British Industrialization and Cultural Change: Evidence From the Use of Proverbs*

Elliott Ash†
ETH Zurich

Melanie Meng Xue‡
London School of Economics

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Abstract

This paper examines the relationship between industrialization and cultural change by analyzing the historical usage of proverbs in printed texts from Great Britain over the period 1550 to 1900. We identify proverbs from historical proverb dictionaries, classify them into thematic dimensions and topics, and track their appearance in books and newspapers over time. Using a panel dataset structured in 50-year periods, we estimate changes in cultural values across regions with varying industrial intensity, measured by the number of steam engines installed before 1800 and the number of cotton textile plants in 1838. We test whether regions that industrialized the most had already exhibited increasing trends in values such as progress, practical knowledge, and bourgeois virtues before 1750, and whether industrialization itself contributed to shifts in values related to punctuality, innovation, and individualism. Results suggest that cultural change played a role in shaping industrialization while industrialization reinforced certain cultural shifts. These findings contribute to debates on economic and cultural change and introduce a novel empirical framework for quantifying cultural evolution.

Keywords: Growth, Industrial Revolution, Cultural Change, Historical Text Analysis

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†Associate Professor at ETH Zurich and Research Affiliate at the Center for Economic Policy Research (CEPR). Email: ashe@ethz.ch

‡Assistant Professor at London School of Economics and Political Science (LSE) and Research Affiliate at the Center for Economic Policy Research (CEPR). Email: m.m.xue@lse.ac.uk.

I Introduction

The British Industrial Revolution stands as one of the most transformative periods in human history, fundamentally altering economic structures, social organization, and technological progress. As Hobsbawm (1969) describes, it represents "the most fundamental transformation of human life in the history of the world recorded in written documents." This period, spanning roughly from the late 18th to the mid-19th century, saw unprecedented shifts in production processes, driven by mechanization, urbanization, and the rise of factory-based manufacturing. It marked the beginning of sustained economic growth, setting the stage for modern industrial economies.

A rich body of literature has sought to explain both the causes and consequences of the British Industrial Revolution. Early accounts, such as Ashton (1949), emphasize the role of technological progress and entrepreneurship. Crafts (1989) and Crafts and Harley (1992) provided quantitative reassessments of industrialization, challenging earlier views by demonstrating that productivity growth was more gradual than traditionally believed. Institutional perspectives highlight the role of political and legal structures in facilitating industrial expansion (O'Brien and Quinault, 1993). Recent scholarship has debated the key economic forces behind industrialization. Allen (2010) argues that Britain's industrialization was driven primarily by its high-wage economy and access to cheap energy, which made labor-saving technologies profitable. In contrast, Mokyr (2010) emphasizes the role of scientific knowledge, technological creativity, and the Enlightenment in fostering an environment conducive to industrial innovation. The role of global trade and its impact on industrialization has also been explored by O'Rourke and Williamson (2005) and Findlay and O'Rourke (2007), who assess whether international trade played a causal role in Britain's early industrialization. Meanwhile, economic historians have analyzed how industrialization reshaped labor markets and household structures. Voth (1998) examines changes in working hours and labor productivity, while Humphries (2013) explores the impact of industrialization on family economies and child labor.

Despite extensive research on economic, institutional, and technological explanations, the role of cultural factors in the Industrial Revolution remains under-explored. Scholars have debated whether shifts in values—such as attitudes toward work, thrift, or innovation—contributed to industrialization, yet empirical evidence remains scarce. Some have argued that pre-industrial cultural conditions played a role in Britain's early transition to industrialization, while others view culture as an outcome rather than a causal factor. Important contributions, such as McCloskey (2010) and Mokyr (2016), have advanced the discussion by emphasizing the role of ideas, values, and rhetoric—McCloskey arguing for the transformative impact of bourgeois virtues, and Mokyr emphasizing how cultural and intellectual developments, particularly those tied to Enlightenment thinkers, shaped the environment necessary for sustained technological progress. Their work has

deepened our understanding of culture's influence on economic change, yet systematic quantitative evidence remains limited, making it difficult to assess these claims rigorously. Filling this gap requires new approaches that connect cultural narratives with empirical data to better evaluate culture's role in industrialization.

This paper examines the relationship between industrialization and cultural change in Britain by systematically analyzing the use of proverbs – concise expressions of widely held beliefs and values that reflect social and economic norms. While economic historians have extensively studied the institutional and technological forces behind Britain's industrial takeoff, the role of cultural transformation remains less understood, largely due to the scarcity of systematic quantitative evidence. We address this gap by measuring usage of value-laden proverbs to track how cultural attitudes evolved during the Industrial Revolution.

We begin by compiling a dataset of proverbs from historical proverb dictionaries that were either published before 1900 or explicitly document proverbs of origins predating 1900. These specialized compilations serve as a reference for proverbs that were widely known and circulated in past centuries. After identifying these proverbs, we systematically track their usage in historical texts, including books and newspapers, to analyze how their prevalence evolved over time and across locations. This approach allows us to assess how frequently different proverbs appeared in written discourse, reflecting shifts in cultural emphasis.

We adopt AI tools to analyze the cultural content of proverbs. Proverbs frequently employ metaphorical language, complicating their precise interpretation, especially when analyzed through conventional natural language processing tools, which typically struggle with metaphor and historical phrasing. This difficulty is particularly acute for eighteenth- and nineteenth-century sayings, as modern annotators may be unfamiliar with archaic language or subtle period-specific allusions. To overcome these interpretive barriers, we use GPT-4o, an advanced AI-based language model, explicitly prompting it to clarify proverbs by elucidating their implied beliefs, values, attitudes, and norms. We thoroughly validate the resulting explanations with historical, AI, and human-annotator checks.

Next we take the proverbs and their cultural meanings and undertake an LLM approach to classify nuanced cultural dimensions present in proverbs. We prompt GPT-4o to annotate the proverbs across eleven specific dimensions based on the historical literature: patience, honesty, punctuality, hard work, rationality, innovation, progress, practical knowledge, bourgeois virtues, individualism, and curiosity. We generate detailed, dimension-specific datasets. These classifications allow us to measure and analyze how the prevalence and prominence of particular cultural values evolved during key phases of the Industrial Revolution. Qualitative inspections of the classifications, supported by the model's concise explanations, indicate robust interpretive accuracy.

Besides these specific literature-motivated dimensions, we take a data-driven clustering approach that uncovers broader cultural themes encoded in historical proverb usage. Specifically,

we employ the BERTopic algorithm to group proverbs into thematic clusters based on their AI-generated explanations. This method captures the deeper moral lessons and social norms expressed in the proverbs, and provide a more comprehensive view of the the cultural narratives most salient in historical Britain. As done with the explanations, we subject these clusters to substantial human and AI validation checks.

To examine cultural patterns systematically, we aggregate proverb data geographically, assigning each proverb mention to specific counties based on its source – newspapers by their place of publication, and books to authors' birthplaces. To ensure comparability across different publication types and regions, we standardize proverb frequencies relative to the total number of printed pages and apply a further scaling correction to account for baseline differences across media. As a validation step, we compare our county-level proverb measures against first-name usage patterns from the 1851 census, demonstrating that name-usage distances between county pairs are highly correlated with proverb-usage distances. This high correlation helps us interpret proverbs as reliable indicators of local cultural identity.

Beyond analyzing aggregate trends, we investigate regional variation in cultural shifts by linking our proverb-based measures to historical data on industrialization across different parts of Britain. Additionally, we explore how the Industrial Revolution influenced the relative intensity of different cultural themes, examining whether new economic realities reinforced, replaced, or reshaped them.

The first question is whether and how culture may have led to industrialization. Our empirical strategy aims to identify which cultural attitudes, reflected in proverb usage, were prevalent in regions prior to their industrialization and may have contributed to industrial growth. We estimate regressions at the county level for each cultural dimension or thematic proverb cluster, modeling how the frequency of proverb usage evolved relative to early indicators of industrialization, measured either by pre-1800 steam engine installations or by the presence of cotton textile plants in 1838. By controlling extensively for geographic factors – such as coastal access, terrain, distance to ports, coal availability, and latitude – as well as variations in text volume and overall proverb usage, our specification isolates whether particular cultural themes systematically gained prominence in regions that eventually industrialized.

We find that cultural attitudes conducive to industrialization were already becoming prevalent in regions that subsequently industrialized. Proverbs emphasizing bourgeois virtues – particularly diligence, thrift, economic rationality, and practical knowledge – were already growing significantly in prominence, suggesting that cultural foundations supportive of market-oriented behavior and technological innovation were already emerging prior to industrial growth. Similarly, proverbs highlighting belief in progress and improvement also increased, reflecting rising optimism about material advancement and systematic betterment. Notably, this cultural shift extended beyond economic values: proverbs stressing resourcefulness, adaptability, intellectual

engagement, and accountability became increasingly widespread, indicating a broader societal transformation. Meanwhile, proverbs associated with spirituality declined, suggesting that secularization processes were already underway. Collectively, these findings support the view that cultural changes preceding the Industrial Revolution were multidimensional, encompassing not only economic values but also attitudes toward knowledge, governance, personal responsibility, and interpersonal relationships, setting the stage for Britain's subsequent economic transformation.

To estimate how industrialization shaped cultural attitudes, we adopt a difference-in-differences empirical strategy, exploiting regional variation in industrial intensity across Britain. Specifically, we regress the frequency of proverbs within each thematic cluster or cultural dimension on the interaction between regional industrialization intensity and an indicator for the post-1750 period. Our specification controls comprehensively for geographic characteristics such as coastal access, terrain slope, distance to ports, coal availability, and latitude, each interacted with time trends. Additionally, we include fixed effects for counties and time periods, as well as controls for variations in text volume and overall proverb usage, with the goal of ensuring that our estimates reflect the impact of industrialization itself rather than other confounding factors. By comparing changes in proverb usage between more and less industrialized regions after 1750, our approach captures how industrialization influenced the evolution of cultural values and norms as measured by proverbs.

We find that industrialization significantly reshaped cultural attitudes, though its impacts extended beyond conventional expectations. We find partial support for key hypotheses: industrialization contributed to increased punctuality and time discipline, consistent with historical accounts of structured labor regimes. Similarly, there is suggestive but less robust evidence of rising individualism, reflecting a shift toward self-sufficiency and economic agency. Attitudes toward innovation showed little change, suggesting industrialization's cultural influence did not strongly emphasize creativity and innovation per se. However, broader transformations were evident across a range of cultural domains: themes related to financial prudence, strategic foresight, authority structures, morality, and social relationships exhibited significant shifts. Some of these changes were already underway before industrialization, suggesting that industrialization both reinforced existing cultural trends and introduced new dimensions of societal transformation.

These findings highlight that cultural transformation acted as both a catalyst and consequence of industrialization. Prior to industrial growth, emerging cultural values – particularly those emphasizing hard work, rationality, practical knowledge, and optimism about continuous improvement – were already gaining prominence, suggesting that evolving social attitudes helped lay the groundwork for economic modernization. Following the onset of industrialization, cultural norms continued to evolve, reflecting adaptations to new economic incentives, factory discipline, and urban lifestyles. Industrialization reshaped values not only related to labor but also to broader

aspects of social life, including perceptions of hierarchy, personal responsibility, risk-taking, and morality. This bidirectional relationship underscores the interplay between economic conditions and cultural traits, helping to motivate theoretical models in which cultural attitudes both shape and are shaped by structural economic change.

Beyond the context of the Industrial Revolution, this study makes two broader contributions. First, it contributes to the literature on culture and economic growth by providing a structured approach to examining how cultural values interact with economic development. Second, it demonstrates the potential of proverbs as a method for studying culture and cultural change, offering a scalable framework for analyzing historical shifts in beliefs, norms, and economic behavior. By integrating computational text analysis with historical sources, we introduce a novel empirical approach for studying long-run cultural evolution.

Related Literature. This research uses proverbs as a measure of cultural beliefs and attitudes to better understand episodes of cultural change, with a particular application to the Industrial Revolution in 18th- and 19th-century Britain. The Industrial Revolution is a central topic in economic history, with extensive literature documenting structural changes in the economy, including the shift of labor from agriculture to manufacturing and services (Broadberry et al., 2015; Wallis, Colson, and Chilosi, 2018). While these transformations are well-documented, the cultural changes that accompanied them remain less understood. What role did cultural beliefs play in shaping industrialization, and how did industrialization in turn reshape cultural values?

Cultural change is a fundamental process in social and economic history, shaped by both long-term persistence and adaptive responses to new conditions. Anthropologists and sociologists have debated whether cultural change occurs incrementally through adaptation (Swidler, 1986) or emerges from external shocks that force a shift in values. Psychologists and cultural theorists have identified dimensions of cultural variation—such as individualism, long-term orientation, and uncertainty avoidance—that evolve in response to broader societal transformations (Hofstede, 1980, 1991; Schwartz, 1999). Economists have modeled cultural transmission, emphasizing both intergenerational persistence (Bisin and Verdier, 2001, 2011), and adaptive evolution, where beliefs respond to incentives and institutions (Bénabou and Tirole, 2006; Fernández and Fogli, 2009). While many studies highlight the importance of culture in shaping long-run economic outcomes, systematic quantitative evidence on how cultural beliefs evolve over time remains scarce. This study addresses this gap by using proverbs as a dynamic, text-based measure of cultural evolution, allowing for a more detailed analysis of how beliefs and values changed over time.

One perspective argues that cultural change preceded and facilitated industrialization. Mokyr (2010) suggests that shifting beliefs about progress and mastery over nature played a pivotal role in driving industrialization. McCloskey (2010) highlights the rise of bourgeois values, including hard work, patience, honesty, rationality, curiosity, and learning, as an important factor enabling

economic dynamism. These arguments emphasize that cultural attitudes toward work, innovation, and economic behavior were evolving before industrialization took off. Some empirical work has explored aspects of these theories, such as Squicciarini and Voigtländer (2015), who examine the role of knowledge-intensive human capital in industrial-age growth. However, the direct measurement of cultural change remains challenging, and systematic evidence on how cultural narratives evolved remains scarce.

A second perspective posits that cultural change was a consequence of industrialization rather than its cause. Industrialization transformed conceptions of time and work (Thompson, 1967) and led to shifts in social organization and labor relations. Landes (1969) argues that industrialization reinforced values such as innovation and progress, reshaping cultural attitudes over time. Other scholars have highlighted endogenous preference formation, where economic transformations altered cultural beliefs through generational transmission (Doepke and Zilibotti, 2005, 2008). While these studies provide important insights into post-industrial cultural change, they rely primarily on qualitative historical sources rather than systematic, quantitative evidence on cultural beliefs.

A third perspective emphasizes the resilience of cultural beliefs amidst economic transformation. While industrialization led to significant shifts in work organization and social identity, some scholars have emphasized the persistence of traditional values. Wiener (1981) highlights ambivalence toward industrialization in parts of English society, where certain segments resisted industrial values and continued to uphold pre-industrial cultural norms. These studies suggest that cultural change was neither uniform nor inevitable, and different communities exhibited varying degrees of adaptation and resistance to economic transformation.

Beyond the Industrial Revolution, this study connects to a broader literature on the relationship between culture and economic growth. Scholars have emphasized the role of cultural traits such as individualism versus collectivism (Hofstede, 1980; Talhelm et al., 2014), long-term orientation (Hofstede, 1991; Galor and Özak, 2016; Figlio et al., 2019), and work ethic (Weber, 1905; Landes, 1998) in shaping economic development. Trust and social capital have also been identified as key determinants of economic growth (Putnam, 1993; Guiso, Sapienza, and Zingales, 2016). Additionally, personality traits such as achievement motivation and thrift (Granato, Inglehart, and Leblang, 1996) and parental investments in patience and risk tolerance (Doepke and Zilibotti, 2013) have been linked to long-term economic outcomes.

This research also contributes to the study of oral traditions and their relationship with cultural transmission in economic history. Oral traditions, including proverbs, have long served as a medium for conveying cultural values, norms, and practical knowledge across generations. While much of the literature on culture and economic growth has focused on written records, recent work has shown that oral traditions reflect historically embedded beliefs that persist over time. Michalopoulos and Xue (2021) demonstrate that variation in traditional oral narratives

corresponds to differences in cultural attitudes, which in turn are associated with contemporary economic behavior. Unlike previous studies that rely on static cross-sectional comparisons, this research explores the temporal dimension of cultural change, taking advantage of the British setting where proverb usage can be systematically tracked over time. Additionally, while prior work has largely focused on recorded collections of oral traditions, we examine actual usage by tracing proverbs in historical texts, allowing for a more direct assessment of how cultural beliefs evolved alongside industrialization. This study expands the scope of research on oral traditions, offering new insights into how informal, widely circulated expressions of cultural beliefs changed over time and interacted with economic transformation.

This research also contributes to the growing literature on the measurement of culture. Advances in computational text analysis have made it possible to quantify cultural beliefs in historical contexts (Falk et al., 2018; Michalopoulos and Xue, 2021). Previous studies have primarily relied on survey-based measures of cultural values, while historical analyses have often been limited to case studies or qualitative assessments. By introducing proverbs as a systematic and large-scale measure of cultural beliefs, this study provides a novel empirical approach to studying cultural evolution over time.

Finally, this paper contributes to the emerging field of research that treats text as data (Gentzkow, Kelly, and Taddy, 2019; Ash and Hansen, 2023), including recent moves to incorporate deep learning models into economics (Dell, 2024), in particular large language models (Ash and Hansen, 2025; Ludwig, Mullainathan, and Rambachan, 2025). Through the lens of large language models, we demonstrate how metaphorical language can be systematically interpreted, thereby opening previously inaccessible sources to quantitative inquiry. Proverbs, once difficult to analyze at scale, now provide evidence on how cultural values and beliefs evolved in response to industrialization. This technique—translating symbolic or metaphorical texts into literal forms—holds promise for future investigations into memes, narratives, and other expressions that convey collective identity or moral codes, helping to advance the growing agenda on culture and economic development.

II From Proverbs to Cultural Values

II.A Background: Proverbs as Cultural Indicators

Proverbs are a universal feature of human languages and cultures that reflects the beliefs, values, and worldviews of a society (Mieder, 2004; Hrisztova-Gotthardt and Varga, 2014; Lomotey and Csajbok-Twerefou, 2021). The scholarly study of proverbs, known as paremiology, has faced many challenges, not least the lack of focus given interdisciplinary contributions from linguistics, folklore, anthropology, and psychology. Lists of proverbs have been discovered in the oldest

discovered writings. Even among the educated in the most developed societies, survey respondents recognize and understand dozens of proverbs (Haas, 2008).

Proverbs are concise, memorizable, and metaphorical sentences summarizing ideas, arguments, norms, or folk wisdom. They can thus be drawn on in day-to-day conversations for quick rhetorical effect. Previous qualitative work has noted the prevalence of proverbs related to gender roles (Lomotey and Chachu, 2020). Especially in illiterate societies, proverbs play an important role for education of young children (Penfield and Duru, 1988). On top of that, proverbs can play a social politeness role, by allowing criticism while de-personalizing the conversation (Obeng, 1996). Proverbs are thus effective rhetorical devices because they are concise and draw on an externalized ancestral authority.

Proverbs serve as compressed representations of cultural knowledge that can be transmitted across generations while being resistant to information loss through modification or mutation, especially in oral societies with low literacy rates. In traditional African courts, as late as the 1960s lawyers argued their cases based on proverbs, rather than judicial precedent (Messenger, 1959; Arewa and Dundes, 1964). This role of proverbs as a cultural memory, which could later be substituted by writing, is related to a recent lab experiment by Graeber, Zimmermann, and Roth (2022) showing that information presented as anecdotes is remembered more easily than the same information presented as statistics. In this respect, proverbs can be seen as memes (Dawkins, 1976), which will persist and propagate if they are helpful to those remembering and sharing them. Villers (2022) discusses a variety of selection criteria for a proverb, including its distinctiveness, aesthetic appeal, simplicity, perceived authority, social status, and utility.

In the 1970s, comparative ethnographers noticed that proverbs tended to have similar messages and meanings across cultures, and there were even clear parallels between otherwise totally disconnected cultures, such as the Finnish in Scandinavia and the Ndonga in Namibia (Kuusi, 1970). That led to efforts to systematize the different themes and topics in proverbs (Kuusi, 1972; Permyakov, 1979; Lauhakangas, 2001). Follow-up work trying to apply these typologies to new sets of proverbs revealed major limitations with them (Lauhakangas, 2014). The broad topics boundaries are quite arbitrary, while the assignment of any given proverb is subject to disagreement. A more scientifically founded and reproducible approach is needed, either through clear formal criteria or a more data-driven procedure.

The database in Lauhakangas (2001) provides a list of 1,728 proverbs in English and Finnish, with some information about the languages where they appear. Some proverbs appear to be universal, in the sense that they exist in every language that has been checked. Many more proverbs are not universal and exist in a subset of languages and cultures. Proverb co-occurrence data could therefore be used to assess cultural similarity and influence. That would be a useful complement to data on shared folklore motifs (Michalopoulos and Xue, 2021), or on shared words (Blouin and Dyer, 2022). However, this and other databases do not have systematic and

comparable information explaining the meaning of the proverb. Most proverb dictionaries have relatively few proverbs, they are relatively recent, and the provided definitions include a lot of historical information rather than systematic interpretations of their metaphorical meaning.

As illustrated in the analysis below, many proverbs are related to issues that are salient in behavioral economics, such as patience, risk-taking, cooperation, and conflict. A tiny literature has discussed these issues. Weber, Hsee, and Sokolowska (1998) assess and compare samples of proverbs from China and the U.S. in terms of how the proverbs frame risk-taking. Chinese proverbs were perceived as more supportive of risk-taking than U.S. proverbs by survey respondents. Abou-Zaid (2013) provides a qualitative discussion interpreting a sample of proverbs through economic logic. Chiang (1961) notes that proverbs may be substitutable with religion or education, so they may be less prevalent in more educated societies.

Proverbs often tell a story, either explicitly or implicitly. Those stories are often relevant to politics or policy – e.g., "The power to tax is the power to destroy," or "It takes a village to raise a child". Qualitative work by Mieder (1997) has traced the use of proverbs by notorious politicians, including Churchill, Truman, and Hitler, noting that the use of proverbs is considered an especially effective feature of their persuasive rhetorics. In contrast, Simon (1946) criticized research and practice on public administration as being founded in "proverbs" – that is, conventional wisdom – rather than on science. Hence, proverbs are relevant to the recent and exciting literature in economics on narratives in politics and the economy (e.g. Shiller, 2019; Eliaz and Spiegler, 2020). Previous works have shown how narratives could drive economic fluctuations (Branch, McGough, and Zhu, 2017) and asset prices (Kuhle, 2018), and how they might induce pro- and anti-social behaviors (Bénabou, Falk, and Tirole, 2018; Hillenbrand and Verrina, 2018; Baum, Cohen, Zhukov, et al., 2018). Yet so far proverbs have been ignored in the broader social science and economics literature.

II.B New Collection of Historical British Proverbs

We assembled our primary dataset of historical British proverbs by combining several collections spanning the thirteenth through nineteenth centuries. There are two main sources. The first major source is John Ray's *Compleat Collection of English Proverbs* (1617), which contributed 5,925 proverbs and is widely regarded as one of the earliest systematic catalogs of English sayings. We then included Robert Christy's *Proverbs, Maxims and Phrases of All Ages* (1889), providing 20,612 proverbs gathered from British and international sources.

To further enrich this effort, we added three additional collections that overlap with Ray's and Christy's while introducing additional examples or variations of familiar sayings. We have 347 proverbs from Walter William Skeat's *Early English Proverbs, Chiefly of the Thirteenth and Fourteenth Centuries* (1910), which covers Middle English proverbs. Morris Palmer Tilley's *A Dictionary of the Proverbs in England in the Sixteenth and Seventeenth Centuries* (1950) provided

us with 11,783 proverbs, whilst George Latimer Apperson's *English Proverbs and Proverbial Phrases: a Historical Dictionary* (1929) with 10,316 proverbs.

All materials underwent digitization and text extraction to enable systematic analysis. We applied optical character recognition (OCR) to PDF files, then applied regular expressions to isolate each proverb. Post-processing involved some manual refinement of partial entries, deleting exact and near duplicates, and standardizing format across sources. These steps removed 7,286 entries, leaving us with a dataset comprising 41,697 proverbs and sayings.

We then undertook another phase of manual and automated filtering steps. For example, in Ray's collection, we removed all entries from a section titled 'Proverbial Similes' (pages 224-233) which contained idioms and similes rather than genuine proverbs. Finally, we used the following prompt with GPT-4o to remove any remaining non-proverbs:

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You are a helpful research assistant with knowledge of the literary
and social history of proverbs.

A proverb is a phrase or saying that expresses a general truth,
wisdom, or piece of advice.  It conveys a life lesson or cultural
insight.

Is the following phrase a proverb according to the definition above?
Respond simply with "1" if it is a proverb and "0" if it is not.
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Through these efforts, we formed a cohesive dataset of 26,570 English-language sayings.

II.C Locating Proverb Usage in Books and Newspapers

After assembling the collection of proverbs, the next step was to identify where and when these sayings appeared in historical texts. To do this, we conducted systematic searches in digitized books and newspapers from the fifteenth to the twenty-first century. By tracking proverbs across different sources and time periods, we obtained statistics on their usage across places and over time, allowing us to study when and where these expressions were recorded in written discourse.

EEBO and ECCO. For the period before 1800, when newspaper archives are scarce, we relied on books to track proverb usage. We conducted large-scale searches in two major databases of early printed works: Early English Books Online (EEBO) and Eighteenth Century Collections Online (ECCO). EEBO contains over 146,000 books published in English between 1475 and 1700, while ECCO extends coverage into the 1700s, providing access to more than 180,000 printed works from 1700 to 1800. These databases include a wide range of sources, including religious texts, philosophical treatises, plays, political pamphlets, and instructional manuals, allowing us to identify how proverbs appeared in different genres.

For each proverb in our dataset, we conducted exact match searches in EEBO and ECCO to determine its presence in historical texts. This process allowed us to systematically record metadata for each instance, including the book title, publication year, and author. Since books do not provide direct geographic information about where a proverb was used, we assigned location based on the birthplace of the book's author, where available. The rationale behind this approach is twofold: (a) the author wrote the book and selected the proverbs used in the text, and (b) the author's beliefs and knowledge were shaped by their birthplace, making it a reasonable proxy for the cultural context in which the proverb was used.

British Newspaper Archive. Starting in the eighteenth century, newspapers provide a more immediate and detailed record of language use. Our primary source for historical newspapers is the British Newspaper Archive (BNA), a digitization project by the British Library. The archive contains more than 90 million pages from over 1,000 newspaper outlets, covering the period from the early 1700s until 2009. Each article is linked to a publication date and location, allowing for a geographically and temporally structured analysis of proverb appearances.

We used BNA's search function to look for exact matches of each proverb in newspapers from 1700 to 2009. For each match, we recorded details including the newspaper name, publication date, article title, page number, and surrounding text. Unlike books, where we inferred location from the author's birthplace, newspapers directly provide geographic information through their place of publication.

BNA's search function automatically pre-processes the inputted phrase by removing stopwords, even when doing exact matching. Through trial and error, we constructed the following list of such stopwords: "the", "and", "but", "is", "are", "an", "for", "if", "of", "in", "on", "into", "or", "by", "be", "they", "there", "their", "it", "to", "that", "as", "was", "with", "this", "these", "then", "at". This filtering during the search function produces false positives. To reduce these, we have a stricter search approach with proverbs that contain two or fewer words after dropping the stopwords. For these cases, we only keep hits where the proverb appears exactly in its original form.

Thus, by integrating these data from BNA with our results from EEBO and ECCO, we constructed a dataset of proverb usage across historical British texts, capturing both their presence in formal written works and their occurrence in public discourse.

II.D Interpreting the Proverbs

Proverbs often adopt metaphorical language, which can complicate efforts to interpret them precisely for analytical purposes. Standard text-analysis tools in natural language processing tend to struggle with metaphor, particularly when the expressions come from historical sources. Moreover, eighteenth- and nineteenth-century sayings may pose additional barriers for modern annotators, who may not be familiar with archaic phrasing or subtle period-specific references.

To address these challenges, we incorporate AI-based methods designed specifically to parse and clarify the underlying ideas and values conveyed in proverbs.

The starting point is the collection of proverbs discovered in the compilations and then queried in the books (EEBO and ECCO) and newspapers (BNA). For the subsequent analysis, we excluded any proverbs from the compilations that did not appear at least once in the books or newspapers. That leaves a dataset of 12,831 remaining proverbs.

To interpret the proverbs, we use the following system prompt with GPT-4o:

```
You are a helpful research assistant with knowledge of the literary
history of proverbs.

Explain the meaning of this proverb in a few sentences of plain
language.  Interpret the proverb in terms of the implied beliefs,
values, attitudes, norms, or ideology.

Structure your answer as follows:  "This proverb means that...  If
a person uses this proverb, it implies that this person ...  If this
proverb is prevalent in a society, it implies that the society...".
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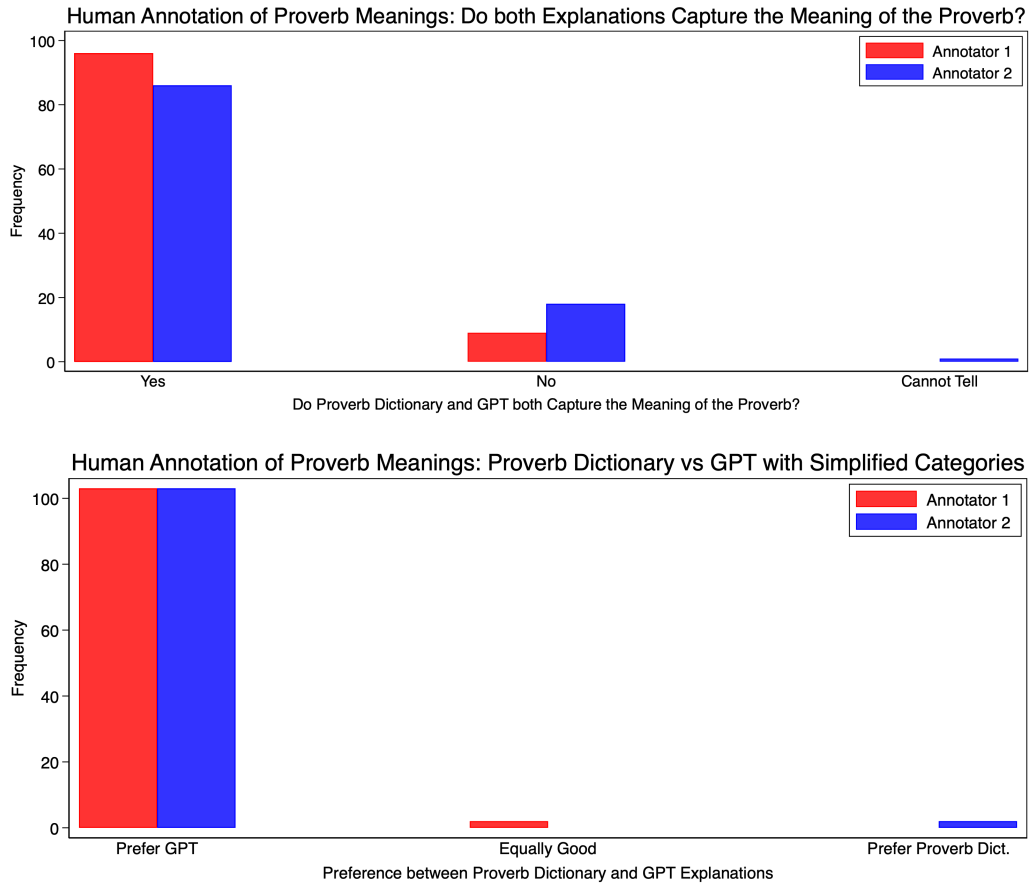
This prompt allows our AI-based system to generate plain-language explanations that specify each proverb's potential ethical or normative implications. By instructing the model to make clear statements of what the proverb means when someone uses it, we get closer to a measurement of the cultural aspects. That reduces ambiguity and produces a uniform structure for subsequent analysis.

Here is an example explanation generated by this prompt.

> ***Proverb****: A bird in the hand is worth two in the bush.*
>
> ***Explanation****: This proverb means that it is better to have a small but certain advantage or possession than to risk it for a potentially greater but uncertain one. If a person uses this proverb, it implies that this person values security and certainty over taking risks for potentially greater rewards. If this proverb is prevalent in a society, it implies that the society values prudence, caution, and the importance of appreciating what one already has rather than constantly seeking more.*

Such an explanation is effective because it captures the moral or behavioral implication, rather than the literal surface meaning. In this proverb, it properly extracts the implied attitudes towards risk and uncertainty inherent in the proverb.

Figure I: Validation of AI Explanations Against Proverb Dictionaries



In order to validate our AI-generated explanations against traditional interpretations, we conducted a blind annotation exercise using two external reviewers. Each reviewer examined 105 randomly chosen proverbs, comparing our system's explanation with that provided by a reputable proverb dictionary. The reviewers were blinded to the information source and the order of explanations was randomized. Reviewers answered two key questions: whether both explanations accurately captured the proverb's essence, and which explanation they preferred.

Figure I shows the results of this exercise. Panel A shows that both annotators overwhelmingly felt like both our explanation and the dictionary explanation were satisfactory. Panel B shows that the annotators usually preferred the AI explanation to the dictionary explanation. They rarely preferred the dictionary explanation to the AI explanation.

For robustness, we tested prompts that explicitly referenced historical contexts. For this check, we selected the 150 proverbs with most cumulative search hits across EEBO, ECCO and BNA. For each of these proverbs, we prompted GPT-4o:

```
Explain what this proverb would have meant in England in 1700 in a few
```

```
sentences of plain language.  Interpret the proverb in terms of the
implied beliefs, values, attitudes, norms, or ideology.
```

We ran this prompt for 1600, 1700, 1800, and 1900. We then asked GPT-4o to compare our main explanation with the historically-sensitive meaning:

```
Based on the definition from 1700 and the definition from today,
did the beliefs, values, attitudes, norms, or ideology implied by
this proverb change over time?  Respond with:  - "1" if the beliefs,
values, attitudes, norms, or ideology implied by this proverb changed
over time.  - "0" if the beliefs, values, attitudes, norms, or
ideology implied by this proverb did not change over time.
```

We found that 100% of the meanings were effectively invariant over time. This consistency suggests that while context-specific prompts might add historical flavor, the underlying moral or ethical thrust of each proverb remained the same across eras (at least, as detectable by the LLM).

For additional robustness, we generated meanings for the same set of 150 proverbs using an alternative model (Anthropic Claude 3.5 Sonnet) and the baseline prompt. GPT-automated checks confirmed that 100% of Claude-generated interpretations were consistent with GPT's. These findings bolster confidence in our methods' generalizability, indicating that our framework is not narrowly tied to one specific AI engine but can be applied across different large language models.

II.E Validating Explanations Using BNA Hits

We validated both the BNA searches and our explanations by systematically inspecting the BNA search results. We randomly selected 1,000 proverbs with at least 5 results from 1700 to 2009 and then randomly sampled 5 BNA results for each proverb, creating a dataset of 5,000 search hits. For each observation, we take the proverb, the proverb's GPT-generated meaning, and the newspaper text snippet containing the proverb. We then analyze the usage example using the following GPT-4o prompt:

```
Your task is twofold:  first, determine if the proverb appears in the
extract; second, assess whether it is used with the specified meaning.
Keep in mind that both the proverb and the newspaper extract are from
digitized scans and may contain OCR errors.

1.  Carefully read the newspaper extract.
2.  Identify whether the proverb appears in the extract:
- Respond "1" if the proverb is present in the extract
```

```
- Respond with "0" if the proverb is not present.
3.  Assess the usage of the proverb:
- Respond with ‘‘Not Applicable" if the proverb is not present in the
extract.
- Respond "2" if it is intentionally used to express the given
meaning.
- Respond "1" if it is used intentionally to express a different
meaning to the one given.
- Respond "0" if it appears in a way that does not intentionally
express the assigned meaning but also does not imply disagreement or
another clear meaning.
4.  Provide a concise explanation for your classifications, focusing
on the context and usage of the proverb in the extract.
```

We use this prompt, combined with exact matching, to check for false positive hits for proverbs. We find that the proverb appears in the newspaper article over 98% of the time when there is a search hit. That is, the false positive rate is less than 2%.

Next we evaluate whether, based on the context, we can check whether the proverb is used with the meaning that GPT-4o initially assigns. Our GPT-4o in-context evaluation finds that proverbs are used to intend the meaning assigned by us 80.5% of the time. In another 17.1% of cases, the proverb is used in a way that does not clearly indicate the assigned meaning but also not implying a different meaning. Finally, it is only in 2.4% of cases that a proverb is used with a clearly different meaning.

II.F Classifying Key Cultural Dimensions in Proverbs

To analyze the cultural dimensions of industrialization through the lens of proverbs, we first need to understand the relevant dimensions expressed by proverb usage. Based on the existing literature on how culture influenced, and was influenced by, the industrial revolution, we identify and classify a set of key cultural dimensions in our proverbs and their AI-generated cultural explanations.

Using GPT-4o to annotate the dataset of 12,000 proverbs, we map a number of dimensions that have been identified in the existing literature as important to the Industrial Revolution or cultural change and differences more generally. We use prompts of the form

```
You are a helpful research assistant with knowledge of the literary
and social history of proverbs.  I will provide you with a proverb and
its meaning.

[Question]
```

```
Read the proverb and its associated meaning and classify it into one
of "Definitely Yes", "Probably Yes", "Probably Not", "Definitely Not",
or "N/A".  Please also provide a short one-sentence explanation for
your classification.
```

The first and final paragraph of the prompt is kept the same for each dimension of interest, with only the second paragraph ("Question") changing. We annotate the following eleven cultural dimensions:

1. **Patience**: Does the proverb emphasize the importance of being patient and/or having a long-term orientation? This includes emphasizing the importance of not being impatient and/or not having a short-term orientation.

2. **Honesty**: Does the proverb emphasize the importance of honesty? This includes emphasizing the importance of not being dishonest.

3. **Punctuality**: Does the proverb explicitly say or clearly imply that one should be punctual?

4. **Hard Work**: Does the proverb emphasize the importance of working hard and having a strong work ethic? Look for phrases or meanings that stress diligence, persistence, self-discipline, or being productive. This includes proverbs that highlight the importance of not being idle or lazy.

5. **Rationality**: Does the proverb emphasize the importance of rationality? That is, emphasizing the importance of evidence and logic. This includes emphasizing the importance of not being irrational.

6. **Innovation**: Does the proverb emphasize the importance of innovation? That is, introducing new ideas, thinking creatively, or adapting to new circumstances.

7. **Progress & Improvement**: Does the proverb emphasize the possibility of continuous progress and improvement? That is, that we can strive to make improvements, advance forward, and change for the better?

8. **Practical Knowledge**: Does the proverb emphasize the importance of practical knowledge? This includes combining theoretical understanding with practical application, and the interplay of learning and doing.

9. **Bourgeois Virtues**: Does the proverb suggest support for bourgeois virtues in a commercial society, as defined by Deirdre McCloskey's "The Bourgeois Virtues: Ethics for an Age of Commerce" (2006)? That includes an emphasis on the values of faith, hope, love, justice, courage, temperance, and prudence in commerce.

10. **Individualism**: Does the proverb emphasize the importance of individualism, specifically focusing on themes such as self-reliance, personal autonomy, private property, or prioritizing individual goals over collective ones? That includes minimizing the importance of kinship ties.

11. **Curiosity**: Does the proverb emphasize the importance of being curious and driven to learn new things?

As discussed in further detail below, each of these dimensions has a grounding in the literature on the cultural aspects of the industrial revolution.

Appendix A.1 provides a list of 5 proverbs associated with each key cultural dimension. From qualitative inspections, these classifications work well and are of high quality. The explanations provided by the LLM add reassurance that the model understands the proverbs and the task.

II.G Assigning Cultural Themes to Proverbs

This subsection describes our more data-driven approach to understanding the content of proverbs. We group them based on their explanations into coherent cultural themes. Our goal is to move beyond individual proverbs and uncover broader ideas – such as responsibility, time valuation, or power dynamics – that repeatedly emerge in the books and newspapers. By mapping each proverb to a high-level category, we seek structured insights into which moral lessons and social norms resonated most strongly in historical Britain.

We apply the BERTopic algorithm to cluster proverbs based on the text of the associated explanations. In this method, each explanation is transformed into a 384-dimensional embedding through a MiniLM-L6-v2 encoder, which is a transformer-based model trained on over a billion sentence pairs to detect semantic relatedness. We then apply UMAP to reduce dimensionality and reveal an underlying manifold, followed by HDBSCAN to identify clusters of thematically related explanations. Finally, a large language model (GPT-4o) generates concise labels for each cluster by examining representative examples. This pipeline yields an interpretable classification scheme that reflects how proverbs align in terms of shared moral and cultural implications.

The main hyperparameter for this method is the minimum cluster size, which we set to 50, meaning that small clusters of proverbs are dropped. Otherwise, BERTopic decides on the number of clusters. At the end, we take the 12,831 proverbs (proverbs appearing at least once in the books or newspapers) and obtain 43 meaningful groups. The list of groups, with a selection of 5 proverbs per group, is shown in Appendix A.2.

Inspection of these clusters indicates that BERTopic generates high-quality groupings. As an illustration, there is a cluster underscoring the value of time, labeled "Opportunities should be seized at the right time, balancing patience and action" (Cluster 12). Representative sayings include "Shake the tree when fruit is ripe", "Everything is good in its season" and "the world

is his who knows how to wait for it". These proverbs collectively emphasize the importance of recognizing and acting upon the right moment and reflect a cultural appreciation for timing, encouraging individuals to align their efforts with favorable circumstances.

We systematically validate the coherence of the proverb clusters with an intruder detection approach. We start with a randomly sampled "anchor" proverb explanation and then present one proverb explanation from the same cluster and one proverb explanation from a random other cluster. The clusters are coherent if the "intruder" among the 3 proverb explanations can be consistently identified.

For the intruder detection, we randomly select three anchor proverb explanations from each of the 43 clusters, for an evaluation set of 129 anchor proverb explanations. For each anchor, we then sample a same-cluster and other-cluster proverb explanation, and then prompt GPT-4o to identify which proverb explanation is closer in meaning to the anchor. In the 129 comparisons, the same-cluster proverb explanation was chosen 84.5% of the time; a separate human evaluation on the same sample yielded a similar result of 78.3%. These statistics support the view that our clusters reflect authentic semantic boundaries rather than arbitrary groupings.

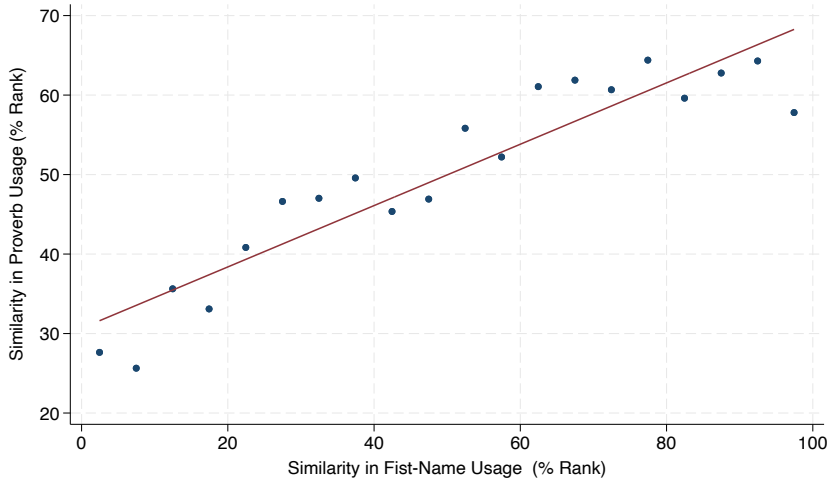
For comparison, we produced vectors and clusters based on the texts of the literal proverbs themselves, rather than the explanations. We don't expect this to work because proverb similarity scores are based on the surface features, rather than cultural implications. Using this literal-text approach, for example, the closest proverb to "All is not gold that glitters" is "One's own hearth is worth gold". Under the explanations-based cluster, the closest proverb is "never judge by appearances." This example illustrates why we need to cluster on explanations: it gets at the behavioral implication of the proverb (e.g., looks can be deceiving), rather than at the surface symbols (e.g. gold). When we scale this up to all the clusters based on the literal texts, the other-cluster proverb explanation is detected as the intruder by GPT only 53% of the time (compared to 84% for the explanations-based clusters). This discrepancy illustrates that explanatory statements are more amenable to consistent grouping, as they capture the moral and practical meaning that is often obscured by the figurative proverbial expressions.

II.H Creating Measures of Cultural Values at the Regional Level

Culture is a macro-level phenomenon that reflects shared values and norms across regions rather than being confined to individuals. To analyze cultural patterns meaningfully, it is necessary to aggregate information at a regional level. We construct measures of cultural values at the county levels, allowing us to capture regional differences in cultural attitudes while preserving local variation.

To generate these regional measures, we assign proverbs to locations based on their sources. Proverbs found in newspapers are attributed to the newspaper's place of publication, which provides a clear geographic reference. Proverbs found in books are assigned to the birthplace of

Figure II: County-to-County Similarity in Proverb Usage vs. First-Name Usage



Binscatter for relationship at the county pair level, of cosine similarity in the topic vectors produced from newspaper proverb usage for the years 1800–1900 (vertical axis), plotted against the cosine similarity of the vector of first name usage frequencies for each county from the 1851 census. Spearman Correlation = 0.39.

the book's author, reflecting the cultural background in which they were likely familiar and relevant. This assignment ensures that both book- and newspaper-based proverbs are systematically incorporated into our dataset in a way that aligns with broader regional cultural patterns.

To ensure consistency across different media, we estimate text volume using word count. Since newspapers differ in format, we distinguish between broadsheets and tabloids, applying a conversion factor to account for differences in text density. Using classifications from The Newspaper Press Directory (Mitchell's Index), we identify whether a historical newspaper was a broadsheet or tabloid. Tabloid pages are weighted as 0.4 of a broadsheet page, ensuring that estimated word counts reflect publication format. This adjustment improves comparability across sources, preventing distortions in regional measures of cultural values.

Figure A.3 presents a map depicting the adjusted frequency of proverbs appearing in books and newspapers, measured as the number of proverbs per 1,000 pages after applying the conversion. Further details on the standardization process are provided in Appendix B.2.

After assigning proverbs to registration districts and counties, we construct aggregate measures by grouping proverbs according to their underlying cultural themes. These themes are identified using the clustering approach described in Section II.G, which groups proverbs into semantically meaningful categories reflecting distinct cultural attitudes. By analyzing these clusters at the regional level, we obtain structured measures of cultural variation across different parts of Britain. This allows us to study how cultural values evolved over time and varied across geographic regions in a systematic way.

To help validate proverbs as a measure of culture, we compare this county-level record of proverb usage to another measure of local culture: first-name frequencies in the 1851 census. For both proverbs and first names, we calculate separate cosine distance matrices, then examine whether counties that are similar on one dimension also resemble each other on the other. Figure II shows a binscatter of the relationship between proverb-based similarity and name-based similarity. The relationship is highly statistically significant with a spearman rank correlation of 0.386; when we adjust for deciles in geographic distance between the pairs, the spearman rank correlation remains high at 0.346. This link indicates that proverbs can serve as a meaningful indicator of local cultural traits, aligning with other recognized dimensions of identity such as naming customs.

III Historical Background: British Industrialization and Cultural Change

The British Industrial Revolution was one of the most transformative periods in economic history, reshaping production, labor organization, and social structures. Between the late eighteenth and early nineteenth centuries, Britain transitioned from an agrarian economy to an industrialized one, driven by technological innovation, capital accumulation, and the expansion of wage labor (Allen, 2009; Crafts, 1995). However, industrialization did not take place at the same pace everywhere. Some regions, particularly in the north and midlands, became early centers of mechanized production, while others, especially in the south and rural areas, remained predominantly agrarian well into the nineteenth century (Hudson, 1992; Smout, 1998).

A wide range of factors contributed to this regional variation. Differences in access to resources, such as coal and waterways, played a role, as did pre-existing commercial networks and financial institutions (Mokyr, 2010). At the same time, industrialization was not just an economic process—it introduced profound social changes. The rise of factory work, urban migration, and the decline of family-based labor altered the way people worked, lived, and interacted (Thompson, 1964). Given these sweeping transformations, an important question is whether cultural values also changed in response to industrialization.

This section provides an overview of cultural change during the Industrial Revolution, considering two key questions. First, did cultural attitudes shift before industrialization, potentially shaping the economic transition? Second, did industrialization itself bring about changes in cultural values? By examining historical patterns and regional variation, we explore whether cultural shifts aligned with the major economic and social changes of the industrial era. The next section presents an empirical analysis to evaluate these questions systematically using proverb data.

III.A Regional Variation in Industrialization

Industrialization did not occur uniformly across Britain. Certain regions became industrial hubs, developing mechanized industries early, while others remained largely agrarian. The northern and midland counties—such as Lancashire, Yorkshire, and Staffordshire—emerged as major centers of textile manufacturing, coal mining, and metalworking. The availability of coal, navigable waterways, and established commercial networks facilitated industrial expansion in these areas. By contrast, many southern and rural regions, including East Anglia and much of the West Country, remained predominantly agricultural for much of the nineteenth century. London, despite being a commercial and financial center, did not experience the same kind of factory-based industrialization seen in the north.

While access to resources, infrastructure, and pre-existing commercial networks shaped these regional differences, industrialization was more than just an economic transition. It also led to major changes in social organization, labor relations, and daily life (Hudson, 1992). The way communities adapted to these changes may have been influenced by shifts in cultural attitudes toward work, thrift, cooperation, and innovation. By studying cultural change in relation to industrialization, we can assess whether shifts in values were already underway before economic transformation or whether industrialization itself led to new cultural norms.

III.B Cultural Change Preceding Industrialization

One key question is whether cultural values evolved before industrialization, potentially laying the groundwork for economic transformation. Some scholars argue that shifts in attitudes toward knowledge, economic behavior, and progress were already taking place before mechanized production took hold (Mokyr, 2010; McCloskey, 2010). If this is the case, we should expect to see changes in the content and prevalence of proverbs that emphasize traits such as practical knowledge, work ethic, or innovation in the period leading up to industrialization.

For example, Enlightenment ideas about technological progress and scientific thinking may have influenced attitudes toward problem-solving and mechanical skill (Mokyr, 2010). Similarly, changing perceptions of commerce and entrepreneurship could have contributed to a broader acceptance of market-based activity (McCloskey, 2010). If cultural change preceded industrialization, we would expect to find evidence of increasing emphasis on these values in proverbs before industrial growth accelerated.

III.C Cultural Change Following Industrialization

Industrialization introduced profound changes to daily life, which may have influenced cultural values. The transition from agrarian economies to factory-based production imposed new labor structures, altered family dynamics, and changed how individuals engaged with economic activity (Hudson, 1992; Smout, 1998). If these transformations shaped cultural attitudes, we

should observe shifts in proverbs that reflect work discipline, individualism, and attitudes toward technological change.

The factory system required workers to adhere to strict schedules, promoting a new kind of time discipline that differed from pre-industrial labor rhythms (Thompson, 1967). Similarly, the rise of wage labor and urban employment may have reinforced values associated with financial prudence, independence, and meritocratic success (Doepke and Zilibotti, 2005, 2008). As communities adjusted to industrial life, proverbs may have evolved to reflect these new realities, reinforcing the importance of diligence, thrift, and self-reliance.

Scholars have also debated whether industrialization fostered a rise in individualism. Some argue that industrial society encouraged greater personal ambition and self-reliance, as economic opportunities expanded and kinship ties weakened (Hudson, 1992; Smout, 1998). Others suggest that individualistic values were already present in England well before the Industrial Revolution (Macfarlane, 1978). If industrialization contributed to a cultural shift toward individualism, we would expect to see a greater emphasis on proverbs that stress self-sufficiency, ambition, and economic independence over time.

III.D Implications for Empirical Analysis

The relationship between industrialization and cultural change is complex. If cultural shifts preceded industrialization, this would suggest that changing values contributed to the transformation of the economy. If cultural shifts followed industrialization, this would indicate that economic change itself reshaped beliefs and attitudes. The next section presents an empirical analysis to test these possibilities by examining whether regional differences in proverb usage reflect cultural change before and after industrialization.

IV Empirical Analysis: Cultural Change and Industrialization

This empirical section follows the discussion in Section III, where we outlined how cultural shifts may have contributed to and been shaped by industrialization. To test these historical hypotheses, we analyze proverbs as a historical record of prevailing social norms, examining whether specific cultural values became more prominent before and after industrialization.

We consider two key periods of cultural change. First, we investigate the pre-industrial period to assess whether regions that later industrialized already exhibited increasing trends in cultural values such as progress, practical knowledge, and bourgeois virtues. Second, we analyze the post-industrial period to determine whether industrialization led to an increase in values related to punctuality, innovation, and individualism.

Our analysis relies on a panel dataset of proverbs spanning 1550 to 1900, constructed by tracking the actual usage of proverbs in books and newspapers over time. Proverbs are classified into

thematic dimensions and clusters to analyze long-term cultural trends. The dataset is structured into seven consecutive 50-year periods, beginning in 1550 and extending through 1900, aligning with the period for which we have systematic coverage of printed materials through EEBO.

We treat 1750 as the onset of the Industrial Revolution, following the convention in economic history that identifies the mid-eighteenth century as the period when mechanized production, technological innovation, and sustained economic growth became widespread in Britain (Mokyr, 1990; Allen, 2010).[1] This assumption allows us to compare cultural trends before and after industrialization, assessing whether certain cultural values gained prominence prior to 1750 in regions that later industrialized and whether their prevalence shifted as industrialization progressed.

Our empirical strategy exploits two sources of variation to estimate the relationship between industrialization and cultural change. First, we compare cultural trends before and after 1750, allowing us to observe shifts in proverb usage around the onset of the Industrial Revolution. Second, we leverage cross-sectional variation in industrial activity across regions, proxied by the number of steam engines installed before 1800 and the number of cotton textile plants in 1838. By combining these two sources of variation, we assess whether cultural values were already diverging in more industrialized regions before 1750 and whether industrialization itself contributed to further shifts in cultural attitudes.

IV.A Cultural Change Preceding Industrial Revolution

IV.A.1 Key Hypotheses

We begin by testing three key hypotheses that connect cultural change to the onset of industrialization:

Practical Knowledge and the Useful Arts. Mokyr (2010) argues that the Industrial Revolution was fueled by an expansion of practical knowledge that increased technological creativity and innovation. He emphasizes the role of the Industrial Enlightenment, where an increasing number of people in Britain acquired knowledge about mechanical processes, engineering, and applied science. This shift made industrial innovation more likely, as individuals were better equipped to adapt, experiment, and improve production techniques. If this view is correct, we should observe an increasing trend in the appearance of proverbs that emphasize the value of practical skills, problem-solving, and applied knowledge in regions that industrialized early.

Bourgeois Virtues and Economic Behavior. McCloskey (2010) argues that a cultural shift toward bourgeois virtues—including diligence, prudence, honesty, and frugality—was a driving force behind modern economic growth. She suggests that the cultural status of commerce, en-

[1]The precise timing of the Industrial Revolution remains a subject of extensive debate in economic history, with some scholars emphasizing earlier developments in the 17th century and others pointing to a more gradual process extending into the 19th century (e.g., Crafts, 1985; Humphries and Schneider, 2019). Our study does not engage with this debate but instead adopts 1750 as a pragmatic threshold commonly used in the literature.

trepreneurship, and industry improved in the lead-up to industrialization, making economic success a respected and socially valued pursuit.

Greg Clark further interprets Bourgeois Virtues as being characterized by six key values: hard work, patience, honesty, rationality, curiosity, and learning (Clark, 2007). His formulation emphasizes the behavioral and cognitive traits that may have supported economic productivity and social mobility in industrializing societies. If these perspectives hold, we should observe an increasing trend in the appearance of proverbs that promote hard work, thrift, and economic rationality in regions that were early adopters of industrialization.

The Mindset of Progress and Improvement. Mokyr (2016) extends the argument further by emphasizing a broader cultural shift toward improvement and progress. He argues that industrialization was not just about technological advancements but also about an evolving worldview in which people increasingly believed in the possibility of improving their material conditions through innovation. This mindset, which encouraged systematic problem-solving and economic ambition, may have created a social environment where industrialization was more readily embraced. If this view is correct, we should observe an increasing trend in the appearance of proverbs that reflect optimism, a belief in progress, and a willingness to embrace change in industrializing regions.

These hypotheses suggest that cultural attitudes toward knowledge, economic behavior, and social progress varied across regions before the Industrial Revolution. If these cultural values contributed to the conditions that enabled industrialization, we should observe systematic differences in the trends of proverb usage across regions that industrialized early versus those that lagged behind. In the next sections, we investigate whether regional differences in the trajectory of cultural values, as reflected in proverbs, align with these historical hypotheses.

IV.A.2 Empirical Specification

To examine whether cultural attitudes evolved in anticipation of industrialization, we estimate separate regressions for each proverb dimension or topic v, modeling the log count of proverbs in a given thematic category as a function of industrialization intensity, geographic characteristics, and controls for text volume. The unit of analysis is dimension or topic v in county i at time period t.

$$\begin{aligned}\ln(\#Proverbs_{i,t,v}) = {} & \beta_{1,v}(Industrialization_i \times pre\text{-}1750\ trend_t) \\ & + \beta_{2,v}(Geo\ Traits_i \times \lambda_t) + \beta_{3,v}\ln(\#Overall\ Proverbs_{i,t}) \\ & + \beta_{4,v}\ln(Estimated\ Word\ Count_{i,t}) + \delta_t + \delta_i + \varepsilon_{i,t,v}.\end{aligned}$$

The coefficient of interest is $\beta_{1,v}$, which captures whether regions that later industrialized exhibited systematic cultural shifts before industrialization began. A positive and significant $\beta_{1,v}$

would indicate that certain cultural values were already becoming more prevalent in regions that eventually became more industrialized.

The variable $Industrialization_i$ is measured using two alternative definitions. First, it is captured as log(number of steam engines installed before 1800 + 1), which reflects early technological adoption and mechanization, a critical driver of industrial expansion. Second, it is measured as log(number of cotton textile plants in 1838 + 1). The cotton textile industry was the most important sector of the Industrial Revolution, driving technological innovation, factory-based production, and large-scale economic transformation.

To account for potential confounders, we include geographic controls ($Geo\ Traits_i \times \lambda_t$), which interact geographic traits with time trends. These controls account for natural and economic geographic factors that could influence both industrialization and cultural change. Coastal access, which indicates whether a county is near the coast, is included to account for the historical role of trade and external influences, as coastal areas often experienced earlier economic development. We also include terrain slope, measuring the average incline of the land, as steeper terrain could limit settlement, infrastructure development, and economic activity, whereas flatter regions may have been more conducive to industrial expansion.

Distance to ports captures how connected a region was to global trade networks, as proximity to ports could facilitate commerce, technological diffusion, and the spread of new cultural ideas. Finally, latitude is included to capture north-south variation, which may proxy for differences in climate, agricultural productivity, and historical settlement patterns.

We also adjust for variation in printed material by controlling for text volume $\ln(Estimated\ Word\ Count_{i,t})$, ensuring that changes in recorded proverbs are not driven by fluctuations in overall print activity. Additionally, we include $\ln(\#Overall\ Proverbs_{i,t})$, which serves two purposes. First, it accounts for general shifts in the use of proverbs, capturing whether societies were adopting or abandoning proverbs over time, independent of industrialization. Second, it controls for variation in recorded proverb frequency, ensuring that observed trends reflect substantive cultural changes rather than fluctuations in how proverbs were used in textual sources across time and regions.

Fixed effects for time periods (δ_t) and regions (δ_i) absorb common shocks and unobserved regional heterogeneity. These fixed effects help isolate the role of industrialization in shaping cultural change by controlling for broader trends that may have influenced proverb usage across all regions or within specific locations.

To correct for spatial autocorrelation, we use spatially adjusted standard errors to account for spatial dependence.

IV.A.3 Results and Interpretation

The Rise of Bourgeois Virtues. The results in Table I indicate that proverbs promoting prudence, thrift, and commercial success were already becoming more prevalent in regions that later industrialized. This supports the argument that the value system associated with bourgeois life—emphasizing diligence, thrift, honesty, and the moral legitimacy of commerce—was strengthening before industrialization took hold. The increasing presence of proverbs reflecting economic rationality and hard work suggests that industrializing regions were fostering attitudes that would later support factory-based production and market-oriented behavior. These results reinforce the idea that cultural shifts toward work ethic and discipline preceded economic transformation.

Alternative Description of Bourgeois Virtues. Gregory Clark has proposed that Bourgeois Virtues consist of six core values: hard work, patience, honesty, rationality, curiosity, and learning (Clark, 2007). The empirical results suggest that regions that later industrialized exhibited rising trends in proverbs emphasizing hard work and honesty, supporting the idea that a disciplined, trustworthy approach to labor and economic activity was already gaining cultural importance prior to industrialization. In contrast, the trends for patience, curiosity, and rationality are weaker or statistically insignificant, indicating that not all components of the bourgeois value system were equally salient in the pre-industrial cultural landscape. This suggests that some aspects of bourgeois culture—particularly those most directly related to labor discipline and commercial trust—may have taken root earlier or more visibly than others.

Expanding Practical Knowledge. The increasing prominence of proverbs related to practical knowledge aligns with the idea that the Industrial Enlightenment—the expansion of applied science, engineering, and systematic problem-solving—was well underway before mechanized production took hold. The rising prevalence of proverbs emphasizing technical expertise and innovation suggests that industrializing regions were already fostering a culture that valued practical knowledge and the ability to apply scientific principles to real-world challenges. These findings support the view that industrialization was not merely a matter of physical capital accumulation but was also facilitated by evolving knowledge systems and the diffusion of mechanical and economic understanding.

Table I: Pre-1750 Trends in Cultural Dimensions and Industrialization Intensity

	Patience				Honesty			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Steam Engines × Pre-1750 Time Trend	-1.49	-1.29			1.82	1.67		
	(1.22)	(1.19)			(1.16)	(1.08)		
Cotton Textile Plants × Pre-1750 Time Trend			6.85**	8.57***			5.37**	3.40
			(3.14)	(3.02)			(2.33)	(2.50)
Geographical Controls × Time Trend	N	Y	N	Y	N	Y	N	Y
Time Period FE	Y	Y	Y	Y	Y	Y	Y	Y
County FE	Y	Y	Y	Y	Y	Y	Y	Y
Observations	224	224	224	224	224	224	224	224
R-squared	0.22	0.24	0.23	0.25	0.25	0.27	0.25	0.26
	Curiosity				Hard-Work			
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Steam Engines × Pre-1750 Time Trend	0.32	1.31			2.61**	2.01		
	(1.04)	(1.19)			(1.20)	(1.33)		
Cotton Textile Plants × Pre-1750 Time Trend			-1.92	-0.29			5.98*	2.43
			(2.93)	(3.47)			(3.05)	(4.26)
Geographical Controls × Time Trend	N	Y	N	Y	N	Y	N	Y
Time Period FE	Y	Y	Y	Y	Y	Y	Y	Y
County FE	Y	Y	Y	Y	Y	Y	Y	Y
Observations	224	224	224	224	224	224	224	224
R-squared	0.07	0.09	0.07	0.08	0.11	0.13	0.10	0.12
	Rationality				Bourgeois Virtues			
	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
Steam Engines × Pre-1750 Time Trend	0.36	0.84			2.86***	2.90***		
	(1.09)	(1.08)			(0.91)	(0.86)		
Cotton Textile Plants × Pre-1750 Time Trend			3.09	3.52			3.46	0.70
			(2.64)	(2.83)			(3.50)	(3.39)
Geographical Controls × Time Trend	N	Y	N	Y	N	Y	N	Y
Time Period FE	Y	Y	Y	Y	Y	Y	Y	Y
County FE	Y	Y	Y	Y	Y	Y	Y	Y
Observations	224	224	224	224	224	224	224	224
R-squared	0.22	0.26	0.22	0.26	0.16	0.19	0.13	0.16
	Progress / Improvement				Practical Knowledge			
	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)
Steam Engines × Pre-1750 Time Trend	2.13**	3.03***			2.33**	3.63***		
	(1.04)	(1.14)			(1.00)	(0.95)		
Cotton Textile Plants × Pre-1750 Time Trend			3.81	3.82			6.06**	5.07
			(2.92)	(3.48)			(2.86)	(3.33)
Geographical Controls × Time Trend	N	Y	N	Y	N	Y	N	Y
Time Period FE	Y	Y	Y	Y	Y	Y	Y	Y
County FE	Y	Y	Y	Y	Y	Y	Y	Y
Observations	224	224	224	224	224	224	224	224
R-squared	0.07	0.10	0.06	0.08	0.19	0.21	0.18	0.20

Note: This table presents estimates of the empirical specification described in Section IV.A.2, examining whether cultural dimensions evolved in anticipation of industrialization. The topics Patience through Rationality correspond to Gregory Clark's interpretation of Bourgeois Virtues. Each topic includes a specification with and without geographical controls. Time period fixed effects and county fixed effects are included in all specifications. The frequency of all proverbs in each of these dimensions can be found in Figure A.4. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Increasing Belief in Progress and Improvement. Proverbs reflecting optimism about material advancement and systematic betterment were becoming more culturally salient before industrialization. This suggests that a belief in economic and technological progress was already

taking root in industrializing regions. The increasing presence of proverbs emphasizing progress indicates that societies were developing an outlook that valued continuous improvement, long-term advancement, and systematic development. These cultural shifts may have helped create an environment in which industrialization could take hold more readily.

Cultural Dimensions and Industrial Revolution: OLS For transparency, Table A.1 presents an alternative specification in which we pool all pre-1750 data and estimate the relationship between the cultural dimensions featured in the key hypotheses and industrialization using an OLS regression. This approach provides a complementary perspective by examining whether regions that later industrialized already exhibited systematically higher levels of certain cultural values before 1750.

The results indicate a positive relationship between industrialization and several cultural dimensions, particularly hard work, rationality, progress/improvement, and practical knowledge. These dimensions happen to also be the ones that show a positive and increasing trend in areas that later industrialized, reinforcing the main findings.

Beyond Hypothesis Testing: Broader Cultural Shifts. In addition to testing our hypotheses, we examine broader trends in cultural change by analyzing clusters of proverbs that were not explicitly predicted by the theoretical framework. Table II presents the estimated coefficients for these clusters, highlighting cultural themes that showed systematic changes before industrialization. A coefficient plot displaying the estimates for all proverb clusters can be found in Figure A.10, providing a more comprehensive view of these trends.

Table II: Pre-1750 Trends and Industrialization: Estimated Trends in All Identified Topics in Proverbs

Topic ID	Topic	Proxy	Coefficient
4	Appearances, Beauty, Superficiality	Steam Engines	2.28**
8	Generosity, Kindness, Giving, Gratitude	Cotton Textile Plants	9.23***
13	Own Responsibility, Their Personal Effort	Steam Engines	1.94*
15	Authority, Leadership, Power	Cotton Textile Plants	6.84*
16	Age, Older Wisdom, Young	Cotton Textile Plants	9.77***
16	Age, Older Wisdom, Young	Steam Engines	4.04***
19	Promises, Results, Action, Words	Cotton Textile Plants	11.84***
19	Promises, Results, Action, Words	Steam Engines	3.95***
21	Pride, Humility, Modesty, Arrogance	Steam Engines	2.90***
25	Empathy, Others, Emotional Understanding	Cotton Textile Plants	-4.07**
26	Actions, Moral Justice, Consequences	Steam Engines	3.58***
27	Small vs. Larger Issues	Steam Engines	2.83***
28	Forgiveness, Revenge	Steam Engines	1.71*
38	Kindness, Politeness, Gentle Communication	Cotton Textile Plants	-7.57**

Note: The clustering method used is BERTtopic, which identified a total of 43 clusters, mapping into 43 topics. This table reports the topics that exhibited statistically significant changes before industrialization. The control variables included in these regressions are the same as those in the even-numbered columns of Table I. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

The results suggest that cultural change before industrialization was already underway in several interpretable domains. Proverbs emphasizing wisdom, age, and intergenerational knowledge

became more common in regions that would later industrialize, indicating growing respect for experience and learning. Similarly, proverbs highlighting personal responsibility and individual effort show a clear upward trend, pointing to a rising emphasis on agency and self-discipline.

Themes related to leadership and authority also gained prominence, suggesting evolving ideas about governance, status, or institutional structure. Proverbs focused on promises, results, and action increased significantly, reflecting a cultural shift toward accountability and follow-through—values likely relevant to both emerging economic arrangements and changing social expectations.

Proverbs dealing with moral justice and consequences also became more frequent, reinforcing the idea that notions of ethical responsibility were becoming more culturally salient. Likewise, the rise in proverbs about pride, humility, and modesty suggests that norms around status, ambition, and self-regulation were in flux.

At the same time, some values declined in salience. Proverbs emphasizing empathy, emotional sensitivity, and gentle communication became less common, as did those promoting kindness and politeness. These declines may point to a cultural shift away from interpersonal deference and toward more assertive or transactional modes of interaction—perhaps reflecting changing social or economic roles in the decades leading up to industrialization.

IV.B Cultural Change After Industrial Revolution

Industrialization introduced profound changes to daily life, which may have influenced cultural values in significant ways. As agrarian economies transitioned to factory-based production, labor structures shifted, family dynamics evolved, and individuals adapted to new economic realities. If these transformations reshaped cultural attitudes, we should observe corresponding shifts in proverbs that reflect changing perspectives on work discipline, individualism, and attitudes toward technological progress.

IV.B.1 Key Hypotheses

Several key hypotheses have been proposed regarding cultural change after industrialization:

Work Ethic and Industrial Discipline. Thompson (1967) argues that industrialization fundamentally reshaped attitudes toward time, labor discipline, and productivity. Unlike pre-industrial economies, where work rhythms were more flexible and seasonal, the factory system imposed strict schedules and required workers to adhere to regimented hours. This transformation may have reinforced cultural attitudes that emphasized punctuality, perseverance, and the moral value of hard work. If industrialization strengthened the work ethic, we would expect to observe an increasing presence of proverbs that stress diligence, self-discipline, and the value of labor.

Attitudes Towards Innovation. Landes (1969) suggests that industrialization was accompanied by a cultural shift toward valuing technological progress and innovation. As mechanized production replaced traditional craftsmanship and scientific advancements played a greater role in economic growth, societies may have increasingly embraced the idea of continuous improvement and technical knowledge. If this view is correct, we would expect to see a rising prevalence of proverbs emphasizing progress, ingenuity, and the pursuit of knowledge during the industrial period.

Individualism. Some scholars have suggested that industrialization fostered a shift toward individualism as economic opportunities expanded and social mobility increased. As traditional kinship networks weakened and urban employment became more prevalent, individuals may have placed greater emphasis on personal ambition, self-reliance, and meritocratic success. Hudson (1992) and Smout (1998) argue that industrialization in Britain led to a decline in collective community structures and a greater emphasis on individual economic agency. If industrialization contributed to a cultural shift toward individualism, we would expect to see a greater prominence of proverbs stressing self-sufficiency, ambition, and economic independence over time.

These hypotheses suggest that industrialization was not just an economic transformation but a process that shaped and was shaped by evolving cultural attitudes. If industrialization contributed to new cultural norms, we should observe changes in the prevalence of certain proverb themes over time, particularly in industrializing regions.

IV.B.2 Empirical Specification

To estimate how cultural attitudes evolved in response to industrialization, we employ a difference-in-differences approach, leveraging variation in the intensity of the Industrial Revolution across regions. This framework allows us to assess whether industrialization influenced cultural change across different thematic dimensions of proverbs. The unit of analysis is dimension or topic v in county i at time period t.

We estimate separate regressions for each dimension or topic, modeling the log count of proverbs in a given thematic category as a function of industrialization intensity, geographic trends, and controls for text volume:

$$\begin{aligned}\ln(\#Proverbs_{v,i,t}) = \theta(Industrialization_i \times Post_t) + \beta_{2,v} \cdot \text{Geo Traits}_i \times \lambda_t \\ + \beta_{3,v} \ln(\#\text{Overall Proverbs}_{i,t}) + \beta_{4,v} \ln(\#\text{Estimated Word Count}_{i,t}) + \gamma_i + \lambda_t + \varepsilon_{v,i,t}.\end{aligned}$$

Here, $Post_t$ is an indicator for the post-1750 period, and $Industrialization_i$ represents the log of the number of steam engines installed before 1800 in county i, plus one, or the log of the number of cotton textile plants in 1838 in county i, plus one. The interaction term $Industrialization_i \times Post_t$ captures the effect of industrialization on cultural change following Industrial Revolution. To mit-

igate endogeneity concerns related to industrial site selection, we instrument for $Industrialization_i$ using coal availability (Fernihough and O'Rourke, 2021).

The model includes county fixed effects γ_i to absorb time-invariant regional characteristics and time-period fixed effects λ_t to control for common nationwide cultural and economic shocks. We also control for geographic traits interacted with time trends, ensuring that the estimated effects are not confounded by regional differences in resource availability, trade access, or pre-existing economic structures. These geographic traits are the same as those included in Section IV.A.2, covering factors such as coastal access, terrain slope, distance to ports, and latitude.

Additionally, we adjust for variation in printed material by controlling for text volume, following the same rationale as in Section IV.A.2. The term $\ln(\#Overall\ Proverbs_{i,t})$ accounts for general shifts in the use of proverbs over time, capturing whether societies were adopting or abandoning proverbs independent of industrialization. Similarly, $\ln(Estimated\ Word\ Count_{i,t})$ ensures that observed trends in proverb frequency are not simply artifacts of fluctuations in text availability across sources and regions.

The identification strategy leverages regional variation in early industrialization, using coal availability as an instrument for industrial intensity. Some counties had greater access to coal, making them more likely to adopt steam engines or develop textile industries, while others remained less industrialized. By instrumenting industrialization with coal availability and interacting it with a post-1750 indicator, the analysis isolates plausibly exogenous variation in exposure to industrialization. Combined with county and time-period fixed effects, this approach mitigates concerns that observed cultural shifts reflect pre-existing regional differences or broader temporal trends, rather than the causal influence of industrialization.

IV.B.3 Results and Interpretation

Our empirical analysis provides evidence that industrialization influenced cultural attitudes, as reflected in proverbs. We begin by testing the three key hypotheses outlined earlier, focusing on punctuality, innovation, and individualism. Table IV presents the estimated coefficients for these dimensions.

The results offer evidence that industrialization was associated with an increased emphasis on time discipline. While the coefficients are not statistically significant at conventional levels for the steam engine measure, the results are large and consistently positive. The cotton textile measure yields similarly large and positive coefficients, though again without strong statistical significance. Taken together, these results are suggestive—though not definitive—of a cultural shift toward punctuality, structure, and time-consciousness, in line with Thompson (1967)'s argument that the factory system reinforced rigid schedules and time awareness.

For the innovation dimension, the results are more robust. Industrialization, particularly when measured by cotton textile plants, is associated with large and statistically significant in-

Table III: First Stage Regression Results

	Cotton Textile Plants		Steam Engines	
	(1)	(2)	(3)	(4)
Coal × Post	1.77***	1.74***	7.57***	7.91***
	(0.15)	(0.17)	(0.44)	(0.44)
Geographical Controls × Time Trend	N	Y	N	Y
Time Period FE	Y	Y	Y	Y
County FE	Y	Y	Y	Y
Observations	392	392	392	392
R-squared	0.66	0.69	0.81	0.82
Kleibergen-Paap Wald rk F statistic	53.04	55.34	510.20	416.01

Note: This table presents the first-stage estimates of the IV-DID regression described in Section IV.B.1, using coal as an instrument variable. Each specification includes and excludes geographical controls. Time period fixed effects and county fixed effects are included in all regressions. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table IV: Estimated Effects of Industrialization on Targeted Cultural Dimensions

	Time Discipline				Innovation				Individualism			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Steam Engines × Post	2.64	2.57			5.21*	8.08***			4.06	5.02		
	(2.35)	(2.71)			(2.78)	(3.05)			(2.58)	(2.76)		
Cotton Textile Plants × Post			11.47	11.68			22.59*	36.64**			17.62	22.79
			(10.65)	(12.76)			(12.65)	(15.58)			(12.36)	(14.56)
Geographical Controls × Time Trend	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y
Time Period FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
County FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	392	392	392	392	392	392	392	392	392	392	392	392

Note: This table presents estimates of the empirical specification described in Section IV.B.1, examining the effects of industrialization on cultural dimensions. The set of dimensions is determined based on existing hypotheses, and GPT is used to classify whether each proverb is related to a given dimension. Each specification includes and excludes geographical controls. Time period fixed effects and county fixed effects are included in all regressions. The frequency of all proverbs in each of these dimensions is shown in Figure A.4. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

creases in proverbs emphasizing innovation, novelty, and forward-looking change. This provides cultural evidence consistent with the technological dynamism of the Industrial Revolution and suggests that industrializing regions not only adopted new techniques but also increasingly valorized innovation as a cultural ideal.

In contrast, the evidence for individualism is more limited. Although point estimates are positive across all specifications, they fall short of conventional significance thresholds. This suggests that while industrialization may have encouraged personal ambition and self-sufficiency—as emphasized by Hudson (1992) and Smout (1998)—the cultural shift in this domain may have

been less pronounced.

Despite only partial support for the pre-specified hypotheses, the results point to widespread cultural change associated with industrialization across a much broader range of topics. Significant shifts appear in areas beyond those captured by the targeted dimensions, including topics related to gender roles, emotional relationships, resourcefulness, financial obligations, and risk-taking. These patterns suggest that industrialization was accompanied by deeper transformations in social norms, moral outlooks, and interpersonal expectations.

However, caution is warranted when interpreting these results. Several topics that exhibit significant post-1750 changes also show clear pre-trends in Table II. For instance, topics such as authority and leadership, wisdom and age, promises and outcomes, and moral consequences were already becoming more culturally prominent before industrialization, raising the possibility that some observed effects reflect the continuation of existing cultural trajectories rather than distinct breaks triggered by industrial change. To address this, we focus on topics that show significant increases only after 1750 and no evidence of pre-trends. These are plotted in Figure A.12, where we verify that they satisfy the parallel trends assumption.

Taken together, the findings suggest that industrialization reshaped cultural attitudes across a wide array of domains—not only those anticipated by theory, but also others emerging inductively from topic modeling. Using an instrumental variable strategy to address endogeneity in industrial intensity, the results highlight the value of a data-driven approach for uncovering previously overlooked dimensions of cultural transformation.

IV.C Summary of Cultural Shifts Before and After Industrialization

The results suggest that certain cultural values—such as work ethic, practical knowledge, and belief in progress—became more prominent in regions that later industrialized, reinforcing the idea that shifts in economic behavior and social attitudes helped create conditions favorable for industrial takeoff. Proverbs emphasizing hard work, systematic problem-solving, and progress and improvement were increasingly used before industrialization, aligning with arguments that cultural attitudes toward labor were evolving in anticipation of economic modernization.[2]

After industrialization, cultural norms and social expectations changed. Factory-based work imposed stricter schedules, technological advancements accelerated economic change, and urbanization reshaped social structures. Proverbs related to time discipline, economic ambition, and strategic foresight became more common, reflecting adaptations to new labor conditions and market dynamics. Beyond work-related values, industrialization also influenced perceptions of hierarchy, morality, and risk-taking, highlighting its broad impact on social attitudes. These find-

[2]While we document cultural shifts preceding industrialization, we do not take a stance on what drove these changes. These transformations could reflect a pure change in ideas and ideology or an adaptive response to evolving economic conditions in early modern England, including shifts in labor markets and consumption patterns associated with the Industrious Revolution (Vries, 2008).

Table V: Estimated Effects of Industrialization on All Identified Topics in Proverbs

Topic ID	Topic	Proxy	Coefficient
3	Women, Marriage, Gender Roles	Cotton Textile Plants	29.53**
3	Women, Marriage, Gender Roles	Steam Engines	6.51***
6	Communication, Speaking, Words	Cotton Textile Plants	25.82*
6	Communication, Speaking, Words	Steam Engines	5.69**
7	Effort, Work, Hard Success	Cotton Textile Plants	22.85*
7	Effort, Work, Hard Success	Steam Engines	5.04*
9	Weather, Natural Patterns, Agricultural	Cotton Textile Plants	30.76***
9	Weather, Natural Patterns, Agricultural	Steam Engines	6.78***
10	Resources, Financial Management	Cotton Textile Plants	28.30*
10	Resources, Financial Management	Steam Engines	6.24**
14	Relationships, Friendship	Cotton Textile Plants	31.35**
14	Relationships, Friendship	Steam Engines	6.91***
15	Authority, Leadership, Power	Cotton Textile Plants	30.18*
15	Authority, Leadership, Power	Steam Engines	6.65**
16	Age, Older Wisdom, Young	Cotton Textile Plants	35.89**
16	Age, Older Wisdom, Young	Steam Engines	7.91***
17	Death, Life, Mortality	Cotton Textile Plants	36.50***
17	Death, Life, Mortality	Steam Engines	8.05***
18	Work Hard, Productivity, Idleness	Cotton Textile Plants	25.36**
18	Work Hard, Productivity, Idleness	Steam Engines	5.59***
19	Promises, Results, Action, Words	Cotton Textile Plants	24.19*
19	Promises, Results, Action, Words	Steam Engines	5.33**
20	Love, Relationships, Affection, Emotional	Cotton Textile Plants	46.48***
20	Love, Relationships, Affection, Emotional	Steam Engines	10.25***
22	Fear, Courage, Bravery	Cotton Textile Plants	43.62***
22	Fear, Courage, Bravery	Steam Engines	9.62***
23	Children, Family, Motherhood	Cotton Textile Plants	25.67*
23	Children, Family, Motherhood	Steam Engines	5.66*
24	Wealth, Material Possessions, Contentment	Cotton Textile Plants	44.99***
24	Wealth, Material Possessions, Contentment	Steam Engines	9.92***
25	Empathy, Emotional Understanding	Cotton Textile Plants	37.73***
25	Empathy, Emotional Understanding	Steam Engines	8.32***
26	Actions, Moral Justice, Consequences	Cotton Textile Plants	-24.72**
26	Actions, Moral Justice, Consequences	Steam Engines	-5.45**
28	Forgiveness, Revenge	Cotton Textile Plants	27.79**
28	Forgiveness, Revenge	Steam Engines	6.13**
31	Money, Financial Wealth, Power	Cotton Textile Plants	29.19**
31	Money, Financial Wealth, Power	Steam Engines	6.44**
32	Financial Debt, Responsibility, Obligations	Cotton Textile Plants	22.92*
32	Financial Debt, Responsibility, Obligations	Steam Engines	5.05*
33	Divine, Faith, Higher Spiritual	Cotton Textile Plants	27.63**
33	Divine, Faith, Higher Spiritual	Steam Engines	6.09**
35	Fairness, Equality, Justice	Cotton Textile Plants	26.71*
35	Fairness, Equality, Justice	Steam Engines	5.89*
37	Time, Rushing, Careful Thoroughness	Cotton Textile Plants	24.54*
37	Time, Rushing, Careful Thoroughness	Steam Engines	5.41*
38	Kindness, Politeness, Gentle Communication	Cotton Textile Plants	29.64**
38	Kindness, Politeness, Gentle Communication	Steam Engines	6.53**
39	Product Quality	Cotton Textile Plants	26.82**
39	Product Quality	Steam Engines	5.91**
40	Resourcefulness, Adaptability, Resources Available	Cotton Textile Plants	41.87***
40	Resourcefulness, Adaptability, Resources Available	Steam Engines	9.23***
41	Talent, Skills, Abilities	Cotton Textile Plants	33.15***
41	Talent, Skills, Abilities	Steam Engines	7.31***

Note: : The clustering method used is BERTtopic, which identified a total of 43 clusters, mapping into 43 topics. This table reports the topics that exhibited statistically significant changes after industrialization. The control variables included in these regressions are the same as those in the even-numbered columns of Table IV. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

ings relate to the economics of cultural change following industrialization, where economic shifts alter long-run cultural preferences through mechanisms such as intergenerational transmission and adaptive learning (Galor and Moav, 2002; Doepke and Zilibotti, 2008, 2017). The evolution of cultural values post-industrialization aligns with models in which economic incentives shape the persistence and transmission of cultural traits, reinforcing the link between structural economic change and social transformation.

These findings reinforce the view that cultural transformation was both a precursor to and an outcome of industrialization. The increasing usage of proverbs reflecting diligence, rational decision-making, and optimism about progress suggests that societies were already moving toward attitudes that supported industrial development. At the same time, industrialization reinforced and expanded certain values, shaping societies in ways that extended beyond economic production.

V Conclusion

This research provides the first systematic examination of the Industrial Revolution and cultural change, using proverbs as a source of quantitative evidence. By analyzing historical trends in proverb usage, we test whether cultural shifts preceded industrialization and whether industrialization itself reinforced further cultural change. The results support both hypotheses.

Before industrialization, regions that later industrialized exhibited increasing trends in proverbs emphasizing work ethic, economic rationality, and belief in progress. These patterns suggest that cultural shifts associated with economic modernization were already underway, reinforcing the idea that evolving knowledge, behaviors, and social attitudes helped create conditions favorable for industrial takeoff.

After industrialization, a different set of values became more prominent. Labor structures shifted, economic opportunities expanded, and technological progress accelerated, leading to an increasing prevalence in the usage of proverbs that stressed time discipline, innovation, and self-reliance. These findings illustrate how industrialization reshaped cultural norms in response to new economic realities.

Beyond hypothesis testing, the cluster-based analysis reveals additional cultural patterns that were not explicitly predicted in existing literature. While the study's dimensions were guided by theoretical expectations, clustering methods uncover emergent themes, such as changes in perceptions of risk-taking, patience, and strategic decision-making. Shifts in proverbs concerning authority and leadership also reflect deeper societal transformations in governance and hierarchy, highlighting industrialization's broader impact beyond economic behavior.

This research also introduces a methodological framework for studying cultural change at scale. By integrating natural language processing with historical and economic analysis, it demon-

strates how proverbs can serve as a valuable source of quantitative evidence for understanding long-run cultural dynamics. This approach allows for systematic tracking of cultural shifts across time and regions, providing insights beyond industrialization.

While historical in scope, these findings remain relevant to contemporary discussions on how cultural narratives shape economic and social behavior. Proverbs, as enduring cultural artifacts, continue to influence attitudes and decision-making in modern contexts, including political discourse, economic expectations, and social cohesion. Understanding how cultural messages embedded in proverbs have changed over time provides deeper insights into the persistence and transformation of social attitudes.

More broadly, this project advances a framework for integrating computational text analysis with historical and economic research. By combining large-scale textual data, transformer-based encoding of ideas, and applied econometric techniques, this study offers a replicable model for analyzing cultural evolution. Proverbs, as concise representations of social values, provide a promising tool for measuring historical and contemporary cultural shifts, with applications in economic history, political economy, and the study of long-run institutional development.

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For Online Appendix

A Proverb Lists

A.1 Proverb Lists by Key Cultural Dimension

- **Patience**
  1. Rome was not built in a day.
  2. Haste makes waste.
  3. Patience is a virtue.
  4. Little strokes fell great oaks.
  5. A watched pot never boils.
- **Honesty**
  1. Honesty is the best policy.
  2. Tell the truth and shame the devil.
  3. Ill-gotten goods never prosper.
  4. A clear conscience is a good pillow.
  5. Better beg than steal.
- **Punctuality**
  1. First come, first served.
  2. Better three hours too soon than a minute too late.
  3. Time and tide tarry for no man.
  4. Early to go to bed, and early to rise, makes a man healthy, wealthy, and wise.
  5. Punctuality is the soul of business.
- **Hard Work**
  1. No gains without pains.
  2. Early to bed and early to rise makes a man healthy, wealthy, and wise.
  3. An idle brain is the devil's workshop.
  4. Where there's a will there's a way.
  5. Constant dropping wears the stone.
- **Rationality**
  1. Look before you leap.

2. The proof of the pudding is in the eating.
3. Seeing is believing.
4. Measure thrice and cut once.
5. Hear first and speak afterwards.

- **Innovation**

1. Necessity is the mother of invention.
2. A wise man changes his mind, a fool never.
3. Nothing venture, nothing win.
4. Times change and we with them.
5. A new broom sweeps clean.

- **Progress & Improvement**

1. Rome was not built in a day.
2. Little strokes fell great oaks.
3. Where there's a will there's a way.
4. Constant dropping wears away a stone.
5. It is never too late to mend.

- **Practical Knowledge**

1. Experience is the mother of science.
2. A man of words, and not of deeds, is like a garden full of weeds.
3. A handful of trade is a handful of gold.
4. Practice makes perfect.
5. The proof of the pudding is in the eating.

- **Bourgeois Virtues**

1. Early to bed and early to rise makes a man healthy, wealthy, and wise.
2. He who saves in little things can be liberal in great ones.
3. Beware of little expenses; a small leak will sink a ship.
4. A penny saved is a penny got.
5. Let honesty and industry be thy constant companions.

- **Individualism**

1. Every man is the architect of his own fortune.
2. Never trust to another what you should do yourself.

3. Every tub must stand on its own bottom.
4. He that would have his business well done must do it himself.
5. Better free in a foreign land than a serf at home.

- **Curiosity**

1. Truth never fears investigation.
2. The fool wonders; the wise man asks.
3. Home-keeping youths have ever homely wits.
4. Travel is the great source of true wisdom.
5. Knowledge hath no enemy but ignorance.

A.2 Proverb Lists by BERTopic Cluster

Topic 0: 'One should learn wisdom through experience and humility.'

- Hide not your light under a bushel.
- He who has a head won't want for a hat.
- The simple man's the beggar's brither.
- He is sufficiently learned that knows how to do well, and has power enough to refrain from evil.
- most things have two handles, and a wise man takes hold of the best

Topic 1: 'Honesty and Integrity Should Prevail as Truth Will Ultimately Be Revealed'

- tale-bearer is worse than a thief
- There is no smoke without fire.
- He declares himself guilty who justifies himself before accusation.
- How use doth breed a habit in a man.
- The still sow eats up all the draught.

Topic 2: 'Moderation Should Be Practiced for Health and Well-Being'

- Pleasures steal away the mind.
- Possession is nine points of the law.
- a bow long bent at last waxes weak
- Too much is not enough.

- Short pleasure, long lament.

Topic 3: 'Traditional Gender Roles in Marriage: Women Should Fulfill Expected Roles'

- Young wenches make old wrenches.
- An ill marriage is a spring of ill-fortune.
- more belongs to marriage than four bare legs in a bed
- a wise woman is the ornament of her house
- He that marries a daw eats meikle dirt.

Topic 4: 'One should look beyond superficial appearances to assess true character or value'

- Smooth waters rin deep.
- He has meikle prayer but little devotion.
- One cannot live on beauty.
- A nice wife and a back door,Do often make a rich man poor.
- Fair feathers make fair fowls.

Topic 5: 'Resilience Should Be Cultivated in Times of Adversity'

- He that falls into the dirt the longer he lies the dirtier he is.
- Misfortunes make us wise.
- Crosses are ladders which lead to heaven.
- the sharper the storm, the sooner it's over
- What does not poison, fattens.

Topic 6: 'Words Should Be Chosen Wisely'

- The seeds of knowledge may be planted in solitude but must be cultivated in public.
- The tongue is the rudder of our ship.
- Many words hurt more than swords.
- Empty vessels make the most sound.
- A fool's lips are the snare of his soul.

Topic 7: 'Success Should Be Earned Through Hard Work and Perseverance'

- nothing will come of nothing
- handsaw is a good thing, but not to shave with
- He plays best who wins.
- a hard beginning hath a good ending
- things hardly attained are long retained

Topic 8: 'Acts of Generosity Should Lead to Mutual Benefits and Gratitude'

- Spread the table and contention will cease.
- To raise esteem we must benefit others; to procure love we must please them.
- Give a thing and take a thing, & c. or, Give a thing and take again, And you shall ride in hell's wain .
- On adamant our wrongs we all engrave,But write our benefits upon the wave.
- gifts break a rock

Topic 9: 'Society should value traditional wisdom to predict weather and agricultural outcomes'

- Change of weather is the discourse of fools.
- bearded frost forerunner of snow
- A green winter makes a fat church-yard.
- september, blow soft till the fruit is in the loft
- so many fogs in march, so many frosts in may

Topic 10: 'Individuals should manage resources wisely to achieve financial stability and future prosperity.'

- sparing is a rich purse
- A hungry horse maketh a clean manger.
- Great ships require deep waters.
- Very good corn grows in little fields.
- there is a time to spare and a time to spend

Topic 11: 'One should prioritize caution and prudence to avoid unnecessary risks and potential dangers.'

- do not triumph before the victory
- a stitch in time may save nine
- Comparisons are odious.
- Hang him that hath no shift, and him that hath one too many
- Do not carry too much sail.

Topic 12: 'Opportunities should be seized at the right time, balancing patience and action.'

- Be lang sick, that ye may be soon hale.
- One hour to-day is worth two to-morrow.
- hereafter comes not yet
- hope is a good breakfast but an ill supper
- To wait and be patient soothes many a pang.

Topic 13: 'Individuals Should Take Responsibility for Their Own Actions'

- Let him drink as he has brewen.
- Every man is the son of his own works.
- A man is weal or woe, as he thinks himself so.
- The lame returns sooner than his servant.
- He that puts on a public gown must put off the private person.

Topic 14: 'True friendships should be valued for their loyalty and support, especially in times of need.'

- it's merry when friends meet
- it is merry when friends meet
- When freends meet hearts warm.
- One rogue is usher to another still.
- Fire and water are not more necessary than friends are.

Topic 15: 'Leadership should reflect humility, accountability, and the shared responsibilities of power.'

- Those that eat cherries with great persons, shall have their eyes sprinted out with the stones.
- Opinion is the great pillar that upholds the commonwealth.
- Masters should be sometimes blind and sometimes deaf.
- A place at court is a continual bribe.
- A cat may look at a king.

Topic 16: 'Age Should Bring Wisdom and Experience'

- When old age is evil youth can learn no good.
- Ragged colts may make fine horses.
- virtue never grows old
- A young saint, an old devil.
- the kick of the dam hurts not the colt

Topic 17: 'Awareness of Mortality Should Encourage Meaningful Living'

- Better to live well than long.
- A death-bed's a detector of the heart.
- A man dies, his name remains.
- to go the way of all flesh
- The memory of the just is blessed.

Topic 18: 'One should stay busy and active to avoid the negative consequences of idleness.'

- lazy sheep thinks its wool heavy
- sloth is the devil's cushion
- The sluggard's convenient season never comes.
- to burn one's candle at both ends
- always in his saddle, never on his way

Topic 19: 'Topic: Actions Should Speak Louder Than Words'

- take a man by his word and a cow by her horn
- many words will not fill a bushel.
- great cry and little wool
- When a man repeats a promise again and again he means to fail you.
- Few words, many deeds.

Topic 20: 'Love should be valued as a powerful, resilient force that fosters genuine relationships and emotional growth.'

- Quarrels of lovers but renew their love.
- The soul is not where it lives but where it loves.
- People in love think other people's eyes are out.
- Love makes time pass away, and time makes love pass away.
- Lovers are fools.

Topic 21: 'Pride should be moderated to avoid downfall and embrace humility.'

- pride goes before and shame comes after
- The devil wipes his tail with the poor man's pride.
- to blow one's own trumpet
- the higher any man rises, the greater is his fall expected
- Pride ne'er leaves its master till he gets a fa '.

Topic 22: 'Fear should be faced with courage and decisiveness for personal growth and positive outcomes.'

- a coward's fear can make a coward valiant
- A man of courage never wants weapons.
- Of the malady a man fears, he dies.
- Many a one threatens while he quakes with fear.
- Fear is a great inventor.

Topic 23: 'The Family Should Emphasize the Influence and Values Passed Down to Children'

- Children are certain cares, but very uncertain comforts.
- he has neither child nor chicken
- We may not expect a good whelp from an ill dog.
- Gold must be beaten and a child scourged.
- There is no mother like the mother that bore us.

Topic 24: 'True Happiness Should Be Found in Contentment, Not Material Wealth'

- Wealth is best known by want.
- A fat sorrow is better than a lean one.
- The love of pelf increases with the pelf.
- He that desires but little has no need of much.
- Little goods—little care.

Topic 25: People should strive for empathy and understanding towards others' unique challenges.

- He that falls all the world runs over.
- in a hundred pound of law there is not a half penny weight of love
- good words help sick minds
- Who hath bitter in his mouth spits not all sweet.
- The losing side is full of suspicion.

Topic 26: 'Actions should reflect moral values, as wrongdoing will lead to negative consequences.'

- The triumphing of the wicked is short.
- Wickedness proceeds from the wicked.
- give a thief rope enough and he will hang himself
- Pardoning the bad is injuring the good.
- Where vice goes before, vengeance follows after.

Topic 27: 'Small Issues Should Be Addressed to Prevent Larger Problems'

- Many grains of sand will sink a ship.

- You may lose a fly to catch a trout.
- Little wood, much fruit.
- The little wimble will let in the great auger.
- he that gripes too much holds fast but little

Topic 28: 'Topic: One should choose forgiveness over seeking revenge to promote peace and reconciliation.'

- He who doth the injury never forgives the injured man.
- We are ever young enough to sin, never old enough to repent.
- To revenge is no valor, but to bear.
- Not to repent of a fault is to justify it.
- He that sharply chides is the most ready to pardon.

Topic 29: 'Topic: The importance of genuine peace over conflict; societies should prioritize harmony and avoid disputes.'

- He that makes a good war makes a good peace.
- Peace has her victories no less renowned than war.
- When one will not, two cannot quarrel.
- One peace is better than ten victories.
- the best remedy against an ill is much ground between both

Topic 30: 'Success Should Be Attributed to Luck and Fortune Over Intelligence or Effort'

- Ungirt, unblessed.
- If a fool have success it ruins him.
- A lucky physician is better than a learned one.
- Selde is the Friday al the wyke y-lyke.
- Thieves and rogues have the best luck if they do but escape hanging.

Topic 31: 'Financial resources should be viewed as a key to power and influence.'

- the devil dances in an empty pocket

- Yes, ready money is Aladdin's lamp.
- if money go before all ways lie open
- A moneyless man goes fast through the market.
- Money is the soul of business.

Topic 32: 'Topic: The Value of Financial Independence: Why Debt Should Be Avoided'

- pay what you owe, and what you're worth you'll know
- A church debt is the devil's salary.
- Borrowing makes sorrowing.
- a borrowed loan should come laughing home
- i love you well but touch not my pocket

Topic 33: 'Topic: One should balance personal effort with faith in divine intervention.'

- The grace of god is gear enough.
- When it pleaseth not God, the saint can do little.
- have god and have all
- help thyself and god will help thee
- Adversity reminds men of religion.

Topic 34: One should focus on self-awareness and personal growth before criticizing others' faults.

- Nothing is easier than fault-finding.
- Few love to hear the sins they love to act.
- Self-love exaggerates our faults as well as our virtues.
- A man can know nothing of mankind without knowing something of himself.
- He who knows himself best, esteems himself least.

Topic 35: 'People should treat others with fairness, equality, and justice.'

- hands off is fair play

- Do as you would be done by.
- The bazaar knows neither father nor mother.
- with what measure you mete it shall be measured unto you
- Nab me and I'll nab thee.

Topic 36: 'Accepting Inherent Nature: Why We Should Acknowledge Unchangeable Traits and Qualities'

- Nature passes nurture.
- Every one is as God made him and very often worse.
- whether you do boil snow or pound it, you can have but water of it.
- you cannot make a horn of a pig's tail
- Whatever the bee sucks turns to honey and whatever the wasp sucks turns to venom.

Topic 37: 'You should prioritize patience and thoroughness over speed to avoid mistakes.'

- no haste but good speed
- A hasty man never wants woe.
- Make no more haste than good speed.
- Hasty climbers have sudden falls.
- Soft fire makes sweet malt.

Topic 38: 'One should practice kindness and politeness in communication to foster positive interactions.'

- There is nothing that costs less than civility.
- fair words hurt not the mouth
- Honey in the mouth saves the purse.
- Better be unmannerly than troublesome.
- One outward civility is current pay for another.

Topic 39: 'Quality Should Be Prioritized for Long-Term Savings'

- Cheap things are not good, good things are not cheap.

- At an auction keep your mouth shut.
- Gude ware maks a quick market.
- Good cheap is dear at long run.
- an inch of a nag is worth a span of an aver

Topic 40: 'One should make the best of available resources through adaptability and resourcefulness.'

- Foxes dig not their own holes.
- There is little sap in dry pea-hools.
- Being on the sea, sail; being on the land, settle.
- gnaw the bone that is fallen to thy lot
- Better a louse in the pot than no flesh at all.

Topic 41: 'Practice Should Precede Talent to Develop Skills and Abilities'

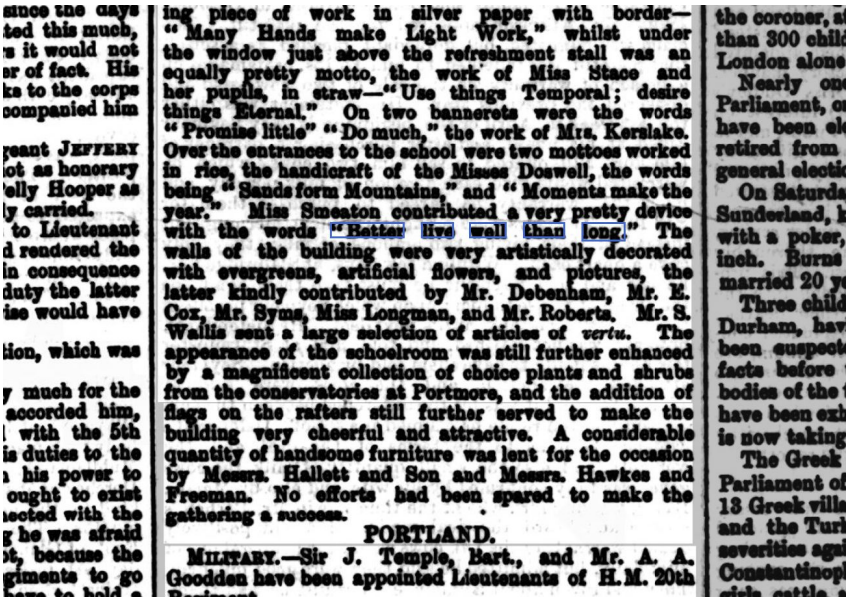
- By hammer and hand all arts do stand.
- as is the workman so is the work
- The best colt needs breaking.
- A good archer is not known by his arrow but his aim.
- Who has not a good tongue ought to have good hands.

Topic 42: 'One should control their anger for better self-mastery and harmony.'

- A man in a passion rides a horse that runs away with him.
- Anger ends in cruelty.
- Hastiness is the beginning of wrath and its end repentance.
- Anger manages everything badly.
- Hot love and hasty vengeance.

B Data Sources and Key Measures

B.1 Exmaples of Proverb Usage in Historical Newspapers

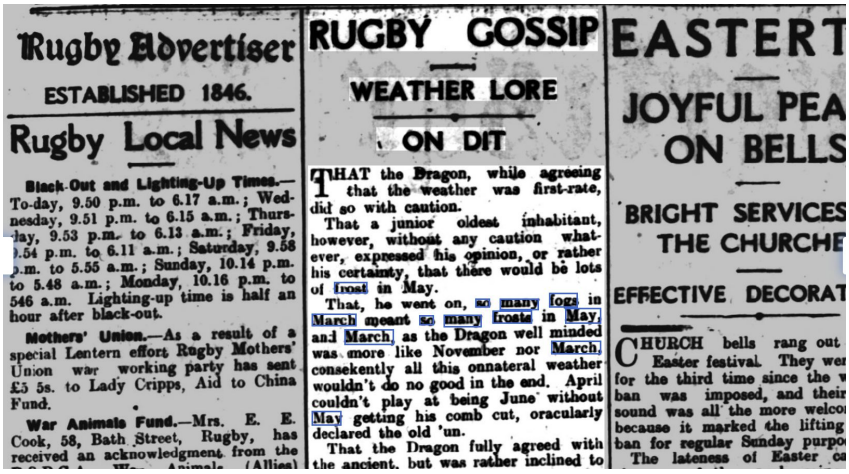


ing piece of work in silver paper with border—"Many Hands make Light Work," whilst under the window just above the refreshment stall was an equally pretty motto, the work of Miss Stace and her pupils, in straw—"Use things Temporal; desire things Eternal." On two bannerets were the words "Promise little" "Do much," the work of Mrs. Kerslake. Over the entrances to the school were two mottoes worked in rice, the handicraft of the Misses Doswell, the words being "Sands form Mountains," and "Moments make the year." Miss Smeaton contributed a very pretty device with the words "Better live well than long." The walls of the building were very artistically decorated with evergreens, artificial flowers, and pictures, the latter kindly contributed by Mr. Debenham, Mr. E. Cox, Mr. Syms, Miss Longman, and Mr. Roberts. Mr. S. Wallis sent a large selection of articles of *vertu*. The appearance of the schoolroom was still further enhanced by a magnificent collection of choice plants and shrubs from the conservatories at Portmore, and the addition of flags on the rafters still further served to make the building very cheerful and attractive. A considerable quantity of handsome furniture was lent for the occasion by Messrs. Hallett and Son and Messrs. Hawkes and Freeman. No efforts had been spared to make the gathering a success.

PORTLAND.

MILITARY.—Sir J. Temple, Bart., and Mr. A. A. Goodden have been appointed Lieutenants of H.M. 20th

(a) Example of proverb usage in historical newspapers: "So many fogs in March, so many frosts in May."



Rugby Advertiser

ESTABLISHED 1846.

Rugby Local News

Black-Out and Lighting-Up Times.—To-day, 9.50 p.m. to 6.17 a.m.; Wednesday, 9.51 p.m. to 6.15 a.m.; Thursday, 9.53 p.m. to 6.13 a.m.; Friday, 9.54 p.m. to 6.11 a.m.; Saturday, 9.58 p.m. to 5.55 a.m.; Sunday, 10.14 p.m. to 5.48 a.m.; Monday, 10.16 p.m. to 546 a.m. Lighting-up time is half an hour after black-out.

Mothers' Union.—As a result of a special Lentern effort Rugby Mothers' Union war working party has sent £5 5s. to Lady Cripps, Aid to China Fund.

War Animals Fund.—Mrs. E. E. Cook, 58, Bath Street, Rugby, has received an acknowledgment from the

RUGBY GOSSIP

WEATHER LORE

ON DIT

THAT the Dragon, while agreeing that the weather was first-rate, did so with caution.

That a junior oldest inhabitant, however, without any caution whatever, expressed his opinion, or rather his certainty, that there would be lots of frost in May.

That, he went on, so many fogs in March meant so many frosts in May, and March as the Dragon well minded was more like November nor March, consekently all this onnateral weather wouldn't do no good in the end. April couldn't play at being June without May getting his comb cut, oracularly declared the old 'un.

That the Dragon fully agreed with the ancient, but was rather inclined to

EASTERT

JOYFUL PEA

ON BELLS

BRIGHT SERVICES

THE CHURCHE

EFFECTIVE DECORAT

CHURCH bells rang out Easter festival. They wer for the third time since the w ban was imposed, and their sound was all the more welco because it marked the lifting ban for regular Sunday purpo The lateness of Easter ca

(b) Example of proverb usage in historical newspapers: "Better live well than long."

Figure A.1: Illustrations of Proverbs in Historical Newspapers

B.2 Standardizing Proverb Mentions Across Books and Newspapers

A key challenge in our analysis is ensuring that proverb mentions in books and newspapers are comparable, given systematic differences in text volume and the way proverbs are used in each source type. Newspapers tend to incorporate proverbs more frequently than books, both due to

editorial practices and because historical newspaper pages contain significantly more words per page than book pages. A direct comparison of normalized proverb mentions across source types could therefore lead to misinterpretation of relative prevalence. To address this, we standardize by estimating total word count rather than relying solely on page count and apply a global correction factor to align proverb frequencies across books and newspapers.

1. Estimating Word Count in Books and Newspapers

Since we do not directly observe word counts for books, we estimate them based on observed or imputed page counts. For newspapers, we estimate word counts using known page counts, distinguishing between broadsheets and tabloids, and applying an appropriate conversion factor for text density.

- **Newspapers:** The word count for newspapers is estimated based on total pages, adjusting for the difference between broadsheet and tabloid formats. Since page counts are not always available, we estimate them using the number of issues published and assume an average number of pages per issue. Furthermore, we apply a conversion factor to account for the higher text density of broadsheets relative to tabloids. The total word count for newspaper j in time period t is given by:

$$\text{Word Count}_{j,t} = \big(\text{Broadsheet Pages}_{j,t} + 0.4 \times \text{Tabloid Pages}_{j,t}\big) \times \text{Avg Words per Newspaper Page}. \tag{1}$$

  The total newspaper word count for a given region i is then:

$$\text{Word Count}_{i,t} = \sum_{j \in J_i} \big(\text{Broadsheet Pages}_{j,t} + 0.4 \times \text{Tabloid Pages}_{j,t}\big) \times \text{Avg Words per Newspaper Page} \tag{2}$$

  where the weighting factor of 0.4 accounts for the lower word count per page in tabloids relative to broadsheets, based on historical samples.

- **Books:** For books, we use observed page counts where available. For books missing page counts, we impute them using the average number of pages per book. We then estimate book word count by multiplying the total number of pages by an estimated average words per page:

$$\text{Word Count}_{i,t} = \sum_{\text{observed books}} \text{Pages} \times \text{Avg Words per Page} + (\#\text{Missing Books} \times \text{Avg Pages per Book} \times \text{A} \tag{3}$$

By converting all text volumes into estimated word counts, we ensure that proverb frequencies are comparable across books and newspapers, reducing potential bias due to differences in publication format.

2. Global Correction Factor for Newspaper Mentions

Even after standardizing by word count, newspapers may still use proverbs at a different rate than books. To account for this, we estimate a global correction factor λ, which adjusts for the relative frequency of proverb mentions per word in newspapers compared to books. This factor is calculated as:

$$\lambda = \frac{\mathbb{E}[\#\text{ Proverb Mentions Per Word in Books}]}{\mathbb{E}[\#\text{ Proverb Mentions Per Word in Newspapers}]}. \tag{4}$$

where $\mathbb{E}[\cdot]$ represents the expected value across all periods and regions. This ratio provides an estimate of how much more frequently proverbs appear in newspapers per word than in books, on average.

We then adjust proverb mentions in newspapers using this correction factor:

$$\text{Adjusted Proverb Mentions} = \#\text{Proverb Mentions in Books} + \lambda \times \#\text{Proverb Mentions in Newspapers}. \tag{5}$$

Applying this adjustment ensures that a proverb mention in a newspaper is weighted appropriately so that its impact is comparable to a mention in a book.

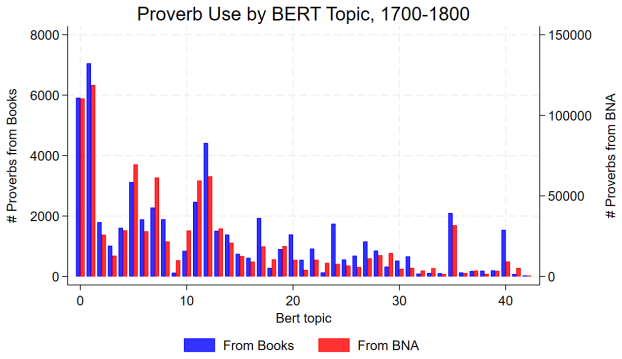
3. Implications for Interpretation

These adjustments ensure that our estimates of proverb usage reflect genuine cultural trends rather than artifacts of different publication formats. Specifically, we:

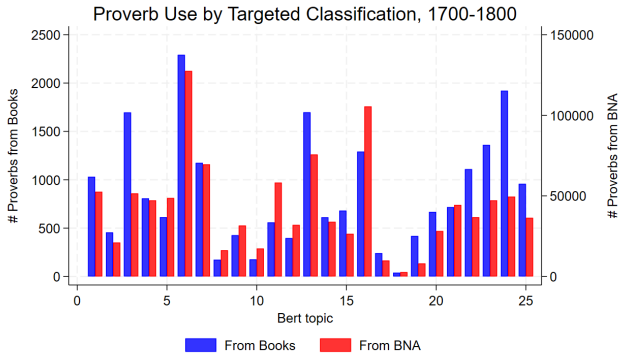
- **Account for differences in text volume** by estimating total word count for books and newspapers.
- **Distinguish between broadsheets and tabloids** by weighting tabloid pages appropriately to reflect their lower word density.
- **Prevent over-representation of newspapers** by adjusting for differences in proverb frequency across media.
- **Ensure comparability across sources**, enabling a unified interpretation of cultural change over time.

By standardizing text volume and applying a correction factor, our analysis captures shifts in cultural attitudes while mitigating biases introduced by differences in historical print media.

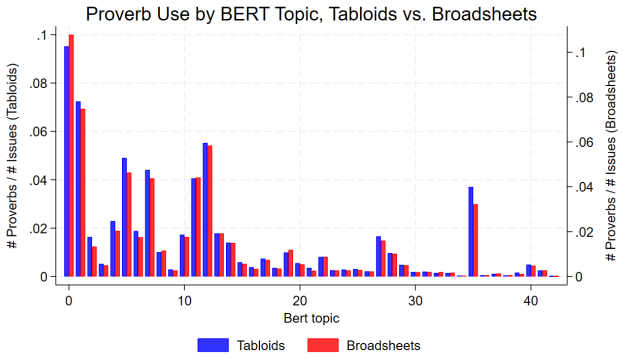
B.3 Proverb Usage by Topic Across Different Types of Media



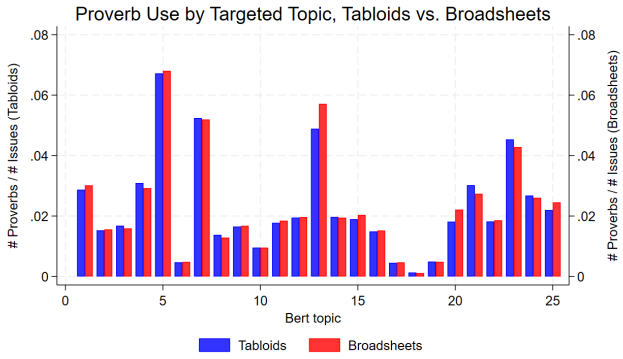
Proverb Use by BERT Topic, books vs. newspapers, 1700-1800



Proverb Use by Targeted Classification, books vs. newspapers, 1700-1800



Proverb Use by BERT Topic, Tabloids vs. Broadsheets



Proverb Use by Targeted Topic, Tabloids vs. Broadsheets

Figure A.2: Comparison of Proverb Use Across Sources and Classification Methods

Note: The upper panel compares proverb use across BERT topic modeling (left) and targeted classification (right). The lower panel examines differences in proverb use between tabloid and broadsheet sources, again using BERT (left) and targeted classification (right).

B.4 Spatial Patterns in Proverb Usage

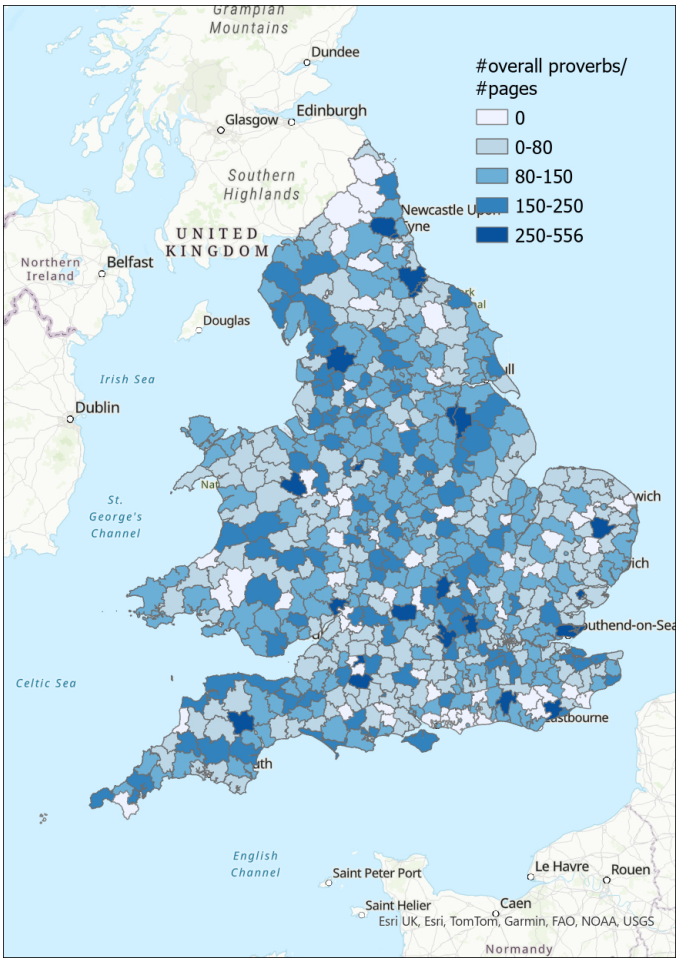
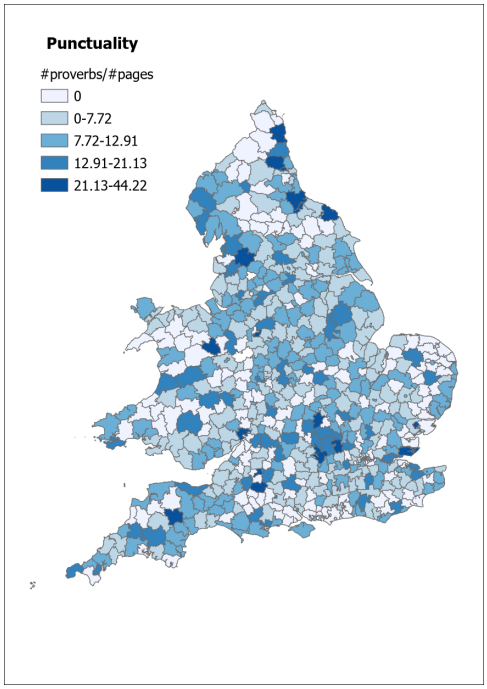
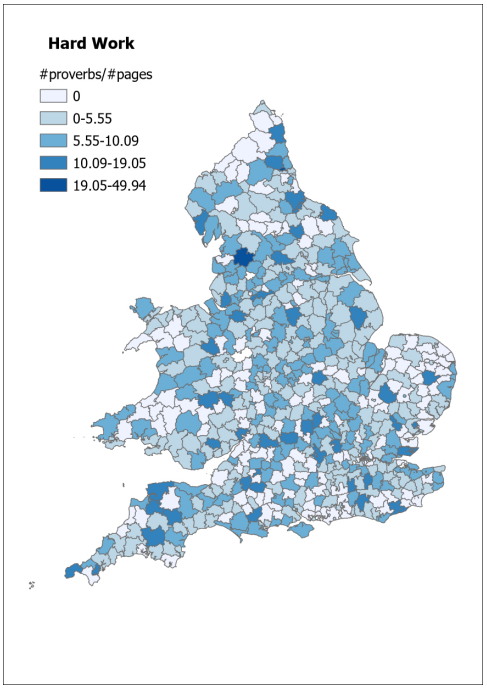


Figure A.3: Proverb Usage Across Registration Districts (1550–1900)

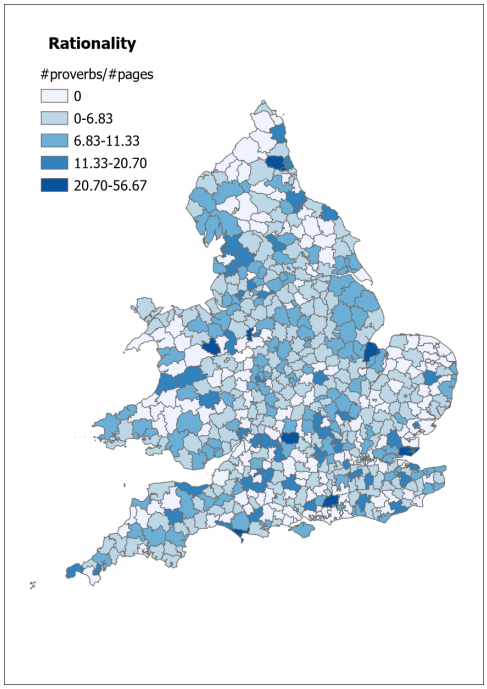
Note: This map illustrates the density of proverb usage across England and Wales at the registration district level from 1550 to 1900. The measure displayed represents the total number of recorded proverbs per 1,000 pages of books and newspapers. Proverbs from books have been adjusted for comparability with those from newspapers. Darker shades indicate districts with a higher proportion of proverbs relative to the total text volume, while lighter shades signify lower density. White areas represent districts with no recorded proverbs. The data is derived by aggregating proverb mentions from historical sources and normalizing by text volume to ensure consistency across regions and time periods.



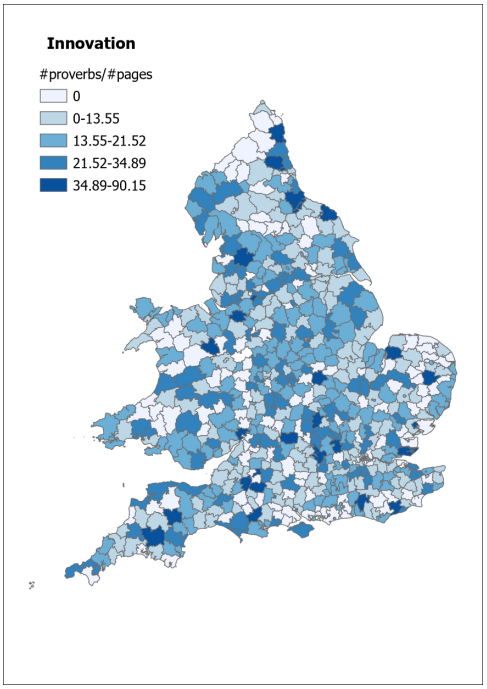
(a) Punctuality



(b) Hard Work

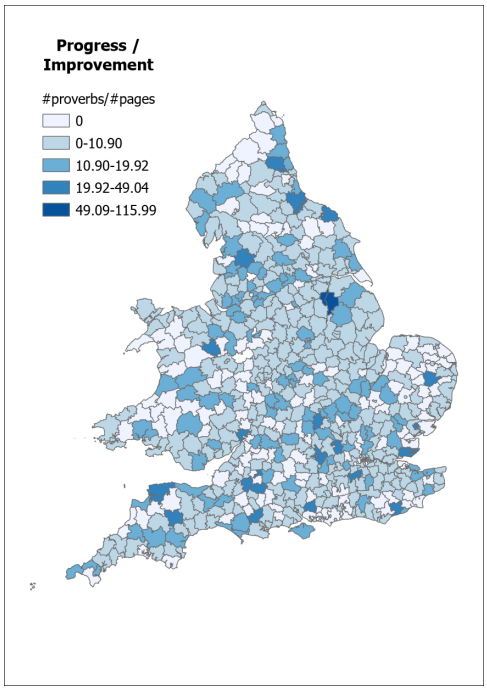


(c) Rationality

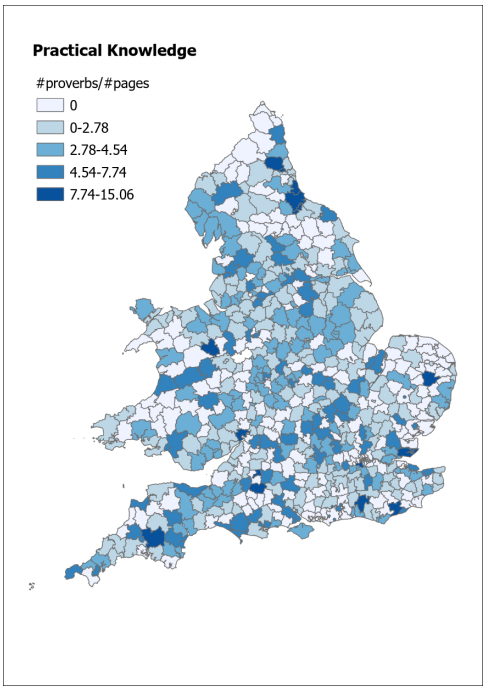


(d) Innovation

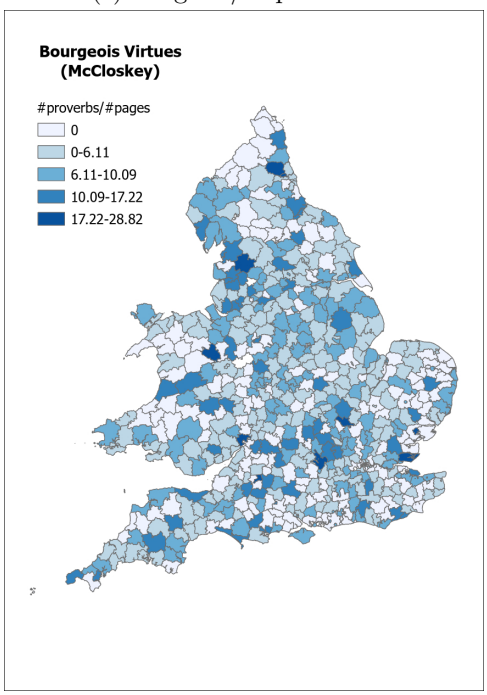
Figure A.4: Proverb Usage Across Registration Districts, by Cultural Dimension (1550–1900) (continued on the next page).



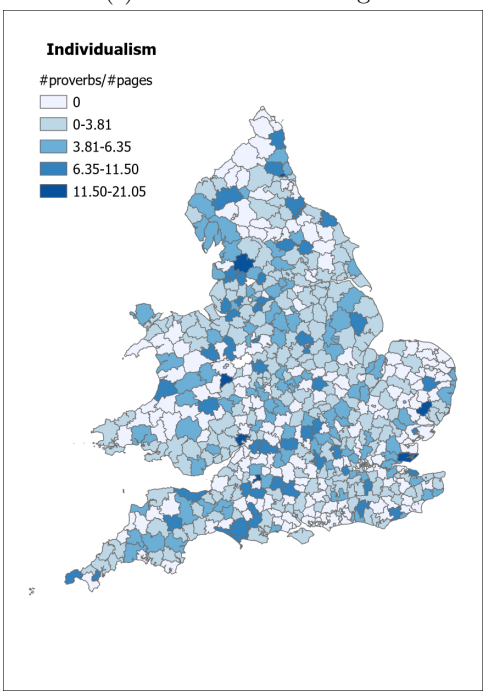
(e) Progress/Improvement



(f) Practical Knowledge



(g) Bourgeois Virtues

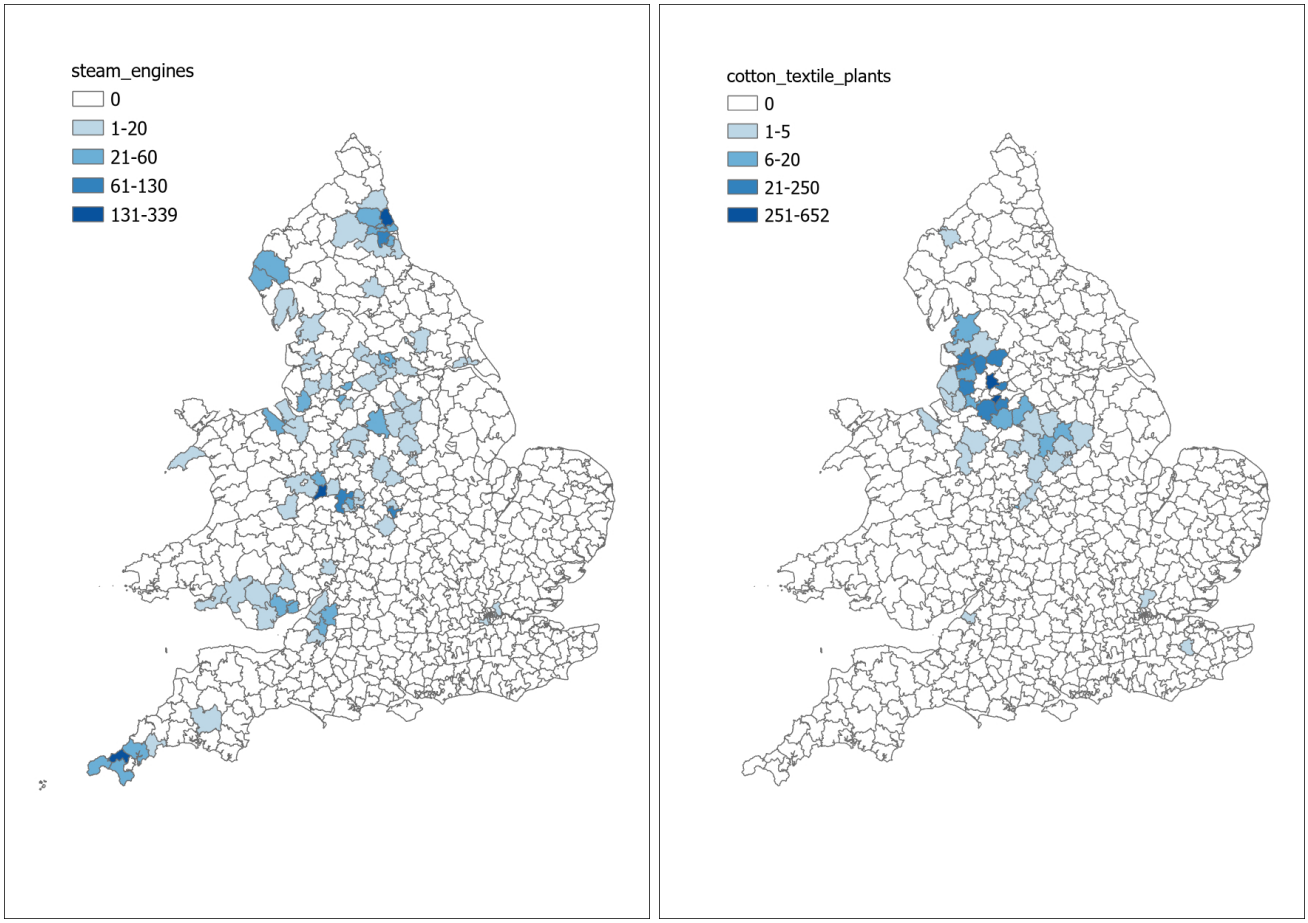


(h) Individualism

Figure A.4: (continued) Proverb Usage Across Registration Districts, by Cultural Dimension (1550–1900)

Note: These maps illustrate the density of proverb usage across England and Wales at the registration district level from 1550 to 1900 for cultural dimensions relevant to key hypotheses. The measure displayed represents the total number of recorded proverbs per 1,000 pages of books and newspapers within each cultural dimension. Proverbs from books have been adjusted for comparability with those from newspapers. Darker shades indicate districts with a higher proportion of proverbs relative to the total text volume, while lighter shades signify lower density. White areas represent districts with no recorded proverbs.

B.5 Proxies for Industrialization



(a) Steam Engine Distribution Across Registration Districts (Pre-1800)

(b) Cotton Textile Plants in 1838 Across Registration Districts

Figure A.6: Proxies for Industrialization

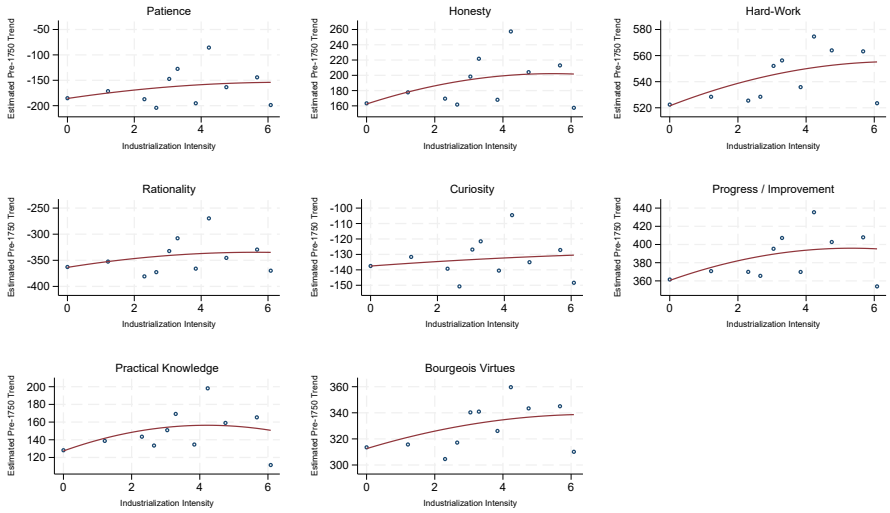
Note: These maps display two proxies for industrialization in England and Wales. The first map shows the distribution of steam engines installed before 1800, with darker shades indicating higher concentrations of early industrial technology. The second map presents the distribution of cotton textile plants in 1838, representing the spatial expansion of the textile industry. White areas correspond to districts with no recorded steam engines or textile plants, respectively. Both maps highlight regional variation in industrial intensity and technological adoption.

C Additional Results

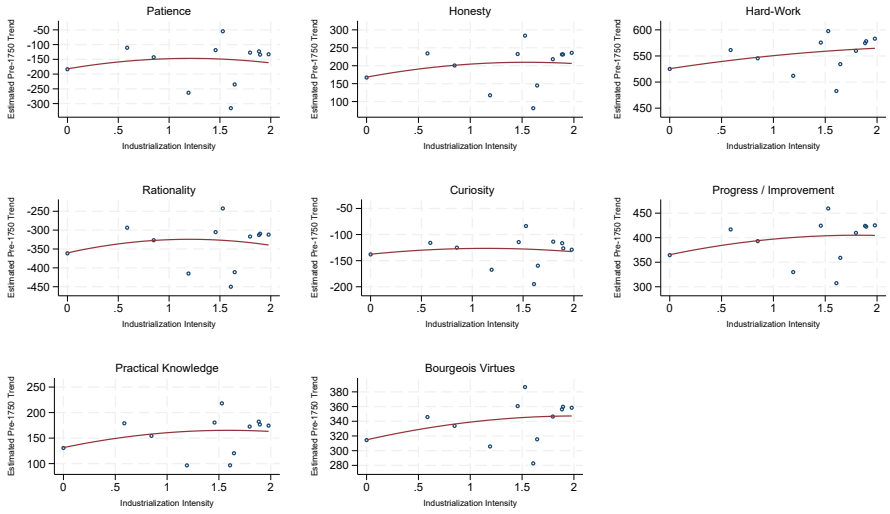
Table A.1: Cultural Dimensions and Industrial Revolution: OLS

	Patience			Honesty			Curiosity		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Steam Engines	0.79	1.49	1.90*	1.11	1.16	1.25*	0.76	0.99*	0.55
	(1.01)	(1.03)	(1.02)	(0.71)	(0.70)	(0.66)	(0.54)	(0.53)	(0.51)
Cotton Textile Plants	0.27	0.36	0.24	0.24	0.27	0.23	0.18	0.18	0.05
	(0.29)	(0.31)	(0.32)	(0.21)	(0.21)	(0.20)	(0.16)	(0.16)	(0.16)
	Hard-work			Rationality			Progress / Improvement		
	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Steam Engines	0.96	1.48**	1.1	1.51*	1.51**	1.83**	0.77	0.99**	0.42
	(0.66)	(0.70)	(0.67)	(0.84)	(0.86)	(0.88)	(0.49)	(0.46)	(0.50)
Cotton Textile Plants	0.25	0.30	0.17	0.30	0.32	0.26	0.18	0.18	0.037
	(0.19)	(0.21)	(0.21)	(0.25)	(0.27)	(0.27)	(0.15)	(0.14)	(0.15)
	Practical Knowledge			Bourgeois Virtues					
	(19)	(20)	(21)	(22)	(23)	(24)			
Steam Engines	1.15*	1.92***	2.05***	1.24*	1.64**	1.59**			
	(0.62)	(0.66)	(0.63)	(0.68)	(0.74)	(0.71)			
Cotton Textile Plants	0.17	0.25	0.15	0.22	0.21	0.16			
	(0.19)	(0.21)	(0.21)	(0.20)	(0.23)	(0.22)			

Note: This table presents estimates from an OLS regression of cultural dimensions on Industrial Revolution. The dimensions are determined based on existing hypotheses, and GPT is used to classify proverbs into categories. The first row under each cultural dimension presents results using pre-1800 steam engines as a proxy for IR, while the second row presents results using cotton textile plants in 1838 as a proxy for IR. The first column under each cultural dimension represents the specification with only controls for # overall proverbs and # pages. The second column additionally includes geographical controls, specifically: access to coast, terrain ruggedness, distance to port, coal, and latitude. The third column further includes further includes additional controls for economic and institutional factors, specifically: population density in 1750, the proportion of land used for crops in 1750, market presence in 1600, and pre-1650 Enclosure.



(a) Estimated Pre-1750 Trends Using Cotton Textile Plants as a Proxy of Industrialization Intensity



(b) Estimated Pre-1750 Trends Using Steam Engines as a Proxy for Industrialization Intensity

Figure A.8: Estimated Pre-1750 Trends in Key Cultural Dimensions

Note: Each panel presents a binned scatter plot of the predicted pre-1750 trend in proverbs related to different cultural dimensions—including patience, honesty, hard work, rationality, curiosity, progress/improvement, practical knowledge, and bourgeois virtues—against industrialization intensity. The y-axis represents the estimated pre-1750 trend for each cultural dimension, derived from a fixed-effects regression of the cultural dimension on period, controlling for geographical factors and county fixed effects. The x-axis measures industrialization intensity, proxied by the number of steam engines installed before 1800 (top panel) and the number of cotton textile plants in 1838 (bottom panel).

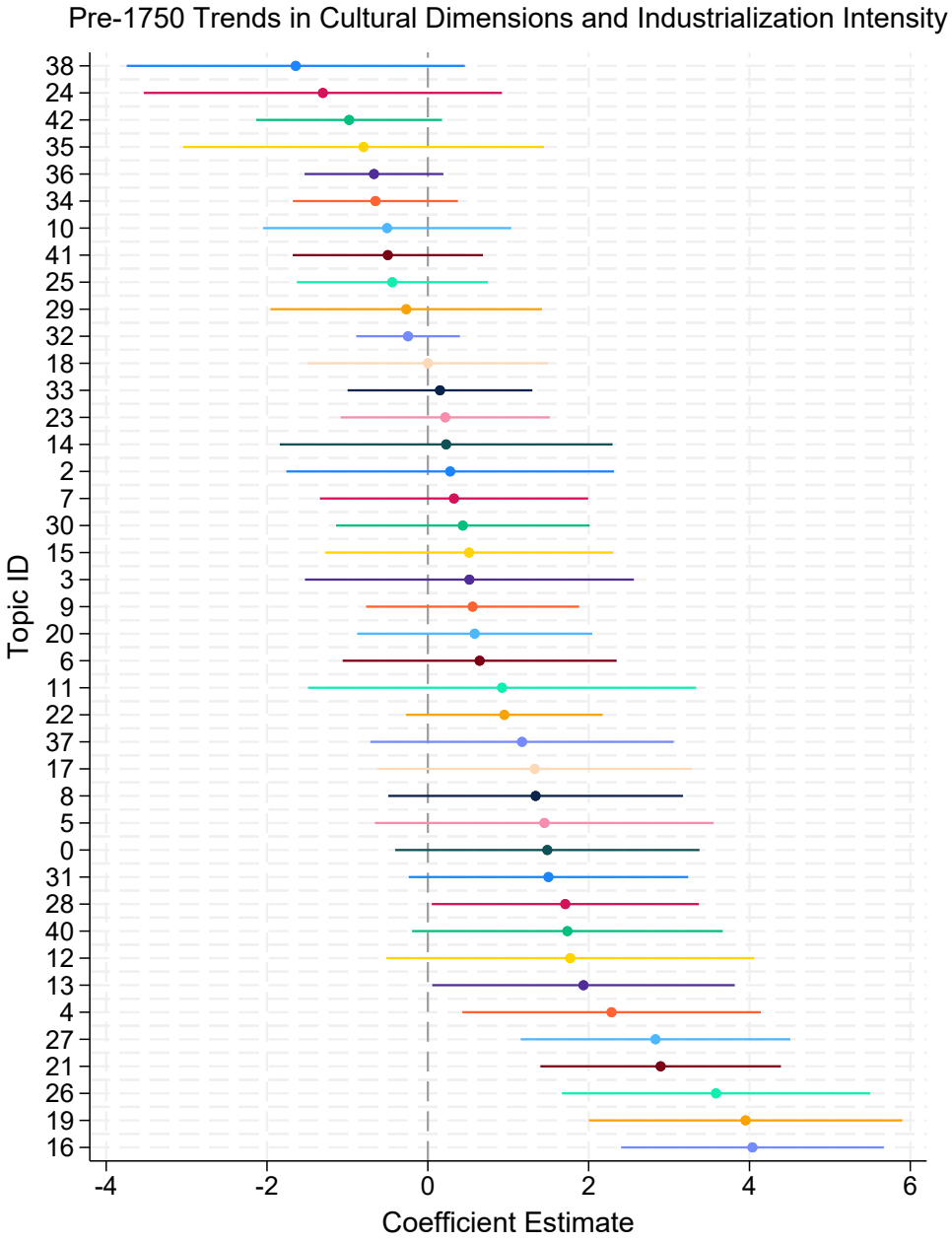


Figure A.10: Estimated Pre-1750 Trends in Proverb Clusters by Industrialization Intensity.

Note: This figure summarizes the estimated coefficients $\beta_{1,v}$ from the regression model in Equation . Each coefficient captures whether the prevalence of proverbs within a given cluster exhibited systematic trends before 1750 in regions that later industrialized. Positive estimates indicate that a particular proverb cluster was already becoming more common in later industrializing regions before the onset of the Industrial Revolution. The figure displays coefficient estimates for each cluster, with error bars representing 90% confidence intervals.

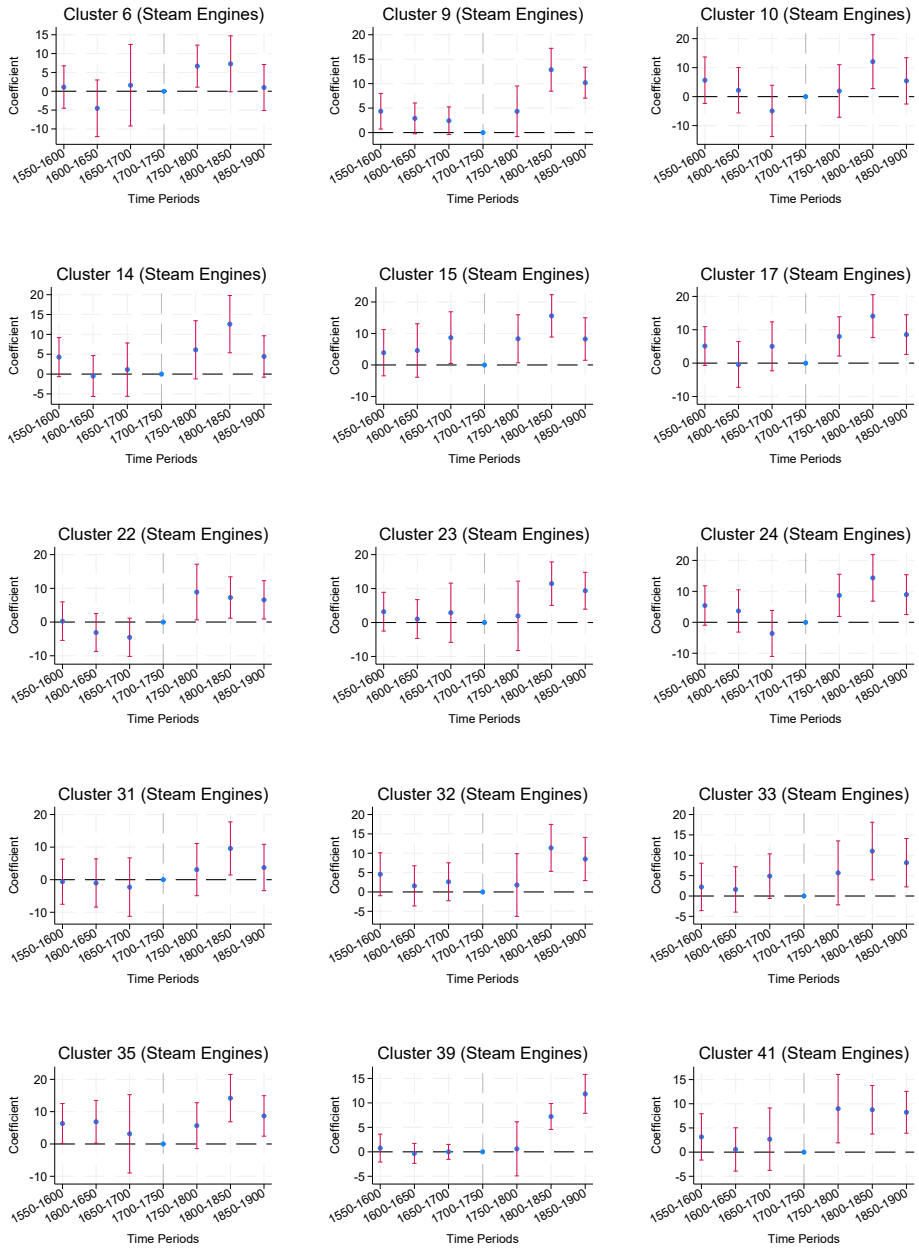


Figure A.11: Effects of Industrialization Intensity on the Frequency of Proverbs in Significant Clusters, 1550–1900

Note: This figure presents the estimated coefficients from a flexible difference-in-differences (DID) model examining the relationship between industrialization intensity and the frequency of proverbs in clusters that exhibit significant changes following industrialization, without a significant trend before 1750. Each panel corresponds to a different proverb cluster and displays the estimated effects of industrialization intensity—proxied by the number of steam engines installed before 1800—on the frequency of proverbs within that cluster over time. The y-axis represents the estimated coefficient, capturing changes in the frequency of proverbs within each cluster relative to the baseline period (1700–1750), while the x-axis represents different historical time periods from 1550 to 1900. Error bars indicate 90% confidence intervals. Positive estimates suggest that the usage of proverbs in a given cluster increased in more industrialized regions relative to less industrialized ones, while negative estimates indicate a relative decline.

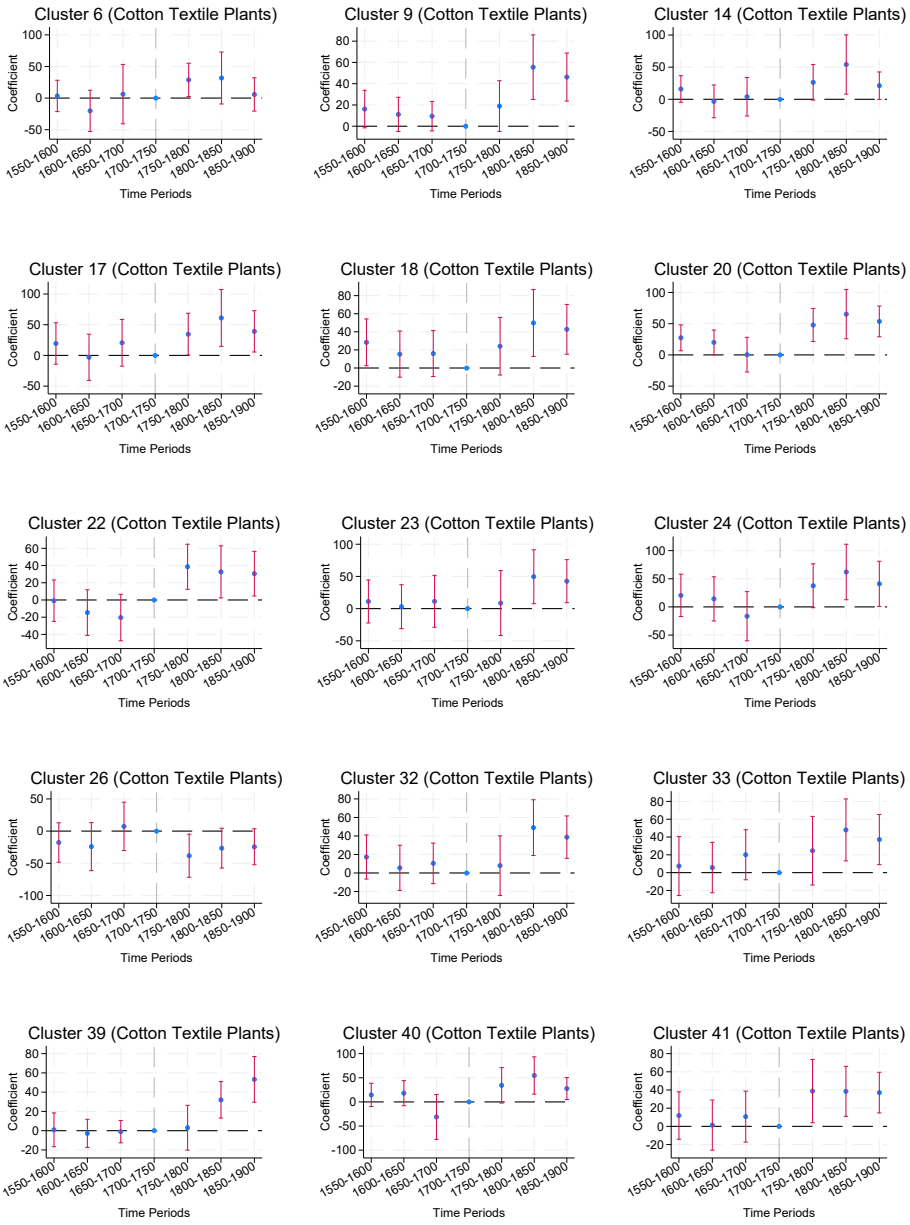


Figure A.12: Effects of Industrialization Intensity on the Frequency of Proverbs in Statistically Significant Topics, 1550–1900

Note: This figure presents the estimated coefficients from a flexible difference-in-differences (DID) model examining the relationship between industrialization intensity and the frequency of proverbs in clusters that exhibit significant changes following industrialization, without a significant trend before 1750. Each panel corresponds to a different proverb cluster and displays the estimated effects of industrialization intensity—proxied by the number of cotton textile plants in 1838—on the frequency of proverbs within that cluster over time. The y-axis represents the estimated coefficient, capturing changes in the frequency of proverbs within each cluster relative to the baseline period (1700–1750), while the x-axis represents different historical time periods from 1550 to 1900. Error bars indicate 90% confidence intervals. Positive estimates suggest that the usage of proverbs in a given cluster increased in more industrialized regions relative to less industrialized ones, while negative estimates indicate a relative decline.