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Literary Fiction Indicates Early Modernization in China Prior to Western Influence

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Abstract: Modernization refers to the shift from traditional values to individual autonomy and self-development, driven by economic development. Previously considered unique to Western culture, modernization has now emerged as a global phenomenon, with East Asia playing a leading role. This article explores the possibility that modernization might have occurred outside the Western world prior to Western influence. We pioneered a novel approach for understanding the evolution of Chinese values by creating a unique and comprehensive database of narrative fiction. This database includes all major Chinese narrative fiction from the Tang dynasty (7th century) to the present, encompassing 3,496 works from mainland China and 3,338 modern works from Singapore, Taiwan, and Hong Kong. It also provides a systematic comparison of ancient fictions and their modern adaptations (e.g., *Journey to the West*). Our findings confirm that modernization has been underway in China since the late twentieth century. Surprisingly, a similar rise in modern values was detected as early as the seventeenth and eighteenth centuries, coinciding with significant economic development. This era saw an increasing expression of romantic love, open-mindedness, and reciprocal cooperation. However, this shift was not sustained, leading to a significant reassertion of traditional values from the late eighteenth century until the early twentieth century. These findings not only highlight the nuanced dynamics of early modernization beyond Western contexts but also demonstrate that values are dynamic, evolving constantly in response to economic development, thereby challenging the binary distinction between WEIRD (Western, Educated, Industrialized, Rich and Democratic) and non-WEIRD societies.

Keywords: modernization; value; history; fiction; economic growth

Reproducibility Package: The data analyzed in this article are available at https://osf.io/5bkqa. All replication codes and detailed instructions for replication can also be accessed at the same link. The pre-registration documents are available at `https://osf.io/9nxpe`.

MODERNIZATION refers to the process of transition from a traditional society to a modern one (Giddens 1991; Inglehart and Welzel 2005; Weber 1978), involving significant shifts in individual motivations as economic and physical security increase. For example, this transformation includes an intergenerational shift in values from group solidarity, collective social norms, and authoritarian attitudes to a greater tolerance of outgroups, openness to new ideas, more egalitarian norms, individual autonomy, and self-actualization (Inglehart 2018). Although modernization was once thought to be unique to Western societies (Weber 1978), it is now recognized as a global process (Welzel 2012). Extensive research has shown that economic development leads to predictable and coordinated changes in societal values and psychological traits, transcending cultural, religious, and geographic boundaries (Inglehart 2018; Inglehart et al. 2000; Norris and Inglehart 2004; Rotem, Weinstock, and Greenfield 2024; Weinstock et al. 2015; Welzel and Inglehart 2005).

The process of global modernization finds a compelling illustration in contemporary China, where social movements such as "lying flat" (*tang ping*) and "kinship disconnection" (*duan qin*) mark a generational departure from traditional values of hard work, discipline, conformity, and parental authority, while prioritizing subjective well-being and self-development (Han 2023; Zhao 2018). Supporting these observations, quantitative studies reveal notable generational shifts in individual values since the 1980s. Younger generations have increasingly emphasized personal enjoyment and self-improvement over societal contributions (Egri and Ralston 2004; Sun and Wang 2010), become more individualistic (Cai et al. 2018; Ma and Yuan 2016; Xu and Hamamura 2014; Zhang 2010), shown greater curiosity (Zhou et al. 2018), exhibited greater extraversion, openness, and conscientiousness (Peng and Luo 2021), valued more intimate friendships (Sun and Wang 2010), reduced obedience to family elders (Zhou et al. 2018), become less frugal (Hung, Gu, and Yim 2007), and become less collectivistic (Zeng and Greenfield 2015). Taken together, these qualitative and quantitative findings reveal an ongoing process of modernization in contemporary China in response to economic development.

If modernization inherently accompanies economic development, this phenomenon would not be confined to contemporary times, but would also be discernible during previous periods of economic growth, even outside the Western contexts. Intriguingly, cultural historians have observed that the Ming and early Qing dynasties witnessed substantial shifts in values, including increased self-awareness (Gao 2010; Hegel 1981; Postel 2017), romantic love and the expression of sentiment (Carlitz 2011; Pan 2015; Ropp 2006; Sun and Wang 2010), cooperation with non-kins through friendship (Huang 2007), moral obligation toward non-kins (Hanan 1985; Sibau 2018), and self-development (Lufrano 1997; Yü 2021). These observations are particularly relevant given that recent studies have revealed a significant period of economic development during the Ming and early Qing dynasties (seventeenth and eighteenth centuries), marked by rising Gross Domestic Product (GDP) per capita (Bolt and Van Zanden 2020; Xu et al. 2015), urbanization ratios (Xu, van Leeuwen, and van Zanden 2018), and expanded industrialization during these periods (Li 2000).

These observations suggest that China may have experienced an early phase of modernization during the seventeenth and eighteenth centuries, coinciding with economic progress, largely occurring prior to Western contact. During the seventeenth century, Jesuit missions reached Beijing, yet their impact was limited to a small group of scholars, and their translations of Western texts were largely concentrated on subjects of astronomy, cartography, and mathematics (Deng 2009; Mungello 2012). By the eighteenth century, the Jesuits were expelled from China, and only a small proportion of Christian converts remained. Even after the First Opium War, which forced the government to open ports for trade and cede or lease territories, the educated elite remained largely ignorant of the West and its learning (Xiong 1998). It was not until the end of the nineteenth century that the first Western novels were published in Chinese (Pollard 1998).

Interestingly, modernization theory predicts that, if this modernization phase occurred, it was not sustained. During the nineteenth century, China experienced a serious economic decline marked by a decline in GDP pc (Broadberry, Guan, and Li 2018), daily wages (Allen et al. 2011; Baten et al. 2010), and urbanization

ratio (Xu et al. 2018). Despite a modest recovery at the end of the late nineteenth and early twentieth centuries (Broadberry et al. 2018; Morgan 2004), significant economic growth did not occur until the late twentieth century. The prolonged economic stagnation throughout much of the nineteenth and twentieth centuries likely hindered and even reversed the process of modernization, suppressing the emergence of new values. Thus, China presents an intriguing case in economic and cultural path, providing a unique opportunity to explore the modernization process outside the Western hemisphere.

Tracing the values of historical populations is challenging, as it is impossible to use experiments or questionnaires. Yet, the abundant cultural productions left behind by these populations, combined with recent computational tools, provide a possible solution (Duan et al. 2023). Specifically, works of fiction offer rich information about the people who created and consumed them, and the society in which they lived. Fiction has been shown to reflect specific individual preferences (Baumard et al. 2023). For example, individuals who value romantic relationships are more likely to be interested in reading romance fiction (van Monsjou and Mar 2018). People who value exploration and seek out adventure are more likely to be interested in imaginary worlds and fantasy fiction (Dubourg et al. 2023). Consumption patterns of fiction can even reflect the person's personality (Cantador et al. 2013; Kraaykamp and Eijck 2005; Nave, Rentfrow, and Bhatia 2020; Ng et al. 2017; Rentfrow, Goldberg, and Zilca 2011). Overall, fictions from the past can be construed as "cognitive fossils": they represent the cognitive imprints of psychological traits belonging to people who no longer exist and can be leveraged to track more or less distant psychological changes throughout history (Atari and Henrich 2023; Baumard et al. 2023).

The aim of this article is to draw on findings from behavioral sciences to quantify the evolution of values over time, using Chinese fiction as material. To do so, we reviewed the literature in behavioral sciences to identify and select values that are likely to be plastic in response to economic changes (Baumard 2019; Dubourg et al. 2024; Pepper and Nettle 2017). For example, the importance of romantic love has been reported to vary both across countries and within a country, correlating with levels of social development (Sorokowski et al. 2023).

Second, the selected values must be related to the broader modernization process. For example, individuals who prioritize status, strong kinship and in-group ties, punishment, social control, and authoritarianism tend to favor dominant, strong leaders, adhere to tradition, and suppress the emergence of new cultures. Conversely, self-expression, cooperation with strangers, and exploratory behavior require greater tolerance of others, openness to diversity, and higher levels of social trust (Inglehart and Welzel 2010), which contribute to the formation of modern institutions.

Third, fiction is constrained by topics and genres that appeal to readers in a predictable way, rather than bargaining ideologies, rules, or knowledge as nonfiction does (Clasen 2017; Dubourg et al. 2024; Morin, Acerbi, and Sobchuk 2019; Salmon 2012). We select values that are well represented in Chinese fiction. For example, Carlitz (2011) highlights the strong emphasis placed on conjugal love between husbands and wives by male epitaph writers of the late Ming period.

Despite traditional Confucian norms that prioritized father–son and clan relationships, Ming intellectuals increasingly expressed their emotional bonds with their spouses, defying the conventional view that such expressions of affection were inappropriate. The increasing value placed on love is well reflected in fictional works during the period when it became a genre itself, the *scholar-beauty* story (Geng 2004; Huang 2001). The genre features a young scholar and a beautiful woman, who represent the best in intelligence, appearance, and moral character: "They meet by chance and then get to know each other, often through the exchange of literary messages, especially poetry. It becomes spontaneously apparent that they are meant for each other. Mean people try to steal the woman away or otherwise prevent the two from uniting, but they fail because the youths are so much cleverer and virtuous. They match for their own benefit rather than their parents, although ultimately they obtain their parents' blessing as well as conform to the idea that the man should pass the official exam before marrying the woman" (McMahon 1995:103). The *Gods and Demons* genre, exemplified by *Journey to the West*, blends supernatural beings and religious themes to convey the pursuit of adventure, self-development, and morality. Similarly, *Yanyi* genres dramatize historical events, often set in times of war or political upheaval, to convey the appraise of loyalty, friendship, and cooperation among characters. These various genres at the time have enjoyed a tremendous popularity and proved highly tempting to many book buyers, judging by the increasing profitability of printing houses publishing these works since the fifteenth-century China (Chia 2002). In conclusion, Chinese fiction embed various values through significant literary genres, such as love (Geng 2004; Hsieh 2008; Huang 2001; Lee 2006; Pan 2015; Wang 1995), fantasy (Lu 2000; Marling 2017; Ni 2020; Song 2016; Xu 2017), cooperation (Shields 2020; Wan 2009; Wang 1997), honor–shame (Liu 2022), self-development (Ni 2020; Xu and Zhang 2023), tightness (Soh 2012), and decency (Ding 2002; Sommer 2007). We selected these values with proper definition based on behavioral science literatures and literary history studies.

Utilizing fiction as material to trace the evolution of social values throughout history presents various challenges. Both the language and the medium of fiction have undergone significant changes. We address this issue by using metadata generated by modern readers and literary scholars. Extensive research has demonstrated the feasibility of using knowledge from Wikipedia to support historical and literary research (Fischer et al. 2023; Konieczny and Klein 2018; Vrandeèiæ and Krötzsch 2014). In addition, projects conducted by humanities scholars in recent decades have generated increasingly large amounts of metadata. For instance, Jiangsu Social Science Center (1990), based on studies of previous works (Sun 1982), has compiled thousands of summaries of fictional works accessible in libraries in China and overseas. Based on these rich materials, we built a comprehensive and representative database of metadata for Chinese fiction. On the one hand, we integrate the rapidly expanding knowledge from encyclopedias such as Wikipedia and Baidu Baike. On the other hand, we include knowledge generated by humanities scholars (Jiangsu Academy of Social Sciences 1990) (see examples in Fig. 1). This approach allows us to combine complementary information from different platforms, mitigating data biases introduced by specific materials or sampling methods. Our data set includes metadata of 3,496 fictional works, spanning from 690 AD to 2022 AD, with a total
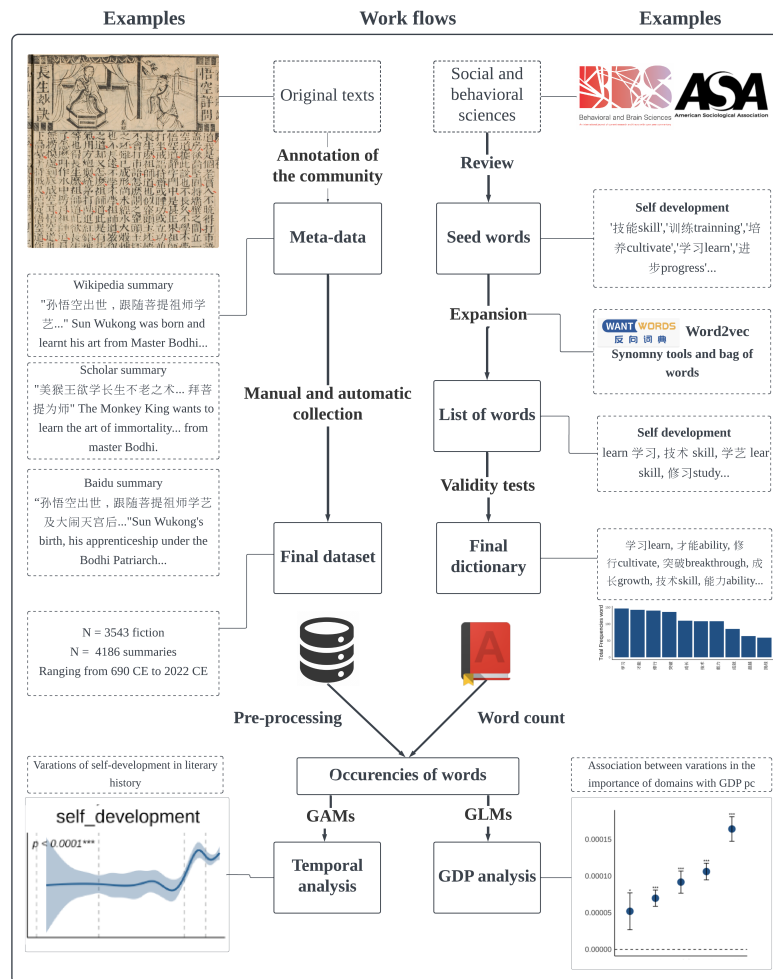
Figure 1: Chart of the workflow. On the left side, we collected metadata from three different sources to summarize the original story of Chinese fiction, using *Journey to the West* as an example. On the right side, we demonstrate how we conduct literature reviews and create dictionaries for values, using *Self-development* as an example. Finally, we analyze how the values have historically changed and how variations in these values are associated with changes in GDP pc.

of 4,180 summaries written by scholars and online communities. In addition, the database also documents the transmission and adaptation of stories throughout history, drawing on information from referenced bibliographies and Wikipedia.

To quantify the relative importance of selected values in fiction, we used a dictionary-based approach, which has been effectively used to measure the occurrences of love (Baumard et al. 2022), cooperation (Martins and Baumard 2020), morality (Alfano, Cheong, and Curry 2024), and empathy (Yaden et al. 2024) in texts. However, there are two potential challenges with this approach: first, the possibility of researchers selectively cherry-picking words. We employed word embedding and semantic models during word generation to avoid selection bias and pre-registered the generated dictionaries prior to analysis. Second, there is the

challenge of assessing the validity of occurrence of words representing social value evolution.

We conducted a series of pre-registered validity tests for dictionaries. First, the results show that the summaries well reflect the information of the original full fiction texts. The occurrences of love dictionary in summaries are highly correlated with that in full texts ($R = 0.53, p < 0.001^{***}$). Second, different film genres cater to meaningful segments of content preferences. For example, romantic films appeal to romantic ideas, fantasy films appeal to openness and imagination, and historical films appeal to interests in strategies, cooperation, and kinship. We created an independent sample of film summaries of different genres from Wikipedia to test whether dictionaries exhibit higher occurrences in the films that cater to the predicted interest. The results show notable group differences in the occurrence of value dictionaries in film summaries, with romantic comedy films, for example, showing a higher incidence of words of love and cooperation, whereas fantasy films show a greater presence of words of open-mindedness compared to historical films, controlling for sentence length. Dictionaries that failed to pass these validity tests were excluded from further analysis. Third, if the evolution of occurrences for dictionaries in summaries of fiction over time is consistent with the empirical evolution of values surveyed in other studies, then it is a signal that the dictionary is capturing meaningful changes. We take the sub-samples of fiction ranging from 1978 to 2022 and estimate the co-efficiency of value word occurrences with the years while controlling for other factors. We retained the values of dictionaries that positively correlate with time as modern values (*love*, *open-mindedness*, *self-development*, *friendship*, and *reciprocal cooperation*) and values that negatively correlate with time as traditional values (*honor*, *tightness*, *decency*, and *intensive kinship*). Through the series of validity tests, we retained dictionaries that could reflect the social values—at least within the dimensions as we have defined them—enabling us to delve into the past.

Results

Continuous Change over the Long Run

We begin with a descriptive analysis to examine how the importance of values may change over time. The definition and word frequencies for each value are presented in the online supplement. We used generalized additive models (GAMs) to visualize the nonlinear evolution of the importance of values in fiction over time, as shown in Figure 2b. Details of the modeling are described in the methods section and online supplement. Confidence intervals for periods prior to 1450 CE are wide due to the relatively smaller sample sizes ($N = 368$). From 1450 and 1911, there were 1,264 fictional works, with an even larger number of datapoints in the twentieth century and beyond. Therefore, we present temporal modeling results focusing on the period from 1450 to 2022 to provide a more informative illustration here.

As shown in Figure 2b, love experienced a marked increase from the 1600s (late Ming dynasty) to the eighteenth century (High Qing period), then entered a period
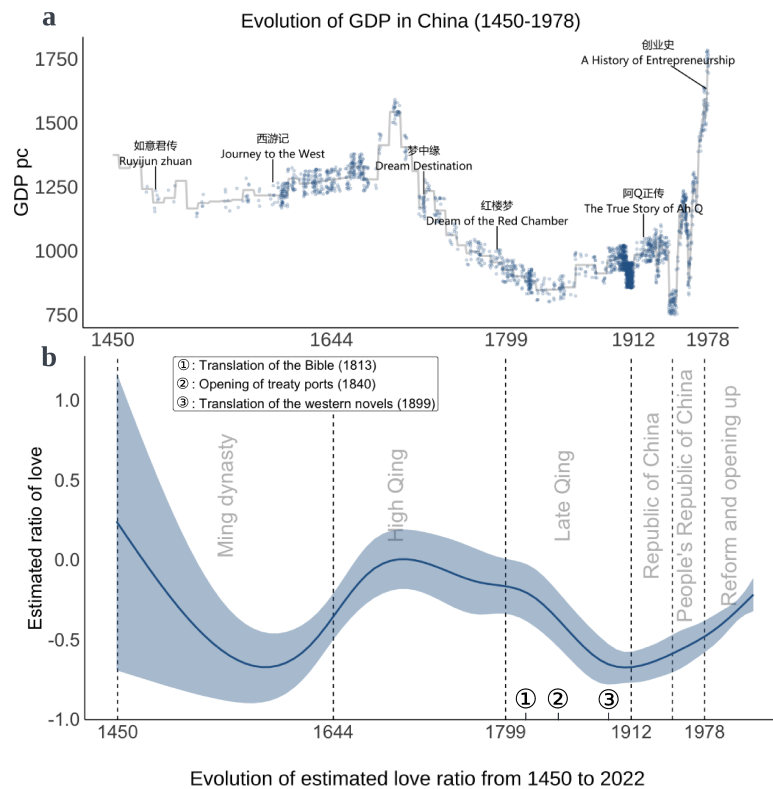
Figure 2: Evolution of GDP pc and romantic love in literary history. (a) Distribution of Chinese fictions (blue dots) with examples, and evolution of GDP pc from 1450 to 1978 (gray line). (b) Evolution of the estimated ratio of love in Chinese fiction from 1450 to 2022. The fitted line represents the average estimated smooth trend in the long run.

of steadiness before declining in the late nineteenth century (late Qing). In the twentieth to the twenty-first centuries, love regained its stature. This quantitative estimation aligns largely with qualitative statements in sociology and humanities studies, which suggest that love became more and more important to the Chinese's lives and marriages during the late Ming and high Qing period (Carlitz 2011; Ropp 2006), as well as during the early twentieth century (Lee 2006; Pan 2015; Su 2016; Yan 2003), and in contemporary times (Karjanto, Zhang, and Park 2023). Interestingly, the estimated importance of love in fiction appears to parallel the evolution of economic development (GDP pc), as shown in Figure 2a.

We replicated the descriptive analysis for the other eight values (see Fig. 3a). Similar to *romantic love*, modern values—*friendship*, *open-mindedness*, and *reciprocal cooperation*—increased in importance during the seventeenth and eighteenth centuries (economic rise), declined during the nineteenth century (economic decline), and rose again in the twentieth and twenty-first centuries (economic rise). In contrast, traditional values—*honor*, *intensive kinship*, and *decency*—were prominent until the late nineteenth century but declined rapidly from the late nineteenth century to the 1950s, with a further drop in the twenty-first century (economic rise). *Self-development* exhibits a modern pattern of evolution as well, but later in
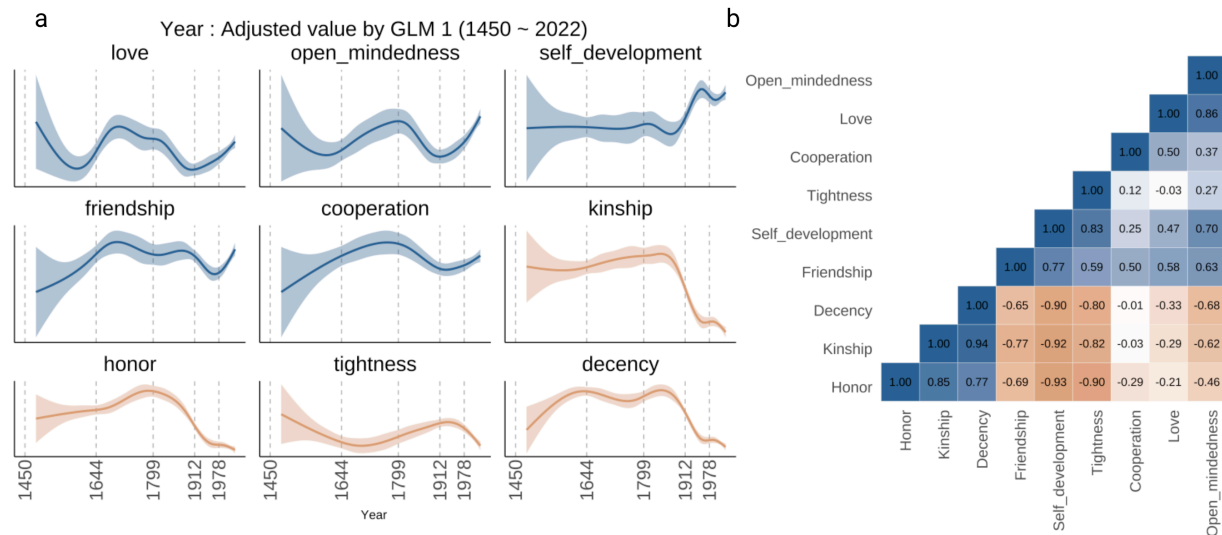
Figure 3: Evolution of nine values and "the modernization syndrome." (a) Evolution of the occurrence of nine values in Chinese fiction from 1450 to 2022. Eras are divided by benchmark years in history. (b) Correlations between the ratio of domains based on GAM model values. Mean correlation $r = 0.3248(p < 0.0001^{***})$.

time, with an increase during the twentieth century. The evolution of *tightness* is more complex, peaking during the 1940s to 1950s (the periods of World War II, the Chinese Civil War, and the Korean War) before declining sharply in subsequent decades (economic rise).

Taken together, the results suggest that signs of modernization were present as early as the seventeenth and eighteenth centuries, followed by a prolonged interruption and a long period of "de-modernization." We also observed a brief interruption in the modernization process, as shown in Figure S24 (online supplement), characterized by drops in *love*, *friendship*, and *self-development* from the 1950s to the 1970s (the Great Leap Forward and the Cultural Revolution), coinciding with a drop in GDP pc around 1960s (Bolt and Van Zanden 2020).

Test the "Modernization Syndromes"

Economic development can trigger a series of changes in preference expression, suggesting a coordinated change in motivation systems (Baumard 2019; Inglehart and Welzel 2010). Figure 3b presents the matrix of correlation coefficients between nine values. Results reveal that eight values change coordinately in response to the economic shifts, except for the value of *tightness*. The increase in the importance of *open-mindedness* is highly positively correlated with the increase in *love*, *self-development*, and *friendship*. In addition, they are both correlated with declining in *intensive kinship, honor,* and *decency*. A bootstrap analysis was conducted to examine how statistically significant this coordination is likely to occur. By reshuffling the data across nine columns of values 10,000 times, we disrupted temporal associations between estimated value importance and time before calculating mean correlation scores between nine values for 10,000 iterations. The procedure produced a normal

distribution of mean correlation scores centered around zero. Notably, the observed correlation score of 0.3248 was significantly higher than this normal distribution ($p < 0.0001^{***}$) (see Fig. S27 in the online supplement), indicating the systematic pattern of modernization process.

## Value Changes Correlate with Economic Development

With significant inter-correlated variations in values and economic development over the long run, we conducted an inferential analysis to test whether value changes are correlated with economic development. Generalized linear regression models (GLMs) with Poisson regression were employed to examine the correlation between the frequency of value words and GDP pc (based on the year in which the fiction was produced). Variables such as year of publication (the estimated publication year for the fiction), source of summary (whether Wikipedia, Baidu, or scholars), type of fiction (textual or video), and length of summary (the number of words in summary) were controlled. The analysis combines all fiction samples spanning from 690 CE (Tang dynasty) to 2022 CE, with a total sample size of 4,186.

Given the substantial disparity between ancient and modern GDP pc, we also used logarithms of GDP pc as an indicator and replicated the analysis. Additionally, we hypothesize that changes in values may be sensitive to the economic cycle, including short-term upturns and downturns. To explore this, we calculated the decadal rate of change in GDP pc (ΔGDP pc) and replicated our analysis.

The estimated parameters of dependent variables (nine value word occurrences) and the independent variables (three different treatments of GDP pc: GDP pc, logarithm of GDP pc, and ΔGDP pc) are reported in Figure 4. The *y*-axis represents the estimated coefficients of independent variables. The relationship between economic development and change in values is consistent with our prediction across different treatments of GDP pc. Specifically, the occurrences of words of *love*, *friendship*, *open-mindedness*, and *self-development* in fiction are significantly and positively associated with GDP pc, the logarithm of GDP pc, and ΔGDP pc. The occurrence of words of *reciprocal cooperation* in fiction is only significantly associated with ΔGDP pc. In contrast, *intensive kinship*, *decency*, *honor*, and *tightness* are negatively associated with three treatments of GDP pc. In summary, our findings reveal an association between economic development and value changes in fiction, indicating that during periods of economic development, people are more likely to produce fiction involving modern values while creating fewer fiction that mentions traditional values.

External Validity Checks

To further explore the modernization hypothesis, we draw on China's long and rich literary history, characterized by adaptations, borrowings, and transformations. Literary works form transmission chains in which storylines are passed down through generations. These chains go beyond replication or imitation; they are characterized by transformation, mutation, and innovative reworking (Claidière et al. 2014; Morin 2016; Sperber 2001). For instance, we consider the adaptation of the *Biography of Yingying*, a Tang dynasty short story, into *The Story of the Western Wing*,
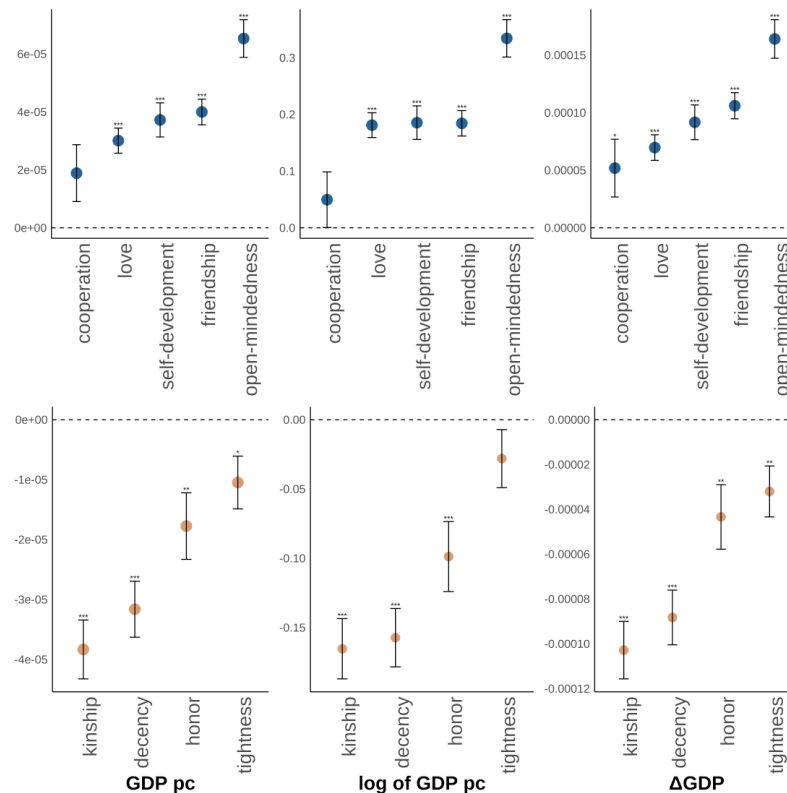
Figure 4: Estimation of three groups of GDP pc with domain occurrences. The *y*-axis represents the coefficient values of the indicators and the *x*-axis represents the names of nine values. Significance of each model is marked at the top of the bar ($p < 0.001$; $p < 0.01$; $p < 0.05$).

a Yuan dynasty play. In the original Tang version, Yingying does not immediately fall in love but initially rejects the scholar's advances, engaging with him physically without explicit emotional expression, and the story concludes without a happy ending. Conversely, the Yuan adaptation offers a romantic and joyous conclusion, portraying Yingying as passionate, intelligent, and morally conflicted—a stark contrast to her depiction as capricious and unreliable in the Tang version (Geng 2004; Lanselle 2018; Mair 2010).

Similarly, *Journey to the West*, the best-known *gods and demons'* story, is based on the historical record of Xuan Zang's journey to India. Through its transmission from historical fact to Ming version to modern fiction, imaginary elements and romantic love have revitalized the story and contributed to its modern global success (Sun 2018). By analyzing how the same story is transmitted across time, we can trace changes in readers' values over time (Dubourg and Baumard 2022). Figure 5 presents 630 adaptation relationships between 580 adaptations and 138 original works (details of data collection are presented in methodology and online supplement).

We modeled the association to examine how changes in the importance of different values across versions of a transmitted story are associated with the economic conditions at the time these versions were created. After controlling for
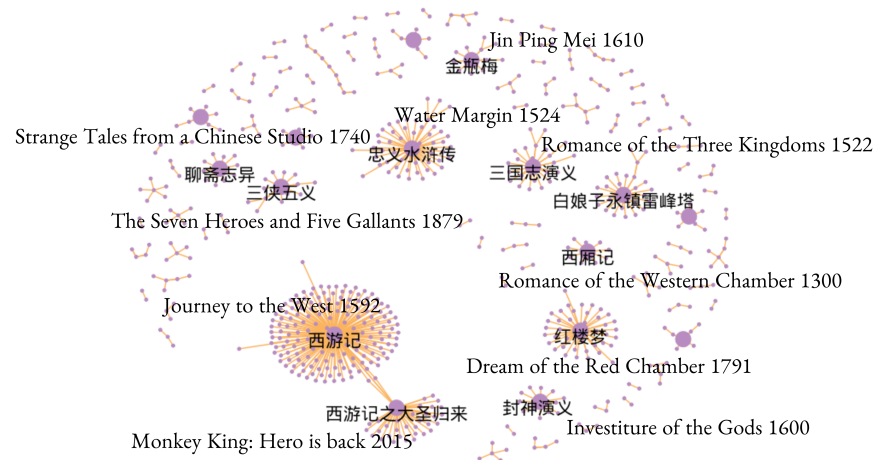
Figure 5: Literary transmission chains of Chinese fiction. Each point represents a fiction and the connections between these points symbolize the relationship of adaptation. Labels of Chinese names are given to the fiction that is adapted over seven times in history.

the influence of media type, length of summary, and year produced (see model 4), we found an increasing occurrence of values words in story for *open-mindedness* ($b = 0.2027, p < 0.001^{***}$), *friendship* ($b = 0.2579, p < 0.001^{***}$), and *self-development* ($b = 0.1313, p < 0.001^{***}$) in adaptations created during economically better years compared to the original versions. In contrast, we found a negative correlation between *tightness* and economic development ($b = -0.2252, p < 0.001^{***}$), where adaptations tend to display less *tightness* than the original works when they are produced in economically better year. No significant results were found for the other values. We investigated further whether changes in the content of adaptations align with historical periods in China. To examine this, we calculated the interaction effects between changes in GDP (ΔGDP) and historical periods (coded as dummy variables based on the year the adaptation was produced). The results reveal that the effects of ΔGDP on the frequency of values in adaptations vary by period. Notably, a significant positive relationship between ΔGDP and an increase in themes of love and friendship is observed in adaptations, especially in seventeenth and nineteenth centuries. In contrast, no significant association was found between ΔGDP and changes in open-mindedness, cooperation, or self-development during these periods. Full results are presented in Table S14 (online supplement).

Finally, we took advantage of the fact that since 1949, several regions, namely Hong Kong, Taiwan, and Singapore, have developed independently of mainland China. Despite sharing a common cultural heritage, including language, literature, and religion, these regions have followed significantly different trajectories, characterized by earlier and more substantial economic growth. For instance, more than 58 years from 1960 to 2018, Singapore's GDP per capita surged twentyfold. In comparison, by 2018, mainland China's GDP pc ($13102) was still comparable to Hong Kong's GDP pc in 1976 ($12,929) (Bolt and Van Zanden 2020). This comparison provides an external case for validating the hypothesis of modernization.

To do so, we compiled a new data set encompassing modern films and novels from these three regions ($N = 3,338$), spanning from 1900 to 2023, using Wikipedia and Baidu Baike (details are provided in the online supplement). Our results largely support the modernization theory, showing that individual values reflected in fiction for *love* ($b = 8.179e − 06, p < 0.001^{***}$) and *open-mindedness* ($b = 8.510e − 06, p < 0.001^{***}$) are positively associated with economic development. In contrast, the occurrences of *tightness* ($b = −8.179e − 06, p < 0.001^{***}$), *intensive kinship* ($b = −7.848e − 06, p < 0.001^{***}$), and *honor* ($b = −1.057e − 05, p < 0.001^{***}$) in fiction are negatively correlated with economic development. Interestingly, different from mainland, we find a significant negative correlation between economic development with *reciprocal cooperation* ($b = −1.228e − 05, p < 0.001^{***}$) and *friendship* ($b = −3.182e − 06, p < 0.05^{*}$) in these three regions. No significant relationship is found between economic development with *decency* and *self-development*. The results remain consistent for the logarithm of GDP pc.

Discussion

The modernization process was long considered as a purely Western phenomenon (Weber 1978). Later, it was refined to describe how increased security, the eliminating of starvation, extending life expectancy, and, more generally, economic development, bring about changes in human motivation, enabling people to shift from survival strategies to the pursuit of a wider range of aspirations (Inglehart 2018:201). The modernization of Japan, and then East Asia in general, has shown that modernization is a universal phenomenon, correlated with economic development and partially independent of cultural, religious, or institutional legacies (Inglehart 2018). Our work goes further. The study constructed a data set of 3,496 Chinese fictional works spanning from 680 CE to 2022 CE, enriched with important metadata and transmission network data. Additionally, we developed a complementary database documenting modern fiction in Chinese from the regions of Hong Kong, Taiwan, and Singapore, which offers potential for future research on cultural change and evolution. We pioneered a novel approach to reconstruct individual values in various domains through cultural fossils, quantifying social values in texts and tracking their changes over time through longitudinal models. We further replicated this approach to cultural transmission chains in fiction and modern samples beyond mainland China. Our results reveal that the modernization process is not confined to modern period. It can be detected as early as the seventeenth century, accompanied by economic advances, prior to Western influence. We also identify a potential reversal of the modernization process during the nineteenth century, and later, during the third quarter of the twentieth century. This is consistent with findings on "de-modernization" (Inglehart 2016), observed in modern samples during periods of economic decline (Greenfield 2009; Park, Twenge, and Greenfield 2014, 2017).

These findings also validate previous qualitative research on the evolution of social values in Chinese history, such as love (Baumard 2021; Carlitz 2011; Lee 1997; Pan 2015; Ropp 2006; Wang 1995), open-mindedness (Chang and Owen 2010; Shahar 1996; Sun 2018), friendship (Huang 2007; McDermott 2006), and

self-development (Hegel 1981; Postel 2017; Xu and Zhang 2023; Yü 2021). They echo quantitative historical analyses of Western countries that document similar shifts in psychology parallel to economic advancements, including increases in cooperative behaviors (Martins and Baumard 2020; Safra et al. 2020) and the elevation of romantic love as a cultural norm (Baumard et al. 2022). The findings for the late twentieth to twenty-first centuries speak directly to empirical results from values surveys showing generational shifts in Chinese motivations and the restructuring of their life priorities (Han 2023; Zhao 2018). This convergence of qualitative and quantitative evidence underscores a universal pattern: values evolve in response to economic development. However, it is important to note that the mechanisms of modernization require further examination. For example, modern and traditional values are not necessarily mutually exclusive. The emergence of new values does not automatically imply the disappearance of traditional ones. Our external validity analysis shows that the procedure may vary across contexts and political regions. Other factors may also contribute to explaining how modernization drives values change through generational replacement, how new social norms and traditional ones negotiate, and ultimately to how value translate to social consequences, such as science, democracy, institution, and equality (Fukuyama 2001; Inglehart and Norris 2005; Zmerli and Newton 2008).

The study aligns well with a growing body of research in behavioral science and psychology, which shows that improvements in living standards lead to significant changes in individual behavior and preferences (Boon-Falleur, Baumard, and André 2024; Pepper and Nettle 2017; Sng et al. 2018). Specifically, as living conditions become more favorable, individuals tend to adopt a more long-term and optimistic mindset, which translates into increased exploratory behaviors, greater interpersonal trust, and investment in relationships (Boon-Falleur et al. 2024; Zhu and Chang 2019, 2020; Zhu, Lu, and Chang 2021), and conversely, a decrease in behaviors characterized by distrust, strong social control, punishment, and dominance (Baumard 2019; Boon-Falleur et al. 2024; Pepper and Nettle 2017). These behavioral and value shifts can be seen as adaptive responses to environmental changes. When organisms have access to more resources, their immediate needs are met, allowing them to focus on long-term and potentially more rewarding goals. This pattern, observed in both humans and non-human animals (Pepper and Nettle 2017), helps explain why individuals develop new preferences and the nature of the recurrent modernization.

Future studies could test modernization through other materials such as administrative data (Shang and Huang 2022) or cultural artifacts (e.g., paintings) in other societies. An obvious candidate would be Japan during the Tokugawa period, when Japan was strictly isolated from the rest of the world because of the Sakoku policy. Despite this isolation, the period was marked by notable economic development, as evidenced by an increase in trade, industry, and urbanization (Bassino, Fukao, and Settsu 2020; Nakabayashi et al. 2020). The period saw a flourishing of artistic creativity and a growing cultural emphasis on romantic love (Keene 1999), indicating profound shifts in social values.

Finally, these findings challenge the traditional dichotomy between Western and non-Western societies, a concept referred to as "Orientalism" by Said (1979), which we find today in the distinction between WEIRD and non-WEIRD societies

(Ghai 2021; Krys et al. 2024; Sakaluk and Daniel 2022). This viewpoint tends to overemphasize similarities among non-Western societies while exaggerating the differences with Western societies, positing Western (or Christian) societies as inherently more individualistic, open, and modern. For example, rather than recognizing that societies are dynamic and constantly evolving, the WEIRD framework may "freeze" non-Western societies as if they were fundamentally incompatible with traits such as individualism or rationalism (Ghai 2021). In fact, most societies are becoming more educated, industrialized, and democratic (Greenfield 2018; Rosling, Rönnlund, and Rosling 2018). Thus, our research provides evidence that WEIRD characteristics can emerge in societies with favorable economic conditions. The rapid modernization observed in many non-Western societies demonstrates that geographic or cultural proximity to the West is increasingly irrelevant to a society's modernization trajectory (Inglehart 2018). Our work also challenges the explanatory power of the culturalist framework, which posits that "cultures" predominantly shape and determine individual values. Instead, our findings suggest that individuals show remarkable plasticity to prioritize personal goals and relationships rather than adhere to traditional rules, even within societies traditionally labeled as "collectivist."

Materials and Methods

Data Collection

Fiction data. Before the twentieth century, fiction was not included as a separate catalog in historical records, and there was not even a definition of "fiction" in Chinese. Since the twentieth century, historians have begun systematically documenting fictional works and compiling them into the bibliographies of fiction. Important works include Lu Hsun's study on ancient Chinese fiction, which documents the most popular fictional works from the Han dynasty (400 AD) to the end of the Qing dynasty (1912 AD) (Lu 2000). The bibliographies of Chinese popular fiction compiled by Sun (1982), and the continuation of work based on these efforts (Jiangsu Academy of Social Sciences 1990) contribute to further complement the database, with metadata on 1,164 vernacular fictions and 960 well-written summaries by scholars.

These materials not only serve as indices for tracing fiction in history but also directly provide summaries of fiction for our database. For modern fiction produced since the twentieth century, significant media changes have occurred, as modern Chinese audiences consume large amounts of video-based fiction. Fortunately, these fictions are well documented in online encyclopedias such as Wikipedia and Baidu Baike, which contain more than 2,000 entries on Chinese films and dramas. Although the crowded materials may introduce noise, they are sufficient to provide the thematic information of the story, such as fantasy, love, friends, battle, trust, and kinship. These words then can be easily computed through dictionary methods (see examples in Fig. 1). It is also important to mention the limitations of this data collection method. For example, the transmission of cultural records throughout history is incomplete, and the available data may represent only a fraction of the total population, likely biased toward popular ones. In addition, the metadata

generated by contemporary readers may introduce biases in the representation of certain topics, reflecting modern interpretations. However, this potential bias does not necessarily translate into bias in analysis. We aim to track changes in values over time, and the bias may result in a fluctuation of evolutionary line as a whole rather than a localized bias. Furthermore, we controlled the influence of sources of information in our statistical models (Wikipedia users, Baidu Baike users, and scholars).

For literary fiction, we collected data based on bibliographies compiled by humanities scholars. For narrative fiction before 1912, we began with the list of fictional works mentioned by Lu Hsun (Lu 2000), starting from chapter eight "Tang *Chuanqi*" (because stories before the Tang Dynasty are not recognized as fiction by most scholars). We first verified whether the work mentioned is fictional based on the information provided by Lu Hsun and other online encyclopedias, and if so, we collected available metadata for the work from both Baidu Baike and Wikipedia. This process concluded with the last Qing Dynasty sample, *A Flower in a Sinful Sea* (1905 CE). We repeated the same process using another bibliography (Jiangsu Academy of Social Sciences 1990), collecting not only the metadata from Baidu Baike and Wikipedia but also the metadata written by scholars in this bibliography. We stopped at the last example in this book, which is the *Biography of Guo Gong* (*Daiyin Qi Yuan Guo Gong An* 1912 CE). This process added not only online materials but also 960 fiction summaries written by literary scholars. For narrative fiction published after 1912, we repeated the process by referring to contemporary literature bibliographies (Hong 2007; Qian, Wen, and Wu 1998) and the annual rankings of the most popular books listed on Douban (https://book.douban.com/top250) and Dangdang (for the year of 2022, e.g., http://bang.dangdang.com/books/bestsellers/01.00.00.00.00.00-year-2022-0-1-1). Based on these sources, we gathered metadata again from Baidu Baike and Wikipedia. For popular fiction not mentioned by literary scholars, such as *martial arts* novels or online literature, we completed the lists by automatically retrieving all existing narrative fiction associated with China on Wikipedia. This step resulted in a database of the most important literary works of fiction ranging from Tang to modern times.

The data for the non-literary fiction category were collected using the query services provided by open access knowledge base, Wikidata (https://query.wikidata.org/). Wikidata is a database that serves as a repository for all items found in Wikipedia and other databases. The database offers automatic query methods based on characteristics of items such as country of origin, genre, and instance of art. We conducted an automated data harvesting process for films, TV series, and dramas published in China. The metadata, which includes the summary of the stories, the year of publication, and the thematic content of the films, are then collected based on the URLs provided by the Wikidata services. Duplicates were removed. Details of data collection are presented in the online supplement.

For the year of publication, we coded it based on information provided by bibliographies and online encyclopedias. For fiction with an unknown publication date, we inferred an approximate date based on the author's lifespan. In cases where the author was unknown, we inferred an intermediate date based on the dynasty during which the book was written. For books with multiple editions, we used the year of the earliest edition for coding.

Adaptation data. During data collection on ancient fiction, we paid attention to the adaptation's information mentioned in literary bibliographies, Baidu Baike, and Wikipedia pages. We recorded these adaptation relationships and, based on the fiction names given in these sources, further collected the metadata of each adaptation from Baidu Baike and Wikipedia. If an adaptation had other adaptations, we repeated the collection process until no other adaptations were found. Full details of the adaptation collection process are provided in the online supplement. Description of the data is shown in Figure 5.

Fiction Data for Three Regions in Asia

The purpose of our data collection was to automatically gather available modern novels and films from Hong Kong, Taiwan, Singapore, and Mainland China using Wikipedia and Baidu Baike, independently from previous part for an external validity check. For novel data, we collected lists of novelists, playwrights, or screenwriters from Wikipedia based on the region (Taiwan, Singapore, and Hong Kong). Then, we checked the Baidu Baike website to see if there were entries about these writers, and if so, we extracted the titles of the fiction created by these authors and the corresponding Baidu Baike links of works. Next, we extracted the following information from the Baidu Baike page: description (including the first paragraph of the entry page and the main story, usually under specific tags) and date of publication (the first recorded date of publication for each work). For movie data, we used the Wikidata Query Service to query modern films from Taiwan, Hong Kong, and Singapore. Based on the URLs of each work, we extracted the following information from Wikipedia: the name of the film, the year of the film's release, and the description (including the first paragraph of the entry page and the main story). For details on data collection, see the online supplement.

GDP Per Capita

We used GDP pc estimated for mainland China, Singapore, Hong Kong, and Taiwan from the Maddison 2020 project (Bolt and Van Zanden 2020). This database aggregates the most updated and significant works done for China's economic history. Notably, independent teams of scholars who quantified Chinese economic growth before 1900 produced remarkably similar estimates (Broadberry et al. 2018; Xu et al. 2015). Because continuous datapoints are not available for every year, we used interval estimates to construct a continuous annual indicator of GDP pc. For GDP pc from 2019 to 2022, we used World Bank data and converted the units of currency to maintain consistency with Maddison's data (calculated in 1990 U.S. dollars).

Methodology

To quantify the importance of domains in texts, we performed a series of procedures, including text pre-processing, generating dictionaries, calculating value word occurrences, temporal modeling, and model analysis (see Fig. 1).

Pre-processing of Text

For each summary of fiction, we segmented the sentences into "tokens." This was done using the Jieba package in Python, which is optimized for modern Chinese language. We removed the punctuation using the package "zhon."

Generating Dictionaries for Values

We built new dictionaries for each value in this study. Existing tools, such as LIWC and the Chinese version of LIWC (Boyd et al. 2022; Tausczik and Pennebaker 2010), are more suited for analyzing domains as sentiment analysis for social media texts. To tailor the analysis for our target variables, we operationalized value concepts into measurable dictionaries. To do so, we reviewed literature in psychology, sociology, and cultural studies to identify seed words for each domain. For example, *love* is conceptualized as three components in literature, including *intimacy*, *passion*, and *commitment* (Sternberg 1986). Detailed definitions of all values are provided in the online supplement.

We then extended the list of seed words by adding relevant terms. Specifically, we used Wantwords (Zhang et al. 2019) and Python package "synonyms" (https://github.com/chatopera/Synonyms/) to identify semantically related words for each seed word. Finally, we used word embedding method to evaluate and expand the word lists selected in previous steps. The embedding was based on the Word2vec algorithm, trained on a Chinese corpus from Baidu Baike. Through this process, we extracted 10 words (each word represents a vector), which were located closely around words selected in the previous steps. We then manually evaluated whether these words were appropriately embedded in the context of romantic love. We pre-registered the processes and the dictionaries for values on the OSF platform.

Validity Test of Methodology

We conducted a series of validity tests for dictionaries. The first test is to check whether the frequencies of dictionaries present meaningful differences between fictional genres, which are created to cater to different segmentations of audiences' interests. For example, romantic comedy films target romantic themes, whereas historical films target group dynamics, kinship, and alliances. If genres reliably segment these topics, differences in the occurrence of dictionaries would emerge in a predictable way. We expected a significantly higher occurrence of love dictionary in romantic comedy films compared to historical films. Similarly, words of open-mindedness were predicted to occur more frequently in fantasy films than in other genres. To conduct this validation, an additional data set of films was gathered from Wikipedia, with a total size of 2,834 films. These films cover a range of genres, including romantic comedy, historical, fantasy, martial arts, and Chinese drama films. Through multiple group *t*-tests for value dictionaries occurrences between genres, we retained the value dictionaries that significantly fit with genre target. We pre-registered that dictionaries not matching the genre target would not be included in further analysis. This led us to eliminate the value dictionaries of *punishment* (measurement of social control), *parenting*, and *self-cultivation* (a proxy for *self-development* value).

Second, we examined the reliability of the metadata by comparing it to the original text. A total of 802 original texts of ancient Chinese fiction were collected from open-source websites, including Wikisource, Handian, Open Literature, and Gushiwenwang. Among these, 334 fiction texts already existed in the database with summaries. This allows us to make the comparison. To analyze the full texts of ancient literature, we created a new dictionary for romantic love to quantify its presence in the original texts. For this purpose, the seed words of the generated dictionary of romantic love were previously selected, after which all sentences in texts containing these words were filtered out. Then, all words related to love in these sentences were manually extracted into a list.

During this process, we discovered that love is extremely implicitly in the original texts. For instance, romantic feelings were conveyed through the descriptions of beautiful appearances, or symbolic environments as "wind and moon" in the original texts. To capture these nuances, the ancient corpus (comprising the raw texts of 802 fictions) was employed to train a vector space utilizing word2vec embedding. The initial word list was then evaluated, and new words closely distributed within the vector space were added to the dictionary. Finally, the texts were pre-processed, and the ratio of love was calculated separately in full texts and summaries. Ratio of love was calculated by dividing the occurrences of love words by the total number of words in texts. A strong positive correlation was found between the two ratios with $r = 0.53, p < 0.001^{***}$. This indicates that the summary retains a great deal of information that can be used to identify the existence of value in story.

The present work assumes that fiction reflects the specific values of individuals. Does this assumption remain applicable in ancient societies where fiction may have been consumed by only a subset of the population? Evidence suggests that in ancient China, fiction was primarily consumed by the urban population, which included both literati and non-literati. Estimates indicate that the male literacy rate during imperial China was approximately 30–45 percent. Of greater significance is the fact that education extended well beyond the elites to prepare non-elites for the prestigious civil-service examinations, reaching a wide spectrum of society to fulfill the demand for commerce, local administration, or even agricultural production (Rawski 1979). Furthermore, historical studies provide compelling evidence that fictional narratives were disseminated beyond the literati (Chang and Owen 2010; Chia 2002). For instance, Chia (2002:247) wrote: "The cheaper works could and probably did command a larger market, which nevertheless overlapped with the market for the higher-priced works. The shangtu xiawen works of fiction in the Ming, therefore, enjoyed an audience that ranged from military officials to children to older students, who found them a less demanding way to learn their history, to all those who enjoyed reading or listening to the same tales told by storytellers on the street."

Although there is no direct way to test the validity of this point, recent quantitative surveys and social science studies in China have been reviewed to assess whether the observed measurement of dictionaries in fiction over the past 40 years align with trends estimated by large-scale empirical surveys. To test this validity, we modeled the correlation between word occurrences of dictionaries and years, controlling for length of summary, fiction type, and source of summary. This analysis was conducted using subsamples of our data spanning from 1978 to 2022.

Except for *authority*, *caring*, and *fairness*, all other value measurements were found to align with predictions and empirical evidence. These include an increased emphasis on romantic love (Yan 2003), young generations valuing self-development and friendship more than the older generations (Sun and Wang 2010), increased openness to experience (Zhou et al. 2018), greater individualism (Ogihara 2023), a decline in word occurrences of "efforts" in books (Zeng and Greenfield 2015), and a decline in emphasis on family and traditional rules (Schwartz 2006; Xu and Hamamura 2014). Based on the results of this validity test, we categorized the values to facilitate analysis. Values demonstrating a statistically significant positive correlation with time (1978–2023) are classified as "modern values," whereas those showing a negative correlation with time are categorized as "traditional values." Dictionaries that did not pass the validity test were excluded from the formal study. Nine dictionaries passed the test and were being processed for further analysis. Additional details are provided in the online supplement.

Temporal Evolution Analysis

We modeled the frequencies of value words against the text length and computed the residuals of this model. This procedure allowed us to control for the length of the summaries (see model 1), as ancient text summaries tend to be longer than modern fiction, which would bias the frequencies of domain words for pre-modern fiction (see Fig. S2 in the online supplement). The *b*1 value reveals the correlation between the number of occurrences of words and the total word count in each summary. The residuals of this model represent the adjusted frequencies of domain words in each summary

$$\text{Frequency}_i \sim \text{Poisson}\,(\lambda_i)$$

$$\log\,(\lambda_i)\ = b_0 + b_1 \cdot \text{Length}_i + \varepsilon_i \tag{1}$$

To graphically represent how the adjusted frequencies of domain words evolved, we used GAMs to describe the evolution of values over time. GAMs allow for flexible modeling of non-linear relationships by combining linear and nonlinear functions of the predictors. It is widely applied in time series modeling (Winter and Wieling 2016). For a detailed explanation of the method, see also Simpson (2018).

In GAMs, a smoothed function is fitted by combining several low-level functions (such as a linear function, a quadratic function, and a logarithmic function) over the entire time span. The *k* parameter limits the number of low-level functions used to construct the curve. By adjusting the value of *k*, we control the localized trend of the curve. To prevent overfitting, we used the default *k* term ($k = 10$) for all values. The *p*-value calculated by this model indicates the significance of non-linear relationship between year and adjusted frequency. The function is written as follows (where *s* represents the smooth term):

$$\text{Adjusted\_frequency}_i = s\,(\text{Year}_i, k = 10) + \varepsilon_i \tag{2}$$

Figures 2b and 3a show the results of the GAMs modeling, where we fit adjusted value word frequencies against years for intervals from 1450s to 2022s ($N = 4{,}082$).

The smooth line represents the estimated trends within the time interval. The temporal window through which the GAMs view the data is altered by adjusting the *x*-axis time interval. This alteration affects the inclusion of datapoints and the detection of temporal patterns and trends. For example, narrowing the time interval may result in the model focusing more on short-term fluctuations and localized trends, whereas widening it could highlight long-term patterns and broader trends. Graphical representations of the GAMs models for the entire data ($N = 4,186$, spanning from 690 to 2022) and the modern era (from 1900 to 2022) are presented in the online supplement.

Model Analysis with GDP pc

We predict that modern values (*love*, *open-mindedness*, *friendship*, *reciprocal cooperation*, and *self-development*) will be positively related to GDP pc, whereas traditional values (*honor*, *decency*, *intensive kinship,* and *tightness*) will be negatively associated with GDP pc. To test this hypothesis, we employed GLMs with Poisson regressions. GLMs extend ordinary linear regression by allowing response variables to follow a Poisson distribution, which is well-suited for modeling variables such as the frequencies of words. We examined the relationship between frequencies of value words with GDP pc (and the logarithm of GDP pc, ΔGDP pc). The year, the type of the fiction (textual or video), and the source of the summary (Baidu Baike, Wikipedia, or scholar) were controlled in models. The analysis was conducted on a total of 4,186 summaries, which range from the year 690 to 2022.

Here, we take years into our model to test the cultural accumulation theory, which suggests that cultural traits or knowledge tend to increase and improve over time because people continually refine and build upon existing ideas (Henrich 2015). We reported the co-efficiencies for year variables also in the online supplement

$$\text{Frequency}_i \sim \text{Poisson}(\lambda_i)$$

$$\log(\lambda_i) = b_0 + b_1 \cdot \text{Length}_i + b_2 \cdot \text{GDP}_i + b_3 \cdot \text{Year}_i + b_4 \cdot \text{Source}_i + b_5 \cdot \text{Type}_i + \varepsilon_i \tag{3}$$

Adaptation Analysis

Based on the coding of the adaptation relationships, transmission chains were visualized through network analysis with the igraph package in R.

For each original work and its adaptation, we calculated the difference between them in terms of frequencies of value words (ΔFrequency), GDP pc (ΔGDP pc), year (ΔYear), and type (ΔType). We hypothesize that differences in frequencies of value words (ΔFrequency) between adaptation with original fiction should be associated with ΔGDP *pc*, following the same prediction for each value as in the main study. To test the hypothesis, we employed GLMs for 580 adaptations and 138 original works. We did not control for sources of summaries because it is collinear with the type of fiction, where novels are collected from Baidu Baike, and video type of fiction is collected from Wikipedia. The model is written as

$$\Delta\text{Frequency}_i = b_0 + b_1 \cdot \Delta\text{GDP}_i + b_2 \cdot \Delta\text{Length}_i + b_3 \cdot \Delta\text{Year}_i + b_4 \cdot \Delta\text{Type}_i + \varepsilon_i \tag{4}$$

Method of Three Regions in Asia

For the fictions from Hong Kong, Singapore, and Taiwan, we merged them into one data set. Pre-processing was done using the same procedure as the main study, tokenizing the summaries, and computing the frequencies of value words in summaries. We replicated model 1 as above for data of the three regions to compute the adjusted occurrences of value words in fiction. Then, we performed temporal analysis for data spanning from 1950 to 2023 (this interval is selected due to data availability). We added regions into models instead of sources, compared to model 1. Years were not controlled in this model, because the year variable was collinear with GDP pc in this case

$$\text{Frequency}_i \sim \text{Poisson}\left(\lambda_i\right)$$
$$\log\left(\lambda_i\right) = b_0 + b_1 \cdot \text{GDP}_i + b_2 \cdot \text{Length}_i + b_3 \cdot \text{Type}_i + b_4 \cdot \text{Regions}_i + \varepsilon_i \quad (5)$$

Author Contributions

YZ, VT, and NB: conceptualization; YZ, VT, and NB: data collection; YZ: methodology; YZ, VT, and NB: visualization; YZ and VT: supervision; VT and NB: writing—original draft; and YZ, VT, and NB: writing—review and editing.

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