

**RELIGION OR KNOWLEDGE DIFFUSION:
A PROTESTANT ECONOMIC HISTORY OF CHINA, 1840-1920[†]**

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ABSTRACT

We provide an account of how Protestantism promoted economic prosperity in China—a country Weber ruled out for the development of Protestantism and capitalism. Using prefectural-level data from 1840-1920, a period when China was forced to open up to the West and experienced an early phase of capitalist development, we exploit the outcome of the *Boxer Uprising* to identify the causal effect of the subsequent diffusion of Protestantism on economic outcome. The seeming relationship between Protestantism and greater economic prosperity disappears once we control for the two channels through which knowledge was transmitted to the Protestant prefectures. The first pertains to the introduction of a Western primary education, whereas the second concerns practices of Western medicine. In contrast, the religious endeavors, most notably the erection of Bible schools, had no distinctly identifiable effect on economic prosperity.

Key Words: Protestantism, Knowledge Diffusion, Economic Prosperity, China

JEL Code: N35, Z12, O18

I. INTRODUCTION

There is little doubt that the best-known attempt to associate religion, or specifically Christianity, with economic prosperity has been that of Max Weber's.¹ In his famous work *The Protestant Ethic and the Spirit of Capitalism*, Weber (1930) hinted at the "subtle link" between the teachings of Calvin and Puritan divines of encouraging savings, investment, and the relentless pursuit of profit, on the one hand, and the unintentional consequences of capitalist behavior and ultimately economic growth, on the other (Hoffman, 2006, p. 82). While the results of the empirical vindication of Weber's thesis (of whether countries affected more by Protestantism tended to experience higher growth rates) have been mixed,² endeavors to examine the various alternative channels of growth have considerably enriched our understanding of the mechanisms through which Protestantism may have contributed to economic outcome.³ These alternative channels include moral codes (Lipset and Lenz 2000; Stulz and Williamson 2001),⁴ a country's openness (La Porta, et al 1998),⁵ "spiritual capital" (Barro and McCleary 2003; Barro 2004; McCleary and Barro

¹ Also known as the "most famous link between culture and economic development" (Acemoglu, Johnson, and Robinson, 2005: 401).

² For instance, while Glaeser and Glendon (1998) show that economic growth was faster in the Protestant than in the Catholic countries, Delacroix and Nielsen (2001) simply fail to identify any systematic relationship between Protestantism and the spread of capitalism. And, in his review of the pertinent literature, Iannaccone (1998) concludes that the available empirical evidence tends to reject rather than support Weber's thesis.

³ While Hoffman (2006: 82) suspects that the famous Weber thesis may have been the unwitting result of his oversight of a parallel religion (post-Tridentine Catholicism) that shared a common ethos in terms of "disciplined behavior associated with capitalism", he does encourage endeavors to examining "factors unrelated to Weber's Protestant ethic" (p. 83). We thank Philip Hoffman for this observation.

⁴ Lipset and Lenz (2000) provide empirical evidence that Protestant countries are less corrupt, whereas Stulz and Williamson (2001) contend that Protestant countries provide greater legal protection for the creditors than do the Catholic countries.

⁵ La Porta, et al (1998) find that legal traditions that originated from France—a proxy for Catholicism—tend to provide less protection for outsiders than those originating from England—a proxy for Protestantism.

2006a, 2006b),⁶ social networks (Sacerdote and Glaseser 2001; Putnam 2000),⁷ and human capital (Becker and Woessmann, 2009, 2010; Gallego and Woodberry, 2010; Woodberry, 2006, 2007a, 2007b, 2010a, 2010b). In line with the spirit of this literature, we examine if Protestantism had any distinct economic impact in China during 1840-1920—a period when it was forced to open up to the West—in economic and other spheres. We test the effect of a new channel, knowledge diffusion in both primary education and hospitals, on economic prosperity.

There are two unique reasons why it is important to examine the Protestant economic history of China. To begin with, for Weber, China represents the counter-case of the development of Western religion; the failure for Protestantism to develop in China was seen as the main reason behind the failed development of capitalism (Weber, 1930, 1964).⁸ The second is that China's age-old tradition in Confucianism and Taoism means that the Western religions and their underlying ethics—be they Protestantism or Catholicism—were not embedded within the society and institutions of China. The exotic nature of Western religion in the Chinese context thus allows us to exploit the exogenous variations in the diffusion of Protestantism and accordingly the measureable effects of their activities on economic development.

In addition, and this is especially important from Weber's standpoint, is that the period under analysis, 1840-1920, represents the genesis of capitalist development

⁶ “Spiritual capital” includes religious beliefs and such related characteristics or traits. The studies undertaken by Barro and his collaborators show that economic growth correlates positively with religious beliefs—especially beliefs in the concept of hell.

⁷ Both Sacerdote and Glasser (2001) and Putnam (2000) regard the networks fostered by houses of worship and churches as important elements of social capital. Given that social capital is productive, church attendance should have a separate, positive effect on economic growth.

⁸ According to Weber, the prevalence of, and protection afforded by, China's *kinship* system not only created enormous moral hazard problems, but also obstructed the development of factor markets (land sales), technical innovations, a rational bureaucracy, and not the least a codified system of law, all of which combined to undermine the development of capitalism (see, for example, Bendix, 1977, pp. 114-116).

in China, and thus is the setting when the Protestant ethic should have been most effective. With the opening up of China following its defeat by the Western powers since the opium war (circa 1839-1842), the missionary presence in China increased enormously. These missionaries were now able to move around the country freely, even beyond the treaty ports. By drawing upon the variations in the diffusion of Protestantism across China's 249 prefectures, a level just below that of the province, we show that there was indeed a positive association between Protestantism and economic outcome in China in the 1920s.⁹ To deal with the potentially endogenous relationship between Protestantism and economic progressiveness, we exploit the effect of the Boxer Uprising¹⁰—a political event that resulted in the massacre of many foreign missionaries in 1900 in some 26 prefectures—on the subsequent diffusion of Protestantism. An immediate consequence of the Boxer Uprising was that many missionaries targeted by the Boxers abandoned their congregations and fled for safety elsewhere in the country. We are thus interested in how the dispersion of the missionaries away from the areas of the Uprising might have affected the diffusion of Protestantism in the prefectures to which the missionaries had fled. The validity of this instrument (specifically the squared term of distance from the Uprising) is substantiated by the findings that it is insignificantly correlated with the development of Protestantism *prior to* the Boxer Uprising (around the 1890s) but is significantly correlated with its subsequent development—especially between 1900 and 1920. Moreover, this instrument is also uncorrelated with the penetration of Catholicism in China as well as a number of pertinent economic variables.

⁹ To the best of our knowledge, Becker and Woessmann (2009) are the only ones to study the effect of the channels of Protestantism on economic outcome in a single country. Ours is the first endeavor that studies China at the sub-national level.

¹⁰ The “Boxers” were, broadly speaking, a group of spontaneously formed patriotic, anti-imperialists whose hatred against foreigners culminated in the killing of many foreign missionaries in 1900. For accounts of the Boxers incident, see Cohen (1997) and Esherick (1987), Hsu (2000), among others.

In addition to conducting missionary work, the Protestant missionaries, as part of their non-religious activities, effectively transmitted various important corpuses of Western knowledge to China, which may have proven “useful” for economic development (Kuznets, 1965).¹¹ First, together with the translations and publications of a wide spectrum of Western knowledge—principally in the natural sciences but also in administrative sciences, culture, history, and geography, the Protestant missionaries erected many schools and introduced a qualitatively new curriculum into China. Prior to these concerted efforts, the traditional Chinese education focused almost singularly on the memorization and mastery of the Confucian classics, and on reading and writing in order to pass the civil exams.¹² Indeed, many have attributed the failure of the rise of modern science and industry in China to its educational institutions and their attendant civil examinations in late Imperial China (Ho, 1962; Huff, 2003; Lin, 1995). Second, the Protestant missionaries also erected hospitals and successfully introduced Western medicine into China, which may have contributed to a healthier workforce and population. Prior to their endeavor, traditional Chinese medicine was the mainstream in China, which is radically different from Western medicine (Needham, 1954).

Indeed, while we will show that Protestantism and economic outcomes are significantly correlated, that seeming association disappears once we control for the various channels of knowledge diffusion due to Protestantism; the entire effect is then

¹¹ For an erudite discussion of this concept, see Mokyr (2002, p. 3).

¹² In particular, Weber saw that the emphasis placed on reading and writing was achieved at the expense of speaking, and accordingly resulted in a great loss of education in defining and reasoning and in the lack of training in logic—the bedrock of scientific inquiry (Kasler, 1988, p. 103). Weber remarked that “one did not manage the administration with mere poetry in China” (Weber, 1964, p. 132). Moreover, the development of science in China may have also been hampered by the enormous importance the Chinese placed on magic; hence the popularization of astrology (beliefs in the cosmos) rather than astronomy, pharmacology (aspirations for long and healthy life rather than a salvaged afterlife), and geomancy (instead of geometry) (see Bendix, 1977; Kasler, 1988). An erudite analysis of China’s civil examinations can be found in Elman (2000).

specifically accounted for by primary school enrollment and, more significantly the erection of hospitals. In contrast, the diffusion of religious knowledge, as measured by the number of Bible schools erected and religious newspapers and periodicals founded, have had no identifiable effect on economic prosperity.

While our account essentially complements the human capital story of Becker and Woessmann (2009, 2010), we beg to claim two distinct contributions. The first is that, in empirically examining the Protestant history of China, we are able to identify additional channels whose effects go beyond that of an increase in literacy.¹³ The introduction of a qualitatively new educational curriculum, combined with an expansion of primary school enrollment, produced a new set of skills that might have been more useful for economic development than the traditional educational curriculum underpinned by Confucianism. Based on unique Chinese data sources, Yuchtman (2009) indeed provides suggestive evidence on the links between the choice of educational institutions (Western versus Chinese traditional) and accordingly educational content, on the one hand, and labor market outcomes on the other.¹⁴ By the same token, the transmission of knowledge on Western medicine may have contributed to a healthier workforce and population more generally, the result of which was greater economic prosperity. Mokyr (2002, p. 167), for example, shows how household knowledge of infectious diseases had effectively resulted in the

¹³ Becker and Woessmann (2009) show that, while the counties in Prussia with a larger share of Protestants, which includes Weber's own hometown, fared better economically than those with a larger share of Catholics, the observed difference was in fact not caused by the Protestant ethic but rather due to the increase in literacy rate and accordingly human capital, as more people in the former had greater opportunities to read the translated biblical texts.

¹⁴ Specifically, he shows that modern, Western education tended to produce human capital that was more "differentially productive in modern industry" than did the traditional Chinese education system (Yuchtman, 2009, p. 5). This would imply, in our context that regions influenced more by Protestantism and, by implication, a greater penetration of Western education, would produce the type of human capital that is more conducive to modern economic growth.

decline in mortality rates in the industrialized West even before effective cures of such diseases were discovered.

Our second distinct contribution is that, by separating the effects of non-religious activities from those of the religious ones (most notably the conversion of the communicants, but also the founding of Bible schools and religious periodicals and newspapers), we are able to demonstrate the effectiveness of knowledge diffusion activities even after controlling for the Protestants' religious endeavors. We believe that this marks a novel contribution. Finally, despite the existence of many other religions embedded in the Chinese context such as Taoism and Confucianism and the resulting competition, we are able to show that Protestantism—a religion introduced into China from the outside—did manage to take root on the Chinese soil, albeit via a number of non-religious endeavors.

The remainder of this article is organized as follows. In Section II, we provide a brief review of the development of Protestantism in China, and, based on the history of what we categorically refer to as a wide spectrum of knowledge diffusion activities, we introduce a testable hypothesis regarding the likelihood of an alternative channel through which the effects of Protestantism on economic prosperity are tested in the Chinese context. We then introduce our data sources and define the variables that we employ in our analysis in Section III. We estimate the effects of Protestantism on economic outcome in Section IV, and then provide evidence on the importance of knowledge diffusion activities in accounting for the above effects in Section V. Section VI summarizes and concludes the study.

II. THE DEVELOPMENT OF PROTESTANTISM AND THE INTRODUCTION OF WESTERN KNOWLEDGE - THE CHINA CASE

II.A. Development of Protestantism in China

Before the First Opium War (1839-1842), which marked the end of China's long-term isolation and the beginning of modern Chinese history, Christianity had been banned entirely in China since 1721, after Emperor *Kangxi* (1661—1722) disagreed with Pope Clement XI's decree over the Chinese Rites controversy, which led to a complete severance of ties with the Roman Catholic Church.¹⁵ But with the signing of various “Unequal Treaties” with the Western powers between 1839 and 1942 (especially the Treaty of Nanjing), the *Qing* government was forced to admit the Western missionaries into China beyond the treaty ports, after which Protestantism spread quickly.¹⁶ Figure 1 clearly shows that while the missionary presence was negligible in 1840, it grew to approximately 10 percent of the Chinese counties in the 1880s, and by the 1920s, the missionaries penetrated nearly 70 percent of the counties in China.¹⁷

Figure 1 about here

II.B. Introduction of Western Knowledge to China

¹⁵ The Chinese Rites controversy was a dispute between the Chinese government and the Roman Catholic Church from the 1630s to the early eighteenth century. It revolved around whether Chinese folk religious rites and offerings to the emperor constituted idolatry. Pope Clement XI decided in favor of the Dominicans (who argued that Chinese folk religion and offerings to the emperor were incompatible with Catholicism), the result of which led to an enormous reduction in the presence of Catholic missionary activities in China (Hsu, 2000, pp. 100-103).

¹⁶ Graham (1995, p. 10) notes that the impact of these treaties on the success of Christian missionary work was “considerable”. With the presence of foreign missionaries in China officially sanctioned, the treaties not only allowed “existing missions to expand into China proper, (but also) drew new missionary groups into the field.” Spence (1990, p. 206) points out that “(t)he missionaries in China represented a wide range of nationalities and religious backgrounds”; with over 30 Protestant groups by 1865.

¹⁷ These data are obtained from Stauffer (1922), which reports, on a county basis, the dates when Protestant missionaries began their conversion work.

The pertinent question is what were the channels of growth for Protestantism in China? According to Spence (1990), a preeminent historian of China, “the impact of the mission movement came through the spread of Christian texts, the publication of general historical or scientific works, the development of schools, and the introduction of new techniques of medicine” (p. 206). “Through their texts, their presses, their schools, and their hospitals, the efforts of missionaries affected Chinese thought and practice. The strength of that influence is impossible to calculate, but the missionaries did offer the Chinese a new range of options, a new way of looking at the world” (p. 208). Moreover, although the Chinese led in earlier scientific discovery, they had fallen vastly behind for many centuries (Needham, 1954). And although the Jesuits attempted to introduce Western science to the Chinese in the seventeenth century, their compromising attempt at “fusing Chinese science with universal world science...” had limited effects (Elman, 2005). By funding the translations and publications of Western science in Chinese and the erection of schools that introduced and disseminated it, the Protestant missionaries played a singularly important role in the “introduction of modern science” to China from around the 1850s (Elman, 2006: 101), a time when China badly needed such knowledge for advancing its economy.

II.B.1. Education

The translations and publications of texts represented an integral part of the Protestant endeavors to introduce Western science and technology into China. The concerted efforts of many publishers—chief amongst them Inkstone Press who was renowned for being “the publishing Mecca of missionary activities” (Elman, 2006, p. 102)—had been instrumental in translating texts from a whole host of Western scientific and engineering disciplines. In particular, Alexander Wylie, who supervised Inkstone Press after 1947 and who worked with other distinguished missionaries like

Joseph Edkins and a number of outstanding Chinese scholars, had hugely influenced the subsequent diffusion of Western science in China. Under his supervision, the Chinese terminologies of such important fields as chemistry, geography, animals and plants, astronomy, calculus, electricity, mechanics, fluid mechanics and even optics and sound were introduced in a systematic manner on Chinese soil for the very first time (Elman, 2006, p. 116).¹⁸ In addition, Spence (1990) notes that the missionaries, once again with Wylie playing a leading role, had translated works on Western governments and history that were circulated widely in China beginning from the second half of the nineteenth century.¹⁹

The introduction of Western science and a variety of applied disciplines into China took on disproportionate importance when placed in the context of China's antiquated educational system. For many centuries—beginning from as early as the Han Dynasty and through Ming times—the Chinese had placed huge emphasis on reciting and memorizing the classic Chinese texts which had little, if any, relevance for both scientific inquiry and the practical administrations of government.

Articulated by Alexander Williamson in an 1857 publication (of what was a common theme among both missionaries and reformers), he noted that while the Chinese were very skilled, they wasted time on civil examination essays (Elman, 2006, p. 117; see

¹⁸ Woodberry (2010b: 10-11) disputes Habermas' (1989) claim that it was printing and capitalism combined that gave birth to civil society. Citing evidence from both Europe and Asia, he contends that it was the conversionary Protestants' preoccupation with the belief that "everyone needed access to 'God's word'" that underpinned the mass expansion of texts and newspapers. In the case of Asia, for instance, it was not until the arrival of Protestant missionaries in the nineteenth century did printing begin to supplant manuscripts, and newspapers began to develop in earnest. More specifically, the first newspapers in Chinese were actually printed by Protestant missionaries (p. 12).

¹⁹ One may note, in this context that while both Protestants and Catholics had actively engaged in the translations and publications of journals on Western science, the former outnumbered the latter by a considerable margin. For instance, in addition to publishing 4,000 books on Western sciences in 1835, a year later the Protestants published twice as many journals as the Catholics did—238 compared to 115 (Yang, 1968). This is consistent with the European evidence that, "from the 1600s on, Protestant areas had and exported more printed material per capita than Catholic areas" (Eisenstein, 1979, cited in Woodberry, 2010b: 11).

also Lin, 1995).²⁰ It is thus the systematic translation of a large corpus of literature on the modern sciences, and the concomitant introduction of a Western-based curriculum in schools erected by the Protestant missionaries, that together became an important channel or channels through which this body of new and useful knowledge was disseminated in China since around the mid-nineteenth century.²¹

In the Chinese context, the Protestant missionaries had been an integral part of the development of a national system of education (Gregg, 1946, p. 23).²² With the appointment of the School and Textbook Committee in 1877 and its eventual succession by the Educational Association of China, schools in general, and mission schools in particular, grew rapidly in the midst of Empress Dowager's reinstatement of the Imperial Examinations system after the failed Hundred Days' Reform in 1898.²³ Whilst 1902-1905 saw the remarkable development of government education, the period also witnessed the launching of a missionary system of education and, accordingly, a rapid increase in the number of schools and students. For example, the number of boarding missionary institutions increased from just over 100 in 1902 to 456 in 1909, with a fourfold increase in enrollments, from approximately 5,000 to 21,785 (including 919 college students).

²⁰ Not surprisingly, Williamson was noted to have also "disdained Chinese literature and poetry" (Elman, 2006, p. 117). Under the classical Chinese education system, students were expected to memorize the sounds and characters in the classical texts without knowing what they meant. As such, the system did not reward independent thinking or creativity. Because such system provided the state with an ample pool of potential civil servants (tested by the Imperial Civil Service Examinations), the traditional education in China was aimed at securing "the repose of the state", according to Alice Gregg (1946, p. 6). Elman (2000) provides an erudite analysis of the classical Chinese examination system.

²¹ The diffusion of Western science was confined to the literati and intellectuals. However, it was also linked to the development of a national curriculum via the organized effort of the School and Textbook Committee in the second half of the nineteenth-century (Gregg, 1946, p. 19).

²² This is in fact consistent with the evidence stated elsewhere that "even when European governments formed state school systems, they often merely nationalized religious schools" (Woodberry, 2010b: 14).

²³ As E. T. Williams remarked in 1899, mission schools were "never more crowded" (cited in Gregg, 1946, p. 43).

A similar trend was experienced by the day schools. By 1906, over 2,500 Protestant schools were founded, enrolling some 57,000 students. One must note that, in this context, tremendous efforts had to be made to prepare the Chinese associates for teaching, medical work, and evangelism.²⁴ By 1922, the Protestant missionaries had founded 956 senior primary schools and 5,637 junior primary schools, enrolling 32,899 and 151,582 students, respectively (Lutz, 2001: 186). The Catholics' efforts simply paled in comparison to the Protestants' in this regard. Whilst the Catholics did step up their efforts in 1938, they only erected 362 senior primary schools and 3,135 junior primary schools, and enrolled 18,805 and 115,793 students respectively; clearly they were still far behind their Protestant counterparts after playing catch-up for 16 years (Yang, 1968). An important reason why the Catholics were less aggressive in the provision of education and health services had to do with their greater emphasis on the cardinal virtue of preserving and nurturing faith among their followers than on the direct involvement in social and community affairs (Wiest, 2001).

The expansion of a missionary education system was undergirded by the introduction of a new curriculum of which Mathematics, Astronomy, English, History, and Geography (in addition to Chinese) were made crucial, all of which were intentionally tied to some putative flaw in the Chinese education system. For example, the study of astronomy could allegedly help dispel and correct many superstitious beliefs of the Chinese, whereas mathematics taught "the faculties of reasoning and

²⁴ The rapid expansion of education by the Protestant missionaries meant a great expansion of the missionary force and of Chinese teachers. It is little wonder that the missionary body nearly doubled between 1902 and 1909 (Gregg, 1946, p. 43). Again, the Chinese experience is consistent with that of the European's prior to the late nineteenth century, where religious groups were found to have devoted a great deal of resources to teacher training, child-focused texts, and so forth in order to make mass schooling possible (Woodberry, 2010b: 13-14).

analysis in which the Chinese are so deficient” (Graham, 1995, p. 42).²⁵ By demonstrating the superiority of Western science and culture, the missionaries hoped that the Chinese would open up (or would be more open) to Christian teachings. We, however, are more concerned with how this uncanny diffusion of knowledge at the school level may very likely have produced an educational outcome that was far superior in economic terms. By analyzing a unique dataset on the human resources of a Chinese corporation in the nineteenth century, Yuchtman (2009) admirably links the superior labor market outcome of the group of employees to the Western curriculum that they received in school.²⁶

II.B.2. Western Medical Knowledge and Hospitals

In line with their endeavours to diffuse the knowledge of Western science, the Protestant missionaries similarly pioneered a series of medical and science translations under the earlier efforts of Benjamin Hobson, an English medical missionary. More importantly, these missionaries erected hospitals in earnest in the 1860s—initially in the treaty ports but quickly spread to the interior—where such knowledge could be put to real practice (Elman, 2006, p. 104).²⁷ While they may not be aware of the productivity consequence of a healthier workforce and population, the

²⁵ Similarly, history was taught to show the Chinese students “what has been and is now her (China’s) real position amongst the nations of the earth”, whereas geography was to show “what a small space China occupied on the map of the world and what other countries have achieved in comparison” (Graham, 1995, p. 42).

²⁶ There is some support of this claim from the Chinese officials, who were trying to develop a new “Examination Scheme” in Western subjects throughout the winter of 1899-1900, amidst the growing persecution of Christians in the North, “so that successful candidates might possess certificates having ‘some recognized value’” (Gregg, 1946, p. 25). If Yuchtman’s (2009) finding is reliable, the value of a Western curriculum would be recognized not only on paper, but also in reality.

²⁷ Hobson’s *Treatise on Physiology*, which presented modern anatomy and reintroduced the centrality of the brain and the nervous system, had remained standard in China until 1886, when it became superseded by new translated texts of the Medical Missionary Association, which printed its own medical journal in Chinese (Elman, 2006, p. 105). The translations of Hobson’s works into Chinese were important as they led some literati to question the use of traditional medicine, which is something the Jesuits had not been able to accomplish. These translations included the *Treatise of Natural Philosophy*, which was the first work to introduce modern Western chemistry (and included in it also sections on physics, astronomy, geography, and zoology) to China.

practice of Western medicine and the diffusion of such knowledge to a wider populace had likely resulted in greater economic prosperity. Mokyr (2002, p. 167), for example, shows how an increase in household knowledge of medicine and health had effectively prevented infectious diseases from driving up mortality rates in the industrialized West after 1870, long before effective cures to such diseases came about (only after 1945).

To be fair, by 1935 the Catholics had built 233 hospitals-cum-old people's homes, housing some 89,321 patients. Nonetheless, their efforts still paled in comparison with the Protestants', who by 1937 had built 271 hospitals housing over 224,258 patients, while also having treated more than four million (4,150,342) out-patients. In addition, the Protestants had set up 140 schools to train the nurses. In fact, long before these endeavors, the Protestants had already established a Medical Missionary Society in China in 1838 and the China Medical Missionary Association in 1890, the purposes of which were to provide medical consultations, to contribute financially to hospital constructions, and to publish medical journals and books, which included the publication of the all-important bilingual (Chinese and English) medical dictionary (Yang, 1968).

II.C. Testable Hypotheses

The crux of all these is whether the great variety of new knowledge that was not only spread through texts but also diffused in the everyday context of schools and hospitals served to enhance economic efficiency or productivity in the Chinese context. Yuchtman's (2009) preliminary evidence tends toward the affirmative. Mokyr (2005), who stresses the efficiency implications of knowledge, also tends to

endorse the kind of linkages that we are attempting to establish in this context.²⁸ So do those who are able to substantiate the view that (the inseparable) knowledge and technological progress matter for economic growth (Aghion and Howitt, 1992; Arrow, 1962; Grossman and Helpman, 1991; Nelson and Phelps, 1966; Romer, 1987, 1990; Solow, 1956; Uzawa, 1965). What we want to emphasize, in this connection, is that the same corpuses of new knowledge that allegedly stimulated the economic growth of the West, was (subsequently) brought into China by the Protestant missionaries. More importantly, as we shall demonstrate with empirical evidence, our approach provides a fresh explanation of an alternative channel through which the activities of Protestantism stimulated economic growth in a country with no prior tradition in Western religion.

III. DATA AND DEFINITIONS OF VARIABLES

To conduct an analysis of the relationship between Protestantism and economic prosperity in 1840-1920 China, we construct a dataset that covers 249 prefectures²⁹ in 17 provinces to the south of the Great Wall, whose locations are shown on the map of Qing China (circa 1820, Figure 2).³⁰ As mentioned earlier, we choose 1840 because it marked the beginning of China's integration into the world capitalist economy, which, according to Weber represents the stage of economic development during which the alleged effects of Protestant ethic on economic growth

²⁸ "Technology is knowledge. Knowledge, as is well known, has always been a difficult concept for standard economics to handle. It is at the core of modern economic growth..." (Mokyr, 2005: 119).

²⁹ In China, prefecture represents the administrative unit that is immediately below the province but above that of the county.

³⁰ We exclude in our analysis the provinces of Gansu, Tibet, Tsinghai, Inner Mongolia and also those of Northeast China, for two reasons. The first pertains to data availability, in addition, they were not settled agricultural communities.

would be most pronounced.³¹ We chose 1920 as the end point of our analysis because soon after that China was caught in waves of civil conflicts between the Communists and the Nationalists, not to mention the Sino-Japanese War.³² We define the variables that we have employed in our analysis in the remainder of this section. We begin with our dependent variable, economic prosperity.

Figure 2 about here

Urbanization. To measure the consequence of Protestantism on economic prosperity, we need information on the regional distribution of income across China for the period 1840 to 1920. Unfortunately, such data are not available. As a substitute, and following Acemoglu, Johnson and Robinson (2002, 2005), we use the degree of urbanization to proxy for economic outcome, given its positive and significant correlation with per capita income.³³ As with various other measures of Protestantism, data on urbanization in China in 1920 are obtained from Stauffer (1922), which contains population statistics on cities of sizes larger than 25,000. This allows us to compute, at the prefectural level, the share of urban population in the overall population as our measure of urbanization—our dependent variable (refer to Appendix I for details). The overall mean of the share of urban population in a prefecture in 1920 was roughly 5.26 per cent.

Protestantism. By the 1920s, evidence suggests that there were a total of 6,182 organized congregations and 8,414 evangelistic centers spreading across 249

³¹ Between 1842 and 1860, both Catholic and Protestant missionaries entered the treaty port in droves under the Toleration Clauses of the treaties (Gregg, 1946, p. 8).

³² Erupted initially in April of 1927, the Chinese Civil War was fought between the Nationalist Party and the Communist Party which was intermittently interrupted by the Second Sino-Japanese War, which ended in 1945, after which the two parties resumed full-scale confrontations for another four years.

³³ It is worth pointing out that the foregoing relationship exists even after a country has undergone industrialization.

prefectures in the 17 provinces in China where pertinent data exist (*The Christian Occupation of China: A General Survey of the Numerical Strength and Geographical Distribution of the Christian Forces in China*, Stauffer, 1922).³⁴ To measure the effects of Protestantism (p_i), we use the number of organized congregations (log-term) and the number of communicants per 10,000 persons in each of these 249 prefectures (log-term) as pertinent proxies (refer to Appendix I for details on the construction of the pertinent variables).

Knowledge diffusion. To measure the diffusion of knowledge, we employ three pertinent proxies (obtained also from Stauffer (1922); again, refer to Appendix I for detailed sources). The first two variables, the number of students enrolled in missionary primary schools and the number of missionary middle schools, are obviously good proxies for Christian education. The third variable is the number of hospitals built by the Protestants, which is employed to measure the outcome of a number of channels pertaining to the diffusion of medical knowledge and possibly its health consequences in China. While the Protestant missionaries did not build all that many university hospitals (only seven with one in each of seven prefectures), it is the effect of these university hospitals disseminating the medical knowledge to other non-teaching hospitals that we think is more germane. As reported in Table A3 of Appendix II, the positive correlation found between the proximity of university hospitals and the number of general hospitals does support the possible existence of this diffusing mechanism. But there is an additional reason why it is the number of general hospitals that matters more: the non-teaching hospitals were in fact the main means through which the ordinary people could experience the efficacy of Western medicine. To the extent that the diffusion of Western medical knowledge helped

³⁴ For details on the regional distribution of these measures, see Appendix I.

promote the health of the workforce, the above has favorable implications for economic development. To facilitate our analysis of the possible effects of these various non-religious activities such as knowledge diffusion, we transform the three correlated variables (all in log-term) into one single variable using Principal Component Analysis (refer to Appendix II for details on the construction of the pertinent index).

The diffusion of Biblical knowledge. In order to test the possible effect of the spreading of the Bible, we employ two pertinent measures. The first pertains to the number of Bible Schools erected by the Protestant missionaries, whereas the second the number of religious journals founded. These two variables are likely correlated with both the diffusion of Protestantism and the increase in literacy but not with the diffusion of practical Western knowledge of science and technology, including medicine. As with what we did in measuring the effect of knowledge diffusion, we transform the two “religious” variables (both in log-term) into a single variable similarly using Principal Component Analysis (refer to Appendix II).

Catholicism. Roman Catholicism has had a long and convoluted history in China since at least the eighth century A.D. But the Chinese Rites controversy, which sparked a dispute and resulted in a temporary break in ties between the Chinese government and the Catholic Church from the 1630s to the early eighteenth century, substantially reduced the presence of Catholic missionaries in China (Hsu, 2000). But similar to the spread of Protestantism in China since the Opium War (of 1839-1842), Catholic missionaries became active again. The average number of Catholic missionary stations (log-term), which we employ to proxy for the development of Catholicism in China after the 1840s, was 4.9 per prefecture.

Western influence. With the establishment of the first five treaty ports in China in 1842,³⁵ new and exogenous economic forces began to penetrate China's autarkic economy. Since this process of economic penetration or integration occurred simultaneously with the development of Christianity, it is necessary to control for the effects of these Western economic influences on the Chinese economy. We did so by means of two variables that were likely to be correlated positively with both the development of Western religion and the Chinese economy. They are the duration of treaty ports and the duration of railway networks. We assign a value of zero to prefectures with no treaty ports, and a positive value to those with treaty ports, with the value reflecting the number of years that a treaty port had been in existence by the year 1920. We did the same for the duration of railway. Table 1 shows the average duration of both treaty port and railway networks, which are 5.3 years and 4 years, respectively.

Initial Economic Prosperity. Given that urbanization is a gradual process, the level of urbanization in 1920 would most likely be correlated with its lags. But since we do not have the share of urban population in 1840, we can only control for this lag using the three levels of urbanization generated by Rozman (1974) in the form of dummy variables.³⁶ According to Rozman's classification, big cities were those with a population of 300,000 and up, the ones in the middle between 70,000 and 300,000, and small cities between 30,000 and 70,000. According to these criteria, 19 per cent or 48 prefectures are classified as small cities, 12 per cent or 31 prefectures as mid-sized cities and 4 per cent or 10 prefectures as big cities.

³⁵ They are Shanghai, Guangzhou, Ningbo, Fuzhou, and Xiamen.

³⁶ Although Rozman (1974) defines seven levels for the Chinese cities, he reports only the four highest levels in his analysis. Refer to Appendix I for details.

Geography. In development economics, geography is considered by some as a key factor in accounting for the difference in economic performance. As Sachs (2000: 30) explains: “Geographical advantages might include access to key natural resources, access to the coastline and sea-navigable rivers, proximity to other successful economies, advantageous conditions for agriculture, advantageous conditions for human health”. To control for the differences in geography among our prefectures, we use two dummy variables; one is whether a prefecture is located on the coastal seaboard (coast), whereas the other considers whether a prefecture is situated along the *Changjiang* (or Yangtze) River, the most navigable river in China. Our inclusion of these two geographical variables is premised on the notion that they were likely partial determinants of economic growth and were probably also correlated with the development of Protestantism. Approximately 6.4 per cent of the sampled prefectures were located alongside the *Changjiang* River and 14.1 per cent on the coast.

Population density and regional size. The development of religion may also be affected by population density and the size of a region, as foreign missionaries supposedly chose to begin their work in populous or larger regions. As with treaty ports, both population density and regional size should affect economic growth. Thus to control for their effects, we include both the population density in 1850 and the size of a prefecture in our empirical estimations. In addition, we also control for the provincial dummies. Details concerning the definition, summary statistics of the pertinent variables and their sources are summarized in Table 1.

Table 1 about here

IV. THE ASSOCIATION BETWEEN PROTESTANTISM AND ECONOMIC OUTCOME

IV.A. Baseline Results

We begin by regressing the economic outcome (y_i) of the 249 Chinese prefectures on the proxy of Protestantism (P_i) using the Censored Regression (Tobit) model based on the specification in Equation (1). In our estimations, we also control for a number of independent variables (W_i) including Roman Catholicism, the degree of Western influences, the (degree of) urban development before 1840, whether a prefecture was located on the coast and along the *Changjiang* River, the population density (1850) and the size of prefecture, and the provincial dummies and the constant term.

$$y_i = \rho P_i + W_i \gamma + \varepsilon_i \quad (1)$$

Reported in Table 2, the results show that a significant and positive relationship exists between Protestantism and economic prosperity or specifically the degree of urbanization. In columns (1) and (3), where the proxies of Western influence and initial urbanization are omitted, we find that both Protestantism (measured by the number of Christian communicants for every 10,000 persons) and Roman Catholicism (measured by the number of missionary stations) are positive and significant. But where these two factors are controlled for, as in columns (2) and (4), only Protestantism has a significant effect on economic prosperity. In terms of marginal effect, a doubling of the number of Christian communicants (for every 10,000 persons) increases the level of urbanization by 23.1 per cent (column 4).

What Table 2 also shows is that the estimated coefficients on Roman Catholicism are insignificant, which supports Weber's thesis. Only one of the

geographical variables, namely coast, is significant throughout the estimations, but with a negative coefficient, whereas measures of Western influences—the duration of treaty ports and railway networks—are significant and positive. These results suggest that, had the coastal prefectures not been opened up as commercial (treaty) ports, they might have been less developed than those in the inland areas. As expected, the initial levels of urbanization are significantly positive in our estimations.

Table 2 about here

IV.B. Instrumental Evidence

In estimating the effect of Protestantism on economic development, it is necessary to deal with the various endogeneity issues associated with the measure of Protestantism. There is first of all the problem of measurement error. Our key explanatory variable, Protestantism, is possibly a noisy proxy, so that the coefficient on the inexactly measured Protestantism may be biased towards zero. Reverse causality presents another source of endogeneity. Rather than religious development leading to economic growth, conceivably it could be the other way round (e.g., Samuelsson, 1993; Barro and McCleary, 2003).³⁷ Last, but not least, is the problem of omitted variable bias, despite our attempt to control for a variety of factors that are likely correlated with both economic development and Protestantism (Iyigun, 2008).³⁸ To correct for these potential biases, we need to identify an exogenous variation that correlates strongly with Protestantism but not with urbanization, except through the

³⁷ This is in fact what the *secularization* hypothesis has postulated (see, e.g., Samuelsson, 1993). This thesis states that economic development has the effect of rendering individuals less religious as measured by church attendance and religious beliefs. In a different twist, the same thesis argues that economic development undermines the importance of organized religion both in the realms of political decision-making and in the social and legal processes (Barro and McCleary, 2003; Berger, 1967; Chaves, 1994; Martin, 1978; Weber, 1930; Wilson, 1966).

³⁸ Christianity may be influenced by historical events, which may be correlated with economic growth. For instance, Iyigun (2008) shows the Protestant Reformation was affected by the rise of the Ottoman Empire.

effect of the former. The exotic nature of Protestantism in the Chinese context allows us to exploit the exogenous variations in the dispersion of Protestant activities. The *Boxer Uprising*, which resulted in the massacre and accordingly fleeing of many missionaries in 1900 in 26 prefectures across seven Chinese provinces (Figure 3), provides just such an exogenous source of variation.³⁹

Figure 3 about here

IV.B.1. Effect of the Boxer Uprising on Subsequent Protestant Dispersion

Due to the geographical relocation of the missionaries, the Boxer Uprising had likely influenced the diffusion of Protestantism after 1900 in both the afflicted areas and those not directly affected. However, since one cannot rule out the possibility that such violent outbreaks were also due to the Boxers' hatred of foreigners that resulted from the penetration of Western economic powers, the incident itself is not an ideal instrument.⁴⁰ In fact, evidence suggests that both the level of Protestantism in 1890 and the penetration of Western economic powers are significantly correlated with the incidence of the Boxer Uprising (Appendix II). But while we cannot directly use the Boxer Uprising as an instrument, we can make use of its immediate consequences on the *dispersion* of Protestantism in the prefectures not directly afflicted by it to generate the exogenous variations, from which a valid instrument can be derived.

³⁹ There were a total of 26 prefectures where the Imperial Civil Examination had been temporarily suspended as a result of the Qing government's decree in June 1901. In these prefectures, a total of 53 foreign Catholic missionaries and 188 foreign Protestant missionaries were killed during the Boxer Uprising. The number of Catholic and Protestant communicants killed in the same incident amounted to 23,000 and 5000, respectively (Yang, 1968). We should point out though that the Boxer Uprising represented only the pinnacle of the patriots' hatred of foreigners—a sentiment that could be dated back to as early as the 1860s. The Uprising was predated, for example, by the Tianjin “massacre”, or the vengeance of the French against the killing of their Consul and several traders and their wives by a hostile Chinese crowd four decades earlier.

⁴⁰ Although according to Spence (1990, p. 205), the Boxer Uprising was spurred by “the deep fissures that lay between the Christian effort at conversion and the Chinese Confucian gentry's sense of their own worth and authority”.

An immediate consequence of the Boxer Uprising was that many missionaries attacked by the Boxers abandoned their congregations and fled for safety elsewhere in the country (Song and Li, 1995; Austin, 2007).⁴¹ We are thus interested in how the dispersion of the missionaries away from the areas of the Uprising possibly affected the diffusion of Protestantism in those prefectures to which the missionaries had fled. Simply stated, we employ the possible consequences of the Boxer Uprising on the diffusion of Protestantism as our instrumental variable. Since we have no information on how many missionaries had fled to the various prefectures, we need to find a proxy to capture the effect of the missionaries' retreat on the diffusion of Protestantism. Intuitively, we know that the farther one flees, the safer one gets, but at a greater cost of travel. For instance, while the cost of fleeing to a nearby prefecture might be small, it was likely not safe enough. Conversely, while safety increases with distance, the marginal benefit of safety would be outweighed by the marginal cost of travel should one move too far. In equilibrium, rationality thus dictates that the fleeing missionaries would have chosen an optimal distance of retreat so that the marginal utility of distance (of the retreat) equals to zero (more on this below).⁴² Specifically, the marginal effect of the distance of retreat is positive when it is less than optimal, but becomes negative when it is larger than optimal, which suggests that the effect of distance on the diffusion of Protestantism is likely a *nonlinear* one. In light of the (possible) nonlinear relationship between distance and the fleeing missionaries to a given prefecture due to the threat of the Boxers, we employ the squared term of

⁴¹ In their account of the Canadian Protestant missionaries' experience of the Boxer Uprising, for instance, Song and Li (1995, p. 67) find that most of these missionaries had retreated from the north of Henan Province when their congregations were attacked by the Boxers. Similarly, Austin (2007) characterizes the evacuation of the missionaries from Shanxi Province to the coast as an "exodus" (p. 415). While many returned to the inland afterwards, others stayed in the safer areas; in both cases they were joined by a new generation of missionaries "who did not know what had happened" (Austin, 2007, p. 426; see also Graham, 1995, p. 10).

⁴² We are thinking in terms of the distance between the prefecture of the Uprising and the prefectures to which the missionaries fled. Alternatively, another way of conceptualizing the problem is to think about how many missionaries fled to a particular prefecture.

distance to proxy for the number of these migrant missionaries. We now turn to develop this intuition more formally.

Assuming that a rational missionary chooses to balance between the margins of safety (S) and the cost of travel (C), both of which are positively correlated with distance, the utility function (U) of safety tends to increase at a decreasing rate, i.e., $U'(\cdot) > 0$ and $U''(\cdot) < 0$. The optimal distance of retreat would be determined by the following optimization problem:

$$\max \pi(D) = U(S(D)) - C(D) \quad (2)$$

The optimal distance (D^*) is determined by the first order condition, $\pi'(D^*) = 0$,⁴³ such that when $D < D^*$, $\pi'(D) > 0$, and conversely when $D > D^*$, $\pi'(D) < 0$. Given these conditions, it follows that the diffusion of Protestantism would be positively correlated with D when $D < D^*$, and negatively correlated with D when $D > D^*$. In other words, the relationship between the distance of missionary retreat and the diffusion of Protestantism would most likely be a nonlinear one. This property of nonlinearity can be captured using the squared term of distance, as in Equation (3):

$$P_i = \delta_1 D_i + \delta_2 D_i^2 + W_i \theta + v_i \quad (3)$$

in which, $\delta_1 > 0$ and $\delta_2 < 0$ meaning that the effect of distance is positive when

$$D_i < -\frac{\delta_1}{2\delta_2}, \text{ and is negative when } D_i > -\frac{\delta_1}{2\delta_2}.^{44}$$

⁴³ The second order condition $\pi''(D^*) < 0$ holds under the assumption that $S''(D) \leq 0$ and $C''(D) \geq 0$. Moreover, with the non-negative constraint of D , the optimal distance D^* is conditional upon $\pi'(0) > 0$, which means that fleeing away from the prefectures where the Boxers had revolted represents a Pareto-superior alternative than not to leave.

⁴⁴ Unlike Becker and Woessmann (2009), who cogently defend the exogeneity of their instrument for Protestantism—distance to Wittenberg (the hometown of Luther)—on the basis of an insignificant correlation between distance and pre-Reformation economic development, we cannot make the same argument in the Chinese context. The reason is that the Boxer Uprising was likely correlated also with

How valid is our instrument? First, suppose that the nonlinearity of distance was caused by the Boxer Uprising, then the initial geographical spread of missionary influence prior to the Boxer Uprising (in the 1890s) should be insignificant, but should become significant thereafter (in the 1910s). This is indeed our finding in Table 3. The significantly positive sign of distance (D_i) and the negative sign of its squared term (D_i^2) confirm our hypothesized reasoning that distance exhibits an inverted-U shape property as a result of the Boxer Uprising. Moreover, the robustness of our instrument is further supported by the evidence that distance is not correlated with a host of factors that in turn are likely correlated with the economic outcome of Protestantism. Columns (3) through (6), which represent both Catholicism and a number of measures of economic factors such as initial economic prosperity (the number of bank branches in the 1850s) and the penetrations of the Western economy (duration of treaty ports and railways), are indeed not correlated with our instrumental variable.

Table 3 about here

IV.B.2. Effect of Instrumented Protestantism on Economic Prosperity

In Table 4, we report the instrumental-variable (IV) estimates of Protestantism on economic outcome by employing the IV-Tobit model specified in Equation (4):

$$\begin{aligned} y_i &= \rho P_i + W_i \gamma + c_1 D_i + \varepsilon_i \\ P_i &= \delta_2 D_i^2 + W_i \theta + \delta_1 D_i + v_i \end{aligned} \quad (4)$$

such economic factors as the penetration of Western economic powers (Appendix II), which, like Protestant diffusion, could disperse concentrically from the prefectures of the Uprising.

The results show that there is a significantly positive relationship between Protestantism and economic outcome.⁴⁵ For example, in column (2), the estimated marginal effect of the number of evangelistic centers (log-term) is about 0.699. This suggests that a doubling of the number of evangelistic centers increases the level of urbanization by 69.9 per cent. The result remains robust when we use the other pertinent proxy, the number of Christian communicants (for every 10,000 persons, log-term). At 0.900, the corresponding marginal effect of the number of Christian communicants (for every 10,000 persons, log-term) is even larger.

Table 4 about here

Since the above regressions have not included the 26 prefectures where the Boxer Uprising had occurred, it may lead to inconsistent estimators caused by sample selection bias. To correct for this bias, we run a PROBIT model:

$$\begin{aligned} I_i^* &= \tilde{W}_i \kappa + u_i \\ I_i &= 1 \text{ (namely } B_i = 0) \text{ if } I_i^* > 0 \end{aligned} \quad (5)$$

and control for the Inverse Mills Ratio, denoted by $\hat{\lambda} = \phi(\tilde{W}_i \hat{\kappa}) / \Phi(\tilde{W}_i \hat{\kappa})$ (in which $\phi(\cdot)$ and $\Phi(\cdot)$ are, respectively, the density function and probability function of standard normal distribution), in Equation (4). The model obtains formal identification from the normality assumption when the same covariates appear in the selection Equations (4) and (5), but identification is tenuous unless there is substantial nonlinearity in the Inverse Mills Ratio. Generally, at least one variable has to have a nonzero coefficient in one of the selection equation. A good candidate for this variable is drought in 1900, since it is correlated with the Uprising but has no direct

⁴⁵ Our results provide strong empirical support for the claim that education expanded rapidly only after the Protestant Reformation and other similar religious revival movements, and that economic development did not initially spur mass literacy (Graff, 1987; Johansson, 1977; Vincent, 2000). They are also consistent with the observation that “before the 20th century, countries with more Protestant had higher literacy, provinces with more Protestants had higher literacy, and Protestant individuals in the same country had higher literacy” (Woodberry, 2010b: 14).

effect on both the diffusion of Protestantism and long-term economic growth. As shown in Appendix II, deviations in precipitation or specifically drought in 1900 did have a significant impact on the Boxer Uprising. Hence we include this variable in Equation (5) in order to obtain a robust identification. We report the pertinent results in Table 5. After controlling for the Inverse Mills Ratio ($\hat{\lambda}$), both the magnitude and significance of our key explanatory variable, the degree of Protestantism, remain unchanged; in particular, the magnitudes of the pertinent proxies are trivially different from those reported in Table 4.

Table 5 about here

IV.B.3. Robustness Check – Alternative Instruments

The intuition underlying our instrument is that the relationship between distance and the dispersion of Protestantism was likely to have been more intimate for the nearby regions than for the farther ones. Based on this intuitive reasoning, we generate an alternative instrument—the difference in the coefficients of distance between the nearby and farther regions—to check the robustness of our original instrument. We did this by first classifying the sample prefectures into two regions; the nearby region, whose distance (log-term) to the prefectures of the Uprising is below the sample average (\bar{D}), and the farther region, whose distance (log-term) to the prefectures of the Uprising is above the sample average (\bar{D}). We then use the interaction ($N_i D_i$) of the nearby region (N_i) and distance (D_i) as an alternative instrument, while simultaneously controlling for both the nearby region (N_i) and distance (D_i), as specified in Equation (6):

$$P_i = \theta_1 D_i + \theta_2 N_i D_i + \theta_3 N_i + W_i \theta + v_i \quad (6)$$

The results are reported in columns (2) and (4) of Panel A of Table 6. At 0.729 and 0.981, the corresponding marginal effects of the number of evangelistic centers (log-term) and of the number of communicants per 10,000 persons is strikingly similar with those in Table 4 (columns 3 and 4).

Table 6 about here

In addition, we can also test the validity of our alternative instrument. Assuming that distance (log-term) is normally distributed with both an unknown mean μ and an unknown standard deviation, we divide the prefectures according to the population rather than the sample mean of distance \bar{D} . Furthermore, we assume that the sample mean \bar{D} follows a t -distribution with mean μ and standard deviation s/\sqrt{n} , where s is the sample standard deviation and n is the number of observations. By classifying those prefectures whose distance to the prefectures of the Uprising lay in the 99 per cent confidence interval of the population mean as the middle region (M_i),⁴⁶ we can test the robustness of our alternative instrument using the following specification:

$$P_i = \theta_1 D_i + \theta_2 N_i D_i + \theta_3 N_i + \theta_4 M_i D_i + \theta_5 M_i + W_i \theta + v_i \quad (7)$$

The results are reported in columns (2) and (4) of Panel B of Table 6. At 0.704 and 0.976, the corresponding marginal effects of the number of evangelistic centers (log-term) and of the number of communicants per 10,000 persons differ trivially from those in Panel A of the same table (Table 6).

⁴⁶ The 99 per cent confidence interval for the population mean is $\bar{D} \pm t_{(0.005, n-1)} \frac{s}{\sqrt{n}}$.

V. PROTESTANTISM, KNOWLEDGE DIFFUSION AND ECONOMIC OUTCOME

In order to provide a more thorough analysis of the relative importance of knowledge diffusion and the Protestant ethic in determining economic outcome, we estimate the effects on urbanization between the three measures of Protestantism and the level of knowledge diffusion at the prefecture level based on Equation (8):

$$y_i = \rho P_i + \varphi_1 k_i + \varphi_2 b_i + W_i \gamma + \varepsilon_i \quad (8)$$

Reported in columns (1), (2) and (4) of Table 7, the results show that the coefficient of Protestantism is significantly affected by the inclusion of various measures of knowledge diffusion activities. In sharp contrast, all the coefficients of Protestantism (measured by the number of Evangelistic centers) now drop to near zero and become statistically insignificant with the inclusion of the knowledge diffusion variables. That does not imply, however, that our previous estimates of Protestantism (Table 2) were invalid. In fact, even after accounting for knowledge diffusion, the standard errors of various Protestantism measures are strikingly similar to those without their inclusion (see Table 2). This suggests that the coefficients previously estimated were just as precise—only the size of their effects have changed.

The decomposition of knowledge diffusion yields more specific and interesting results. Between the two educational variables, only primary school enrollment but not the number of middle schools erected is marginally significant. Our conjecture is that, for those who had attended primary school, the marginal effect of attending middle school would be limited. Interestingly, of the three knowledge diffusion variables, it is the number of hospitals built by the Protestant missionaries that is most significant—at the one per cent level—and with the largest magnitude.

What this suggests is that hospitals had likely played a significantly positive role in stimulating urban economic growth or economic prosperity in China in the early 1900s. In the absence of further evidence, it is possible that the increasing awareness of Western medicine and health practices may have enhanced the physical health of those workforces positively affected by the diffusion of this particular strand of Western scientific knowledge, thereby contributing to productivity and economic growth. In sharp contrast, both measures of the diffusion of Biblical knowledge—be it the number of Bible schools erected or the number of religious periodicals and newspapers founded—are insignificant, suggesting that, while these activities may have strengthened the Protestant ethic as well as raised the level of literacy, they had no measureable effect on economic outcome. In columns (5), (7) and (8) we aggregate the various knowledge-diffusing activities into a single index, and find that the previous effect of Protestantism is no longer significant (compare with results in Table 2). In contrast, the coefficient of Protestantism hardly changes even after controlling for the Bible diffusion index (column 6).

Table 7 about here

Summing up, the foregoing results suggest that the effect of Protestantism on economic outcome is likely correlated with that of knowledge diffusion. This motivates us to estimate the following system of equations:⁴⁷

$$\begin{aligned}
 y_i &= \phi k_i && + W_i \gamma + c_1 D_i + \varepsilon_i \\
 k_i &= \rho_1 P_i && + W_i \gamma_2 + c_2 D_i + u_i \\
 P_i &= \delta_2 D_i^2 && + W_i \gamma_3 + \delta_1 D_i + v_i
 \end{aligned}
 \tag{9}$$

In this system, which we will estimate using the three-stage least squares (3SLS) method, the first stage sets out to predict the degree of Protestantism in a prefecture

⁴⁷ This subsection is heavily inspired by Becker and Woessmann (2009).

with our instrument (D_i^2). The part of the variations in Protestantism that is due to our instrument is then used in the second stage to predict the degree of knowledge diffusion. In the third stage, this variation in knowledge diffusion is then used to predict economic prosperity. Reported in Table 8, the 3SLS results unambiguously support the hypothesis that economic prosperity in China was basically due to the diffusion of a wide spectrum of knowledge-intensive activities associated with the degree of Protestant development rather than with the diffusion of Biblical knowledge. Specifically, the 3SLS results show that our instrument is positively correlated with the degree of Protestantism; the part of Protestantism that is due to the instrument is positively associated with knowledge transmission; and the part of knowledge transmission that is due to the part of Protestantism that is due to our instrument has a positive effect on economic outcome.

Table 8 about here

Given that treaty ports were more likely to engage in international trade and that residents in the area/vicinity had accordingly more opportunities to acquire Western knowledge, we would expect Protestantism to play an even greater role in diffusing knowledge in prefectures that were not treaty ports. To see if that is the case, we performed a robustness check by excluding treaty ports in our sample, and ran the same regressions again based on Equation (9). The results, reported in Table 9, show that the coefficient of knowledge diffusion is about 1.10, which is much larger than the estimator using the total sample (of 0.626 and 0.622, Table 8). This result suggests that, where Western influences had been less pervasive, the effect of knowledge diffusion brought about by the Protestant missionaries would have been much more important to economic progressiveness, a result that further substantiates our hypothesis regarding the economic growth effect of knowledge diffusion.

Table 9 about here

VI. CONCLUSION

In response to Weber's inspiring thesis regarding the effect of the Protestant ethic on economic prosperity, many have ventured to test whether the cultural ethic in question was precisely the channel through which countries with greater Protestant influence have prospered. While evidence suggests that the Protestant countries have fared better economically than their non-Protestant counterparts, the superior performance of the economies with *cultural* affinity to Protestantism is actually attributable to a variety of channels other than the Protestant ethic; these channels range from moral codes, a country's openness, "spiritual capital" to social networks and more recently human capital. Our study, which focuses on the diffusion of a completely new paradigm of knowledge embodied in both a qualitatively new curriculum in education and in the practice of Western medicine, adds to this list of possible mechanisms.

While our findings may be subsumed under the broad category of human capital, clearly there is more to it. For instance, the new curriculum, along with the translation of a variety of literature on Western science that the Protestants endeavored to introduce to China, represents the abolition of Confucianism's century-old monopoly of the education system. The Protestants brought to China a corpus of what Kuznets (1965) called "useful knowledge", or a set of productivity-enhancing skills. This is more than an increase in literacy. By the same token, while the Jesuits had also endeavored to introduce Western science and medicine into China, unlike the Protestant missionaries, they were forced to compromise and tolerate the coexistence

of Chinese medical practices. The erection of not only teaching hospitals but also general hospitals by the Protestant missionaries had, according to our estimates, profound implications for economic progressiveness. This, too, is a novel finding. These “intrusions” by the Protestant missionaries had a qualitatively important effect, as they came at a time when China seemed unable to break from the stranglehold on knowledge in both education and science and medicine—the two areas in which contrast between the East and the West was most profound.

Our second contribution is that we are able to disaggregate the effect of non-religious activities from the more purely religious ones, such as the erection of Bible schools and the dissemination of religious periodicals and newspapers. Finally, but not the least, we are able to test Weber’s “most famous link” between culture and economic development in a country ruled out by Weber himself for the possible development of a Western religion and accordingly capitalism at a time most suited for testing this subtle link. We are immensely fascinated to have found that, in sharp contrast to Weber’s prediction, Protestantism was in fact able to thrive on the soil that for thousands of years had been predominated by the ethics of Confucianism, and with positive economic consequences, albeit not due to the precise channel through which such effects occurred.

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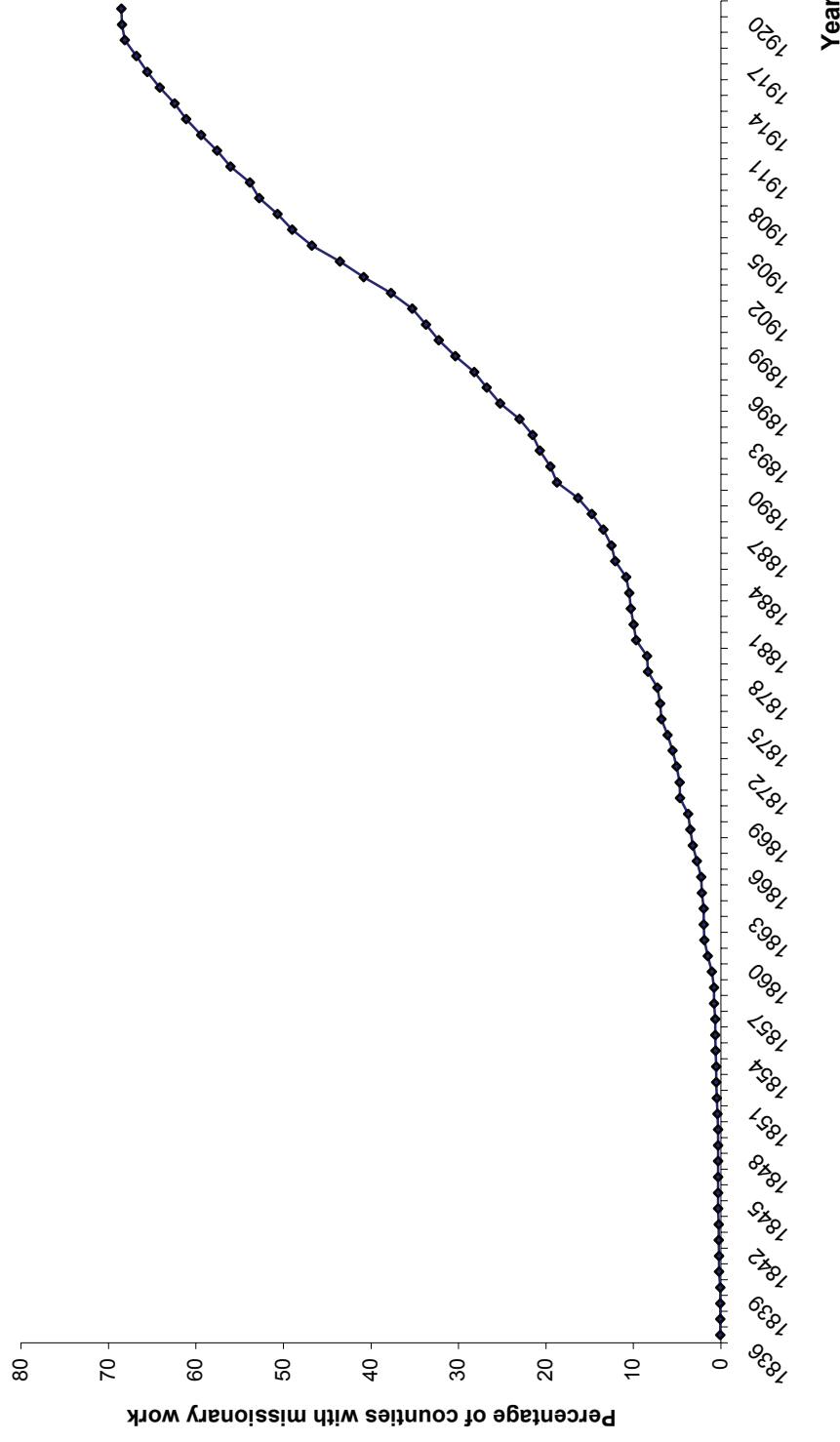
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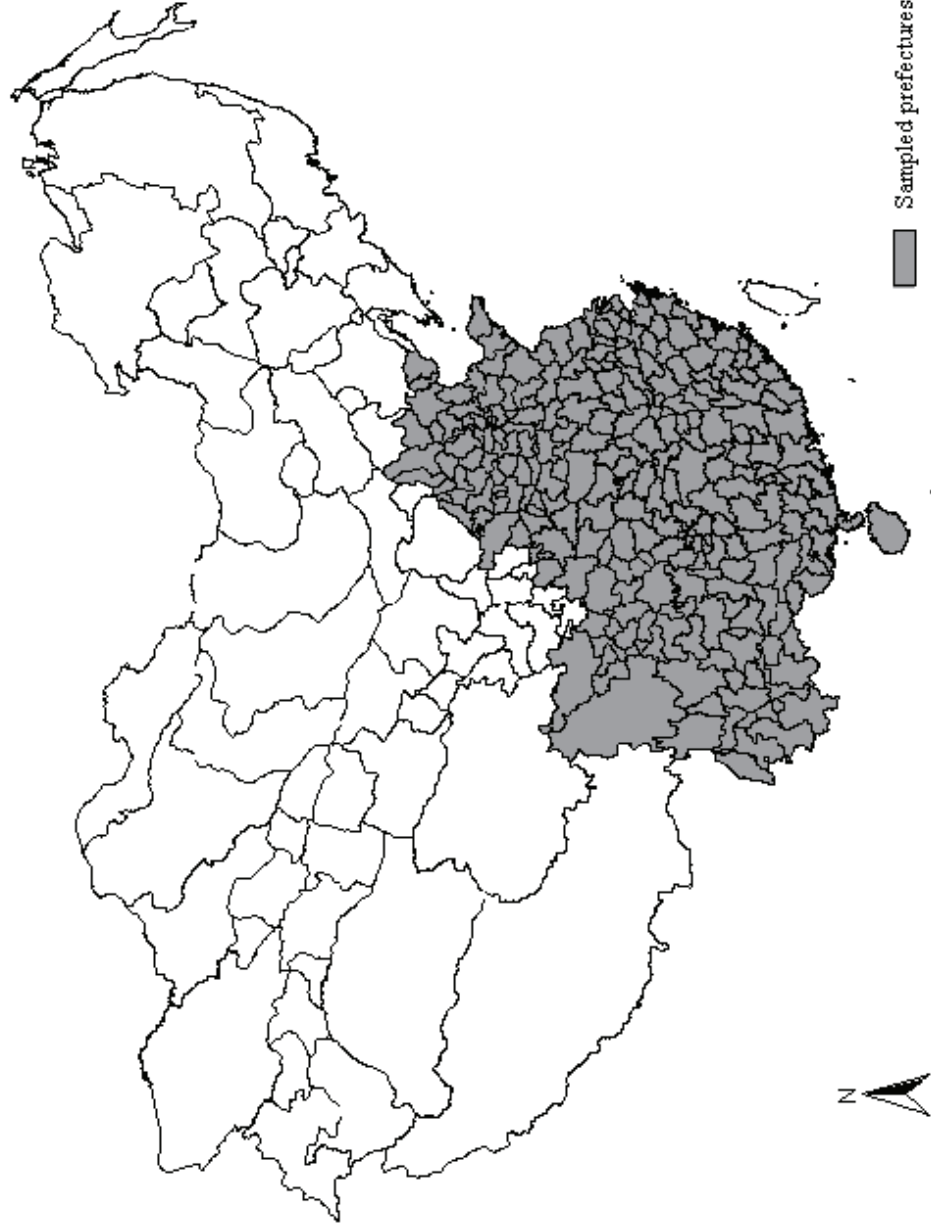
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Figure 1: The Development of Protestantism in China



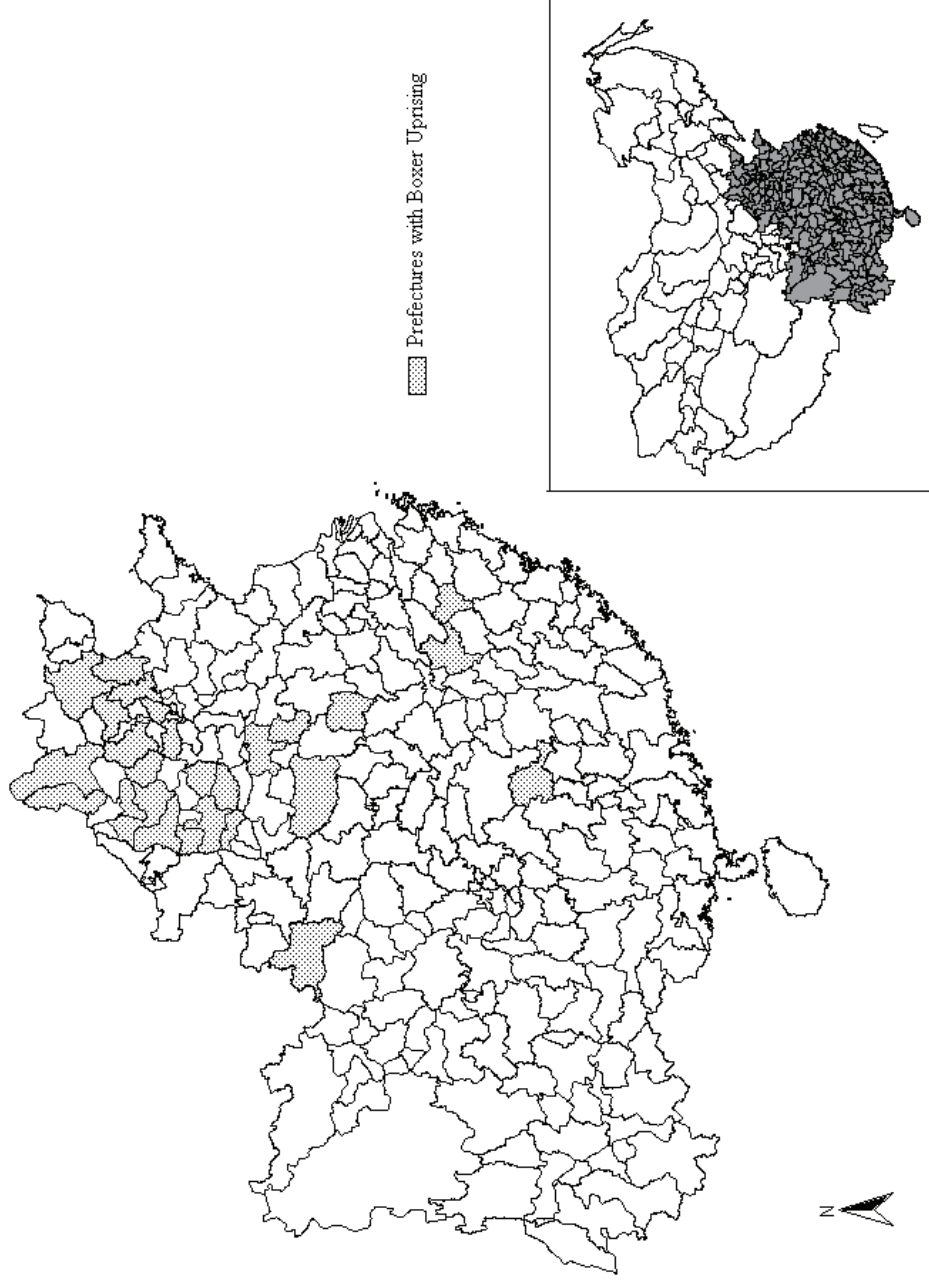
Source: *The Christian occupation of China: a general survey of the numerical strength and geographical distribution of the Christian forces in China.*

Figure 2: The Boundaries of Qing-China Prefectures, 1820



Source: "CHGIS, Version 4" Cambridge: Harvard Yenching Institute, January 2007.

Figure 3: The Geography of the Boxer Uprising (1900)



Source: "CHGIS, Version 4" Cambridge: Harvard Yenching Institute, January 2007.

Table 1: Summary Statistics of Variables

Variables	Definition	Mean	S.D.
Urbanization	Percentage of urban population to total population (the urban population is censored to zero if it is less than 25,000)	5.262	9.200
	Log-term	1.183	1.115
Protestantism	Number of Evangelistic centers	33.791	57.953
	Log-term	2.692	1.366
	Number of communicants per 10,000 persons	7.161	11.784
Knowledge diffusion	Log-term	1.582	1.022
	Index of knowledge diffusion	0.000	1.543
	Primary school enrollment in 1920	1282.888	2526.111
	Log-term	5.164	2.857
	Number of middle schools in 1920	1.067	2.587
Bible diffusion	Log-term	0.407	0.668
	Number of hospitals in 1920	0.965	1.618
	Log-term	0.474	0.581
	Index of Bible diffusion	0.026	1.302
	Number of Bible Schools	0.394	0.975
Roman Catholicism	Log-term	0.203	0.437
	Number of religious periodicals and newspapers	0.201	1.101
	Log-term	0.085	0.324
Duration of treaty ports	Number of Roman Catholic missionary stations	4.859	4.565
	Log-term		
Duration of railway	1920 minus the initial year a prefecture was established as a treaty port	5.297	15.482
	1920 minus the year of railway construction	3.964	8.437
Small city before 1840	City with an urban population larger than 30,000 but less than 70,000	0.193	0.395
Mid-sized city before 1840	City with an urban population larger than 70,000 but less than 300,000	0.124	0.331
Big city before 1840	City with an urban population larger than 300,000	0.040	0.197
Riverside (<i>Changjiang</i>)	Prefecture located along the <i>Changjiang</i> River	0.064	0.246
Coast	Prefecture located on Coastal seaboard	0.141	0.348
Population density, (1850)	Ln (population density, persons per square kilometers)	4.584	1.026
Size of prefecture	Ln (Size of prefecture, in square kilometers)	9.284	0.737
Distance	Ln (distance to prefectures of Boxer Uprising)	4.544	0.754

Note: the log-term is computed by $\ln(x+1)$.

Table 2: Baseline Estimates of Protestantism on China's Urbanization

	(1)	(2)	(3)	(4)
Evangelistic centers	0.301*** (0.084)	0.221*** (0.082)		
Christian communicants			0.328*** (0.085)	0.231*** (0.083)
Roman Catholicism	0.260* (0.133)	0.157 (0.128)	0.242* (0.133)	0.150 (0.128)
Duration of treaty ports		0.012*** (0.005)		0.011** (0.005)
Duration of railway		0.012 (0.010)		0.011 (0.010)
Small city (pre-1840)		0.373** (0.167)		0.364** (0.166)
Mid-sized city (pre-1840)		0.715*** (0.202)		0.724*** (0.202)
Big city (pre-1840)		0.745** (0.341)		0.723** (0.341)
Riverside (<i>Changjiang</i>)	0.178 (0.291)	-0.314 (0.293)	0.019 (0.291)	-0.415 (0.292)
Coast	-0.246 (0.216)	-0.540** (0.229)	-0.163 (0.212)	-0.464** (0.227)
Ln (population density, 1850)	0.421*** (0.147)	0.277** (0.139)	0.587*** (0.135)	0.404*** (0.131)
Ln (size of prefecture)	0.285** (0.138)	0.205 (0.134)	0.528*** (0.124)	0.383*** (0.123)
Province dummies	Yes	Yes	Yes	Yes
Observations	249	249	249	249

Note: Marginal effects are reported. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Constant terms are not reported.

Table 3: Testing the Validity of the Instrumental Variable (OLS Estimation)

	(1) Share of counties with missionary work (1890s)	(2) Share of counties with missionary work (1910s)	(3) Roman Catholicism (1920)	(4) Number of Bank Branches (1850s)	(5) Duration of Treaty ports (1920)	(6) Duration of Railway (1920)
Ln (Distance)	0.337 (0.281)	1.013** (0.404)	-0.119 (0.723)	-0.059 (0.552)	-14.232 (18.909)	9.424 (8.584)
Ln (Distance) ²	-0.044 (0.033)	-0.137*** (0.047)	0.006 (0.084)	0.006 (0.064)	1.724 (2.200)	-0.983 (0.999)
Small city (pre-1840)	-0.017 (0.039)	0.036 (0.055)	0.079 (0.099)	0.005 (0.076)	3.161 (2.594)	0.255 (1.178)
Mid-sized city (pre-1840)	0.085* (0.050)	0.040 (0.072)	0.126 (0.128)	0.236** (0.098)	11.389*** (3.357)	2.803* (1.524)
Big city (pre-1840)	0.123 (0.078)	0.063 (0.113)	0.319 (0.201)	1.484*** (0.154)	23.446*** (5.272)	3.496 (2.393)
Riverside (<i>Changjiang</i>)	0.028 (0.066)	0.046 (0.094)	-0.234 (0.168)	0.125 (0.129)	8.416* (4.406)	0.669 (2.000)
Coast	0.231*** (0.052)	0.084 (0.075)	0.119 (0.134)	-0.091 (0.103)	20.327*** (3.518)	2.425 (1.597)
Ln (population density, 1850)	0.029 (0.022)	0.099*** (0.031)	0.445*** (0.056)	-0.000 (0.042)	0.070 (1.456)	1.483** (0.661)
Ln (size of prefecture)	0.017 (0.022)	0.039 (0.032)	0.439*** (0.056)	0.040 (0.043)	-0.125 (1.479)	0.235 (0.671)
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	223	223	223	223	223	223
R-square	0.49	0.51	0.63	0.46	0.39	0.46

Note: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Constant terms are not reported.

Table 4: The Effect of Protestantism on China's Urbanization – Instrumental Evidence

	(1)		(2)	
	1 st -step	2 nd -step	1 st -step	2 nd -step
Evangelistic centers		0.699** (0.352)		
Christian communicants				0.900* (0.489)
Roman Catholicism	0.203** (0.102)	0.027 (0.151)	0.239** (0.102)	-0.046 (0.183)
Duration of treaty ports	0.005 (0.004)	0.009* (0.005)	0.006 (0.004)	0.006 (0.006)
Duration of railway	0.022** (0.009)	-0.005 (0.014)	0.025*** (0.009)	-0.012 (0.017)
Small city (pre-1840)	0.089 (0.142)	0.296* (0.178)	0.087 (0.142)	0.277 (0.193)
Mid-sized city (pre-1840)	0.313* (0.190)	0.510** (0.251)	0.242 (0.189)	0.506* (0.268)
Big city (pre-1840)	0.378 (0.303)	0.473 (0.396)	0.329 (0.302)	0.429 (0.432)
Riverside (<i>Changjiang</i>)	-0.202 (0.244)	-0.239 (0.300)	0.189 (0.243)	-0.553* (0.328)
Coast	0.453** (0.208)	-0.797*** (0.291)	-0.021 (0.207)	-0.459** (0.270)
Ln (population density, 1850)	0.601*** (0.093)	-0.048 (0.250)	0.101 (0.092)	0.298** (0.151)
Ln (size of prefecture)	0.705*** (0.092)	-0.206 (0.267)	-0.014 (0.092)	0.315 (0.132)
Ln (Distance)	3.482*** (1.038)	0.457* (0.253)	2.723*** (1.032)	0.369 (0.247)
Ln (Distance) ²	-0.459*** (0.121)		-0.349*** (0.120)	
Province dummies	Yes	Yes	Yes	Yes
Observations	223	223	223	223

Note: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Constant terms are not reported.

Table 5: The Effect of Protestantism on China's Urbanization – Correcting for Sample Selection Bias

	Correcting for Sample Bias (IV-TOBIT)			
	(1) 1 st -step	(2) 2 nd -step	(3) 1 st -step	(4) 2 nd -step
Evangelistic centers		0.706** (0.350)		
Christian communicants				0.905* (0.485)
Lamda	0.355 (0.459)	0.005 0.576	0.301 (0.457)	-0.042 (0.613)
Ln (Distance)	3.558*** (1.041)	0.462* (0.254)	2.788*** (1.036)	0.370 (0.247)
Ln (Distance) ²	-0.467*** (0.121)		-0.356*** (0.120)	
Control variables	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes
Observations	223	223	223	223

Note: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Constant terms are not reported.

Table 6: The Effect of Protestantism on China's Urbanization – Robustness Check Using Alternative Instruments

Panel A		The nearby region includes prefectures whose distance is less than the sample average			
		(1)		(2)	
		1 st -step	2 nd -step	1 st -step	2 nd -step
Evangelistic centers			0.729** (0.313)		
Christian communicants					0.981** (0.460)
Ln (Distance)		-1.606*** (0.326)	0.674** (0.289)	-1.045*** (0.326)	0.509* (0.283)
Nearby region		-7.206*** (1.725)	0.400 (0.253)	-5.171*** (1.724)	0.236 (0.271)
Nearby region *Ln(Distance)		1.522*** (0.370)		1.124*** (0.369)	
Control Variables		Yes	Yes	Yes	Yes
Province dummies		Yes	Yes	Yes	Yes
Observations		223	223	223	223
Panel B					
		(1)		(2)	
		1 st -step	2 nd -step	1 st -step	2 nd -step
Evangelistic centers			0.704** (0.348)		
Christian communicants					0.976** (0.492)
Ln (Distance)		-1.671*** (0.384)	0.543* (0.306)	-1.127*** (0.384)	0.423 (0.309)
Nearby region		-7.876*** (2.078)	0.182 (0.314)	-5.755*** (2.086)	0.092 (0.346)
Middle region		-5.586 (8.151)	0.137 (0.249)	-0.603 (7.101)	0.102 (0.276)
Nearby region *Ln (Distance)		1.681*** (0.437)		1.247*** (0.439)	
Middle region *Ln (Distance)		1.159 (1.777)		0.090 (1.547)	
Control Variables		Yes	Yes	Yes	Yes
Province dummies		Yes	Yes	Yes	Yes
Observations		223	223	223	223

Note: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Constant terms are not reported.

Table 7: Protestantism, Knowledge Diffusion, and China's Urbanization – TOBIT Estimation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Evangelistic centers	0.050 (0.109)	0.007 (0.108)	0.218** (0.084)	0.009 (0.110)	0.087 (0.097)	0.224*** (0.083)	0.085 (0.097)	
Knowledge diffusion					0.225** (0.090)		0.262*** (0.096)	0.270*** (0.076)
Primary school enrollment	0.115** (0.048)	0.088* (0.048)		0.088* (0.048)				
Number of middle schools	-0.014 (0.153)	-0.262 (0.173)		-0.245 (0.191)				
Number of hospitals		0.650*** (0.214)		0.648*** (0.216)				
Bible diffusion						-0.014 (0.068)	-0.080 (0.072)	
Number of Bible schools			0.061 (0.201)	-0.015 (0.223)				
Number of religious periodicals and newspapers			-0.129 (0.248)	-0.066 (0.246)				
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	249	249	249	249	249	249	249	249

Note: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Constant terms are not reported.

Table 8: Protestantism, Knowledge Diffusion, and China's Urbanization (Three-SLS Estimation)

Dependent variable	Protestantism measured by Evangelistic centers			Protestantism measured by Christian communicants		
	(1.1) Urbanization	(1.2) Knowledge diffusion	(1.3) Protestantism	(2.1) Urbanization	(2.2) Knowledge diffusion	(2.3) Protestantism
Knowledge diffusion	0.626* (0.341)			0.622* (0.341)		
Evangelistic centers		0.725*** (0.202)				
Christian communicants					0.962*** (0.312)	
Ln (distance)	0.165 (0.170)	0.242 (0.160)	3.988*** (1.053)	0.165 (0.170)	0.173 (0.176)	3.143*** (1.046)
Ln (distance) ²			-0.541*** (0.126)			-0.413*** (0.126)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	223	223	223	223	223	223
R-squared	0.52	0.84	0.75	0.52	0.79	0.55

Note: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Constant terms are not reported.

Table 9: Protestantism, Knowledge Diffusion, and China's Urbanization (Three-SLS Estimation) – Robustness Check

Dependent variable	Protestantism measured by Evangelistic centers			Protestantism measured by Christian communicants		
	(1.1) Urbanization	(1.2) Knowledge diffusion	(1.3) Protestantism	(2.1) Urbanization	(2.2) Knowledge diffusion	(2.3) Protestantism
Knowledge diffusion	1.102** (0.504)			1.097** (0.505)		
Evangelistic centers		0.596*** (0.210)				
Christian communicants					0.837** (0.347)	
Ln (distance)	0.138 (0.205)	0.243 (0.161)	3.971*** (1.199)	0.138 (0.205)	0.194 (0.177)	2.893** (1.197)
Ln (distance) ²			-0.540*** (0.144)			-0.383*** (0.144)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	189	189	189	189	189	189
R-squared	0.21	0.78	0.69	0.21	0.71	0.47

Note: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Constant terms are not reported.

APPENDIX I: DOCUMENTATION OF DATA SOURCES – Table A1

Variables	Data sources
Protestantism	<p>The various measures of Protestant missionaries in China in the period 1918-1921 were jointly surveyed by the Special Committee on Survey and Occupation and the China Continuation Committee (Source: “<i>The Christian Occupation of China: A General Survey of the Numerical Strength and Geographical Distribution of the Christian Forces in China</i>”, Stauffer, 1922).</p> <p>Appendix A of Stauffer (1922) contains information on the following variable at the county level, which we have aggregated into the prefectural level: the number respectively of Evangelistic centers (1920), Christian communicants (1920).</p>
Knowledge diffusion	<p>Appendix A of Stauffer (1922) contains information on the number of primary student enrollment at schools (1920) erected by the Protestants at the county level, which we have aggregated into the prefectural level.</p> <p>Appendix E of Stauffer (1922) enumerates the middle schools and hospitals by location. Based on this information, we computed the number of middle schools and hospitals for each prefecture.</p>
Bible diffusion	<p>Appendix E of Stauffer (1922) enumerates the bible schools by location. Based on this information, we computed the number of bible schools for each prefecture.</p> <p>With regard to religious periodicals and newspapers, Stauffer (1922, p. 455) contains a list of these publications, which we have aggregated into the prefecture level.</p>
Roman Catholicism	<p>Appendix C of Stauffer (1922) contains maps of the provincial distribution of Roman Catholic Mission Stations. Based on these maps, we counted the number of Roman Catholic Mission stations for each prefecture.</p>

Urbanization in 1920	<p>Appendix G of Stauffer (1922) contains a list of cities with urban population larger than 25,000. Based on the information on total prefectural population (<i>China Population History</i>, Ge, 2000), we obtained the urbanization ratio for each prefecture by dividing the urban population by the total population.</p>
Western influence	<p>The duration of treaty ports and railway is calculated from the initial year of the establishment of a treaty port or a/the railway, the information of which is provided in Luo (1995) in <i>Selected Statistical Materials on the Modern Chinese Economy (Zhongguo Jindai Jingji Ziliao Xuanbian)</i>.</p>
Urbanization before 1840	<p>In his book “<i>Urban Networks in Ch’ing China and Tokugawa Japan</i>”, Rozman (1973) ranks cities in China into four categories. Since the highest category contains only one city (Peking), we reclassified all cities into only three categories, namely Big, Mid-sized, and Small.</p>
Geography	<p>The <i>China Historical Geography Information System (CHGIS)</i> of Harvard Yenching Institute provides detailed information on the coastline and rivers of China, from which we derived two dummy variables to indicate whether a prefecture is located on the coast and along the <i>Changjiang</i> River (Yangtze River). Also, based on the data of <i>CHGIS</i>, including latitude and longitude of prefecture capital, we can compute the distance to the Boxer Uprising for each prefecture.</p>
Population density and regional size	<p><i>China Population History</i> (Ge, 2000) contains information on population density as well as the size of each prefecture in 1850.</p>

Appendix II: Construction of the Knowledge Diffusion Index

Since there is not a direct measure of knowledge diffusion across prefectures, we therefore employ three relevant variables to proxy for the diffusion of knowledge-intensive activities. These are: primary school enrollment (log-term), denoted by A_1 , the number of middle schools (log-term), denoted by A_2 , and the number of hospitals (log-term), denoted by A_3 . As shown in Table A2, the correlations among these three variables are significant at the 1 per cent level.

The method of Principal Components Analysis allows us to compress the data by reducing the number of dimensions without losing much of the information.

With $A = [A_1, A_2, A_3]$, we subtract the mean of A_i ($i = 1, 2, 3$) from A_i to obtain the derivations, denoted by $\tilde{A} = [\tilde{A}_1, \tilde{A}_2, \tilde{A}_3]$, and then compute a 3×3 covariance matrix of the three vectors (\tilde{A}_1, \tilde{A}_2 , and \tilde{A}_3), denoted by C . We then calculate the eigenvectors (P_i) and eigenvalues (λ_i) of the covariance matrix C and define it as $CP_i = \lambda_i P_i$. The three pertinent eigenvalues and three eigenvectors are thus:

$$\lambda = \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{pmatrix} = \begin{pmatrix} 2.38 \\ 0.44 \\ 0.18 \end{pmatrix}, \text{ and } P = [P_1, P_2, P_3] = \begin{pmatrix} 0.54 & 0.81 & 0.21 \\ 0.58 & -0.54 & 0.61 \\ 0.61 & -0.21 & -0.77 \end{pmatrix}. \text{ Since only } \lambda_1 > 1, \text{ we}$$

can compress these three dimensions into one dimension, and obtain our variable of interest k , as $k^T = P_1^T \times \tilde{A}^T$, where T is the transposed term.

Using the same method, we similarly reduce the number of proxies of Bible diffusion—the number of Bible schools and the number of religious periodicals and newspapers—to generate an index of Bible diffusion.

Table A2: Correlation matrices of the three knowledge-diffusing activities

Panel A

	Number of primary students enrolled (log-term)	Number of middle schools (log-term)	Number of hospitals (log-term)
Number of primary students enrolled (log-term)	1.0000		
Number of middle schools (log-term)	0.5784***	1.0000	
Number of hospitals (log-term)	0.6804***	0.8054***	1.0000

Panel B

	Number of Bible school (log-term)	Number of religious periodicals and newspapers (log-term)
Number of Bible school (log-term)	1.0000	
Number of religious periodicals and newspapers (log-term)	0.6234***	1.0000

Note: *** significant at 1%.

Table A3: The Effect of Teaching (Medical) Universities on General Hospitals

	Number of hospitals (log-term)		
	(1)	(2)	(3)
Distance to teaching (medical) university	-0.094*** (0.034)	-0.094*** (0.035)	
Distance to treaty ports	-0.035 (0.031)		-0.034 (0.029)
Roman Catholicism	0.005 (0.042)	0.009 (0.042)	0.023 (0.042)
Duration of treaty ports	0.007*** (0.002)	0.008*** (0.002)	0.008*** (0.002)
Duration of railway	0.017*** (0.004)	0.017*** (0.004)	0.017*** (0.004)
Small city (pre-1840)	0.082 (0.078)	0.084 (0.078)	0.099 (0.076)
Mid-sized city (pre-1840)	0.321*** (0.087)	0.322*** (0.087)	0.345*** (0.089)
Big city (pre-1840)	0.390** (0.167)	0.397** (0.169)	0.587*** (0.173)
Riverside (<i>Changjiang</i>)	0.057 (0.113)	0.083 (0.110)	-0.006 (0.110)
Coast	-0.023 (0.116)	-0.019 (0.117)	-0.028 (0.119)
Ln (population density, 1850)	0.120*** (0.037)	0.124*** (0.037)	0.117*** (0.039)
Ln (size of prefecture)	0.185*** (0.040)	0.179*** (0.040)	0.166*** (0.041)
Province dummies	Yes	Yes	Yes
Observations	249	249	249
R-squared	0.70	0.70	0.69

Note: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Constant terms are not reported.

APPENDIX III: DETERMINANTS OF THE BOXER UPRISING INCIDENCE

There are two reasons for testing the causes of the Boxer Uprising. First, since we employ the Boxer Uprising to identify the causal effect of Protestantism on economic outcome, it would be useful to ascertain the characteristics of those prefectures in which the Uprising had occurred. Second, since we drop all the prefectures of the Uprising when using the instrumental variable, it is necessary to correct for the sample selection bias by finding at least one exogenous determinant to predict the Inverse Mills Ratio.

To show that the Boxers' hatred of the foreigners may have resulted as much from the penetration of the Western economic powers as it was a consequence of religious conflict with the Christian evangelism, we regress the incidence of the Boxer Uprising on a host of independent variables that include: the level of Protestantism (share of counties with missionary work, 1890s), the level of Roman Catholicism, Western economy penetration (duration of treaty ports and duration of railway), the initial economic prosperity (pre-1840), and geographical variables (coastal, population density and size). Reported in Table A4, the results show that the Boxer Uprising had higher odds of occurring in prefectures with higher diffusion of Protestantism and greater Western economic penetration (railway).

Moreover, in light of the intimate relationship between economic shocks (such as droughts) and social conflicts (Miguel et al., 2005), we control for the level of drought in 1900 in the same regression, and find that it is significantly and positively correlated with the incidence of the Boxer Uprising.⁴⁸ In order to prove that the drought in 1900 is exogenous, we need to show that it is uncorrelated with

⁴⁸ Based on deviations from average precipitation, the meteorological index of drought has a distribution that ranges between zero (least severe) to five (most severe).

droughts in other years. We therefore include 1899 as control, and find that it is not significant, with the marginal effect of the 1900 drought remaining little changed.

Table A4: Determinants of the Boxers Uprising Incidence

	The Boxer Uprising Incidence (Prefectures affected = 1)		Selected Samples (Prefectures unaffected = 1)
	(1)	(2)	(3)
Share of counties with missionary work (1890)	0.081* (0.048)	0.079* (0.046)	
Roman Catholicism	0.003 (0.015)	0.003 (0.015)	-0.012 (0.021)
Coast	-0.068*** (0.019)	-0.069*** (0.019)	0.041** (0.019)
Duration of treaty ports (1900)	-0.001 (0.001)	-0.001 (0.001)	
Duration of treaty ports (1920)			0.002 (0.001)
Duration of railway (1900)	0.010*** (0.004)	0.010*** (0.004)	
Duration of railway (1920)			-0.003* (0.001)
Small city (pre-1840)	-0.030* (0.017)	-0.029* (0.017)	0.052** (0.022)
Mid-sized city (pre- 1840)	0.025 (0.040)	0.031 (0.043)	-0.037 (0.053)
Big city (pre-1840)	-0.029** (0.014)	-0.029** (0.014)	0.042** (0.021)
Ln (population density, 1850)	0.025 (0.016)	0.022 (0.015)	-0.032 (0.021)
Ln (size of prefecture)	0.038* (0.021)	0.040* (0.021)	-0.049** (0.025)
Drought 1900	0.036*** (0.014)	0.032** (0.013)	-0.052*** (0.014)
Drought 1899		0.008 (0.007)	
Observations	249	249	249

Notes: Marginal effects are reported and standard errors in parenthesis; * significant at 10%; ** significant at 5%; *** significant at 1%.