such as coopers and boatsteerers, had better conditions, but still little space. Working conditions were also extremely difficult due to the inherent dangerous nature of the hunting process and ocean sailing.

The impact of these conditions on conflict and teamwork could vary over time. Initially, they could initially lead to greater conflicts among more diverse crews because of taste-based discrimination. As whalemen continued to live in close proximity to each other, however, they might have the opportunity to develop bonding. It is therefore conceivable that conflicts could arise in the short run as diversity increased, but repeated interaction over time could allow the benefits generated by a diverse background to dominate over the initial costs.

We test this argument empirically by running regression analysis based on the same specification as (2) with the only difference being that we interact the linear term for the fractionalization index with three dummy variables indicating whether the length of the voyage was 12 months at the most, between 12 and 24 months, or more than 24 months. About 26 percent of the voyages in our sample last for maximum one year, 25 percent is between one and two years, and the remaining voyages are at least two years long.[31]

Table 6 shows the IV estimates where each different column presents results from using alternative sets of fixed effects. We uncover three important findings. First, in short voyages greater racial diversity had a negative effect on productivity. This confirms the intuition that with greater racial heterogeneity the initial impact was dominated by intergroup conflict, with a net negative effect on team performance. The elasticity is -0.42 at median diversity for the full specification, -0.08 and -0.71 for very homogenous and diverse teams, respectively. Second, in voyages of medium length (one to two years) diversity had a small effect on productivity, with elasticities equal to -0.09, -0.02, and -0.16 for median, low, and high team diversity. That seems to indicate that the initial costs were offset by the rising benefits of diversity, developing over time thanks to the mixing of individuals with different races. Third, for longer voyages, over two years, we find that greater diversity among workers generated sufficiently high benefits of diversity to exceed the cost and have a net positive effect on productivity. The estimated coefficient is large and statistically significant across all specifications with elasticities equal to 0.07, 0.37, and 0.62 for low, median, and high diversity. These three results provide support for the hypothesis that over time extended intergroup contact helped to mediate the initial cost of diversity and allowed benefits to arise as suggested by the literature both in economics (Lazear, 1999a) and psychology (e.g., Ramos et al., 2022).

8. Conclusions

In this paper, we exploit unique data from the history of the American offshore whaling industry to examine the relationship between racial diversity and team performance. Previous analyses of this relationship have encountered significant challenges due to difficulties of data availability, causal identification, and model specification. The advantages of focusing on the historical experience of the whaling industry include not only extremely rich data regarding the racial composition of the crew and the production process of whaling voyages but also an excellent natural experiment to identify the causal effect of racial diversity on team performance.

[31] To avoid perfect collinearity, we do not include in our specification the fractionalization index of the crew as a separate variable.

Our empirical analysis is based on a large number of data sources, including the archival records of the whaling industry, the U.S. Federal Census schedules, and external sources regarding the names of native Americans employed in the whaling industry. Determining the race of crew members based on this information, we construct indices of fractionalization for each whaling voyage and estimate the effect of racial diversity on the voyage's total revenue. Although endogeneity concerns regarding crew selection are minimal in this setting, we address potential concerns by using an IV analysis based on instrumenting racial diversity with the pre-existing regional diversity at the home port. In our empirical specification crew diversity affects performance in a quadratic form.

Our results show the existence of a U-shaped relationship between racial diversity and team performance. While increases in diversity at low levels induce a sharp decline in the value of output, higher levels of racial heterogeneity yield substantial gains. Additionally, we study the reasons behind the U-shaped relationship between racial diversity and team performance by examining two channels of transmission that would potentially work in opposite directions and conduct a temporal analysis of adaptation to diversity over time. We first focus on conflicts arising during voyages by examining cases of whaleman who failed to return to home port because he deserted or left, or was discharged, drowned, or lost at sea. The results provide suggestive evidence that more diverse crews experienced greater numbers of conflicts and that the effects varied between racial groups. Regarding the positive mediating effects of diversity, we examine skill complementarity among the crew in sighting, striking, and trying whales. Distinguishing among the categories of crew according to hierarchy and skill, we find support for the argument that diversity among the skilled members of the crew (skilled maritime and artisan and service personnel) had a positive effect on striking and trying whales. Finally, we investigate whether the effects of diversity varied over time by comparing results across voyages that differ only by duration. The results show that diversity negatively affected revenue in short voyages (less than 12 months), had no effect in voyages of medium length (12-24 months), and had a strong positive effect in long term voyages (over 24 months). Altogether, these results suggest that the costs of diversity initially dominated, but whaling crews were able to overcome the cost and increasingly realize the benefits of diversity over time.

Table 1 – Summary Statistics; Voyage Analysis.

Variable	Obs.	Mean	Std. Dev.	Min	Max
Voyage characteristics					
Tonnage	4,384	268.733	105.426	45	700
Voyage duration (months)	4,294	26.959	15.518	0	143
Crew size (N.)	4,407	26.566	7.97	10	120
Diversity					
Share black	4,407	0.771	0.154	0	1
Share native	4,407	0.171	0.144	0	1
Share white	4,407	0.052	0.059	0	.4
Share other	4,407	0.007	0.023	0	.3
Racial Fractionalization	4,407	0.326	0.154	0	.667
Ethnic Fractionalization	4,407	0.269	0.194	0	.79
Rigging					
Sloop (One mast)	4,403	0.001	0.037	0	1
Schooner (Two masts)	4,403	0.117	0.322	0	1
Brig (Two masts)	4,403	0.086	0.281	0	1
Bark (Three masts)	4,403	0.379	0.485	0	1
Ship (Three masts)	4,403	0.416	0.493	0	1
Real output value (1860$)					
Sperm oil	4,264	43,820	72,016	0	834,972
Whale oil	4,264	29,618	69,061	0	1,233,256
Baleens	4,264	8,806	29,044	0	554,247
Total	4,264	82,244	120,745	0	1,820,350
Hunting grounds					
Atlantic	4,407	0.422	0.494	0	1
Indian	4,407	0.139	0.346	0	1
Pacific	4,407	0.418	0.493	0	1
Arctic	4,407	0.016	0.124	0	1
Unknown	4,407	0.086	0.28	0	1
Incidents (N.)					
Deserted or Left	422	2.647	3.464	0	22
Discharged	422	1.045	2.668	0	31
Drowned	422	0.097	0.579	0	7
Lost	422	0.182	0.823	0	10

Table 2 – Summary Statistics; Logbook Analysis.

Variable	Obs.	Mean	Std. Dev.	Min	Max
Voyage characteristics					
Tonnage	611	282.499	100.8	66	700
Voyage duration (months)	611	29.208	14.22	2	73
Crew size (N.)	611	28.254	7.747	13	68
Master's age	419	38.186	9.275	14	86
Diversity[a]					
Fractionalization: Officers	110	0.187	0.252	0	1
Fractionalization: Skilled maritime	110	0.208	0.282	0	1
Fractionalization: Artisans and service	110	0.337	0.289	0	1
Fractionalization: Unskilled maritime	110	0.243	0.183	0	0.64
Racial Fractionalization	110	0.314	0.146	0	0.556
Ethnic Fractionalization	110	0.210	0.128	0	0.612
Rigging					
Schooner (Two masts)	611	0.106	0.309	0	1
Brig (Two masts)	611	0.043	0.202	0	1
Bark (Three masts)	611	0.367	0.482	0	1
Ship (Three masts)	611	0.484	0.5	0	1
Productivity measures					
Sight rate	611	0.040	0.065	0	0.352
Strike rate	611	0.044	0.049	0	0.375
Tried rate	611	0.057	0.064	0	0.625

[a] Using data for voyages with rank information for at least ten crew members.

Table 3. Effect of Crew Diversity on Log of Real Output Value.

	OLS				IV
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Fractionalization	-0.523	-1.143	-1.048	-1.074	-1.523
	(0.265)**	(0.345)***	(0.357)***	(0.358)***	(0.651)**
	[0.498]	[0.437]**	[0.323]***	[0.314]***	[0.458]***
Fractionalization squared	0.801	1.613	1.530	1.535	2.000
	(0.409)*	(0.530)***	(0.549)***	(0.549)***	(0.993)**
	[0.647]	[0.544]***	[0.422]***	[0.426]***	[0.751]***
p-value for joint significance of linear and quadratic term (clustered SE)	0.180	0.017	0.005	0.005	0.002
Mean Log Revenue ($1,000)			0.389		
Master FE	No	Yes	Yes	Yes	Yes
Hunting ground-by-year FE	No	No	Yes	Yes	Yes
Ethnicity	No	No	No	Yes	Yes
R-squared	0.367	0.243	0.231	0.231	0.232
Number of clusters (ports)	27	27	27	27	27
Number of clusters (masters)	970	970	970	970	970
N. of obs.	3,971	3,971	3,971	3,971	3,971

* p<0.10, ** p<0.05, *** p<0.01. Robust standard errors in parentheses. Standard errors in squared brackets are clustered at home port and captain level. The empirical specification also includes the log of tonnage and crew size, year of departure and rig fixed effects. Regressions are weighted by the total number of voyages taken by the same vessel over the sample period. The number of observations does not include groups with only one observation on captains and vessels.

Table 4. Relationship between Diversity and Conflicts: Total Incidents and Incidents by Race (IV estimates).

	Lost	Discharged	Drowned	Deserted or Left
Panel A. All Crew				
Fractionalization	1.346	0.644	0.0884	0.469
	(0.438)***	(0.679)	(0.142)	(0.858)
Mean of dependent variable	0.182	1.045	0.097	2.647
R-squared	0.055	0.037	0.009	0.031
N. of obs.	407	407	407	407
Panel B. White				
Fractionalization	0.977	0.324	0.0719	-0.601
	(0.364)***	(0.558)	(0.119)	(0.632)
Mean of dependent variable	0.156	0.810	0.071	2.083
R-squared	0.054	0.025	0.010	0.036
N. of obs.	407	407	407	407
Panel C. Non-White				
Fractionalization	0.369	0.320	0.0165	1.070
	(0.0834)***	(0.173)*	(0.0284)	(0.295)***
Mean of dependent variable	0.026	0.235	0.026	0.564
R-squared	0.051	0.050	0.012	0.044
N. of obs.	407	407	407	407

* p<0.10, ** p<0.05, *** p<0.01. Each panel represents a separate regression where the dependent variable is denoted by the number of incidents of the nature indicated by the title of the column. The empirical specification includes the log of tonnage, crew size, and voyage duration, year, rig, and hunting grounds-by-year fixed effects, as well as crew ethnicity. Standard errors clustered at home port and captain level. Regressions are weighted by the total number of voyages taken by the same vessel over the sample period.

Table 5. Effect of Skill Diversity on Hunting and Processing Whales (IV estimates).

	Sighted	Struck	Tried
Fractionalization for:			
Officers	-0.030	-0.009	0.009
	(0.007)***	(0.012)	(0.010)
Skilled maritime	0.007	0.045	0.049
	(0.015)	(0.005)***	(0.004)***
Artisan and Service personnel	-0.005	0.024	0.028
	(0.026)	(0.007)***	(0.005)***
Unskilled maritime	-0.049	-0.030	-0.0001
	(0.038)	(0.023)	(0.019)
Mean of the dependent variable	0.040	0.044	0.057
Within R-squared	0.140	0.111	0.143
N. of obs.	110	110	110

* p<0.10, ** p<0.05, *** p<0.01. Dependent variable is the total number of instances during a voyage in which a whale was spotted (sighted), harpooned (struck), or processed (tried). Officers include the captain (master) and his mates. Skilled maritime group include boatsteerers, ship keepers, and captain apprentices. The artisan and service group includes artisans, such as coopers, carpenters, blacksmiths, sailmakers, and service personnel, e.g., engineers or cook. Seamen are semi-skilled seaman, greenhands, boys, and other ordinary crew members. The empirical specification includes the log of tonnage and crew size, rig and year of departure fixed effects as well as the share of the voyage spent in a FAO fishing area and crew ethnicity. Standard errors clustered at home port level. Regressions are weighted by the total number of voyages taken by the same vessel over the sample period. Regressions use data for voyages with rank information for at least ten crew members.

Table 6. Effect of Crew Diversity by Voyage Duration (IV estimates)

	(1)	(2)	(3)	(4)
Fractionalization × (0-12] Months	-1.208	-1.429	-1.222	-1.269
	(0.115)***	(0.168)***	(0.141)***	(0.120)***
Fractionalization × (12-24] Months	-0.0852	-0.452	-0.239	-0.286
	(0.0859)	(0.230)**	(0.174)	(0.152)*
Fractionalization × (24-] Months	1.531	0.936	1.117	1.115
	(0.0974)***	(0.223)***	(0.207)***	(0.166)***
Mean Log Revenue ($1,000)		3.894		
Master FE	No	Yes	Yes	Yes
Ground-by-year FE	No	No	Yes	Yes
Ethnicity	No	No	No	Yes
R-squared	0.274	0.174	0.168	0.168
N. of obs.	3,977	3,977	3,977	3,977

* p<0.10, ** p<0.05, *** p<0.01. Dependent variable is the Log of Output value. The empirical specification also includes the log of tonnage and crew size, year of departure and rig fixed effects, and crew ethnicity. Standard errors clustered at home port and captain level. Regressions are weighted by the total number of voyages taken by the same vessel over the sample period and controls for ethnicity.

Figure 1. Total Number of Voyages over Time

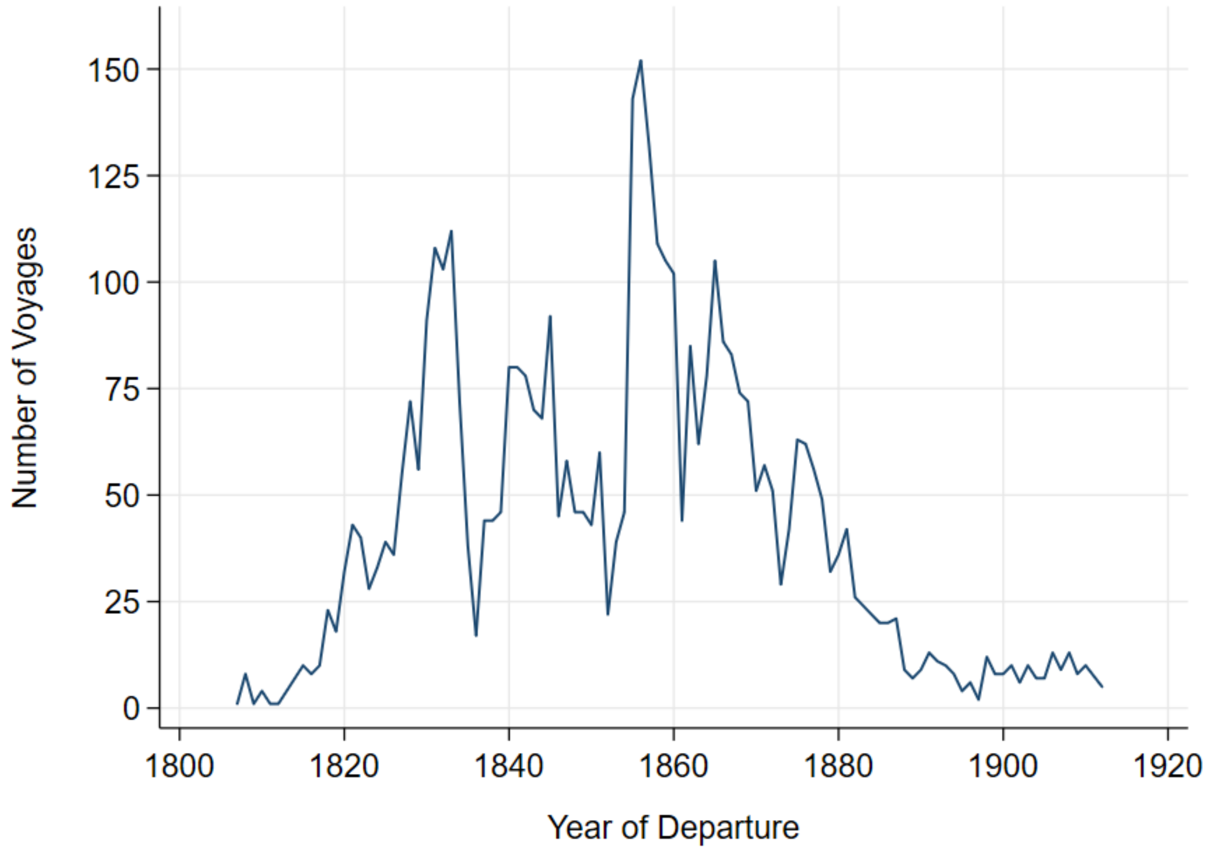


Figure 2 – Fractions of Crew by Race (voyage average) over Time.

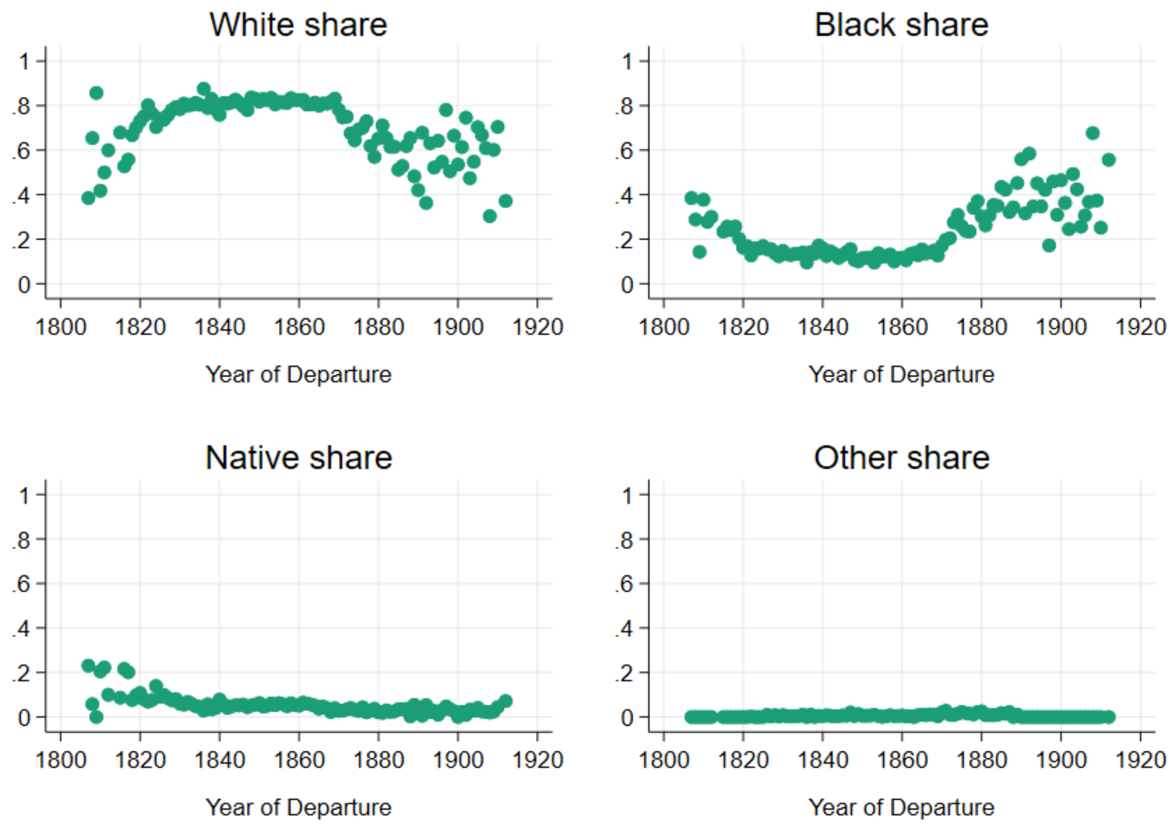


Figure 3 – Index of Racial and Ethnic Fractionalization (voyage average) over Time.

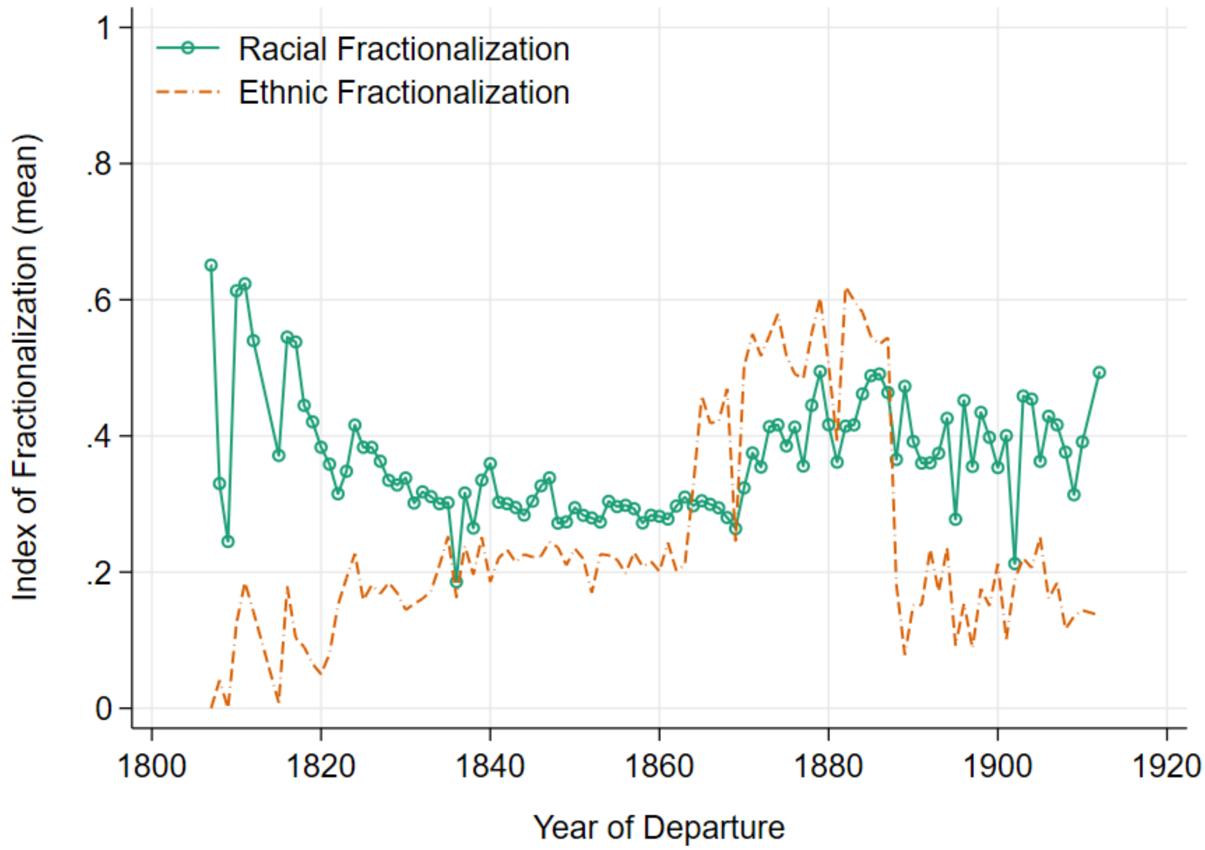
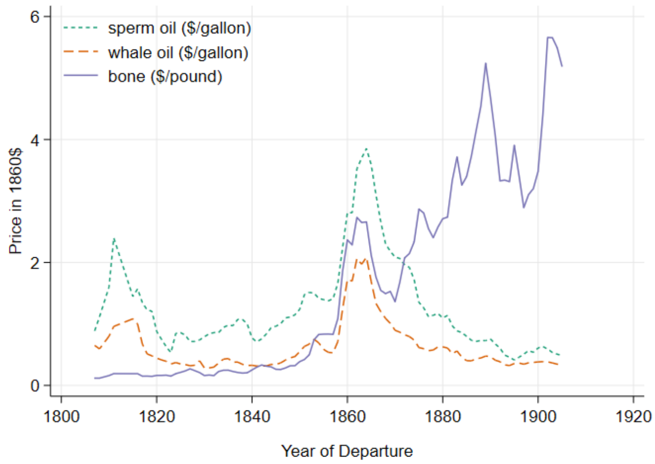
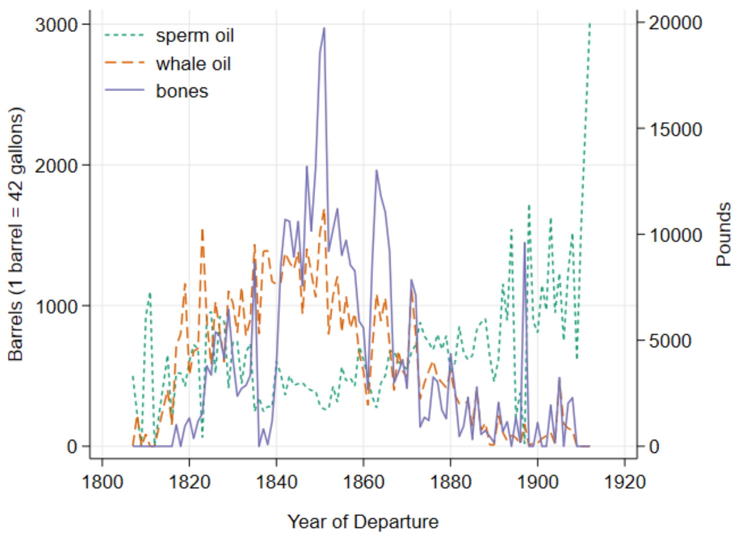


Figure 4 – Output Price, Quantity, and Value (voyage average).

A. Real Prices.



B. Output quantities.



C. Real Output Value.

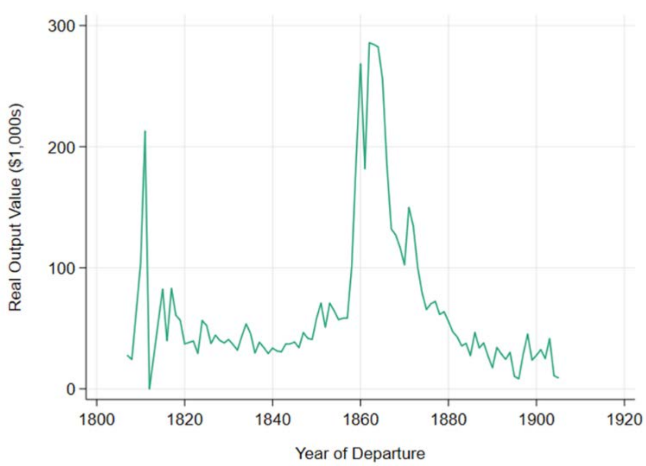
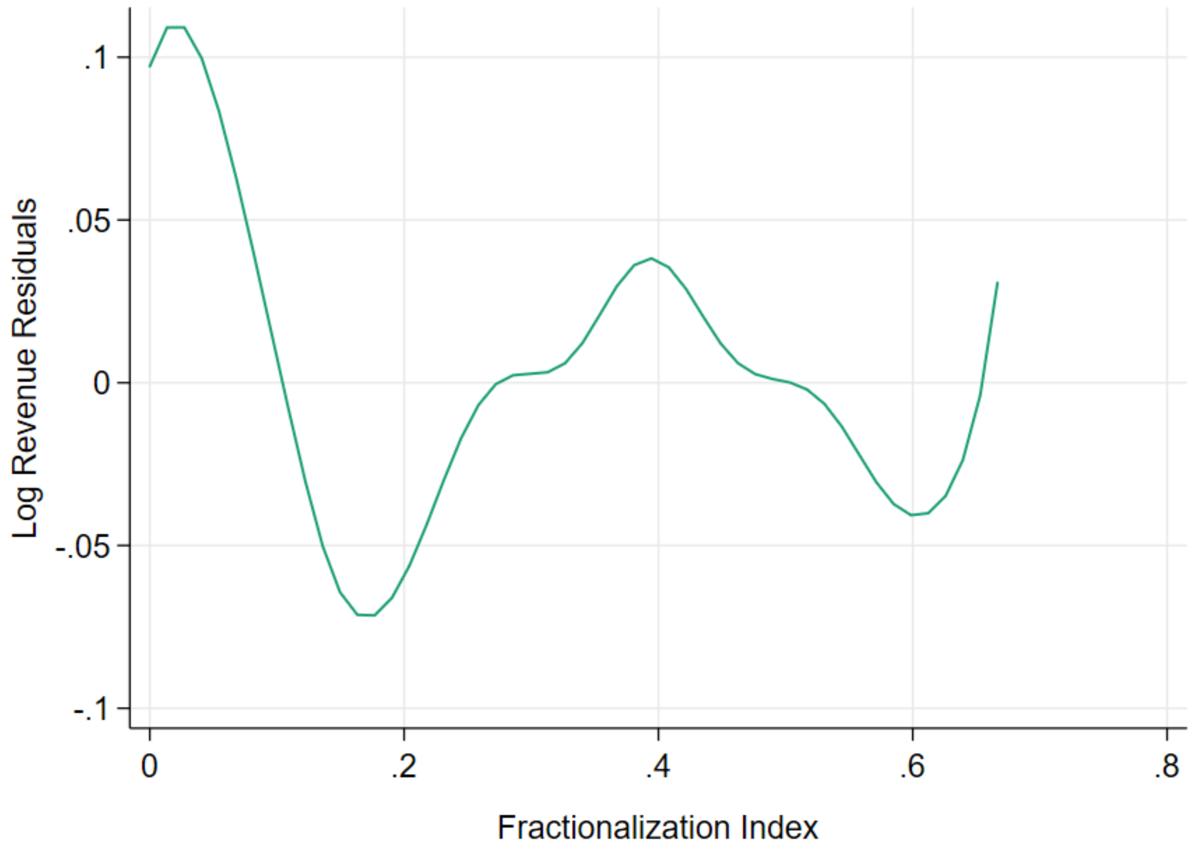
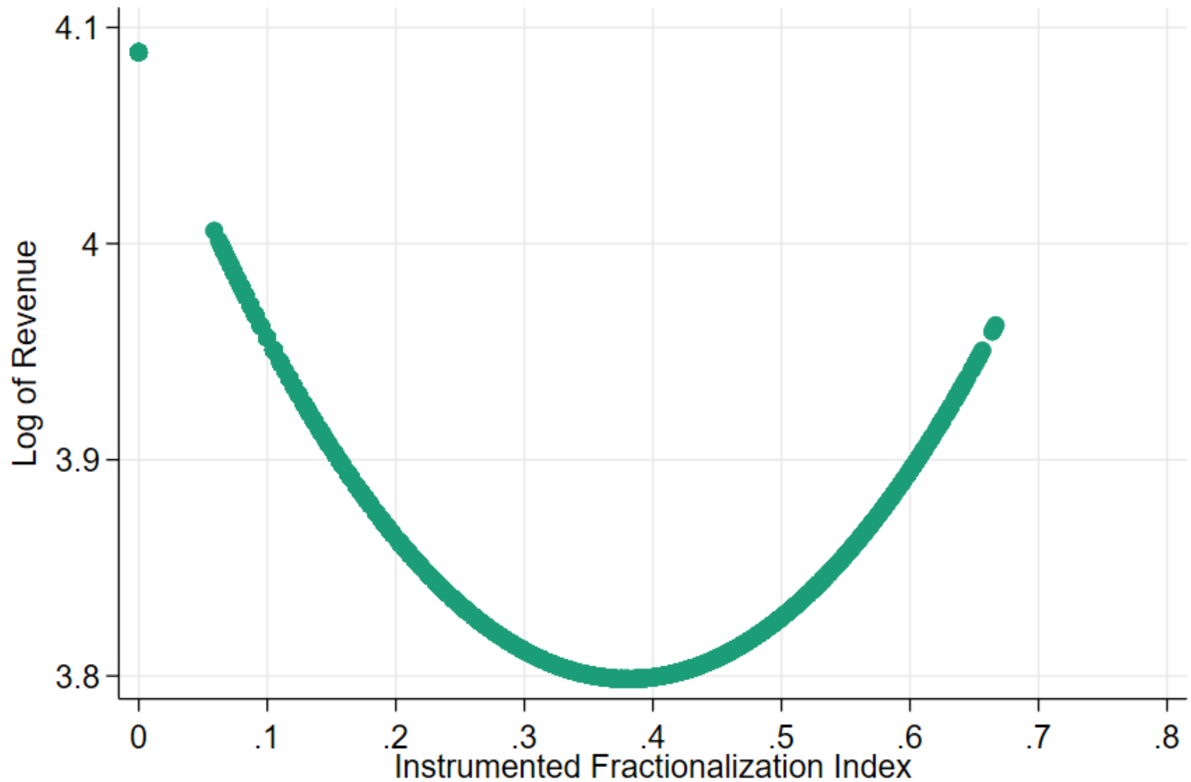


Figure 5 – Observed Racial Diversity and Output Value.



Notes: This figure depicts the estimated relationship between fractionalization index and the residuals from regressing the log of output value on the log of tonnage, crew size, and voyage duration, and rig and year of departure fixed effects. The figure shoes the fit of a nonparametric regression using local second-degree polynomial smoothing based on a Gaussian kernel function and a kernel bandwidth of 0.05.

Figure 6 –Racial Diversity and Output Value (IV regression)



Note: Median Index of Fractionalization 0.333; range [0,0.667].

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APPENDIX A

A.1 Crew Diversity

To determine the race of crew members, we use data compiled from official customs records, enumeration schedules of the U.S. Censuses, and lists of whalemen's race produced by previous researchers. In this appendix we provide a brief description of the contents and compilation processes of these sources. Customs registers include the crew lists for each voyage and the "shipping papers" that specify the position (rank) and payment (share) of each crew member. Information about the crew includes name, age, height, birthplace, residence city, citizenship, rank, and payment.

The American Offshore Whaling Crew List database is the product of a joint effort by the New Bedford Whaling Museum and Mystic Seaport Museum. It includes the crew lists of whaling voyages recorded at the customs houses in the ports of New Bedford, Fall River, and Salem in Massachusetts and the port of New London in Connecticut during the period between 1809 to 1927. For crewmen on the list, grouped by voyage, the database includes detailed information about their personal characteristics, such as residence, age, height, and complexion. The Crew List database also includes information from the Shipping Papers (articles), another set of legal documents filed with the customs at the beginning of the voyage. Instituted in 1790, the documents specified for each crew member their "service, pay, voyage, and all other things," to be shared with American consuls, judges, and other parties in cases of disputes between masters and seamen regarding compensation and work conditions. The Database includes over 177,000 entries. However, because of duplications between the customs lists drafted for departure and the lists included in Shipping Papers, there are only about 119,000 unique entries in the database. Since some of these whalemen joined multiple voyages, the Crew Lists database includes information for about 67,000 unique names, possibly corresponding to a significantly lower number of individuals given the likelihood of different spellings of names across voyages.

The Registers of Seamen's Protection Certificates includes similar information about the whalemen. The Certificates were created after the Congress passed an "Act for the Relief and Protection of American Seamen" in 1796 in response to the impressment of American seamen by British ships. Required by the Act, each seaman was registered with the customs collector and given a certificate. Similar to the Crew List database, the Registers data includes relevant personal characteristics of sailors, such as their names, ages, and places of residence. The information in the database is taken from the copies of original certificates issued from 1796-1871 and kept at the National Archives. The Registers database includes entries for about 31,000 whalemen, though only about 13,500 of these entries contain useful information to determine race.

We supplement the information from databases compiled from the official customs records of the American whaling industry with two sets of external sources. The first are the enumeration schedules of the U.S. Federal Censuses of 1850-1900. Organized by places of residence, these schedules include information regarding the personal characteristics of all individuals, including race. For each whaleman included in the Crew Lists, we matched the information about his name, birthyear, and place of residence with the census records to extract information regarding his race. There are, of course, well-known controversies regarding the recognition and definition of racial categories included in the U.S. Censuses of this period (Hochschild and Powell, 2008). Taking a pragmatic stand in these debates, we simply borrowed the race information as recorded in the enumeration schedules.

Although the U.S. Federal Census enumeration schedules of this period provide information regarding black and white whalemen listed in the schedules, they did not identify the native Americans. For this information, we turn to the lists of Native American whalemen compiled by previous scholars in two separate research projects. The first is the Native American Whalemen's Database created by Shoemaker (2015). She used the crew lists and shipping papers of whaling voyages in conjunction with various other sources, such as newspaper archives and official government records; her database includes over 600 names. The second source to identify Native American whalemen is the Indian Whaler database produced by Handsman, et. al. (2021). To study ethnic communities of whaling, this collaborative project built several databases, one of which expanded on the data collected from comprehensive samples of crew lists by including information about race. It includes the names of 946 Indian whalemen from various New England locations.

A.2. Determining Race and Measuring Diversity

Since none of the sources discussed above provide comprehensive race information for the crew members of all voyages, we developed a stepwise procedure that combined data from all sources sequentially. We started by building a master list of unique whalemen and their personal characteristics by voyage, based on the information recorded in the Crew Lists database. Although the original database includes over 177,000 entries, there were many duplicates caused by the separate entry of crew-specific data from both the official crew lists and the Shipping Papers. To clean up and improve the original dataset, we eliminated duplications and supplemented incomplete or missing information (e.g., by copying missing characteristics of an individual from one voyage to another). The revised original master list consisted about 119,000 entries for 4,464 voyages.

In the first step of the procedure in identifying race, we digitally matched individuals in our dataset with the enumeration schedules of the U.S. Censuses, which provide race information directly. Although the enumeration schedules of this period did not include Native Americans among the racial categories, it recorded blacks and whites at the individual level starting with the 1850 census (i.e., only heads of household were recorded before 1850). Note also that this step would only apply to whalemen whose legal residence was in the United States.

There are well-known potential problems with digitally matching large numbers of individuals accurately between the censuses and other sources. The problems originate from various types of human errors made in the spelling, recording, copying, and digitization of names. In addition, non-unique names present challenges in choosing the right person. Fortunately, these problems have recently been the focus of a fast-growing literature based on the digitization of complete count historical population censuses of the United States. Scholars have developed robust automated methods that link individuals between consecutive censuses to create large longitudinal datasets, which allow studies of migration, intergenerational mobility, effects of important events, and various other changes over time (Abramitzky, Mill, and Pérez, 2020; Berkes, Karger, and Nencka, 2022).

Given the large numbers of individuals in our dataset, we developed a fully automated but conservative probabilistic method that used the information regarding the name, birthyear, and place of residence (town and state) of the whalemen in our dataset (who resided in the United States) to match them with individuals recorded in census enumeration schedules. To address the problems of digital match discussed above, we adapted from the method recently proposed by Abramitzky, Mill, and Pérez (2020). In addition, we followed the strategies recently proposed by Berkes, Karger, and Nencka (2022) to deal with the problem of town names varying over time and between sets of records. We applied conservative parameters by restricting sample to those unique within +-2 years of birthyear. The application of this method to all persons in our dataset resulted in the match of 2,489 whalemen for whom we were able to determine whether they were black or white with a high level of certainty.

Since the U.S. Censuses of this period did not identify the native Americans, in the next step we turned to lists of native American whalemen compiled by Shoemaker (2015) and Handsman, et. al. (2021). Their combined lists included 946 whalemen. Since some of the persons on the list joined multiple voyages, this allowed to us to identify 4,119 entries as belonging to American Indian whalemen with a high degree of certainty. Shoemaker (2015) and Handsman (2021), however, limited their focus somewhat by including in their analysis only a limited number of years or voyages from certain New England ports. Therefore, potentially many other Indian whalemen could be left for identification from other sources in the next step.

In the third step, having already identified the race of about of about 6,600 entries as black, native, or white with a high degree of certainty, we built upon a procedure commonly used by previous researchers to infer the remaining whalemen's race from the information found in the archival records of the whaling industry. Specifically, quantitative historians have previously used the information regarding complexion and hair type entered in the Crew Lists and the Seamans' Protection Certificates to determine race. These records, unlike the census schedules, had no direct column for race on the forms. Instead, they had columns for skin, hair, and eye color that verbally described the physical characteristics of a sailor for identification to relevant authorities, in the absence of photograph technology that currently serves the same function in official documents. In a pioneering quantitative analysis that used skin and hair information to identify blacks, Putney (1987) studied black presence in American merchant fishing and whaling industries from the crew lists of several ports, including Baltimore, New Orleans, New York, and Philadelphia. In his influential *Black Jacks*, Bolster (1997) applied a similar method in his analysis of a large sample of about 50,000 sailors to determine that about one-fifth of them were African American. Craig and Fearn (1993) used the method to categorize a small sample of New Bedford seamen into six different racial groups for an analysis of wage discrimination and occupational crowding in the industry. Finally, in a recent Ph.D. Dissertation, Pariseau (2015) used the method to identify racial minorities in the records for a study of how race relations and activism changed in New England during the nineteenth century.[32]

Following the lead of previous historians who worked on various topics related to race in American whaling, we used the information regarding skin and hair recorded in the Crew List database to categorize whalemen broadly into four simple racial categories: black, Indian, white, and other. Despite the simplicity of categories, however, sorting individuals into them is a highly complicated task. Although the information about skin and hair is extremely useful for identifying race, the problem is that the lists delivered by masters of whaling voyages at New England ports before departure or the copies kept in uniform hand by the custom collectors did not use a systematic system or a defined set of categories to record the information about skin and hair. Instead, the masters used numerous different terms and notations of their choice to describe the types of skin and hair that they observed. As a result, our records contain 213 different terms used to describe skin and 224 terms for hair.[33]

To deal with these complications and to avoid false identifications, we followed a conservative strategy in determining race based on complexion. Specifically, we considered as being black only those with skin recorded as “black” or “colored” or whose hair was recorded as “woolly”. In addition, we considered as black those with birthplace or residence recorded as being in Africa or Cape Verde. Similarly, we considered as white the whalemen whose skin was recorded as “light,” “white,” “fair,” “olive,” “ruddy,” “blonde,” or “sandy,” or whose hair was noted as being “light,” “blonde,” or “fair.” We also identified as white those with birthplace or residence in Europe. Finally, we determined as being native those persons with skin recorded as “Indian” or “copper” or whose hair was entered as “Indian.”

In the final step, we looked for ways to estimate the race of whalemen for whom the information used in previous steps was somehow missing. This was clearly the case for international crew who were not residents of the United States during census enumerations. In addition, for some of these individuals, the official records somehow did not include information regarding physical characteristics. The final pieces of information that could still be used in such cases was the places of their birth or residence. Specifically, based on the literature on whaling industry, individuals who joined the crew as citizens of certain countries in Africa, West Indies,

[32] See Malloy (1990) for references to other studies based on this method.
[33] For examples of difficulties encountered by previous researchers, see Bolster (1997: Appendix), Farr (1983: 164-5), Handsman, et. al. (2021: 52-54, 161-75), Munro (2017: 71-75), Shoemaker (2015: 41-42).

and Cape Verde Islands were typically black. Likewise, the whalemen from Germany, Ireland, England, and other European countries during this period were typically white. Finally, we could lump together in the “other” category the small number of individuals from Asia, South America, the Pacific Islands, and East Indies.

Based on this procedure we were able to identify the race of about 76 percent of all whalemen in our dataset. This left behind about 24 percent for whom information regarding birthplace, residence, skin, or hair was missing or race was difficult to categorize because the information was too vague for a definite classification, such as when their skin was listed as brown, dark, or some other indeterminate term. Rather than make questionable assumptions regarding the enumerator’s meaning with such terms, we followed a conservative approach by leaving the race information as missing so that our measures of diversity for their voyage would depend on other whalemen for whom we have more complete and reliable information. To test whether our results are sensitive to this choice, we included in our baseline analysis only those voyages for which we have race information for a high fraction of the crew. In addition, performed tests of robustness to see if our results are sensitive to the specific cutoff points used in the baseline analysis. Results are presented in table A.1. When we constrain the sample to voyages with complete information on race for at least 50 percent of the crew the results are qualitatively similar to our main analysis, the 2SLS estimates. Applying more restrictive sample selections comes at a cost. That is, it reduces the number of observations considerably. Regardless, we maintain the general relationship between racial diversity and productivity and with coefficients being consistent and precisely estimated. The most restrictive sample, for voyages with complete race information for 70 percent of the crew, gives estimates that are almost identical to our preferred specification.

A.3. Capital, Labor, and Output

The vessels used in this industry can be grouped into five different types depending on their rig and cargo capacity. The smallest vessel is the Sloop, used especially in the early years of the industry which only had one mast and was less than 100 tons and could stay out for a few weeks. Then, there were the Schooner and the Brig, which had both two masts, with the Schooner being around 100-110 tons and the Bring reaching 150 tons and could make voyage of less than a year. Lastly, there were three-mast vessels, the Bark and the Ship, with the former of 270 tons on average and the latter being the largest with more than 350 tons. Both could stay out for three or four years. In our dataset we observe mostly three-masted vessels, almost 75 percent of the sample, while the remaining of the voyages were made by two-masted vessels, 25 percent. Only a handful of one one-mast Sloops participated in the industry mostly in the beginning of our sample period.

The average size of a typical whaling crew ranged between 14 and 32 men, depending on the rigging of the vessel. Sloop had 14 members and were out for 9 months on average. Schooner had a slightly larger crew of 17 with voyage time of 16 months. Bring were very similar, with 19 and 15 months, respectively. Bark's voyages lasted on average 32 months, with a crew of 28 and Ships made slightly shorter voyages, 29 months, but had a larger crew, 30 men. In addition to a captain, each vessel had a few first mates who directed operations. The specialized personnel included service workers such as a cook and a steward, skilled marine professionals like boatsteerers and harpooners, and several artisans such as a cooper and a blacksmith. The remaining crew was comprised of several unskilled workers called seamen or greenhands.[34]

The most visited hunting grounds were the Pacific and the Atlantic Oceans.[35] The average revenue obtained in a voyage amounted to 82 thousand dollars, mostly made by the value of sperm and whale oil. Output value per voyage experienced a large increase right after the mid-1800s, a period when output prices rose significantly (Figure 4). But such increase in voyage revenue lasted only a few years. In fact, as the price of sperm and whale oil decreased, also revenue did, and the sharp increase in the price of whale bones was unable to counteract the trend because that particular output drop considerably.

A.4. Whales' distribution

As any other fishing industry, the profitability of whaling rests on the availability of its prey. The spatial and temporal distribution of whales' populations depends on both natural and anthropogenic factors. Spatial distribution is subject to considerable seasonal variation and exhibits marked latitudinal trends that are common to all cetaceans. Whales' migration is determined to a large degree by the pursuit of foraging opportunities that are in turn highly correlated with the spatial variability of oceanographic features, especially sea surface temperature (SST) and related primary productivity (Smith et al., 1986; Brown and Winn, 1989; Mannocci et al., 2014; Stanistreet et al., 2018; and others). Indeed, whales have been observed to be more prevalent in colder productive coastal waters (e.g., Smith et al., 1986). [36] As the industry expanded the pressure on the stock of whales increased. As a result, the abundance of whales conceivably shrunk contributing to the contraction of the whole industry. Davis et al. (2007, Ch. 4) however, disagree with this interpretation. They suggest that the number of whales killed in the nineteenth century was small in comparison to the previously existing stocks. The reason was that hunting pressure induced a change in the behavior of whales, once unfearful of men, and that they later became timid and more difficult to locate. An extensive discussion of the spatial and temporal distribution of whales is found in Smith et al. (2012). As highlighted by Jaquet (1996), although these migrations might be partially an artefact given the difficulty of hunting in high latitudes during the winter, whale concentrate in areas of cold surface temperatures and strong upwelling, i.e., high primary productivity. Colder waters are correlated with higher primary

[34] For detailed descriptions of whaling crews, see Davis, et. al. (1997: Chapter 5) and Hohman (1928: Chapters 6-7)
[35] For 35 percent of the voyages there is no information of the declared hunting grounds.
[36] Sea surface temperature (SST) is linked to the surface ocean stratification which influences the upwelling intensity, with higher concentrations of chlorophyll, and planktonic productivity (Jaquet, 1996; Kwiatkowski et al., 2017).

productivity, greater zooplankton abundance, increased prey availability and consequently increased prevalence of whales (Block et al., 2011; Dodson et al., 2020).

A.4. Diversity and Productivity

We now turn to the Logbook data, which has information on the whales seen, harpooned and processed, and the date and location of the vessel throughout the voyage for a subset of all voyages. We use this information to investigate the relationship between team diversity and productivity. Productivity is defined by measures of the successfulness of three main tasks in the whaling operations: spotting a whale, striking it, and once struck, processing the whale and recovering the oil and the baleens. We estimate the effect of diversity on productivity using the same specification as in (5), where the outcome variables are the rate of whales that we sighted during the voyage, the rate of whales harpooned (or struck), and finally the rate of whales that were processed.

Table A.5 presents both OLS and IV estimates for the effects of diversity on productivity. The results indicate that a U-shaped relationship also exists between racial diversity and team productivity. However, because of the small sample size we do not have enough power to estimate precisely the relationship. This relationship is particularly evident for productivity during hunting operations as both the linear and quadratic term of diversity are strongly statistically significant. The nonlinear relationship also exists for the successful completion of the hunt and the processing of the whale: rate of trying. The linear coefficient is negative, although not significant with a p-value equal to 0.128. The quadratic term is positive and statistically significant. The estimated relationship for the rate of sighting whale, while still U-shaped, it is not statistically significant for the IV estimates, while is significant when estimated using OLS.

Table A.1. Effect of Crew Diversity on Log of Real Output Value.

	(1)	(2)	(3)	(4)	IV
Fractionalization	-0.523	-1.143	-1.048	-1.074	-1.523
	(0.265)**	(0.345)***	(0.357)***	(0.358)***	(0.651)**
Fractionalization squared	0.801	1.613	1.530	1.535	2.000
	(0.409)*	(0.530)***	(0.549)***	(0.549)***	(0.993)**
Log of Tonnage	0.750	0.697	0.661	0.663	0.665
	(0.045)***	(0.075)***	(0.079)***	(0.079)***	(0.071)***
Log of crew size	0.249	-0.109	0.003	0.003	0.012
	(0.065)***	(0.095)	(0.098)	(0.0979)	(0.094)
Log of voyage duration	0.718	0.641	0.626	0.625	0.627
	(0.019)***	(0.029)***	(0.030)***	(0.030)***	(0.034)***
Ethnic fractionalization				0.098	0.137
				(0.108)	(0.098)
Master FE	No	Yes	Yes	Yes	Yes
Hunting ground-by-year FE	No	No	Yes	Yes	Yes
Ethnicity	No	No	No	Yes	Yes
R-squared	0.367	0.243	0.231	0.231	0.232
N. of obs.	3,970	3,970	3,970	3,970	3,970

* p<0.10, ** p<0.05, *** p<0.01. Robust standard errors in parentheses. Standard errors in squared brackets are clustered at home port and captain level. The empirical specification also includes the log of tonnage and crew size, year of departure and rig fixed effects. Regressions are weighted by the total number of voyages taken by the same vessel over the sample period. The number of observations does not include groups with only one observation on captains and vessels.

Table A.2. Effect of Crew Diversity on Real Output by Share of Non-Missing Race Data (IV estimates).

	(1)	(2)	(3)
Fractionalization	-1.413	-1.323	-1.583
	(0.377)***	(0.330)***	(0.360)***
Fractionalization squared	1.837	1.816	1.935
	(0.572)***	(0.320)***	(0.374)***
Share of non-missing race information for the crew in a voyage	0.5	0.6	0.7
Percentage of the sample	94	85	72
R-squared	0.229	0.225	0.214
N. of obs.	3,796	3,383	2,820

* p<0.10, ** p<0.05, *** p<0.01. Standard errors clustered at port and captain level. The empirical specification also includes the log of tonnage and crew size, year of departure, master, rig, and hunting grounds-by-year fixed effects, as well as crew ethnicity. Standard errors clustered at home port and captain level. Regressions are weighted by the total number of voyages taken by the same vessel over the sample period and controls for ethnicity. Regressions are weighted by the total number of voyages taken by the same vessel over the sample period.

Table A.3. Correlation between Predicted Diversity and Conflicts: Total Incidents and Incidents by Race (OLS estimates).

	Lost	Discharged	Drowned	Deserted or Left
Panel A. All Crew				
Fractionalization	1.460	0.375	0.144	1.700
	(0.553)**	(0.848)	(0.065)**	(0.519)***
Mean of dependent variable	0.182	1.045	0.097	2.647
R-squared	0.055	0.037	0.009	0.033
N. of obs.	407	407	407	407
Panel B. White				
Fractionalization	1.057	0.118	0.108	0.031
	(0.448)**	(0.777)	(0.068)	(0.398)
Mean of dependent variable	0.156	0.810	0.071	2.083
R-squared	0.055	0.025	0.010	0.037
N. of obs.	407	407	407	407
Panel C. Non-White				
Fractionalization	0.403	0.258	0.036	1.669
	(0.114)***	(0.141)*	(0.020)*	(0.194)***
Mean of dependent variable	0.026	0.235	0.026	0.564
R-squared	0.052	0.049	0.012	0.049
N. of obs.	407	407	407	407

* p<0.10, ** p<0.05, *** p<0.01. Each panel represents a separate regression where the dependent variable is denoted by the number of incidents of the nature indicated by the title of the column. The empirical specification includes the log of tonnage, crew size, and voyage duration, year, rig, and hunting grounds-by-year fixed effects, as well as crew ethnicity. Standard errors clustered at home port and captain level. Regressions are weighted by the total number of voyages taken by the same vessel over the sample period.

Table A.4. Effect of Skill Diversity on Hunting and Processing Whales (OLS estimates).

	Sighted	Struck	Tried
Fractionalization for:			
Officers	-0.021	-0.014	0.0001
	(0.013)	(0.012)	(0.012)
Skilled maritime	0.008	0.021	0.021
	(0.018)	(0.006)**	(0.007)**
Artisan and Service personnel	-0.010	0.027	0.031
	(0.031)	(0.006)***	(0.006)***
Seamen	-0.037	-0.009	0.020
	(0.047)	(0.014)	(0.012)
Mean of the dependent variable	0.040	0.044	0.057
R-squared	0.415	0.268	0.386
N. of obs.	110	110	110

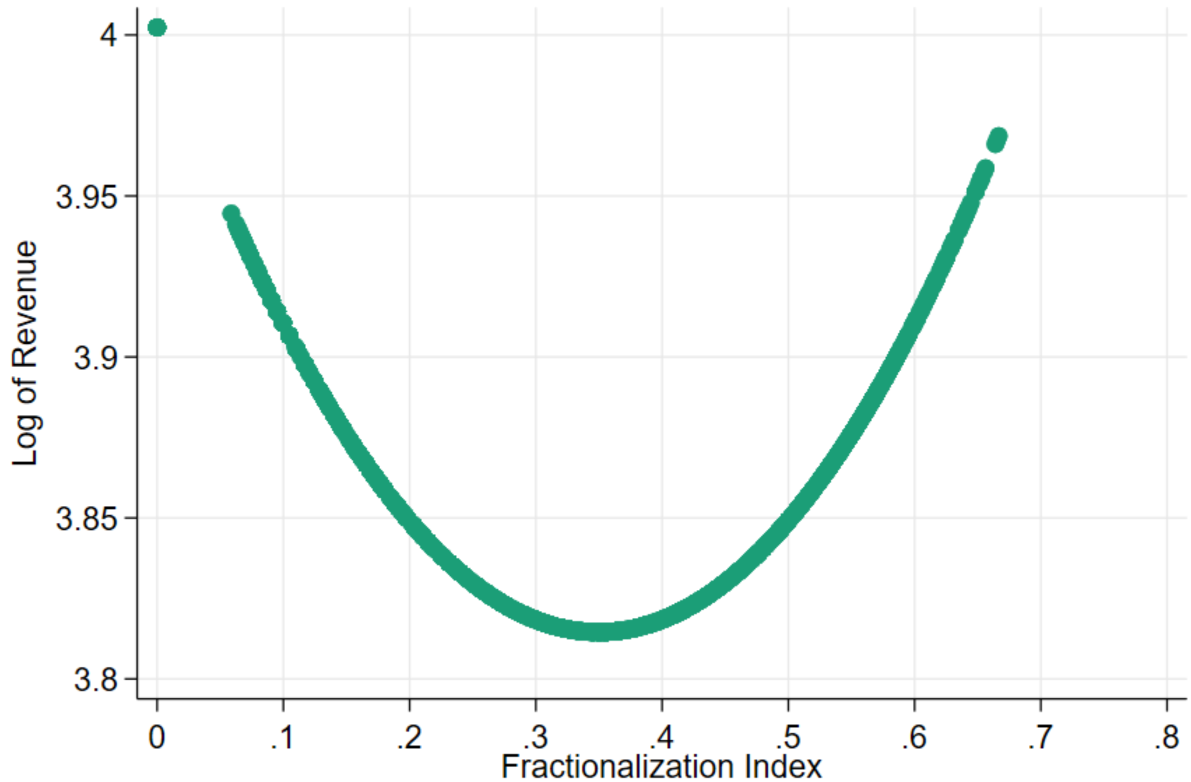
* p<0.10, ** p<0.05, *** p<0.01. Dependent variable is the total number of instances during a voyage in which a whale was spotted (sighted), harpooned (struck), or processed (tried). Officers include the captain (master) and his mates. Skilled maritime group include boatsteerers, ship keepers, and captain apprentices. The artisan and service group includes artisans, such as coopers, carpenters, blacksmiths, sailmakers, and service personnel, e.g., engineers or cook. Seamen are semi-skilled seaman, greenhands, boys, and other ordinary crew members. The empirical specification includes rig and year of departure fixed effects as well as the share of the voyage spent in a FAO fishing area and crew ethnicity. Standard errors clustered at home port level. Regressions are weighted by the total number of voyages taken by the same vessel over the sample period. Regressions use data for voyages with rank information for at least ten crew members.

Table A.5. Effect of Crew Diversity on Productivity: The Rate of Sighting, Striking, and Trying Whales.

	Sighting		Striking		Trying	
	OLS	**IV**	**OLS**	**IV**	**OLS**	**IV**
Fractionalization	-0.133	-0.188	-0.111	-0.0988	-0.0881	-0.0830
	(0.0656)*	(0.126)	(0.0388)**	(0.0307)***	(0.0518)	(0.0545)
Fractionalization squared	0.151	0.214	0.171	0.161	0.157	0.176
	(0.0795)*	(0.143)	(0.0455)***	(0.0392)***	(0.0653)**	(0.0802)**
Mean of dependent variable	0.040		0.044		0.057	
R-squared	0.050	0.013	0.057	0.011	0.086	0.015
N. of obs.	419	419	419	419	419	419

* p<0.10, ** p<0.05, *** p<0.01. Standard errors clustered at home port and captain level. The empirical specification includes the log of tonnage and crew size, master age and rig fixed effects, crew ethnicity, as well as share of time spent in a FAO fishing area, share of time in a specific year, and share of time spent in FAO area by month. Regressions are weighted by the total number of voyages taken by the same vessel over the sample period.

Figure A.1. –Racial Diversity and Output Value (OLS regression)



Note: Median Index of Fractionalization 0.333; range [0,0.667].

Figure A.2. – Density of Whalemen not Returning from their Voyage.