WAS WEBER WRONG? A HUMAN CAPITAL THEORY OF PROTESTANT ECONOMIC HISTORY*

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Max Weber attributed the higher economic prosperity of Protestant regions to a Protestant work ethic. We provide an alternative theory: Protestant economies prospered because instruction in reading the Bible generated the human capital crucial to economic prosperity. We test the theory using county-level data from late-nineteenth-century Prussia, exploiting the initial concentric dispersion of the Reformation to use distance to Wittenberg as an instrument for Protestantism. We find that Protestantism indeed led to higher economic prosperity, but also to better education. Our results are consistent with Protestants' higher literacy accounting for most of the gap in economic prosperity.

I. INTRODUCTION

In the century since Max Weber suggested in *The Protestant Ethic and the Spirit of Capitalism* that a "Protestant ethic" was instrumental for economic progress (Weber 2001), several interpretations have emerged as to how Protestants came to be more prosperous than Catholics. Weber's study is considered a seminal work in sociology, and subsequent sociological interpretations have incorporated the idea that the specific ethic of Protestant theology may have induced its followers to work harder and to save more. To these sociological theories we offer a simple alternative economic theory based on the standard human capital model. Martin Luther explicitly favored universal schooling in order to enable all Christians to read the Gospel by themselves. We

*The idea that the rise of Protestantism may have fostered human capital accumulation in Europe stems from our discussions with Paul E. Peterson, who again traces it back to a late-1960s Chicago seminar by C. Arnold Anderson and Mary Jean Bowman. We received substantive comments during seminar presentations at the Universities of Harvard, Stanford, UC Davis, Munich, Zurich, Stockholm, Florence, and Rome "Tor Vergata," the London School of Economics, Aarhus Business School, the Ifo Institute Munich, ZEW Mannheim, WZB Berlin, the Max Planck Institute for Research on Collective Goods Bonn, the Third Christmas Conference of German Expatriate Economists, the European Meeting of the Econometric Society in Budapest, the Oslo conference of the European Association of Labour Economists, and the Munich conference of the German Economic Association. Discussions with and comments from Andreas Ammermüller, Knut Borchardt, David Card, Andreas Diekmann, Guido Friebel, Claudia Goldin, Avner Greif, Bob Hart, Mathias Hoffmann, Larry Kahn, Tim Lorentzen, Volker Meier, Petra Moser, Paul Peterson, Guido Schwerdt, Holger Sieg, Daniel Sturm, Marty West, Ulrich Woitek, the editors, and anonymous referees were very fruitful. Support has come from the Program on Education Policy and Governance of Harvard University. Erik Hornung, Martin Hofmann, and Clemens König provided capable research assistance. We are grateful to all of them.

The Quarterly Journal of Economics, May 2009

suggest that, incidentally, the ensuing literacy among Protestants was also then used in economic activities.

We take Weber's own perspective to test our theory empirically, using variation across the 452 counties of his native Prussia, the dominant state of the German Empire. We find a significant, positive association between Protestantism and economic prosperity in late-nineteenth-century Prussia, confirming Weber's descriptive observation. To our knowledge, this is the first thorough empirical analysis of the Weber thesis at the subnational level. More importantly, we argue that the approximately concentric diffusion of Protestantism in Prussia around Luther's city of Wittenberg in Lutheran times allows us to identify exogenous variation in Protestantism in the late nineteenth century. Using distance to Wittenberg as an instrument for counties' shares of Protestants, we find that Protestantism had a strong effect on literacy, confirming the basic mechanism of our human capital theory. In this model, identification comes from the assumption that the Reformation was an exogenous event, generating a random shock that spread concentrically around Wittenberg. We corroborate this identifying assumption by showing that distance to Wittenberg is indeed unrelated to a series of proxies for economic and educational development before 1517, including the pre-Luther placement of schools, universities, monasteries, and free imperial and Hanseatic cities and urbanization.

The Protestant lead in literacy is large enough to account for practically the entire Protestant lead in economic outcomes. When we restrict the economic return to literacy to values consistent with existing causal estimates in the literature, the point estimate of the independent effect of Protestantism on economic outcomes adjusted for literacy approaches zero. Our results thus suggest that human capital can account for at least some of the denominational difference in economic affluence, and they are consistent with the hypothesis that it can account for most or even all of the difference. This would leave little scope for independent effects of channels traditionally associated with the Weber thesis, such as increased work effort and saving. The result holds for a series of measures of economic outcomes, including per capita income taxes, an income measure based on teacher salaries, and the size of the nonagricultural sector.

Prussia in the late nineteenth century provides the natural place to study the relationship between Protestantism, education,

and economic prosperity. It includes Wittenberg, where the Reformation was initiated and from whence Luther's doctrine diffused in its purest form. Prussia had uniform laws and institutional settings, so that the empirical investigation is not hampered by institutional heterogeneity. It was also reasonably well divided between Protestants and Catholics, at roughly two-thirds to one-third of the population, so that no denomination constitutes just a small minority. Finally, the Prussian Statistical Office collected an impressive amount of data, the quality of which is generally accepted as having been outstanding already in the nineteenth century, and which have survived at the county level in the archives. The 1871 Prussian Census was the first to survey the literacy of the whole population. We thus do not have to rely on data from selective samples such as military recruits, which provide only a limited picture of the population at large. The Prussian county data allow us to go beyond the existing empirical literature on the Weber thesis, which mostly uses cross-country variation. Although the issue is not fully resolved in the literature (cf. Iannaccone [1998]; Delacroix and Nielsen [2001]), we provide descriptive evidence below that Protestant countries were on average economically more advanced in 1900 than Catholic countries—and were substantially more literate.

A broader context of papers studies the association between religion and economic outcomes. As an important expression of culture (Guiso, Sapienza, and Zingales 2006), religion is generally viewed as a possible fundamental determinant of economic growth. Thus, Barro and McCleary (2003, 2005) study the association between different religions and economic growth. In a study concerned with controlling for the effects of economic institutions, Acemoglu, Johnson, and Robinson (2001, 2005) find no effect of religion on growth in a cross-country setting.

Any cross-country study is plagued by the difficulty of disentangling the effect of religion from other possible fundamental causes of economic prosperity that vary across countries, such as institutions and geography. By contrast, looking at regional data within Prussia exposes all our observations to the same institutional and legal setting. Similarly, problems of geographical variation are substantially smaller within Prussia than globally, and we test for robustness by adding controls for a rich set of geographical features. We can even include district fixed effects, using only variation across counties within each district. In effect, we

hold institutions and geography constant and ask whether there is a role for religion in economic outcomes.[1]

Our results suggest that although religious affiliation indeed had economic consequences, this may have been for reasons other than the disposition of the work ethic. Our human capital theory of Protestant economic prosperity is certainly complementary to ethics-based theories in the sense that the economic role of the Protestant ethic may work essentially via human capital accumulation (a thought that, however, is not explicitly contained in Weber's work). But our evidence that the human capital channel can be traced back to denominational variation stemming from the choices of local rulers during the Reformation in the sixteenth and early seventeenth centuries suggests that explanations based purely on differential work ethics may have limited power. A major driving force of the higher economic prosperity of Protestants in late-nineteenth-century Prussia was education. Of course, religion *was* important for economic success in the sense that without intention it resulted in an uneven accumulation of human capital. The denominational differences originating in the Reformation affected economic outcomes even after several centuries.

The next section presents evidence that Protestant countries and regions were economically more prosperous than Catholic countries and regions in the late nineteenth century. Section III develops the theoretical foundation. Section IV demonstrates that Protestant countries and regions had better-educated populations. Section V shows that this association warrants a causal interpretation in an instrumental variable model exploiting the historical origin of the Reformation in Prussia. Section VI provides evidence on the importance of education in accounting for the Protestant economic lead in late-nineteenth-century Prussia.

II. The Basic Facts: Protestantism and Economic Prosperity

The purported association underlying the Weber thesis is that Protestantism was correlated with greater economic prosperity. This section provides several pieces of evidence—patterns

1. In a cross-country study, Glaeser et al. (2004) find that human capital may be a more basic source of growth than institutions. Our finding of an important role of education is also consistent with a long literature stressing the importance of human capital for historical economic development in general; cf., for example, Easterlin (1981), Goldin (2001), Lindert (2003), and Galor (2005). For a recent review of the vast literature on the role of human capital in modern economic growth, cf. Hanushek and Woessmann (2008).

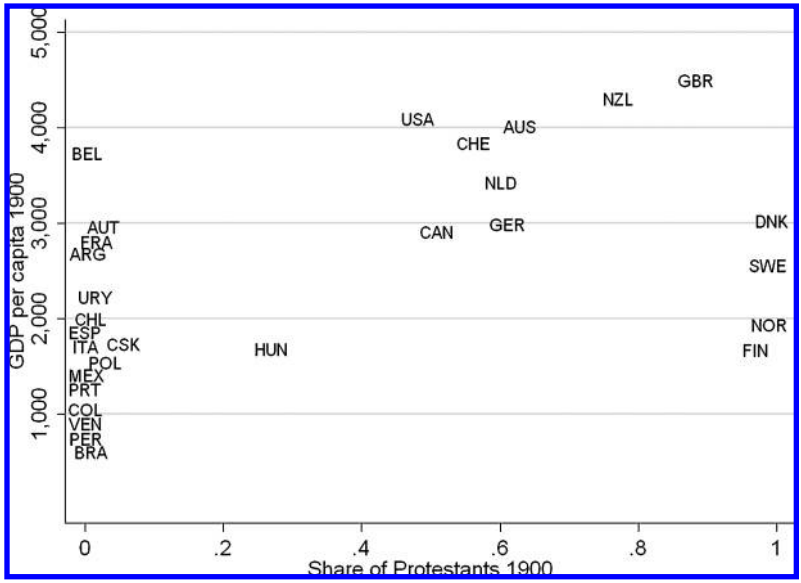

FIGURE I
The Cross-Country Pattern of Protestantism and GDP Per Capita, 1900
See Appendix III for data details.

across countries in 1900, within-country patterns in the existing literature, and new evidence for Prussia in the 1870/1880s and Germany today—confirming the validity of this basic association.

Despite some negative cross-country assessments in the literature (Iannaccone 1998; Delacroix and Nielsen 2001),[2] Glaeser and Glendon (1998) provide evidence from available data that economic growth between 1820 and 1950 was faster in seven predominantly Protestant countries than in five predominantly Catholic countries. They also report that average income levels were higher in the Protestant countries. In Figure I, we plot Maddison's (2006) data on GDP per capita in 1900 against the data on religious population shares by Barrett, Kurian, and Johnson (2001) for all countries in which Catholics and Protestants together accounted for the majority of the population. The cross-country pattern in 1900 reveals that countries with a larger share of Protestants were on average economically more advanced than countries with

2. See also the growth model calibrated to England by Cavalcanti, Parente, and Zhao (2007), which suggests that differences between Catholics and Protestants could at best account for only slight delays in the start of industrialization.

a larger share of Catholics. The correlation coefficient across the 29 countries for available data is .52 (statistically significant at the 1% level).[3]

Micro evidence from within countries is much scarcer. The only explicit evidence that Weber put forward is a descriptive exposition by Offenbacher (1900) for the German region of Baden in 1885–1895 showing that Protestant children were more likely than Catholics to attend institutions that prepared for technical and commercial occupations.[4] Although George Becker (1997) aptly reveals the shortcomings of these data, his reanalysis still reveals a positive association between Protestantism and orientation toward higher-paying occupations. For the United States, Goldin and Katz (2000) show that Protestants had higher earnings than Catholics in 1915 Iowa.

To this evidence, we add our new 1870/1880s analyses at the county level in Prussia, which was well divided between Protestants and Catholics (see Section VI for details of the data and regression analyses). Our best proxy for county income is income tax revenues in 1877. Per capita income taxes and the share of Protestants are significantly positively correlated for tax data across the 426 counties (correlation coefficient .13, statistically significant at the 1% level). Per capita income taxes are 9.1% higher in the 225 mostly-Protestant counties than in the 102 mostly-Catholic counties (defined as having either more than 80% or less than 20% Protestants).

Another indicator of economic progressiveness is the sectoral structure of the 452 counties in 1882, where we observe the shares of the labor force working in the manufacturing sector and in the service sector. The service-sector share, which includes such businesses as trade, insurance, and transport (but not servants,

3. The scatterplot depicts the role of the Nordic countries as "impoverished sophisticates" (Sandberg [1979] on Sweden) whose level of economic development was not up to their level of human capital before the industrial revolution took hold there. Without the Nordic countries, the correlation between GDP per capita and the share of Protestants across predominantly Christian countries in 1900 is as high as .77.

4. Common perceptions of systematic denominational differences in economic backwardness within Germany also suggest that the Weber observation was indeed viewed as an important stylized fact in Germany both in the late nineteenth century and in the mid-twentieth century. Weber (2001) refers to regular public discussions at official meetings of the Catholic laity in Germany on the general public feeling that Catholics were economically lagging behind Protestants at his time. The very same discussions of Catholic backwardness reemerged in Catholic meetings and media in the 1950s and 1960s (e.g., Herder-Korrespondenz [1954]; Erlinghagen [1965]).

housemaids, or the public administration), is significantly positively correlated with Protestantism (correlation coefficient .10, significant at 4%). The correlation of Protestantism with the manufacturing share in the full sample is not statistically significantly different from zero, but this is driven by the fact that the affluent Ruhr area derived its large manufacturing share from coal, which fostered a large mining industry (subsumed under manufacturing in the 1882 census). Disregarding the two provinces that contain the Ruhr area (Rheinprovinz and Westphalen), the manufacturing share is also significantly positively correlated with Protestantism (correlation coefficient .10, significant at 8%). The same is true for the combined share of the labor force that has moved out of agriculture into manufacturing and services, which we will refer to as nonagricultural share in the remainder of the paper (correlation coefficient .13, significant at 2%).[5] In this sample, the nonagricultural share in the 223 mostly-Protestant counties of 32.0% is 3.5 percentage points higher than in the 45 mostly-Catholic counties.

Finally, using individual-level data from Germany today (see Section VI.E for details), we still observe that Protestants earn 6.9% higher incomes than Catholics.

In sum, there is clear evidence that Protestantism was (and is) associated with economic prosperity, as purported by the Weber thesis. Motivated by these descriptive patterns, we turn to the question of how these basic facts can be explained.

III. The Protestant Ethic versus the Human Capital Hypothesis

This section presents two alternative theoretical approaches to understanding the history of Protestants' relative economic progressiveness, Weber's thesis based on a Protestant work ethic and our human capital theory of Protestant economic history. The two approaches are not mutually exclusive; in fact, they may well be complementary.

III.A. The Weber Thesis of a Protestant Ethic

Max Weber (2001) proposed the "most famous link between culture and economic development" (Acemoglu, Johnson, and Robinson 2005, p. 401), namely that the Protestant Reformation

5. When the two provinces are disregarded, the correlation between income taxes and Protestantism also increases to .30.

was instrumental in facilitating industrial capitalism in Western Europe.[6] The descriptive observation of greater economic prosperity of Protestants had been the subject of a long-running discussion, traceable at least as far back as to Menschenfreund (1772).

The particular feature of Weber's main thesis is that it is the specific *ethic* of Protestantism that affected economic outcomes.[7] Weber argued that the Reformation introduced the crucial notion of the "calling" ("Beruf"), with the current use of the word originating in Luther's translation of the Bible. The notion of the calling carries the suggestion of a religious conception, the sanctification of labor to a task set by God. This notion, according to Weber, created a particular Protestant work ethic, which—in contrast to the Catholic ideal of surpassing worldly morality in monastic asceticism—valued the fulfillment of worldly duties as the highest moral achievement. According to Weber (2001, p. 40), "The only way of living acceptably to God was . . . solely through the fulfillment of the obligations imposed upon the individual by his position in the world. That was his calling."[8] The Protestant work ethic approved of the accumulation of wealth and thus, according to Weber's argument, provided the moral foundation for capitalist industrialization. Success in a calling became regarded as a sign of being among the select group that God will save from damnation (cf. Giddens's introduction to Weber [2001]). Thus, Weber provides an ethics-based theory for economic development.[9]

6. On a cautionary note, we stress that there is considerable controversy about what Weber's own main hypothesis about Protestantism and the development of capitalism actually was. However, it is undisputed that the core of his argument is that there is a difference in ethical disposition between Protestants and Catholics that had a significant bearing on economic outcomes.

7. Doepke and Zilibotti (2008) endogenize preferences and cultural values, suggesting that the preindustrial professional distribution generated class-specific attitudes (among them "the spirit of capitalism" in the middle class) that help to explain the socioeconomic transformation that occurred during the industrial revolution.

8. Weber explicitly traces this central notion back to Luther, whereas later it was most rigorously developed in certain Protestant communities, such as Calvinists, Puritans, Methodists, and Baptists. In Prussia, the vast majority of Protestants were Lutherans. The distinction between Lutherans and the second Protestant community, Reformists, was dropped in official statistics when they were merged into the Protestant Church in Prussia (Evangelische Kirche in Preußen) in 1817. Just before the merge, 94% of Protestants in Prussia were Lutherans (Mützell 1825).

9. Weber's work has been criticized as misinterpreting Protestant doctrine, Catholic doctrine, and the development of specific forms of capitalism (cf. Giddens's introduction to Weber [2001]). Critics also pointed out the historical inconsistencies that most capitalist institutions preceded the Reformation (Tawney 1926), early Reformation leaders were uninterested in or even hostile to economic issues and ignorant of the working of capitalist institutions (Samuelsson 1993),

One mechanism underlying the Weber thesis is that the work ethic drives Protestants to simply work harder. Another mechanism is that their belief system compels them to save more in order to defer gratification, which transforms into investments and thus higher productivity in the longer run.[10] Because there is substantial controversy as to whether Weber was trying to explain economic disparities existent at his time or just the initial origin of capitalism, we resort to aiming our analysis at what has been called the "Common Interpretation" (Delacroix and Nielsen 2001) of the *Protestant Ethic*, which has taken a life of its own, namely the simple emphasis on a "connection between Protestantism and economic progress" (Coleman's 1959 introduction to Samuelsson [1993]) in general.

III.B. A Human Capital Theory of Protestant Economic History

It is a highly acclaimed fact that Martin Luther produced the first widely used German translation of the Bible. He opposed the Roman Catholic practice of reading out the Gospel in the scholarly language of Latin and wanted everyone to be able to understand God's Word. What is less well known today is that Luther also very explicitly promoted the expansion of education (cf. Rupp [1996, 1998]). Quite obviously, if one wants to read the Bible, one must be able to read. Already in his very early preaching, Luther (1888, pp. 461–462) explicitly demanded that every town should have both a boys' and a girls' school where every child should learn to read the Holy Scriptures.

Luther's call to teach everyone so that they are able to read God's Word by themselves is the key feature of our alternative theory of the relative economic affluence of Protestants, because—as a mere coincidence—the literacy that was created also had a significant use in the economic sphere.[11] It should be stressed, though, that Luther never had an economic use in mind. The

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and several selective regional examples of economic development went counter to the Weber thesis (cf. also Iannaccone [1998]).

10. Merton (1936) stressed the importance of Protestantism for the development of science. Blum and Dudley (2001) interpret the Weber thesis in terms of information networks and model the adoption of Protestantism as an increase in the cost of defection in contractual relationships with strangers that increased trade.

11. In a closely related argument, Botticini and Eckstein (2005, 2007) suggest a human capital interpretation of Jewish history, where the ultimate root of Jewish economic prosperity as merchants lies in a centuries-old Judaic rule that required male Jews to be able to read the Torah in the synagogue and to teach the reading of the Torah to their sons.

increased education of Protestants was purely religiously motivated; instruction, learning, and scientific engagement did not carry a value of their own for Luther. "Luther's prime concern in this area was the creation of elementary schools for the people as a means of providing all Christians with access to the word of God, as contained in the Bible" (Rupp 1996, p. 618).[12] This relates both to the authority of a book, the Bible, for Protestantism and to Luther's general theological tenet of the 'universal priesthood of all believers' (cf. Pelikan [2005]). Rather than relying on injunctions by specifically ordained priests, ceremonial exercises, and sacerdotal imagery, each Christian was urged to read the sacred text for himself or herself. This required breaching the clerics' privilege of education in favor of universal basic education. Rupp (1998, p. 172) summarizes the basic line of reasoning:

> because the divine revelation had quasi materialized itself in the Holy Scripture, each Christian, each Protestant believer was indispensably referred to getting to know and reading this scripture. But this, in turn, made it necessary that everybody could indeed read this scripture—and this, of course, had corresponding efforts of education in schools, which had still to be established, as its precondition. . . .

Luther addressed his educational demands to two different addressees. First, as is most evident in a 1524 pamphlet, he pressured the Protestant rulers to build and maintain schools. In *To the Councilmen of All Cities in Germany That They Establish and Maintain Christian Schools*, Luther (1899) assigned the duty of operating schools to the rulers and territorial authorities. If parents did not take care of schools, Luther argued, it would be the duty of the rulers to incur the effort and cost of running schools. In his practical implementation of educational reforms, Melanchthon also made the authorities responsible for organizing the new education system (Rupp 1996). As a consequence, the costs of schooling might have been lower for individuals in Protestant regions than in Catholic regions. Owing to the higher prevalence of public schools in Protestant regions, the commuting costs to schools would be lower. Depending on the incidence of the ruler's financing of the costs of schools, part or all of the financial burden might also not have to be carried by the individual in terms of taxes, but

12. Woodberry (2004) uses a similar argument to show that Protestant (rather than Catholic) missionaries were central in expanding mass education in the colonial world.

might have come, for example, from reduced spending on amenities for the ruler and his protégés.

Second, most evident in his 1530 *Sermon on Keeping Children in School*, Luther (1909, p. 526) also demanded that each individual, especially the parents, put emphasis on education and send children to school:

> I see that the common people are dismissive to maintaining the schools and that they withdraw their children from instruction altogether and turn solely to the care for food and bellies, and besides they either will not or cannot consider what a horrible and un-Christian thing they are doing and what great and murderous harm they are doing everywhere in so serving the devil.

Thus, in line with the universal priesthood of all believers, all Christians are called on to ensure that their children receive a decent education. As a consequence of Luther's postulations, the individual (religious) benefit of schooling would have been higher for Protestants than for Catholics. Luther's educational postulations might also have induced Protestants to view learning as less of a strain and more of an enjoyment, thereby reducing the individual costs of schooling.

Combining the two effects, a simple economic model predicts that when optimizing individual utility, in equilibrium Protestants will have more education on average than Catholics because they have lower costs and higher benefits of schooling (see Section II.C of Becker and Woessmann [2007] for a depiction of this argument in a simple human capital model).

The fact that the Reformation was one of the leading origins of elementary schooling in Germany is well accepted in the study of German educational history (cf. Spranger [1949]; Flitner [1954]; Reble [2002]).[13] The leading reformers were very active in putting Luther's educational preaching into practice. Protestant cities and territories instituted new Church and School Ordinances that postulated universal education of all children and required building new schools (cf. Green [1979] for examples). Regular visitation by leading reformers ensured the implementation of these ordinances. Green (1979) documents the vastly increasing number of schools in the Protestant region of Brandenburg in the first decades of the Reformation until 1600.

13. In the post-Luther era of the Counter-Reformation, it was particularly the Jesuits who tried to advance education also among the Catholic population. However, as our evidence below shows, this was far less encompassing than the Protestant urge for education.

The final step in our argument is that such educational expansion was useful beyond religion, for economic productivity in our case. In economics, the supreme importance of education for economic prosperity has received particular emphasis since the emergence of the theory of human capital in the early 1960s. The key idea is that education is an investment that yields higher labor-market earnings because it increases productivity. The linguistic and methodical skills created by the teaching of God's Word—reading, understanding, and knowing the Bible, including its exegetical comprehension—are thus valuable in other tasks beyond the religious realm.

In sum, Luther's educational postulations give rise to a simple alternative theory of the historical economic success of Protestant regions: Protestants acquired more schooling than Catholics for religious reasons, and as a side effect, this higher schooling then transformed into higher economic prosperity (cf. Becker and Woessmann [2007] for additional details). Of course, such a theory does not preclude other effects of Protestantism. For example, it may well be complementary to the Weber thesis in the sense that Protestants might become more educated because of a better work ethic. But our theory provides the innovation of stressing education as a key channel in the Protestant economic lead.

IV. Evidence on Protestantism and Education

To validate the basic tenet of our human capital hypothesis, this section provides evidence on the association between Protestantism and education. After a brief discussion of the cross-country pattern and existing evidence, we turn to our analysis of county-level data from late nineteenth-century Prussia.

IV.A. The International Pattern

We derive cross-country data on literacy rates in 1900 mainly from the UNESCO (1953) compilation based on national population censuses, reporting the share of persons above 10 or 15 years who could read in 1900 (or a close year). We supplement this by additional literacy data in Cipolla (1969) and Flora (1983), some of which stem from military records on literacy among recruits and from marriage registers on the share of newly married bridegrooms and brides who could sign their marriage

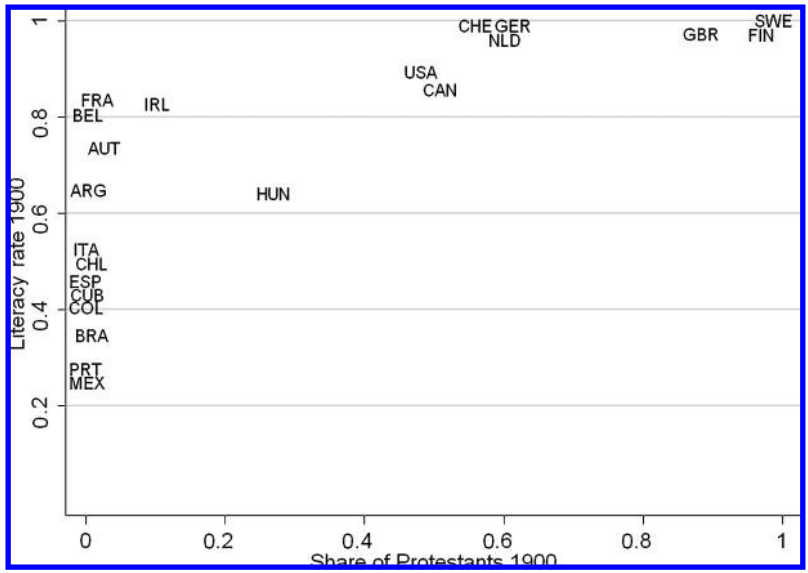

FIGURE II
The Cross-Country Pattern of Protestantism and Literacy, 1900
See Appendix III for data details.

certificates.[14] We follow Tabellini (2005) in combining literacy data from different sources in a cross-country comparison, fully aware that there are severe limits to cross-country comparability due to differences in literacy definitions and samples (cf. UNESCO [1953]). Although such limitations often will not allow establishing literacy rates within a few percentage points, the broad cross-country pattern, as depicted in Figure II, should not be affected.[15]

The figure reveals clearly that among the countries where Protestants and Catholics together accounted for the majority of

14. Both additional sources of literacy data have disadvantages: Military records generally refer to a specific age group of the able-bodied male population only, and marriage registers to varying age compositions and proportions of people who got married.

15. For example, the literacy data for Germany, the Netherlands, and Switzerland refer to military recruits and may thus overestimate literacy among the adult population. The data for Argentina and Colombia refer to 1914 and 1917, respectively, and the data for Cuba count all people attending school as able to read, all of which might bias the estimates upward. All of this suggests that if anything, the positive cross-country correlation between Protestantism and literacy may be underrepresented in the graph.

the population, all countries with Protestant majorities had nearly universal literacy in 1900, whereas no Catholic country reached full literacy, and many Catholic countries fell far short of it.[16] The correlation coefficient between Protestantism and literacy across the 22 countries with available data in 1900 is as high as .78 (statistically significant at the 1% level).[17]

Existing within-country data provide a similar pattern. Goldin and Katz (2002) show that in the United States in 1910–1938, areas that led in secondary education had higher shares of Protestant population. Similarly, Go and Lindert (2007) report that in some specifications, Protestantism had a positive effect relative to Catholicism on several schooling outcomes in 1850 across U.S. counties. In Ireland in 1871, illiteracy among the different Protestant communities was between 7% and 14%, whereas it was 40% among Catholics (Cipolla 1969). In Finland in 1880, only 1.3% of Lutherans were unable to read or write, as against 54.4% among Catholics (Markussen 1990). Even today in Germany, Protestants have 0.8 years of education more than Catholics (with an average of 12.4 years of education; see Section VI.E for details).

IV.B. Data for Prussian Counties in the Late Nineteenth Century

Prussia in the late nineteenth century is the obvious place to probe the association between Protestantism and education more deeply, using subnational data. First, nineteenth-century Prussia has the birthplace of the Reformation at its center. Luther proclaimed his 95 Theses in Wittenberg, and the Prussian territory conserved Protestantism in its purest form. Second, Prussia is Max Weber's birthplace, and his views were shaped by what he observed across Germany. Third, Prussia had rather uniform laws and institutional frameworks, with the possible exception of recent annexations (dealt with below). By contrast, cross-country comparisons, which constitute the existing literature, are notoriously plagued by the difficulty of netting out the effects of other fundamental causes, such as institutions and geography (cf. Acemoglu, Johnson, and Robinson [2005]). Fourth, Prussia was well divided between Protestants and Catholics, with Protestants constituting roughly two thirds and Catholics roughly one third

16. Although there are no encompassing literacy data for Denmark and Norway, there is suggestive evidence that these two Protestant countries also reached universal literacy by 1900 (cf. Markussen [1990]).

17. Dummies indicating the different data sources do not enter statistically significantly into a regression framework and do not change this pattern of results.

of the total population, so that no denomination was an extreme minority. This differs from the more lopsided denominational distributions of most other countries. What is more, Prussia was exceptional in granting freedom of religion to each individual at least as early as the mid-eighteenth century. Frederick the Great, the enlightened monarch of Prussia, had famously declared in 1740 that in his country, everybody might find his salvation in his own way.[18] Fifth, with a population of about 24.6 million in 1871, Prussia was one of the largest European countries and accounted for 60 percent of the inhabitants of the German Empire. Sixth, Prussian proverbial orderliness and thoroughness yielded high-quality data at the county level in the second half of the nineteenth century.

We thus build our database on Protestantism and literacy in nineteenth-century Prussia mainly from census material collected by the Prussian Statistical Office in 1871, which we supplement with additional survey data from the 1870s and 1880s, all available at the county level. Our data cover all 452 Prussian counties (*Kreise*) at the time, divided into 35 districts (*Regierungsbezirke*) and 11 provinces (*Provinzen*); see Appendix I for details.

The 1871 Population Census provides data on religious affiliation and literacy, as well as a set of standard demographic variables such as gender and age. The descriptive statistics, reported in Table I, reveal that the average share of Protestants in a county was 64.2%, against 34.5% Catholics (the remaining shares being Jews at 1.1% and other Christian denominations at 0.2%). There are two things to note. First, both Protestants and Catholics are not just a small minority, but constitute a sizeable fraction of the Prussian population. Second, there is substantial variation across counties, essentially ranging from zero to 100% Protestants or Catholics, which provides the variation for our empirical analysis. In fact, more than 75% (60%) of the counties have a share of at least 80% (90%) of either Protestants or Catholics. Figure III provides a rough impression of the geographical distribution of the religious affiliation across the 452 counties, revealing a mostly concentric pattern of the diffusion of Protestantism with Wittenberg at the center. Protestant diffusion came to a halt in the

18. ". . . hier mus ein jeder nach Seiner Façon Selich werden." Frederick also wrote that "all religions are equal and good." A unique feature in the eighteenth century, a Protestant and a Catholic church stood next to each other in the *Forum Fridericianum* at the origin of the central boulevard "Unter den Linden" in Berlin.

TABLE I
DESCRIPTIVE STATISTICS IN NINETEENTH-CENTURY PRUSSIA

	Mean (1)	StdDev (2)	Min (3)	Max (4)
Economic outcome variables				
Income tax revenue per capita (1877)[a]	1.98	0.70	0.21	5.63
Income of male elem. school teachers (1886)	982.83	200.42	711.96	1,954.19
% of labor force in manufacturing and services (1882)	33.91	15.31	7.93	81.53
% of labor force in manufacturing (1882)	27.65	13.41	6.12	71.76
% of labor force in services (1882)	6.26	3.55	1.80	24.46
Main explanatory variables				
% Protestants	64.18	37.83	0.26	99.89
% Catholics	34.48	37.54	0.04	99.73
% literate	87.51	12.67	37.40	99.33
% pupils with distance to school over 3 km	2.99	3.42	0.00	19.79
Distance to Wittenberg in km	326.19	148.77	0.00	731.46
Control variables				
% age below 10	24.71	2.48	15.33	29.87
% Jews	1.14	1.33	0.00	12.87
% females	51.00	1.51	43.97	54.63
% born in municipality	58.97	12.39	32.01	87.23
% of Prussian origin	99.07	1.97	74.22	100.00
Average household size	4.79	0.34	3.83	5.86
Total population size	54,426.16	42,078.42	11,609	826,341
Popul. growth 1867–1871 (in %)	1.60	4.93	−7.76	33.83
% missing education info	1.69	1.10	0.00	6.72
% blind	0.09	0.03	0.03	0.24
% deaf-mute	0.10	0.05	0.02	0.42
% insane	0.23	0.17	0.02	1.56
Distance to Berlin (in km)	332.89	146.61	0.00	650.04
Latitude (in rad)	90.88	2.53	83.93	97.24
Longitude (in rad)	22.08	8.17	10.52	39.40
Polish-speaking provinces	0.26	0.44	0.00	1.00
% of labor force in mining	2.54	7.57	0.00	54.19
% of county population in urban areas	27.53	21.90	0.00	100.00
Year in which annexed by Prussia	1,751.69	111.05	1525	1866

Source. Data for Prussian counties (452 observations) from the 1871 Population Census, the 1877 Income Tax Statistics, the 1882 Occupation Census, and the 1886 Education Census; see main text and Appendix I for details.
Note. Monetary variables are in Marks (at current prices).
[a]426 observations (data not available for urban counties).

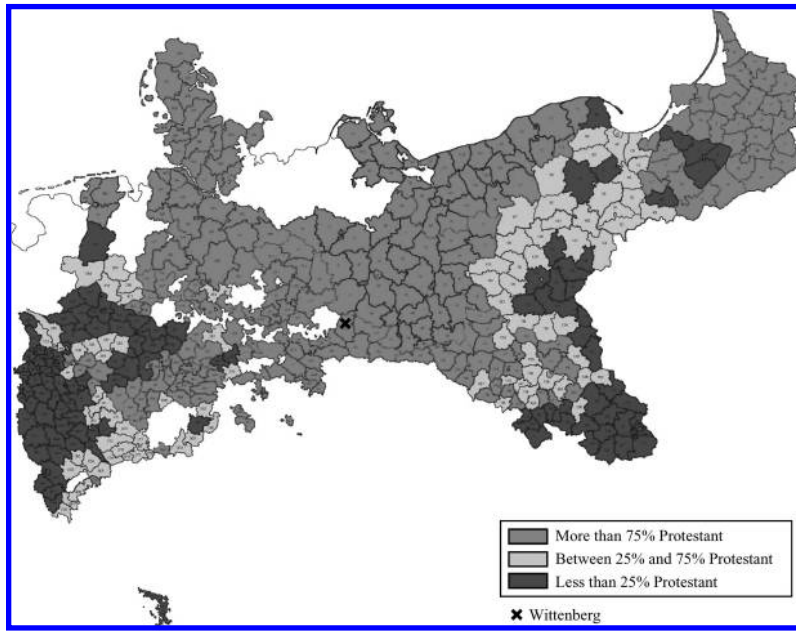

FIGURE III
Protestantism in Nineteenth-Century Prussia
County-level depiction based on 1871 Population Census. See Appendix I for data details.

western provinces (Rhineland and Westphalia) and in the eastern parts, which were predominantly Polish-speaking.[19]

The 1871 census was explicitly the very first census ever to survey literacy in Prussia.[20] People were coded as literate if they could read and write. The question was only to be answered by people aged 10 years or older. As a measure of educational outcome, literacy may be a more informative measure of accumulated human capital than standard enrollment data, which may partly capture years in school that did not lead to effective educational

19. Note that the diffusion of Protestantism was intimately related to Luther's German-language Bible translation and his German-language texts. It is thus no surprise that the Reformation was less successful in the Polish-speaking districts. The German-speaking districts of Königsberg and Gumbinnen in the far east of Prussia, however, have been an integral part of the Prussian mainland for centuries and are again predominantly Protestant. Our regression results are robust when a dummy for the three predominantly Polish-speaking provinces Pommern, Posen, and Schlesien is included.

20. Other parts of the German Empire did not survey literacy in the 1871 census; neither was literacy surveyed again in any later Prussian census (Hesse 1911).

outcomes. Average literacy across the counties was as high as 87.5% (Table I).[21] This mirrors the fact that Prussia was well known for its primary education system in the second half of the nineteenth century, which is often viewed as a key feature responsible for the transfer of industrial leadership from Britain to Germany (cf. Landes [1969, pp. 339–348]). Still, there is substantial cross-county variation in the literate share of the population, ranging from 37.4% to 99.3%, and 16% of the counties had more than one-fourth of their adult population illiterate.

As a measure of the supply of schools, the 1886 Education Census provides county-level information on the share of students who had a distance to school of more than 3 kilometers. Although the information is limited to those who were students in 1886 (rather than the adult population), the measure may still provide a useful proxy for the supply of schools. Note also that the measure applies only to those children who actually attended school; it may underestimate the true average distance to school if there are children who did not attend school because the distance was too far.

Data from the 1886 Education Census also show that the vast majority of students (95.5%) went to schools affiliated with a single religious denomination. Most children attended a school of their own denomination, but schools were open to children from other denominations. Although schools were denominationally affiliated, funding was mostly independent of official church sources. Nearly half of the average funding for teaching staff came from local public authorities, 16.7% from school fees, and slightly above 10% each from endowment funds, trusts, and needs-based central government grants. Thus, local communities and authorities could develop and maintain significant educational differences along denominational lines.

The demographic control variables from the 1871 Population Census include age structure, gender, native population, household size, and county size (Table I).[22] We routinely include population growth between 1867 and 1871 as a control variable to capture possible effects of the Franco-Prussian war of 1870/1871.[23]

21. This made West German regions those with the highest literacy of Western Europe at the time (Tabellini 2005).

22. All our qualitative results are unaffected by excluding certain control variables that are correlated with Protestantism, such as the population share aged below 10 and the average household size.

23. Although the impact of the war on Prussian territory was very low in general, with a relatively low death toll of the Prussian army of 40,000 soldiers,

IV.C. The Association between Protestantism and Literacy in Nineteenth-Century Prussia

The first column of Table II reveals that there is a strong positive association between literacy and the share of Protestants in a county. On average, all-Protestant counties have a literacy rate that is 8.0 percentage points higher than all-Catholic counties. Viewed against an average literacy of 87.5%, this is a substantial difference across religious denominations.

Column (2) adds the list of basic control variables to estimate the model

$$\text{LIT} = \alpha_1 + \beta_1 \text{ PROT} + X\gamma_1 + \varepsilon_1, \tag{1}$$

where LIT is the share of literates in a county's population aged 10 or older, PROT is the share of Protestants in the county, and X is the set of demographic control variables including the share of Jews and females in the county, the share of the county population below 10 years of age, born in the specific municipality, and of Prussian origin, shares of the population with physical or mental disabilities (blind, deaf-mute, and insane), average household size, size of the county, population growth over the four preceding years, and the share of the population with missing information on literacy (which is the case for only 1.7% on average; cf. Table I).[24] In the multivariate specification, the significant association between Protestantism and literacy becomes even larger,

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and there was nearly a year between the end of the war in January and the census in December, the control variable for recent population growth may capture any remaining differential migration or death toll across counties.

24. Given that the dependent variable in this model is clustered near the right-censored value of 100%, the linear model might be inadequate and suffer from heteroscedasticity. We therefore also estimated the model on a logit-transformed dependent variable and with heteroscedasticity-consistent weighted least squares, yielding the same qualitative results (available from the authors). Furthermore, although the supply-side point of our theoretical model—that costs of schooling may be lower in Protestant regions—requires a model specified on aggregate data, the demand-side point—that Protestants may get additional nonmonetary benefits from literacy—raises the issue of ecological inferences of individual associations from aggregate data (cf. Robinson [1950]). However, special tables in the 1871 Population Census on literacy rates by religious denomination within each county show that Protestants are indeed more literate than Catholics, ruling out an ecological fallacy. Unfortunately, the other variables are not reported in a breakdown by religious denomination, so that our lowest possible unit of analysis is the county. Our individual-level analyses of contemporary German data in Section VI.E also confirm the association at the individual level. Note that Robinson (1950) showed that the difference between ecological and individual inference will usually be lower the more the variables are clustered within regions, and our variables—especially Protestantism—are very highly clustered in Prussian counties (cf. Table I).

TABLE II
THE ASSOCIATION BETWEEN PROTESTANTISM AND LITERACY IN NINETEENTH-CENTURY PRUSSIA

	Share literate								Distance to school
	All counties						Excluding free cities	Counties with % Protestants <20% or >80%	All counties
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
% Protestants	0.080	0.099	0.117	0.069	0.101	0.075	0.103	0.089	−0.026
	(0.015)***	(0.010)***	(0.011)***	(0.012)***	(0.010)***	(0.012)***	(0.011)***	(0.010)***	(0.004)***
% age below 10		−1.936	−1.734	−1.438	−1.950	−1.552	−1.952	−1.711	0.148
		(0.158)***	(0.155)***	(0.174)***	(0.159)***	(0.151)***	(0.183)***	(0.176)***	(0.067)**
% Jews		−0.965	−1.712	−0.307	−1.013	0.270	−0.966	−0.970	−0.097
		(0.284)***	(0.264)***	(0.288)	(0.290)***	(0.287)	(0.302)***	(0.416)**	(0.119)
% females		−1.280	0.239	−0.046	−1.256	−1.065	−1.263	−1.077	0.458
		(0.300)***	(0.317)	(0.286)	(0.302)***	(0.284)***	(0.318)***	(0.339)***	(0.126)***
% born in municipality		0.484	0.193	0.095	0.478	0.281	0.488	0.455	−0.108
		(0.033)***	(0.046)***	(0.045)**	(0.034)***	(0.039)***	(0.035)***	(0.037)***	(0.014)***
% of Prussian origin		−0.324	−0.029	0.260	−0.298	−0.041	−0.345	−0.474	0.031
		(0.181)*	(0.166)	(0.159)	(0.184)	(0.174)	(0.237)	(0.229)**	(0.076)
Average household size		−1.812	1.129	−2.747	−1.701	−3.926	−2.498	−0.339	3.067
		(1.273)	(1.211)	(1.393)**	(1.280)	(1.292)***	(1.364)*	(1.337)	(0.528)***
ln(population size)		−1.183	−0.090	0.576	−1.026	0.607	−0.906	−0.016	−0.079
		(0.873)	(0.790)	(0.712)	(0.892)	(0.821)	(0.938)	(0.915)	(0.366)
Popul. growth 1867–1871 (in %)		0.186	−0.091	−0.154	0.184	−0.047	0.159	−0.141	−0.166
		(0.093)**	(0.100)	(0.087)*	(0.094)**	(0.086)	(0.101)	(0.105)	(0.039)***

TABLE II
(CONTINUED)

	Share literate								Distance to school
	All counties						Excluding free cities	Counties with % Protestants <20% or >80%	All counties
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
% missing education info		−0.307	−0.269	−0.002	−0.294	0.020	−0.090	−0.172	
		(0.320)	(0.276)	(0.238)	(0.321)	(0.297)	(0.336)	(0.350)	
ln(distance to Berlin in km)			−0.474	−1.716					
			(0.571)	(0.924)*					
Latitude (in rad) × 100			−0.824	−0.686					
			(0.393)**	(1.007)					
Longitude (in rad) × 100			−0.597	−0.925					
			(1.540)	(3.687)					
Latitude × longitude × 100			−0.074	0.155					
			(1.672)	(4.014)					
Polish-speaking provinces			2.878	−13.207					
			(0.998)***	(4.832)***					

TABLE II
(CONTINUED)

	Share literate								Distance to school
	All counties						Excluding free cities	Counties with % Protestants <20% or >80%	All counties
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
% of labor force in mining			0.139	0.076					
			(0.050)***	(0.045)*					
% of county pop. in urban areas			0.054	0.032					
			(0.018)***	(0.017)*					
35 district dummies				yes					
Year when annexed by Prussia					0.003				
					(0.003)				
36 dummies for years when annexed by Prussia						yes			
Obs.	452	452	452	452	452	452	406	343	452
R^2	.057	.737	.810	.885	.737	.826	.751	.718	.356

Source. Data for Prussian counties from the 1871 Population Census and the 1886 Education Census; see main text and Appendix I for details.
Further controls: % blind, % deaf-mute, % insane.
Notes. Dependent variable in column (9): % Pupils with distance to school over 3 km. Dependent variable in all other columns: % Literate among those aged ≥10. Standard errors in parentheses.
Significance at *10, ** 5, *** 1 percent.

with literacy rates 9.9 percentage points higher in all-Protestant than in all-Catholic counties on average.[25]

The following columns probe the robustness of the association between Protestantism and literacy for more extensive specifications. To exclude the possibility that the result is driven by geographical differences across the Prussian counties, column (3) adds a set of geographical control variables. These include distance of the county capital from the Prussian capital of Berlin (measured as the greater circle distance) to account for periphery; longitude (measured in rad) to proxy for distance to the North and Baltic Seas in the Prussian north; latitude to trace out the westward expansion of Prussia over the centuries; an interaction of latitude and longitude; a dummy for the three predominantly Polish-speaking provinces Pommern, Posen, and Schlesien to proxy for Slavic languages (results are equivalent to a dummy for counties located in Poland today); the fraction of the work force employed in mining, to control for the effects of the availability of natural resources; and the fraction of the county population living in urban municipalities.[26] Although several of the geographical controls enter significantly into the model, the estimated association between Protestantism and literacy is hardly affected. Column (4) adds a whole set of 35 district dummies to the model, thereby excluding all the variation that exists across districts and exploiting only the within-district variation. To the extent that there is unobserved regional heterogeneity, district dummies should be able to capture most of its substance. Although the estimated association between Protestantism and literacy is reduced in magnitude, it remains highly robust.

For territories annexed by Prussia shortly before the 1870s, the assumption of an effectively uniform institutional setting might be questioned, giving rise to potential issues of unobserved heterogeneity in effective institutions. Column (5) therefore

25. As the data from the 1871 Population Census are available separately for urban municipalities and for rural areas in each county (where a population size of 2,000 is used to classify municipalities into urban and rural; see Appendix I for details), we can estimate this association separately for rural and urban areas. Although the association is statistically significant in both subpopulations, it is more pronounced in rural areas, as might be expected with average literacy rates in urban municipalities as high as 91.0% (cf. Becker and Woessmann [2007] for details).

26. Table A.2 in the Appendices shows that the share of Protestants is virtually identical on average in municipalities and in rural areas (64.6% and 64.7%, respectively). There is no tendency for Protestants or Catholics to live predominantly in urban (or rural) areas.

controls for the year in which a county came to Prussia as a linear variable, and column (6) as 36 dummies for all the rounds of annexations after 1525. Our qualitative results are unaffected by these controls. The first specification also shows that there is no significant linear effect of the year of annexation, suggesting that more recent annexations do not perform systematically differently than earlier Prussian territories.[27]

Free imperial and Hanseatic cities, economic and educational hubs in Lutheran times, may have been more inclined to follow the Reformation (cf. Section V.B). Free cities were virtually self-ruling enclaves independent of the rule of regional princes. Many of them had accumulated substantial wealth through trade, and they were well known for their liberal thinking, which might have been conducive to adopting the Reformation. However, excluding all Prussian counties from our sample that contain former free imperial or Hanseatic cities hardly affects the qualitative result (column (7)).

To account for possible nonrandom migration of different denominations, column (8) restricts the analysis to the subsample of counties that are denominationally hardly intertwined, that is, only counties that are either mostly Protestant or mostly Catholic (defined as having more than 80% or less than 20% Protestants). Given the limited pattern of migration, the dominant denomination in these counties will derive from the historical choices of local rulers (see below), but not from migration. Our results are unaffected by restricting the analysis to this sample of 343 counties.[28]

Column (9) uses distance to school as an alternative measure of human capital. The results show that the share of Protestants in a county is negatively related to the share of students who had a long distance to their school, indicating that there was a denser supply of schools in Protestant counties. The same result holds in a bivariate association, and it is robust to all the robustness

27. As an alternative robustness check, we restricted the analysis in an increasingly restrictive manner to subsamples of counties that had been with Prussia for a long time. We start with the 361 counties that had been part of Prussia for more than 50 years in 1871, and then go on to restrict to the 235 counties that had been part of Prussia before 1800, 179 counties before 1750, and 89 before 1650. Again, our main qualitative results are perfectly robust in these subsamples.

28. Note also that our basic model already controls for patterns of migration over the lifespan of the 1871 population by including the share of the population born in the respective municipality and the share of the population that is of Prussian origin. In addition, our results are robust to the sample of counties with above-average shares of inhabitants born in their specific municipality, as well as to the sample of counties with less than 1% of non-Prussian origin (not shown).

specifications just discussed, including controlling for urbanity (not shown).

V. The Historical Origin of the Reformation as an Exogenous Shock

This section addresses potential endogeneity issues in the spread of Protestantism. It exploits the historically concentric dispersion of Protestantism around Luther's city of Wittenberg to use distance to Wittenberg as an instrumental variable (IV) to yield exogenous variation in Protestantism.

V.A. Instrumental Variable Results Exploiting the Concentric Dispersion of Protestantism around Wittenberg

Several concerns may emerge in interpreting the association between Protestantism and literacy presented above as a causal effect. For example, if poor areas with a more prevalent opposition to the Catholic establishment had been more likely to convert to Protestantism during the time of the Reformation, and if economic development was correlated over time, the residual term in equation (1) might not be exogenous to the spread of Protestantism. As a consequence, we need a strategy to deal with potential endogeneity issues.

In principle, however, several historical facts suggest that the spread of the Reformation in Prussia can be viewed as an exogenous shock (see Becker and Woessmann [2007] for greater detail). The vast majority of the regional denominational variation that existed in late-nineteenth-century Prussia had already been determined at the time of Reformation in the sixteenth and early seventeenth centuries.[29] The Imperial Diet held 1555 in Augsburg had adopted the principle "Cuius regio, eius religio" ("Whose rule, his religion"), which meant that denominational choices were made only by the rulers of the large number of territories that constituted the fragmented German empire at the time of Reformation. The citizens were forced to accept their respective sovereigns' denominational choices, which were mostly driven by reasons of power politics, following or seceding from the worldly forces supporting the Pope. There is little room for denominational choices being endogenous to literacy at that time, because literacy

29. This means that the religious variation far predates industrialization and thus any manufacturing occupation that constitutes our sectoral outcome measure below.

in Germany around 1500 is estimated as low as 1 percent of the population, exclusively restricted to the nobility and some townsmen (Engelsing 1973, p. 19).[30] Also, Luther's theses were mostly distributed to the general public by caricatures denouncing the unethical behavior of the Pope and his allies (Scribner 1994). Finally, the regional origination of Protestantism from Luther's city of Wittenberg was triggered by a specific shock, a particularly vicious example of indulgence practice to which many of Luther's parishioners succumbed. Bishop Albrecht of Brandenburg initiated in 1517 the selling of indulgences in the province of Magdeburg officially to support the construction of St. Peter in Rome, but in reality half of the revenues were used to pay off Albrecht's debts to the Fugger dynasty.

Although this historical origin of denominations rules out the most obvious forms of potential endogeneity, some possible sources of endogeneity might remain. For example, Ekelund, Hébert, and Tollison (2002) hypothesize that the diffusion of the Reformation might have been facilitated in societies characterized by the decline of feudalism and a relatively unstable distribution of wealth. This hypothesis is explicitly aimed at the diffusion across countries, though, and may be less relevant for the diffusion within Prussia. Similarly, although the idea that choice of denomination may be endogenous to education (Glaeser and Sacerdote 2008) in principle provides an additional source of endogeneity, this source also seems less of an issue in our case, because there was hardly any effective individual denominational choice in the nineteenth century.[31] However, wealthy regions may have been less likely to select into Protestantism at the time of the Reformation because they benefited more from the hierarchical Catholic structure, because the opportunities provided by indulgences allured to them, and because the indulgence costs weighted less heavily on them. When education became more widespread in subsequent centuries, these regions could have more easily afforded to educate their children. The fact that "Protestantism" was initially

30. If there was any systematic aspect about the spread of Protestantism, it might have been centered in cities. However, as discussed above, the shares of Protestants in rural and urban areas were in fact identical in the late nineteenth century, and controlling for urbanity and excluding all free imperial cities and Hanseatic cities does not change our results.

31. On average over 1859–1867, only 766 adult Catholics per year out of more than 7 million Catholics converted to Protestantism, mostly in the course of marriage to a Protestant partner (Hilse 1869).

a "protest" movement involving peasant uprisings that reflected social discontent is suggestive of such a negative selection bias.[32]

To rule out such potential remaining worries about endogeneity, we use a particular aspect of the historical diffusion of Protestantism across the German Empire to restrict the variation in Protestantism used in the estimation to a part that is credibly exogenous. Reformation historians refer to the diffusion of Protestantism as resembling the propagation of a wave caused by a stone thrown into water.[33] Luther's work had its most imminent effect in the area surrounding his city of Wittenberg, and there is a tendency for the impact to diminish with distance to Wittenberg. In effect, in the German Empire, Protestantism dispersed around Wittenberg in a mostly concentric pattern.[34] As evidenced in Figure III above, it seems that the Reformation spread out from Wittenberg in all directions, but then came to a halt after some distance.

The main reasons for a circular dispersion around Wittenberg may have been the costs of traveling and of information diffusion through space, and these transportation and transaction costs played a crucial role at the time. Electoral Saxony, the principality around Wittenberg, was an early leader in implementing Luther's visions of reform, serving as a role model of practical and political implementation for princes in other areas (Dixon 2002). This gives places closer to Wittenberg the advantage of being able to observe the Reformation ideals put in practice and to more easily form alliances of Protestant territories against Catholic

32. There is illustrative evidence that rich regions may have been less likely to join the Protestant movement at the time of the Reformation. With the exception of Hanseatic cities, all our indicators of economic and educational development before the Reformation discussed in the next section are negatively associated with the share of Protestants, also after controlling for distance to Wittenberg (to compare regions of different wealth at a similar distance to Wittenberg). Two of the negative associations (with imperial cities and universities in 1517) reach standard levels of statistical significance, the other three (urbanization, monasteries, and schools in 1517) are marginally significant.

33. Luther himself likened the spreading of the sermon to "throwing a stone into the water which makes waves, circles, and streaks around it, and the waves push each other further and further; one pushes the other . . ." (Luther 1905, p. 140). He also stressed that the preaching "will be disseminated further and further and that from the Church which is located in a certain place many others will be drawn to the Word" (Luther 1902, p. 224). In the latter source, Luther explicitly refers to Wittenberg as the place from which a creek irrigates the neighboring regions.

34. We do not purport that the dispersion was concentric outside the German Empire. Other countries had other Protestant reformers, who for example provided the first Bible translation in their native languages. Our argument strictly refers to the diffusion within Prussia and the German Empire.

powers.[35] Furthermore, thousands of students came to Wittenberg to hear Luther's sermons and speeches, and they spread the word as preachers back in their home regions (Peters 1969; Bunkowske 1985). In fact, starting in 1535 everyone who wanted to become a priest in Electoral Saxony had to be centrally ordained in Wittenberg. Although this was not legally compulsory for ordinands in other Protestant territories, many came to Wittenberg for ordination to obtain the seal of approval connected to the prestige of Luther and Melanchthon (Krarup 2007). Given the arduousness of travel in the early 1500s, the propensity to come to Wittenberg to listen to Luther and his successors likely declined with distance to Wittenberg. Finally, the fact that the German regions spoke ever more different dialects the further distant the regions were may also have contributed to a concentric pattern of the dispersion of Protestantism, both by oral and by written means of dissemination, and in the dissemination both to rulers and to the population at large.

The geographically concentric pattern of the dispersion of the Reformation provides a means to obtain a specific variation in Protestantism that is credibly exogenous to economic and educational considerations: the variation due to distance to Wittenberg. We thus use distance to Wittenberg as an instrument for the share of Protestants in a county in nineteenth-century Prussia. The first two columns of Table III report the IV estimate of the effect of Protestantism on literacy, where Protestantism is instrumented by distance to Wittenberg. As is evident from the F-statistic of the instrument in the first stage, distance to Wittenberg is a strong instrument for the share of Protestants in a county. Each 100 km distance to Wittenberg is associated with a Protestant share that is 9.5 percentage points lower.

The second stage uses only that part of the Protestant share that is due to distance to Wittenberg to predict the literacy rate. The positive effect of Protestantism on literacy is highly robust in the IV specification. In fact, the point estimate is significantly higher, with a difference in literacy of 18.9 percentage points between an all-Protestant and an all-Catholic county, indicative of a negative selection bias. Similarly, the negative effect of Protestantism on distance to school is confirmed in the IV specification

35. To rule out concerns of endogeneity, we ensured that our results are robust to dropping those counties that belonged to Electoral Saxony in Reformation times from our analysis.

TABLE III
THE EFFECT OF PROTESTANTISM ON LITERACY: IV RESULTS BASED ON DISTANCE TO WITTENBERG

	1st stage	2nd stage	
Dependent variable:	Share Protestants (1)	Share literates (2)	Distance to school (3)
Distance to Wittenberg in km	−0.095		
	(0.011)***		
% Protestants		0.189	−0.025
		(0.028)***	(0.011)**
% age below 10	0.205	−1.952	0.147
	(0.702)	(0.170)***	(0.066)**
% Jews	−7.264	−0.437	−0.094
	(1.242)***	(0.341)	(0.130)
% females	−0.557	−1.073	0.459
	(1.343)	(0.327)***	(0.126)***
% born in municipality	−1.390	0.607	−0.107
	(0.134)***	(0.050)***	(0.019)***
% of Prussian origin	−1.935	−0.181	0.032
	(0.802)**	(0.199)	(0.076)
Average household size	−14.610	0.885	3.084
	(5.778)**	(1.573)	(0.595)***
ln(population size)	−0.977	−1.318	−0.080
	(3.883)	(0.936)	(0.361)
Popul. growth 1867–1871 (in %)	−1.962	0.410	−0.164
	(0.404)***	(0.119)***	(0.046)***
% missing education info	1.729	−0.505	
	(1.418)	(0.348)	
Observation	452	452	452
R^2	.419	.689	.356
1st-stage F statistic	74.19		

Source: Data for Prussian counties from the 1871 Population Census and the 1886 Education Census; see main text and Appendix I for details.
Further controls: % blind, % deaf-mute, % insane.
Note. Standard errors in parentheses.
Significance at *10, ** 5, *** 1 percent.

(column (3) of Table III). The IV results are robust to the set of robustness specifications discussed above, such as including the geographic controls and indicators for recent annexations and excluding free cities and denominationally intertwined counties (not shown).

V.B. Is Distance to Wittenberg a Valid Instrument?

The fact that it is generally accepted that Wittenberg was an "unimportant place" (Holborn 1942, p. 133) until 1517 suggests

that distance to Wittenberg should be unrelated to a county's economic and educational state before it adopted Protestantism. We probe this more rigorously in a set of empirical tests that can shed light on the validity of the instrument, despite the obvious limits of data on the economic or educational situation at the time of the Reformation (cf. Appendix II for details on the data sources for the following analyses).[36] The first three tests relate to whether several indicators for economic development at Lutheran times are related to distance to Wittenberg, and the next three tests perform the same analysis for several indicators for educational development in Lutheran times (the economic and educational situation may of course be interrelated).

First, free imperial cities (*Reichsstädte*) were major economic hubs at Lutheran times. In the Holy Roman Empire, free imperial cities had particular political systems and legal independence, controlled their own trade, and built an extraordinary amount of wealth. The group of free imperial cities included such important cities as Aachen, Cologne, Frankfurt am Main, Gdansk, and Hamburg. As Table IV reveals, in our sample of 452 Prussian counties, distance to Wittenberg is completely insignificant in predicting the probability of being a free imperial city, measured in pre-Reformation status.

Second, a similar argument about economic advancement can be made for free Hanseatic cities. Although some of them, such as Cologne, Gdansk, and Hamburg, were also free imperial cities, other important cities such as Hanover, Königsberg, and Magdeburg were not, but still belonged to the Hanseatic League. Again, distance to Wittenberg is uncorrelated with the probability of being a Hanseatic city.

Third, economic historians often use urban population as a proxy for preindustrial economic prosperity because cities could only be supported in areas with high agricultural productivity, advanced economic specialization, and developed transport systems (cf. Bairoch [1988]; Acemoglu, Johnson, and Robinson [2002]). We

36. The 1871 Population Census is explicitly the first occasion on which consistent data on literacy were surveyed. There is only scattered historical evidence on the spread of literacy and schooling in Prussia between 1500 and 1871, discussed in Appendix B of Becker and Woessmann (2007), which suggests that Luther's educational postulations did have a long-lasting effect. Our analysis has to leave open whether Luther's educational postulations had economic effects already in the agrarian economy of the sixteenth to eighteenth centuries, or whether they had to wait for the industrial revolution to raise the economic payoff to education, as has been argued for Sweden (Sandberg 1979).

TABLE IV
EXOGENEITY OF THE DISTANCE-TO-WITTENBERG INSTRUMENT

	Indicators of pre-Reformation economic development				Indicators of pre-Reformation educational development				
			Urbanization		Universities			Schools	
	Imperial city in 1517	Hanseatic city in 1517	Urban pop. per km^2 in 1500	City population in 1500	University in 1517	Year of foundation of university	Monasteries per km^2 in 1517	School in 1517	Year of foundation of school
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Distance to Wittenberg[a]	0.0034	0.0008	0.00006	0.0059	−0.0019	−1.626	0.0020	−0.0073	0.0610
	(0.0071)	(0.0084)	(0.00013)	(0.0042)	(0.0047)	(7.998)	(0.0110)	(0.0099)	(0.2384)
Share of municipalities beginning with letter A to L							0.578		
							(0.121)***		
Obs.	452	452	452	148	452	16	452	333	59
R^2	.0005	.00002	.0004	.014	.0004	.003	.049	.002	.001

Note. Standard errors in parentheses. Column (7) uses data on monasteries in the German Empire which is available only for municipalities starting with letters A–L. See main text for details. See Appendix III for data sources.
[a]Distance to Wittenberg measured in 100 km.
Significance at *10, ** 5, *** 1 percent.

use the data on urban population by Bairoch, Batou, and Chèvre (1988) to construct a measure of urban population per square kilometer in 1500 for each county in our 1871 data.[37] As column (3) of Table IV reveals, the extent of urbanization just before the Reformation is uncorrelated with distance to Wittenberg. Likewise, we use all 148 cities of the 1871 German Empire (or the 75 cities of 1871 Prussia) contained in the Bairoch, Batou, and Chèvre (1988) data and estimate whether their population size is correlated with distance to Wittenberg; the point estimate is even positive and approaches standard levels of statistical significance (column (4)).[38] In addition, city growth between 1400 and 1500 is uncorrelated with distance to Wittenberg.

Fourth, one measure of education available for the pre-Luther period is the existence of universities. We use data from Eulenburg (1994) on German universities founded before 1517 to estimate whether distance to Wittenberg predicts whether a county in our sample had a university before 1517 (column (5)). We also regress the year of foundation of universities on the territory of the 1871 German Empire in existence before 1517 on distance to Wittenberg (column (6); results are equivalent when restricting to 1871 Prussian territory). In both exercises, we find that distance to Wittenberg is completely unrelated to the spread of universities before Lutheran times.

Fifth, throughout medieval times, monasteries were the guardians of learnedness, preserving the skill of literacy and often containing substantial libraries (cf., e.g., Marry [1953]; Frank [1993]).[39] The density of monasteries can thus serve as another important correlate of literacy before Luther. Grote (1881) provides an encyclopedia of monasteries in the German Empire, detailing their location, year of foundation, and (if applicable) year of abandonment. Its major advantage is that it covers the whole of Prussia within its borders of the late nineteenth century. A

37. The adjustment for county size in square kilometers is performed to account for the fact that county boundaries in the late nineteenth century are drawn so that counties are smaller in areas of higher population density.

38. Given that the city sample of Bairoch, Batou, and Chèvre (1988) is defined by all cities that had at least 5,000 inhabitants once between 800 and 1800, we also performed analyses on the restricted sample of those cities that had at least 5,000 inhabitants in 1500 to rule out issues of sample selectivity. Results are the same.

39. The importance of monasteries as centers of literacy is also documented by the medieval dictum of Gottfried of St. Barbe-en-Auge in 1170, "claustrum sine armario quasi castrum sine armamentario" ("a monastery without a library is like a fortress without an armory," Migne [1855, Vol. 205, Col. 845A]).

drawback is that the available volume covers only locations beginning with letters A to L; the envisaged second volume was never completed due to Grote's untimely death. We control for this by adding the share of municipalities in each county beginning with letters A to L as a control variable, derived from the complete list of municipalities in the 1871 Prussian Population Census. Although this control enters significantly into a regression of the density of monasteries that were in operation in 1517, distance to Wittenberg does not (column (7)).

Sixth, an explicit "List of the oldest schools in the German-speaking area" is provided at the German version of the Wikipedia encyclopedic website. Although this is not necessarily an exhaustive list, we can use it to get a list of 59 schools that existed before the Reformation, as an additional indicator for pre-Lutheran literacy. In contrast to all previous measures, this measure is available only for German-speaking territory, rather than for the whole of Prussia, so that we exclude the Polish-speaking provinces from the analysis. Note that if there were reporting bias in this list in the sense that schools that survived and prospered after 1517 are more likely to be contained on this list, the fact that the Reformation gave a boost to schools means that our test will be biased toward finding more schools closer to Wittenberg. But in fact, despite this possible bias, distance to Wittenberg is not significantly correlated with the existence of a school in a county before 1517 or with the years of foundation of schools (columns (8) and (9) of Table IV).

To see whether these tests of the validity of our instrument are strong tests, we can look at whether the different indicators for pre-Reformation economic and educational development are correlated with our measure of literacy in the late nineteenth century. Indeed, all six indicators are positively correlated with 1871 literacy. Statistically significant positive correlations exist between 1871 literacy and the existence of schools before 1517 (correlation coefficient .13, statistically significant at the 2% level), the existence of universities before 1517 (.08, 10%), and the probability of having been a free imperial or Hanseatic city (.09, 5%). Thus, these indicators of economic and educational development before Luther's time are indeed measures relevant to literacy in the late nineteenth century, and our instrument is orthogonal to all of them, providing confidence in its plausibility and validity.

VI. The Importance of Education for the Economic Performance of Protestants

The results so far provide empirical support for the fact that Protestantism led to a better educated population, establishing the founding stone for our human capital theory of Protestant economic history. This section turns to an empirical analysis of the importance of education in accounting for the higher economic prosperity of Protestants.

VI.A. Measures of Economic Outcomes in Nineteenth-Century Prussia

Our main measure of economic outcome is a proxy for county income based on income tax statistics. The advantage of income measures is that they are arguably the most encompassing measure of economic prosperity. Our best proxy for county income close in time to our data on religion and literacy is the income tax revenue per capita, available from income tax statistics in 1877 (see Appendix I for details on the different data sources). For historical reasons, there were two types of income tax in 1877—the so-called class tax for annual incomes from 420 to 3,000 Marks and the so-called classified income tax for incomes above that. However, these two effectively constituted an income tax with slightly increasing tax rates up to incomes of 3,000 Marks and a constant tax rate for higher incomes. Hill (1892, p. 214) stresses that at least since the 1873 tax reform, "The [class tax] was . . . recognized as being, in fact, an income tax which was to be assessed 'on the basis of the estimated value of the annual income.'" The classified income tax was a pure income tax. Although very low incomes were exempted from income tax[40] and although the tax rate was linear only for incomes above 3,000 Marks, we think that the total income tax revenues per capita are a reasonable proxy for county income at the time, and certainly the best available one.[41] Average income tax revenues amounted to 2.0 Marks per county inhabitant, ranging from 0.2 to 5.6 Marks across counties.

40. While we do not know what fraction of the population was subject to income tax in 1877, in the income tax statistics of 1892, 41.8% of the population lived in households that were subject to income tax (ranging from 21.9% to 68.4% across the counties). However, the minimum taxable income had been more than doubled (from 420 to 900 Marks) in the early 1880s with the explicit aim of benefiting the poorer classes (cf. Hill [1892]), suggesting that a much larger fraction of households were subject to income taxation in 1877.

41. Income tax data are not available for the 26 city counties in 1877.

Drawbacks of this main measure of economic outcome are that it does not capture the low end of the income distribution and that the underlying income cannot be perfectly inferred from the amount of tax revenues because the tax scale has some progressivity at the low end (although most of the 1877 tax scale is linear).[42] More generally, the per capita income tax measure is not a direct measure of income, but rather infers income indirectly from the income tax revenues of each county.[43] We therefore also use an alternative measure that overcomes this drawback. Although general county-level income data are not available for nineteenth-century Prussia, the 1886 Education Census provides the unique opportunity of direct income data for one specific occupation, namely the average annual incomes of male elementary school teachers. This measure is the only direct measure of income available for all counties at the time and has been used as a proxy for income in general in other studies (e.g., Lee, Galloway, and Hammel [1994]). In nineteenth-century Prussia, teachers' salaries were almost entirely financed from local contributions and therefore reflect the overall income in the county (cf. Schleunes [1989]). The correlation of the teacher income measure with the 1877 per capita income tax measure is .60. The downsides of the teacher income measure are that it refers to one occupational group only, that teacher salaries may be affected by how much education is valued in a county, and that there may be reverse

42. To overcome these drawbacks, we also constructed an advanced proxy of average income from more detailed data available only in later years (for the 60 largest Prussian cities 1892 and for all Prussian counties in 1901). These measures combine data on the share of households not paying income tax with data on daily wages of unskilled day laborers from social security statistics and detailed income tax data that make it possible to infer underlying income directly from taxes paid (see Appendix I for details on the income tax statistics and the social security statistics in 1892 and 1901). Their downsides are the further time lag to our other data and several necessary approximations. Our result that Protestantism does not have a significant effect on income once the latter is adjusted for differences in literacy is perfectly robust to these encompassing average income measures in both bounding analyses reported below, suggesting that tax progressivity and the omission of low earners from the income proxy reported here are not driving the results. Although the estimated effect of Protestantism on the income measure is statistically significant without adjusting for literacy differences in the full sample (available only in 1901), it does not reach statistical significance in the smaller sample of large cities (in 1892).

43. Measures of average income may only partly capture the specific traits of entrepreneurship, a dimension of economic outcomes sometimes implicated with the Weber thesis. As one measure that may capture entrepreneurial income in particular, we also used only the classified income tax part of the total 1877 income tax, which captures only the high incomes, referring to roughly 4% of the population. Qualitative results are the same.

causation from teacher income to literacy, giving rise to problems of endogeneity.[44]

As a second alternative measure of economic development, we also use the sectoral structure, derived from the 1882 Occupation Census. The average share of the labor force in nonagriculture is 33.9% (27.7% in manufacturing and 6.3% in services; cf. Table IV). This measure captures a lot of what the issue of economic development in historical perspective in general, and the Weber thesis in particular, is very explicitly about: modernization, the advancement of capitalism, and division of labor. Weber was not suggesting a theory of income levels but a theory of the advancement of modern capitalism. Sectoral shares may capture such concepts even better than standard income measures. The correlation of the size of the nonagricultural sector with 1877 per capita income tax is .42 and it is .74 with 1886 teacher income. The main drawback of sectoral shares as measures of economic prosperity is that they may miss important dimensions of variation in economic output, such as productivity, hours worked, or entrepreneurship, which may well be related to Protestantism.

Although each of our different measures of economic outcomes has its specific advantages and drawbacks, our results below prove very robust across all the measures, excluding the possibility that they are driven by the drawbacks of one specific measure.

VI.B. The Association between Protestantism and Economic Outcomes

Table V provides results of regressions of our measures of economic outcome Y in the 452 Prussian counties on the share

44. The downside of occupation specificity is overcome in the 1892 and 1901 measures based on income-tax data for higher incomes and wage data for low-income earners, discussed in footnote 42. Another measure of occupation-specific income that should not be subject to the endogeneity problems is the income of city mayors. A special survey collected data on the annual salaries of mayors and other paid members of city magistrates in 1879 in the 138 Prussian cities with more than 10,000 inhabitants with the explicit aim of obtaining first information on the "cost of labor" (Blenck 1880; see Appendix I for details on the 1879 Survey of Mayor Incomes). To the extent that the salary of mayors was financed from local taxes, it likely constitutes a decent proxy for average income. Using mayoral income or the income of all upper-rank civil servants in the 138-county sample also never yields significant positive effects of Protestantism on income after adjusting for literacy differences. However, the association of the income proxy with Protestantism is again not as clear in this sample of big cities, while it does show a significant positive association with literacy. The nominal income measures may also be affected by differences in price levels across counties. However, the Balassa–Samuelson hypothesis suggests that prices are higher in economically advanced areas (Balassa 1964; Samuelson 1964), so that nominal income differences may still provide a good proxy for economic affluence.

TABLE V
PROTESTANTISM AND ECONOMIC OUTCOMES IN NINETEENTH-CENTURY PRUSSIA

	OLS			IV[a]			OLS		
	Main outcome	Alternative outcomes		Main outcome	Alternative outcomes		Main outcome	Alternative outcomes	
	Per capita income tax[b] (1)	ln(teacher income)[b] (2)	Share manuf & serv (3)	Per capita income tax[b] (4)	ln(teacher income)[b] (5)	Share manuf & serv (6)	Per capita income tax[b] (7)	ln(teacher income)[b] (8)	Share manuf & serv (9)
% Protestants	0.154	0.063	0.035	0.586	0.105	0.082	−0.068	0.001	−0.013
	(0.091)*	(0.019)***	(0.015)**	(0.236)**	(0.050)**	(0.039)**	(0.097)	(0.020)	(0.015)
% literate							2.460	0.636	0.490
							(0.424)***	(0.086)***	(0.066)***
% age below 10	−4.721	−1.816	−0.440	−5.301	−1.827	−0.452	−0.812	−0.573	0.507
	(1.810)***	(0.302)***	(0.232)*	(1.881)***	(0.304)***	(0.235)*	(1.874)	(0.331)*	(0.254)**
% Jews	4.236	1.258	−0.005	7.388	1.494	0.262	8.963	1.917	0.463
	(3.018)	(0.538)**	(0.413)	(3.479)**	(0.601)**	(0.464)	(3.045)***	(0.520)***	(0.399)
% females	−20.086	−4.320	−2.857	−18.772	−4.230	−2.755	−16.544	−3.477	−2.234
	(2.992)***	(0.572)***	(0.439)***	(3.143)***	(0.583)***	(0.451)***	(2.935)***	(0.553)***	(0.425)***
% born in municipality	−0.155	0.264	0.361	0.446	0.321	0.425	−1.362	−0.043	0.124
	(0.305)	(0.063)***	(0.049)***	(0.435)	(0.090)***	(0.069)***	(0.361)***	(0.073)	(0.056)**
% of Prussian origin	1.534	−0.133	−0.373	2.473	−0.071	−0.302	2.998	0.091	−0.217
	(1.813)	(0.345)	(0.265)	(1.921)	(0.354)	(0.274)	(1.772)*	(0.329)	(0.252)

TABLE V
(CONTINUED)

	OLS			IV[a]			OLS		
	Main outcome	Alternative outcomes		Main outcome	Alternative outcomes		Main outcome	Alternative outcomes	
	Per capita income tax[b] (1)	ln(teacher income)[b] (2)	Share manuf & serv (3)	Per capita income tax[b] (4)	ln(teacher income)[b] (5)	Share manuf & serv (6)	Per capita income tax[b] (7)	ln(teacher income)[b] (8)	Share manuf & serv (9)
Average household size	−50.042 (11.834)***	−7.149 (2.397)***	−10.818 (1.840)***	−37.441 (13.698)***	−5.954 (2.753)**	−9.465 (2.127)***	−42.230 (11.581)***	−5.738 (2.305)**	−9.963 (1.769)***
ln (population) size	7.618 (8.814)	6.013 (1.663)***	5.217 (1.276)***	8.680 (9.068)	5.972 (1.672)***	5.170 (1.292)***	7.993 (8.513)	6.674 (1.580)***	5.806 (1.213)***
Popul. growth 1867–1871 (in %)	−1.002 (0.960)	1.002 (0.179)***	1.642 (0.137)***	0.292 (1.180)	1.106 (0.213)***	1.759 (0.165)***	−0.940 (0.924)	0.887 (0.170)***	1.550 (0.130)***
Obs.	426	452	452	426	452	452	426	452	452
R^2	.328	.534	.611	.291	.529	.602	.383	.586	.654

Source: Data for Prussian counties from the 1871 Population Census, the 1877 Income Tax Statistics, the 1882 Occupation Census, and the 1886 Education Census; see main text and Appendix I for details.
Note. Standard errors in parentheses.
Further controls: % blind, % deaf-mute, % insane, and (in columns (7)–(9)) % missing education info.
[a] % Protestants is instrumented by distance to Wittenberg; see the first column of Table III for the corresponding first-stage result.
[b] Coefficients multiplied by 100.
Significance at *10, ** 5, *** 1 percent.

of Protestants PROT in the county, as well as our set of control variables X:

$$Y = \alpha_2 + \beta_2 \text{ PROT} + X\gamma_2 + \varepsilon_2. \tag{2}$$

As in the bivariate setting of Section II, the results show that counties with larger shares of Protestants exhibit an advanced degree of economic progressiveness, consistently across the different measures.

The first three columns of Table V report OLS estimates.[45] Columns (4)–(6) report IV estimates, where Protestantism is again instrumented by distance to Wittenberg. These coefficients reflect the total causal effect of Protestantism on economic outcomes, including any indirect effect running through literacy. The IV estimates are larger than the OLS estimates, in line with the negative bias of OLS estimates of the effect of Protestantism on literacy discussed above. They suggest that income tax revenues per capita increase significantly with the share of Protestants in a county. On average, an all-Protestant county has income taxes 0.59 Mark higher per capita than an all-Catholic county.[46] This is equivalent to 29.6% of the average per capita income tax across all counties—an economically and statistically significant difference.

Results are similar for our two alternative measures of economic outcome. The only direct income measure available for all Prussian counties, annual income of teachers, also increases significantly with the share of Protestants in a county. An all-Protestant county has 10.5% higher income than an all-Catholic county on this measure. Similarly, an all-Protestant county has a nonagricultural share of its labor force that is 8.2 percentage points larger than an all-Catholic county.[47] Viewed against

45. These results are robust to the different robustness checks discussed in Section IV.C, including the addition of geographical controls, recognition of different waves of Prussian annexations, exclusion of free cities, and migration analyses (cf. Becker and Woessmann [2007]). An additional way to test whether migration and spillovers across neighboring counties affect our results is to include the average share of Protestants in neighboring counties as an additional control variable. Our results do not change in such a specification, and the share of Protestants in the neighboring counties does not enter significantly into predicting our measures of economic outcomes (not shown).

46. Per capita income tax is used as a level variable because inspection of kernel densities shows that it is roughly normally distributed. In contrast, teacher income is used in logarithm because it is roughly log-normally distributed.

47. Separate regressions show that this combines a manufacturing sector that is 6.5 percentage points larger and a service sector that is 1.7 percentage points larger (2.1 and 1.4, respectively, in case of the OLS estimate). Estimates for the male labor force, reported in Becker and Woessmann (2007), are even higher.

the average share of the nonagricultural sector in total employment of 33.9%, the average difference in economic progressiveness between Protestants and Catholics appears modest, but both economically and statistically significant. In sum, there is robust evidence of a significant positive effect of Protestantism on economic outcomes.

VI.C. The Effect of Protestantism after Adjustment for Literacy: A Bounding Analysis

The main tenet of our human capital theory of Protestant economic history is that Protestantism affected economic outcomes largely via human capital accumulation. Therefore, we now consider the extent to which the causal effect of Protestantism on literacy shown above can account for the association between Protestantism and economic outcomes just described. To do so, we would in principle like to estimate a model with both Protestant shares and literacy rates on the right-hand side:

$$Y = \alpha_3 + \beta_3 \,\mathrm{PROT} + \chi_3 \,\mathrm{LIT} + X\gamma_3 + \varepsilon_3. \tag{3}$$

For descriptive purposes and for comparison with the following exercises, OLS estimates of such a model are reported in the last three columns of Table V. Literacy has a large and significant association both with the main measure of economic outcome and with the two alternatives. Once this association is controlled for, the share of Protestants loses all its association with economic outcomes.

The problem with such a model is that not only Protestantism but also literacy may be endogenous in this setting. Shocks that affect economic outcomes may also affect literacy rates, biasing least-squares estimates of χ_3. Although distance to Wittenberg provides us with exogenous variation in Protestantism, no independent instrument is at our disposal for literacy.

We therefore revert to restricting the literacy effect to estimates $\overline{\chi}$ that are consistent with evidence found in other, well-identified studies in the literature:

$$Y - \overline{\chi}\,\mathrm{LIT} = \alpha_4 + \beta_4 \,\mathrm{PROT} + X\gamma_4 + \varepsilon_4. \tag{4}$$

This strategy allows us to obtain estimates of the effect of Protestantism (instrumented by distance to Wittenberg) on economic outcomes net of the literacy effect.

In his survey of the extensive literature on the causal economic return to education, Card (1999, p. 1802) concludes that "the average . . . return to education is not much below the estimate that emerges from a standard human capital earnings function fit by OLS."[48] He suggests that studies based on identical twins place the causal return at about 10% below the OLS estimate, whereas studies using institutional changes in the education system as instruments estimate returns that are 20%–40% higher than the corresponding OLS estimates. A plausible explanation of the latter is that marginal returns are higher for people with low education outcomes (who are mostly affected by the institutional changes), which makes a downward bias in OLS estimates more likely in our setting.

Assuming that the result of only weakly biased OLS estimates of educational returns also applies in our setting, we proceed by putting upper and lower bounds around the reference estimate of χ_3 obtained by estimating equation (3) by OLS, as reported in the last columns of Table V. This auxiliary regression allows us to estimate β_4 in equation (4) for a range of $\overline{\chi}$ values. Specifically, we bound the range of estimates of the economic return to literacy to 40% below and above its OLS estimate, which at the lower bound is substantially more conservative than suggested by the Card (1999) review.

Table VI reports estimates of β_4 from this exercise for our three outcome measures. All estimates of the effect of Protestantism in this conservative range are small and statistically nonsignificant. Results for our main measure of economic outcome, per capita income tax receipts in 1877, generally point to very small effects of Protestantism after adjustment for literacy differences. For example, assuming that the causal effect of education is 90% of the OLS estimate—equivalent to the bias suggested by twin studies—yields a point estimate that is only 29% of the total effect of Protestantism reported in Table V, statistically no longer distinguishable from zero. Assuming instead that the OLS estimate is downward biased in the range of 20%–40%—equivalent to the bias suggested by IV studies—the point estimate of the effect of Protestantism independent of literacy is very close to zero. The estimates are relatively small and not significantly

48. More recent evidence confirms that there is little ability bias in OLS estimates of the rate of return to education, which is found to be around 10 percent in many developed countries (Leigh and Ryan 2008).

TABLE VI
EFFECT OF PROTESTANTISM ON ECONOMIC OUTCOMES AFTER ADJUSTING FOR LITERACY: BOUNDING ANALYSIS

	Main outcome	Alternative outcomes	
	Per capita income tax[a] (1)	ln(teacher income)[a] (2)	Share manuf & serv (3)
40% below OLS estimate	0.309	0.033	0.027
	(0.226)	(0.047)	(0.036)
20% below OLS estimate	0.216	0.010	0.009
	(0.224)	(0.047)	(0.036)
10% below OLS estimate	0.170	−0.002	−0.0002
	(0.223)	(0.047)	(0.036)
OLS estimate	0.124	−0.014	−0.009
	(0.223)	(0.047)	(0.036)
10% above OLS estimate	0.078	−0.026	−0.018
	(0.222)	(0.047)	(0.036)
20% above OLS estimate	0.031	−0.038	−0.028
	(0.222)	(0.047)	(0.036)
40% above OLS estimate	−0.061	−0.062	−0.046
	(0.223)	(0.048)	(0.036)

Source: Data for Prussian counties from the 1871 Population Census, the 1877 Income Tax Statistics, the 1882 Occupation Census, and the 1886 Education Census; see main text and Appendix I for details. Further controls: % age below 10, % Jews, % females, % born in municipality, % of Prussian origin, average household size, ln(population size), population growth 1867–1871 (in %), % blind, % deaf-mute, % insane.
Note. Each cell reports the result of a separate regression. Reported coefficients are the instrumental-variable estimates on % Protestants, where distance to Wittenberg is the instrument. Dependent variable is the economic outcome measure reported at the top of each column minus % literate times the return to literacy. The return to literacy stems from an OLS estimate on % literate in an auxiliary regression of the economic outcomes on % literate, % Protestants, and the control variables (as reported in columns (7)–(9) of Table V), multiplied by the adjustment factor reported in the first column (to provide bounds for the potentially biased OLS estimate). Standard errors in parentheses.
[a]Coefficients multiplied by 100.
Significance at *10, ** 5, *** 1 percent.

different from zero even when we move down to a return to literacy that is 40% below the estimated OLS return to literacy, an upward OLS bias actually inconsistent with the existing literature.[49]

Results are similar for our two alternative measures of economic outcome. In both cases, when a literacy effect 10% below its OLS estimate is assumed, the point estimate of β_4 is close

49. In fact, we can calculate the threshold value of $\overline{\chi}$ below which the coefficient on Protestantism becomes statistically significant (at the 5% level): Only if the true effect of literacy was at least 71% below the OLS estimate would the effect of Protestantism independent of literacy become statistically significant, at a size of 0.452 (77% of the total Protestantism effect). Of course, if we go down all the way to assuming that literacy does not have any economic effect, we are back to the full total Protestantism effect of Table V.

to zero. For example, the corresponding sectoral share specification implies that a 10-percentage-point increase in the share of Protestants in a county lowers the fraction of the work force in manufacturing and services by 0.002 percentage points, a negligible effect.[50]

Although the point estimates suggest that most of the effect of Protestantism on economic outcomes may be attributable to higher literacy, the statistical power of some of the IV estimates of the independent Protestantism effect does not allow us to rule out substantial effects of Protestantism that come from sources other than literacy.[51] In case of the income tax measure, the upper bound (of 0.609) of the 95% confidence band around the Protestantism point estimate that assumes a literacy effect 10% below its OLS estimate lies just above the total Protestantism effect of Table V. However, when a literacy effect 40% above its OLS estimate is assumed, the upper bound of the 95% confidence band already allows rejecting the possibility that much more than half the total Protestantism effect stems from other sources than literacy. In case of the two alternative outcome measures, the upper bounds of the 95% confidence bands make it possible to rule out the Table V estimate, but not much more, when assuming a 10% upward bias of the OLS literacy coefficient. But when a 40% downward bias is assumed, they allow us to reject the possibility that even one-third of the total Protestantism effect stems from nonliteracy sources.

An alternative way to perform the bounding analysis is to use direct estimates of the causal effect of education on earnings from other studies in the literature for $\overline{\chi}$ in equation (4). This is only feasible in the case of our direct earnings measure, based on teacher salaries. Although there is no evidence on returns to literacy in nineteenth-century Prussia, Mitch (1984), in the scenario closest to ours, calculates an internal rate of return to literacy in

50. Estimating the threshold value of statistical significance, the effect of Protestantism independent of literacy would become statistically significant only when the true effect of literacy was assumed to be at most 6% of its OLS estimate in the case of teacher income and 7% in the case of the nonagricultural share. Given that the nature of the possible endogeneity in the case of the sectoral-share measure may be different from the two income measures, the bounds based on the biases found for income measures in the literature may not directly apply to the sectoral-share measure.

51. Note that the OLS estimates of columns (7)–(9) of Table V are more precisely estimated and allow ruling out magnitudes for the independent effect of Protestantism that are economically significant. There, the 95-percent confidence bands around the estimates allow us to rule out that, once literacy is controlled for, the Protestant lead in per capita income taxes is larger than 0.12 Marks (and larger than 1.65 percentage points in the nonagricultural share).

TABLE VII
EFFECT OF PROTESTANTISM ON INCOME AFTER ADJUSTING FOR LITERACY: BOUNDING ANALYSIS

Return to one year of schooling equal to	Years to achieve literacy			
	4	5	6	7
	(1)	(2)	(3)	(4)
8%	0.045	0.030	0.015	0.00006
	(0.048)	(0.047)	(0.047)	(0.047)
9%	0.037	0.021	0.004	−0.013
	(0.047)	(0.047)	(0.047)	(0.047)
10%	0.030	0.011	−0.007	−0.026
	(0.047)	(0.047)	(0.047)	(0.047)
11%	0.022	0.002	−0.019	−0.039
	(0.047)	(0.047)	(0.047)	(0.047)
12%	0.015	−0.007	−0.030	−0.052
	(0.047)	(0.047)	(0.047)	(0.047)
13%	0.008	−0.017	−0.041	−0.065
	(0.047)	(0.047)	(0.047)	(0.048)
14%	0.00006	−0.026	−0.052	−0.078
	(0.047)	(0.047)	(0.047)	(0.048)
15%	−0.007	−0.035	−0.063	−0.091
	(0.047)	(0.047)	(0.048)	(0.049)*

Source. Data for Prussian counties from the 1871 Population Census and the 1886 Education Census; see main text and Appendix I for details. Further controls: % age below 10, % Jews, % females, % born in municipality, % of Prussian origin, average household size, ln(population size), population growth 1867–1871 (in %), % blind, % deaf-mute, % insane.
Note. Each cell reports the result of a separate regression. Reported coefficients are the instrumental-variable estimates on % Protestants, where distance to Wittenberg is the instrument. Dependent variable: ln(teacher income) $- r \times y \times$ % literate. Each cell refers to a different assumption on the return to literacy $r \times y$. The average return to one year of schooling r varies across rows. The average number of years of schooling required to achieve literacy y varies across columns. Standard errors in parentheses. Coefficients multiplied by 100.
Significance at *10, ** 5, *** 1 percent.

England of 59% in 1839–1843 and 49.5% in 1869–1873. This is, in fact, very close to our OLS estimate of χ_3 of 63.6%, reported in column (8) of Table V. The IV estimate of β_4 that results from estimating equation (4) with the return to literacy restricted to 55% (in the middle of Mitch's estimates) is reported in the fourth row of column (2) of Table VII. The estimate is statistically insignificant and very close to zero: The point estimate of 0.0019 is less than a mere 2% of the total effect of Protestantism on earnings reported in Table V.

A return to literacy of 55% is also in line with the extensive literature on the causal return to a year of education, combined with reasonable assumptions on years required to achieve literacy. As an estimate not too distant in time from our observation, Goldin

and Katz (2000) estimate a rate of return to (high school or college) education of 11% in 1915 Iowa. The survey by Psacharopoulos and Patrinos (2004) suggests that returns to primary education may be substantially higher than for subsequent levels of education. Their average estimate of the social return to primary education, drawn mainly from developing countries today, is as high as 18.9%. In his review, which is more concerned with causality but focused mostly on (higher) education in developed countries today, Card (1999) places the average causal return to a year of education at slightly below 10% and interprets recent IV estimates as showing that returns may be higher for people with low education. Similar estimates have also been used to depict effects of education on countrywide income in extensions of the macroeconomic growth literature following Barro (1991) and others, where Hall and Jones (1999) assume a rate of return of 13.4% for the first four years of education.[52] Given that the larger the return to literacy, the smaller will be the independent effect of Protestantism on earnings, an estimate of 11% can serve as a sensible parameter choice.

To transform returns to years of education into returns to literacy, we need a parameter estimate of how many years of schooling it takes to reach literacy. The Prussian census coded people as being literate if they could read and write. The literacy question was surveyed only for people at least 10 years of age. Given that children tended to enroll in school at age five, this amounts to an implicit assumption of the Prussian census statisticians that it took at least 5 years to reach literacy. This is in line with the fact that progress toward the Millennium education goal of reaching primary schooling is interchangeably measured by literacy rates (similar to our Prussian measure) and by completing a primary school cycle of usually five or six years (cf. Filmer, Hasan, and Pritchett [2006]). Combining this with a return of 11% per year again yields a return to literacy of at least 55%.

Although we thus think that 55% is a sensible conservative estimate of the return to literacy, Table VII shows that our qualitative result is not sensitive to wide bounds of reasonable

52. The equivalence of the effect of education on individual-level and group-level income (relevant in our county-level analysis) corresponds to the studies by Acemoglu and Angrist (2000) and Ciccone and Peri (2006), who find no evidence for externalities of education (see also Lange and Topel [2006]). By contrast, Moretti (2004) finds evidence that social returns are significantly larger than private returns, which would make our parameter choice even more conservative.

alternative assumptions about returns to schooling and about years to achieve literacy.

Another way of assessing the importance of education for the higher economic prosperity of Protestants, assuming that OLS estimates of the literacy effect are hardly biased, is to perform a descriptive accounting exercise. Remember from Table III that, on moving from an all-Catholic to an all-Protestant county, the average literacy rate increases by 18.9 percentage points and from Table V that per capita income taxes (the nonagricultural sector) increases by 0.59 Mark (8.2 percentage points). The (statistically highly significant) OLS coefficients on literacy in a regression predicting economic outcomes (cf. Table V) are equivalent to a 0.46 Mark higher per capita income tax (9.3 percentage points larger nonagricultural share) for an 18.9-percentage-point increase in the literacy rate. It thus turns out that based on OLS estimates of the literacy effect, Protestants' higher literacy can account for roughly the whole gap in economic outcomes between the two denominations.

The point estimates of our analyses suggest that once income differences are adjusted for literacy differences, the remaining difference is no longer systematically related to Protestantism. If education had the same effect on economic outcomes here as it has been shown to have in other settings, our results suggest that the higher literacy of Protestant regions can account for at least some of their economic advantage over Catholic regions, and they are consistent with the hypothesis that literacy can account for most or even all of the advantage.

VI.D. A Three-Stage Model

Given the result that Protestantism does not have an impact on economic outcomes independent of its effect on literacy, we can estimate the following system of three equations:

$$
\begin{aligned}
Y &= \alpha_4 + \beta_4 \widehat{\mathrm{LIT}} + X\gamma_4 + \varepsilon_4 \\
\mathrm{LIT} &= \alpha_5 + \beta_5 \widehat{\mathrm{PROT}} + X\gamma_5 + \varepsilon_5 \qquad (5) \\
\mathrm{PROT} &= \alpha_6 + \beta_6\, \mathrm{WITT} + X\gamma_6 + \varepsilon_6
\end{aligned}
$$

In this system, the first stage predicts the share of Protestants in a county by its distance from Wittenberg (WITT). The part of the variation in Protestantism that is due to distance to Wittenberg is then used in the second stage to predict the literacy rate of the county, as in our IV model above. Finally, in the third stage, this

TABLE VIII
PROTESTANTISM, LITERACY, AND ECONOMIC OUTCOME: A 3SLS MODEL

	Dependent variable		
	1st stage % Protestants (1)	2nd stage % literate (2)	3rd stage per capita income tax[a] (3)
Distance to Wittenberg in km	−0.097 (0.011)***		
% Protestants		0.190 (0.028)***	
% literate			3.242 (1.169)***
Obs.	426	426	426
R^2	.442	.699	.374

Source. Data for Prussian counties from the 1871 Population Census and the 1877 Income Tax Statistics; see main text and Appendix I for details.
Note. Standard errors in parentheses.
Further controls: % age below 10, % Jews, % females, % born in municipality, % of Prussian origin, average household size, ln(population size), population growth 1867–1871 (in %), % missing education info, % blind, % deaf-mute, % insane.
[a]Coefficients multiplied by 100.
Significance at *10, **5, ***1 percent.

variation in literacy is used to predict economic progressiveness. In effect, this system of three equations specifies a "double-IV" estimation, which can be estimated via three-stage least squares (3SLS). Such a model accentuates the three-stage character of our main argument and allows us to provide an estimate of the economic return to literacy in our setting.

The 3SLS results, reported in Table VIII for our main outcome measure, support our previous findings. Distance to Wittenberg is negatively associated with Protestantism; the part of Protestantism that is due to distance to Wittenberg has a positive effect on literacy; and the part of literacy that is due to the part of Protestantism that is due to distance to Wittenberg has a positive effect on economic outcome.

VI.E. An Addendum: Protestantism, Education, and Individual Earnings in Contemporary Germany

As a sequel to the historical analysis, we briefly analyze the association between Protestantism, education, and economic outcomes in contemporary Germany. The German Socio-Economic

Panel (GSOEP) provides data on religious affiliation, years of education, and individual income for a representative sample of Germans in 1997. On a descriptive basis, Protestants have 5.4% higher income and 0.8 years more education than Catholics even today. These associations are confirmed in a standard regression framework (cf. the first four columns of Table IX).[53]

However, once we adjust income for the effects of education, the income difference between Protestants and Catholics vanishes. Similar to the bounding analyses above, we purge the income measure on the left-hand side of an economic return to education taken from the literature. Columns (5) and (6) of Table IX use a rate of return to education of 9.4%, a causal estimate provided for Germany by Ichino and Winter-Ebmer (2004), whereas columns (7) and (8) use a rate of return of 5.2% and 6.0%, respectively, equivalent to 90% of an auxiliary OLS regression using our data (assuming a 10% upward OLS bias, in line with the Card [1999] review). Just as in the historical analysis, Protestants do perform better economically even in contemporary Germany, but again, the whole gap can be accounted for by different levels of human capital.[54]

This observation goes largely unnoticed in present-day Germany because few datasets collect information on religious denomination, education, and income. Still, the current Catholic education gap is not completely surprising, considering the fact that family background plays an important role in human capital accumulation, which perpetuates the education gap over time. Even after more than a hundred years of a public school system that provides equal access to schooling independent of religious affiliation, Protestants are still better educated. The results suggest that Luther's educational postulations may have had very

53. The sample share of Protestants (Catholics) is 29% (40%), average schooling 12.4 (11.6) years, and average gross monthly income 5,061 (4,802) Marks.

54. In a similar vein, the estimate on Protestantism in Table IX approaches zero as soon as years of schooling are added as a control variable to the model (see Becker and Woessmann [2007]). Given that migration waves after World War II, increased mobility, and voluntary Church secessions and conversions may undermine the instrument characteristics of the historical spread of the Reformation for Protestantism today, the contemporary analysis of the association between Protestantism and earnings does not necessarily draw on exogenous variation and thus stays purely descriptive. The three most recent GSOEP waves that collected data on religious affiliation are 1990, 1997, and 2003. We find the same reported (1997) pattern in 1990, but not in 2003. Whether this is due to data problems (e.g., a refreshment sample with relatively young households and thus more volatile incomes) or a true change in economic associations is left for future investigation.

TABLE IX
RELIGION, EDUCATION, AND EARNINGS IN CONTEMPORARY GERMANY

	Dependent variable							
	ln(gross monthly earnings)		Years of schooling		ln(gross monthly earnings) adjusted for 9.4% return to schooling[a]		ln(gross monthly earnings) adjusted for 5.2%/6.0% return to schooling[b]	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Protestant	0.048	0.051	0.806	0.706	−0.028	−0.016	0.006	0.009
	(0.020)**	(0.018)***	(0.128)***	(0.118)***	(0.019)	(0.016)	(0.018)	(0.016)
Other Christian denomination	−0.033	−0.004	−0.579	−0.306	0.022	0.025	−0.003	0.014
	(0.034)	(0.032)	(0.242)**	(0.225)	(0.035)	(0.031)	(0.034)	(0.031)
Non-Christian religious affiliation	−0.169	−0.171	−1.826	−1.818	0.002	0.0002	−0.075	−0.062
	(0.025)***	(0.021)***	(0.202)***	(0.188)***	(0.029)	(0.026)	(0.028)***	(0.026)**
No religious affiliation	0.154	0.156	0.805	0.892	0.078	0.072	0.112	0.103
	(0.024)***	(0.022)***	(0.148)***	(0.136)***	(0.021)***	(0.019)***	(0.021)***	(0.019)***
Female		−0.268		−0.412		−0.229		−0.243
		(0.016)***		(0.107)***		(0.015)***		(0.015)***

TABLE IX
(CONTINUED)

	Dependent variable							
	ln(gross monthly earnings)		Years of schooling		ln(gross monthly earnings) adjusted for 9.4% return to schooling[a]		ln(gross monthly earnings) adjusted for 5.2%/6.0% return to schooling[b]	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Potential experience in years		0.021		−0.202		0.040		0.033
		(0.004)***		(0.027)***		(0.004)***		(0.004)***
Square of potential experience in years		−0.054		0.183		−0.072		−0.065
		(0.009)***		(0.061)***		(0.008)***		(0.008)***
Firm tenure		0.012		0.018		0.011		0.011
		(0.003)***		(0.018)		(0.003)***		(0.003)***
Square of firm tenure		−0.016		0.027		−0.018		−0.017
		(0.009)*		(0.059)		(0.008)**		(0.008)**
Obs.	2,566	2,566	2,566	2,566	2,566	2,566	2,566	2,566
R^2	.040	.183	.073	.210	.009	.223	.018	.207

Source. GSOEP 1997. Sample: full-time employed workers, ages 20–55.
Note. Standard errors in parentheses. Left-out category of religious affiliation is "Catholic."
[a]Dependent variable is earnings $- r \times$ years of schooling, using a rate of return to schooling r of 9.4 percent, a causal estimate for Germany provided by Ichino and Winter-Ebmer (2004, Table 6).
[b]Dependent variable is earnings $- r \times$ years of schooling, using a rate of return to schooling r of 5.2 percent (6.0 percent in column (8)), equivalent to 90 percent of the OLS estimate on years of schooling from an auxiliary OLS regression (assuming a 10 percent upward bias in the OLS estimate).
Significance at *10, ** 5, *** 1 percent.

long-term repercussions. The precise nature of the contemporary associations is a matter for future research, however.

VII. Conclusions

This paper advances an alternative to the Weber thesis: an explanation for the historically greater economic prosperity of Protestant regions based on a standard human capital argument. As an unintended side effect of Luther's exhortation that everyone be able to read the Gospel, Protestants acquired literacy skills that functioned as human capital in the economic sphere. This human capital theory of Protestant economic history is consistent with Luther's preaching, with the cross-country pattern in 1900, and with county-level evidence from late nineteenth-century Prussia. Using the roughly concentric dispersion of Protestantism around Luther's city of Wittenberg during the Reformation to obtain exogenous variation in Protestantism, we find that Protestantism led to substantially higher literacy across Prussian counties in the late nineteenth century. Our results are consistent with the hypothesis that this higher literacy in Protestant regions can account for the major part of their edge in economic progressiveness over Catholic regions.

So, was Weber wrong? Or, more precisely, is what has come to be known as the Weber thesis, as commonly interpreted, wrong? Given the complexity and multifaceted character of the thesis, there can of course be no simple answer to this question. Within the scope of this paper, there are at least three aspects to the question, with three different answers.

First, is the Weber thesis wrong in the main descriptive pattern of its argument? In contrast to the conclusion of some existing cross-country research (Delacroix and Nielsen 2001), we show that Weber was *right* in his observation that Protestant regions were economically more affluent than Catholic regions, across countries in 1900 and within Prussia in the second half of the nineteenth century.

Second, is the Weber thesis wrong with respect to the main channel through which this pattern arises? Our evidence suggests that in this aspect, his thesis as commonly interpreted is likely *wrong*. We find that the key channel appears to be the acquisition of literacy (a factor not generally associated with the Weber thesis), which seems to be able to account for a major part of the association between Protestantism and economic prosperity

in late nineteenth-century Prussia. The results are in accord with an explanation where the main channels advanced by the Weber thesis, namely the pure effects of work effort and thrift, do not have substantial effects.

Third, is the Weber thesis wrong with respect to the importance of ethical considerations in the association between religious denomination and economic success? This aspect is hard to answer (as always when dealing with topics of ethics), given the virtual impossibility of observing ethical considerations, particularly centuries after the fact. We cannot exclude the possibility that Protestants achieved higher literacy partly because of a different work ethic. In this sense, our human capital theory may be complementary to ethical explanations. However, our result that the spread of Protestantism, and with it the spread of literacy, can be traced back to incidents occurring centuries before our time of observation and lying beyond the influence of individual citizens driven by differential ethics may provide an indication that ethical channels may be limited. The relative importance of ethics in advancing literacy remains an important question for future research.

Our findings from nineteenth-century Prussia reveal that the Protestant Reformation had very long-lived economic consequences, spanning several centuries. Protestantism led to substantially higher literacy, which in turn led to economic progress. The link between cultural factors and economic development, although clearly present, may thus work quite differently from what is generally assumed, in ways going beyond the Weber thesis.

Appendix I: County-Level Data for Prussia in the Late Nineteenth Century

Three major censuses and several additional surveys in Prussia provide the data for our analysis: the 1871 Population Census, the 1882 Occupation Census, and the 1886 Education Census, as well as the 1877, 1892, and 1901 Income Tax Statistics, the 1879 Survey of Mayor Incomes, and the 1892 and 1901 Social Security Statistics. By the second half of the nineteenth century, the Prussian Statistical Office collected huge amounts of demographic and socioeconomic data, and the quality of the statistical material is generally viewed as outstanding. Knodel (1974, p. 28) concludes that the quality of Prussian demographic data was very high by the 1860s. Similarly, Wojtun (1968) reports that

population counts were virtually complete by 1864. Demographers have found county-level data for Prussia at the end of the nineteenth century to be a unique source of highest-quality data for analyses at a disaggregate level (cf. Galloway, Hammel, and Lee [1994]; Lee, Galloway, and Hammel [1994]). We have compiled the county-level data from respective archives.

In 1871, Prussia consisted of 452 counties,[55] organized into 35 districts and 11 provinces. Table A.1 lists the names of the Prussian provinces and districts, together with a count of counties in each district.

A. 1871 Population Census

The 1871 Population Census took place on December 1, 1871. Questionnaires were to be filled out by household heads after personal instruction through an agent of the Prussian Statistical Office. The agent assisted in filling out the questionnaire, where requested, and made sure the information provided was correct. Questionnaires were available in the different languages spoken by the Prussian population. The Census surveyed standard demographic variables such as sex and age, but also religion and literacy.

Religious affiliation was surveyed in four categories: Catholic, Protestant, other Christian denominations, and Jews.

Literacy was surveyed for the first time ever in Prussia in 1871. It is measured as the ability of those who are aged 10 years or older to read and write. In the volume detailing the results of the Census, the Prussian Statistical Office attested to the unexpectedly high quality of the literacy question. The state of literacy is unknown for only slightly more than 1 percent of respondents (captured by our variable "% Missing education info"). The Statistical Office expressed surprise about the fact that more than 10 percent of all males were illiterate, given the authorities' longstanding official educational objectives.

In contrast to the other data sources, the data from the 1871 Population Census allow a separate analysis of urban and rural areas in each county, where a population size of 2,000 was used to classify municipalities into urban and rural. Table A.2 reports

55. We combined Communionharz, a tiny county of 690 inhabitants, with the neighboring county Zellerfeld, as the Occupation and Education Censuses do. After 1871, some bigger counties were split into two separate counties; we aggregated the post-1871 data up to the 452 counties existing in 1871.

TABLE A.1
PRUSSIAN PROVINCES AND DISTRICTS

Province (Provinz)	District (Regierungsbezirk)	Counties (Kreise)	Province (Provinz)	District (Regierungsbezirk)	Counties (Kreise)
Brandenburg	Frankfurt/Oder	18	Preußen	Königsberg	20
	Potsdam	16		Marienwerder	13
Hannover	Aurich	3	Rheinprovinz	Aachen	11
	Hannover	7		Düsseldorf	21
	Hildesheim	7		Koblenz	13
	Lüneburg	7		Köln	11
	Osnabrück	5		Trier	13
	Stade	8	Sachsen	Erfurt	10
Hessen	Kassel	23		Magdeburg	15
	Wiesbaden	12		Merseburg	17
Hohenzollern	Hohenzollern	4	Schlesien	Breslau	24
Pommern	Köslin	12		Liegnitz	20
	Stettin	13		Oppeln	19
	Stralsund	4	Schleswig-Holstein	Schleswig	20
Posen	Bromberg	9	Westphalen	Arnsberg	14
	Posen	18		Minden	10
Preußen	Danzig	8		Münster	11
	Gumbinnen	16			

TABLE A.2
RURAL-URBAN BREAKDOWN OF POPULATION CENSUS DATA

	Total	Rural	Urban
	(1)	(2)	(3)
% Protestants	64.62	64.57	64.69
	(38.09)	(39.32)	(35.33)
% literate	87.33	86.27	91.00
	(12.56)	(13.78)	(8.13)
% age below 10	24.91	25.56	22.82
	(2.18)	(2.25)	(2.48)
% Jews	1.08	0.43	3.44
	(1.18)	(0.63)	(4.18)
% females	51.09	51.16	51.13
	(1.42)	(1.44)	(2.32)
% born in municipality	59.65	61.03	55.34
	(11.93)	(13.16)	(10.23)
% of Prussian origin	99.16	99.35	98.69
	(1.85)	(1.46)	(2.31)
Average household size	4.79	4.89	4.51
	(0.34)	(0.40)	(0.36)
Total population size	51,965.22	38,736.12	13,229.11
	(19,124.29)	(14,255.86)	(10,659.00)
Popul. growth 1867–1871 (in %)	1.03	1.79	2.26
	(4.08)	(25.98)	(6.16)
% missing education info	1.71	1.87	1.18
	(1.11)	(1.30)	(0.98)
% blind	0.09	0.09	0.11
	(0.03)	(0.03)	(0.06)
% deaf-mute	0.10	0.10	0.12
	(0.05)	(0.05)	(0.16)
% insane	0.23	0.22	0.27
	(0.18)	(0.15)	(0.52)
Number of observations	452	427	437

Source. Data for Prussian counties from the 1871 Population Census.
Column (1) displays county totals. Column (2) displays values for rural municipalities (≤2,000 inhabitants) in these counties. Column (3) is for urban municipalities (>2,000 inhabitants) in these counties.
*Note.*All columns show means. Standard deviations in parentheses.

descriptive statistics of our Population Census data separately by urban and rural municipalities in the counties.

The source of the Population Census data is the Königliches Statistisches Bureau, *Die Gemeinden und Gutsbezirke des Preussischen Staates und ihre Bevölkerung: Nach den Urmaterialien der allgemeinen Volkszählung vom 1. December 1871* (Berlin: Verlag des Königlichen Statistischen Bureaus, 1874).

B. 1877 Income Tax Statistics

Financial statistics of Prussian counties provide income tax data for the budget year 1877/1878 (ranging from April 1877 to March 1878). They contain information on the total amount of class tax (Klassensteuer) and classified income tax (classifizierte Einkommensteuer) collected in the county. The division into two types of income taxes, which existed until 1891, has historical reasons: the class tax was the successor of the poll tax of 1811, whereas the classified income tax was introduced later in 1851 (cf. Hill [1892] for details).

The class tax was collected on yearly incomes between a minimum taxable income of 420 Marks and a maximum of 3,000 Marks. There were twelve income classes, with tax payments ranging from 3 to 72 Marks. The implied rates on the minimum income of each class increased gradually from $^{5}/_{7}\%$ in the lowest class to $2^{2}/_{3}\%$ in the highest class. The relevant 1873 tax law states that income was to be assessed on the basis of the estimated value of the annual income (cf. Engel [1875]). Even before this, instructions by the finance minister explicitly specified that incomes were meant to constitute the principal determining factor in the assessment of the class.

Incomes above 3,000 Marks were subject to the classified income tax, which was assessed solely on the basis of income. The rates were equivalent to 3% of the minimum income of a large number of increasing income brackets.

To obtain the amount of income tax paid per capita, we divided total tax revenues by the total population of the county in 1877, available from the same source. The financial statistics are not available for the 26 counties that were city counties (where the county equaled one big city) in 1877, so that the total number of observations equals 426 counties in these data.

The source of the 1877 Income Tax Statistics data is the Preussisches Statistisches Bureau, "Finanzstatistik der Kreise des preussischen Staates für das Jahr 1877/78," *Zeitschrift des Preussischen Statistischen Landesamtes*, Ergänzungshefte, 7 (1878), 113–174.

C. 1879 Survey of Mayoral Incomes

In 1879, the Ministry of the Interior mandated a special survey of the incomes of mayors and other paid members of city magistracies. The survey was restricted to all municipalities with

more than 10,000 inhabitants. The survey thus covered 159 towns with a total of 5.2 million inhabitants, constituting 59% of the total urban population (defined by the Prussian Statistical Office as municipalities with more than 2,000 inhabitants) and more than 20% of the total Prussian population at the time. All 159 cities reported data on mayoral incomes, but not necessarily on incomes of other members of the magistracy.

Obviously, mayoral incomes are not a perfect measure of incomes of the population at large, but, to the extent that their salaries were financed from local taxes, they are likely to reflect the income level to an acceptable degree.

In 121 cases, there is only one city with more than 10,000 inhabitants in a county. Only 17 counties host two or three cities with more than 10,000 inhabitants; for these counties, we take average mayoral incomes of the cities. This leaves a total of 138 counties with mayoral income information.

The source of the 1879 Survey of Mayor Incomes data is Blenck, Emil, "Die Gehaltsverhältnisse der höheren Gemeindebeamten in den preussischen Stadtgemeinden mit mehr als 10000 Einwohnern," *Zeitschrift des Preussischen Statistischen Bureaus*, 20 (1880), 271–283.

D. 1882 Occupation Census

The 1882 Occupation Census collected information on employment and self-employment across two-digit sectors. We calculate the share of the total labor force, as well as the share of the male labor force, working in the manufacturing sector and in the service sector. We use the classification provided by the Prussian Statistical Office to classify the two sectors.

The manufacturing sector (Sector B in the 1882 classification) includes mining, construction, and manufacture of metals, machinery, equipment, chemicals, textiles, paper, leather, food products, and wood.

The service sector (Sector C in the 1882 classification) includes trade business, insurance, transport, lodging, and restaurants. Note that the service sector C does not include servants and housemaids, nor does it include those working in public administration and the military.

Our results are robust with respect to dropping or including certain subsectors in the analysis, for example, the mining industry, which in modern sector classifications would not be included in the manufacturing sector.

The source of the Occupation Census data is the *Preussische Statistik*, Vol. 76b, pp. 232–695 and Vol. 76c, p. 239.

E. 1886 Education Census

The 1886 Education Census collected information on both primary schools and secondary schools.

From the Education Census, we derive the average annual income of full-time male elementary school teachers in a county. Given that teacher incomes were almost entirely financed from local contributions, they should provide a reasonable proxy for the average income of the county (cf. Schleunes [1989]).

The Education Census also provides county-level information on the share of students who had a distance to school of more than 3 kilometers. Although the information applies to students (rather than the adult population) in 1886 and does not include school-aged children who did not attend school, the measure may still provide a useful proxy for the supply of schools in the different counties in our analysis.

The source of the Education Census data is *Preussische Statistik*, Vol. 101, pp. 2–391.

F. 1892 and 1901 Social Security Statistics

Starting in 1892, wages of day laborers were systematically collected after an amendment of the Health Insurance System, one of the main pillars of the Prussian social security system. The April 1892 version of the Health Insurance Law decreed that payments to the compulsory Health Insurance System be 1.5% of the customary wage paid to day laborers. The fact that the Prussian authorities used these measures of day laborer wages as reference values to determine contributions shows that they were considered sufficiently representative of wages in low-income households, and thus a useful proxy for the local standard of living of this segment.

Data were collected at the municipality level, separately for male and female workers and for those below and above 16 years of age. A ministerial directive explicitly required that only unskilled labor be considered, that annual averages be computed when wages varied seasonally, and that any in-kind benefits be added to the cash rate at local prices. The wage data are available at the county level, separately for urban and rural municipalities, for the years 1892 and 1901. Individual annual incomes can be computed by multiplying the daily wage by 300, as the official

implementation regulation of the Health Insurance Law assumes 300 working days per year.

The source of the Social Security Statistics data is Neuhaus, Georg, "Die ortsüblichen Tagelöhne gewöhnlicher Tagearbeiter in Preußen 1892 und 1901," *Zeitschrift des Königlich Preussischen Statistischen Bureaus*, 44 (1904), 310–346.

G. 1892 Income Tax Statistics

The 1892 Income Tax Statistics go beyond the 1877 Income Tax Statistics described above by detailing, for 60 urban counties, the number of taxpayers for every one of the 297 income tax brackets, from the lowest income bracket (900–1,050 Marks) to the highest existent bracket in that year (10,900,000–10,905,000 Marks). By multiplying the number of taxpayers in an income bracket by the average income in that bracket (the midpoint of the interval) and summing over all income brackets, we compute the total income of income-tax-paying households in a county.

Several changes occurred in the tax code between 1877 and 1892. After an increase in the minimum taxable income from 420 to 900 Marks in the early 1880s, the income tax law of June 1891 brought further changes (cf. Finanzarchiv [1891]). The class tax was removed and subsumed in the classified income tax to form a new combined income tax. The former cutoff point of 3,000 Marks between the class tax and the classified income tax remained relevant only insofar as it marked the threshold above which an official tax declaration by the taxpayer became compulsory. The new tax schedule, with a finer classification of income brackets, started with a tax of 6 Marks in the lowest income tax bracket, corresponding to a tax rate of roughly 0.6%. Tax rates increased progressively to reach 3% for incomes of 10,500 Marks, remained flat at 3% for brackets up to 30,500 Marks, and then increased again up to 4% for top income brackets.

The source of the 1892 Income Tax Statistics data is the Statistik der preussischen Einkommensteuer-Veranlagung für das Jahr 1892/93, *Mittheilungen aus der Verwaltung der direkten Steuern im preussischen Staate* (1892), 212–281.

H. 1901 Income Tax Statistics

In a special Festschrift on the occasion of its centenary in 1905, the Prussian Statistical Office published a volume containing both the income tax receipts and the total number of income tax payers covering all Prussian counties, averaged over the tax

years 1899 through 1903. The total volume of tax receipts is available, but not the distribution of tax payments across income brackets, as in 1892. The data on the size of the taxpayer population allow inferring the size of the nontaxpayer population.

The source of the 1901 Income Tax Statistics data is the Königlich Preussisches Statistisches Bureau, *Festschrift des Königlich Preussischen Statistischen Bureaus zur Jahrhundertfeier seines Bestehens* (Berlin: Verlag des Königlich Preussischen Statistischen Bureaus, 1905).

Appendix II: Economic and Educational Data before 1517

The data sources for the proxies of economic and educational development at Lutheran times are as follows.

Imperial cities in 1517: Oestreich and Holzer (1973) contains a list of the free imperial cities (*Reichsstädte*). We derive the sample of cities that preserved their status as free imperial cities in 1517.

Hanseatic cities in 1517: Hammel-Kiesow (2000) provides a map of the Hanseatic cities with the dates of their last participation at the Hanseatic Diet. We derive the sample of cities that had participated in Hanseatic Diets at least until 1535.

Urban population in 1500: Bairoch, Batou, and Chèvre (1988) provide data on the population in 1500 of European cities that had at least 5,000 inhabitants once between 800 and 1800.

Universities in 1517: Eulenburg (1994) documents all German universities with their year of foundation, from which we derive the sample of universities founded before 1517.

Monasteries in 1517: Grote (1881) provides an encyclopedia of monasteries, cloisters, preceptories, and convents in the German Empire, detailing their locations, years of foundation, and (if applicable) years of abandonment. Of an envisaged two-volume work, only the first one was published, covering locations beginning with letters A to L. The volume includes male, female, and mixed monasteries. We derive a list of monasteries in existence in 1517, leaving out all monasteries established after 1517 or abandoned before 1517, also drawing on additional information added by P. Adalrich Arnold in 1939.

Schools in 1517: The German version of the Wikipedia encyclopedia website provides a "List of the Oldest Schools in the German-Speaking Area" (Liste der ältesten Schulen im deutschen Sprachraum) at http://de.wikipedia.org/wiki/Liste_der_%C3%

A4ltesten_Schulen_im_deutschen_Sprachraum (accessed September 3, 2007). From this list, which is likely nonexhaustive and covers only German-speaking territory, we draw the sample of schools founded before 1517.

Appendix III: Cross-Country Data in 1900

We restrict our cross-country analyses to the sample of countries in which Protestant and Catholic Christians together accounted for the majority of the population. The data sources are as follows.

GDP per Capita in 1900: Maddison (2006) provides data on per capita GDP in 1900 for a total of 29 countries with a majority of Protestant and Catholic Christians. GDP is measured in 1990 international Geary–Khamis dollars.

Religious Population Shares: Barrett, Kurian, and Johnson (2001) provide data on fractions of religious adherence of the population for 11 religious groups in 1900 for the 29 countries with available GDP data that had a majority of Protestants and Catholics in their data. In addition to Protestant and Catholic, the remaining groups are Orthodox Christian, other Christian, Jewish, Muslim, Hindu, Buddhist, other Eastern religions, other religions, and nonreligious.

Literacy Rates: UNESCO (1953) compiles data on the share of persons above 10 or 15 years who could read in 1900 (or a close year) from national population censuses. Among the 29 countries in the above sample, 11 have literacy data in 1900 (or a directly adjacent year) in the UNESCO compilation, and an additional three countries have somewhat later data (Chile in 1907, Argentina in 1914, and Colombia in 1917). Flora (1983) has 1900 literacy data for an additional four countries in our sample, of which Austria is based on censuses, the Netherlands and Sweden on military records of recruits, and the United Kingdom on marriage registers of the share of newly married bridegrooms and brides who could sign their marriage certificates. Cipolla (1969) provides 1900 literacy data from military records of recruits for another two countries in the sample (Switzerland and Germany). We follow Tabellini (2005) in combining literacy data from different sources in a cross-country comparison but caution that there are severe limits to cross-country comparability due to differences in literacy definitions and samples (cf. UNESCO [1953]).

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