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The Economic Effects of the Protestant Reformation: Testing the Weber Hypothesis in the German Lands

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Abstract

Following Max Weber, many theories have hypothesized that Protestantism should have favored economic development. With its religious heterogeneity, the Holy Roman Empire presents an ideal testing ground for this hypothesis. Using population figures of 272 cities in the years 1300–1900, I find no effects of Protestantism on economic growth. The finding is precisely estimated, robust to the inclusion of various controls, and does not depend on data selection or small sample size. Protestantism has no effect when interacted with other likely determinants of economic development. Instrumental variables estimates, considering the potential endogeneity of religious choice, are similar to the OLS results.

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1 Introduction

What is the relationship between religious beliefs, with their impact on moral reasoning and the related behavioral incentives, and economic growth? This question has been a long-standing topic of research in the social sciences. Many observers have attributed the rise of England and the Netherlands in the 17th and 18th century, as opposed to the decline of Spain and Italy, to their Protestant faith (see Braudel 1982, p. 567). Indeed, Protestantism, with its emphasis on the believers' direct relationship with and responsibility toward God, seems intuitively conducive to a modern, individualistic and rational, view of mankind. As a consequence, several theories have been put forward as to how precisely Protestantism is supposed to affect economic growth, most famously by Max Weber in his essay about the *Protestant Ethic* (Weber, 1904/05, 1930). But in fact, few empirical studies have investigated the comparative performance of Catholics and Protestants over the long run.

The present paper exploits the history of early modern Germany to assess the causal link between Protestantism and economic growth. The "natural experiment" considered here—the forced imposition of religious denominations as a consequence of the Peace of Augsburg (1555)—gave rise to substantial heterogeneity of religious denominations across the Holy Roman Empire and allows the investigation of differences in growth patterns across the Protestant and Catholic parts of the Empire. Using a dataset of cities and their population sizes, I find no positive effect of Protestantism on economic growth over the very long run (1300–1900); in fact, the growth performances of Catholic and Protestant cities are virtually indistinguishable. Throughout the regressions, the estimated impact of Protestantism on city size is small in magnitude and precisely estimated, allowing to exclude meaningful magnitudes of the effects. These findings are robust to a wide array of alternative specifications, and are confirmed by an instrumental variables strategy.

The empirical setting used here presents a series of advantages. First, the homogeneity of religious choice: almost all the territories analyzed were either entirely Protestant or entirely Catholic from the 16th century until well into the 19th century. Second, the exogeneity of religious choice: an individual's religious denomination was not freely chosen, but was the result of the choice of the local ruler (prince, duke…) whether to join the new religion; this choice was imposed on

the subjects according to the principle *cuius regio, eius religio* (whose realm, his religion). I will also investigate the exogeneity of the ruler's religious choice and discuss to what extent it can be considered orthogonal to his territory's latent characteristics. Last, as opposed to studies about religious minorities and their economic success (e.g., the Huguenots), religious choices in early modern Germany affected the whole spectrum of the local population, and are therefore more indicative of the net (causal) effect of Protestantism on economic activity.

The purpose of this paper is to analyze the long-term economic development of Protestant and Catholic regions over six centuries (1300–1900). The long time span considered allows to verify the presence of potential pre-existing trends and more generally to quantify the time-varying nature of the postulated treatment effects. The main dependent variable used is the size of cities, which, as argued in the following sections, provides a good proxy for the level of economic development, especially in the pre-industrial world. No other variable among those commonly used in the analysis of historical trends of well-being (real wages, body heights, quality of housing...) is available with a comparable cross-sectional breadth and temporal frequency.

Figure 1 gives an intuitive impression of the relationship between choice of denomination and average city size. To control for pre-trends across groups before the actual onset of the Reformation, I classify a city as "Protestant" in the years before 1517 if it became Protestant by 1600. A broad pattern, which I will later substantiate through regression analysis, is evident from the graph: Protestant cities are not growing differently from Catholic cities in the period after the Reformation; if anything, differences in (log) city size become less evident over time.[1]

[Figure 1 about here]

Because of this temporal scope, I may not be able to test specific channels of causation to the extent that a single cross-section in time or survey data would allow to do. However, in addition to the sizes of cities and their religious affiliations that form the core of my dataset, I collect a wide variety of additional variables on city and territory characteristics from several sources: these variables comprise information about geographic characteristics, such as latitude, longitude, or

[1]Two other facts are noticeable in this graph, and will be discussed later: cities of the Protestant camp start off smaller in 1300, and are more severely hit by the Thirty Years' War (1618-1648), as evident from the decline between 1600 and 1700.

presence of a navigable river; about institutional features and economic characteristics, such as the prevalent inheritance rule or the number of monasteries. With these variables, I can assess the impact of a series of confounding factors and shed light on the extent to which the effects of Protestantism are heterogeneous across cities; the potential presence of such heterogeneities can suggest the prevalence of certain channels of transmission. Finally, I try to disentangle the causality nexus between Protestantism and economic success with an instrumental variables strategy.

There are several strands of research related to this paper. First, there are cross-country studies relating Protestantism to economic outcomes in a variety of countries, such as Grier (1997), Delacroix and Nielsen (2001), Barro and McCleary (2003), and Ekelund et al. (2006, ch. 8). My work expands on this by examining the same relationship within a well-defined, culturally homogeneous setting, and by considering the endogeneity of religious choice. Moreover, the present paper is novel in its use of a panel spanning six centuries, rather than a single cross-section, to measure the long-run effects of Protestantism.

A related branch of literature uses survey data to understand the effects of Protestantism on contemporary socioeconomic outcomes: see, for example, the works by Glaeser and Glendon (1998), Guiso et al. (2003), or Spenkuch (2011). This paper can support the interpretation of contemporary findings by providing a description of the historical evolution of differences in economic outcomes across Catholics and Protestants.

Finally, this paper expands on existing work on the economic differences between Protestants and Catholics in the specific context of Germany—an analysis begun by Offenbacher (1900), whose studies provided the empirical observations Weber based his theory on, and most recently continued by Becker and Woessmann (2009). The latter paper considers a cross-section of Prussian counties in 1871 and finds a positive effect of Protestantism on economic development, which, it is argued, can be entirely attributed to differences in literacy between Protestants and Catholics. I discuss the relationship between the findings in the present paper and in the article by Becker and Woessmann (2009) in section 6.3 below.

In the following section, I expose the arguments that have been proposed to link Protestantism with economic progress, and give an introduction to the historical events in the German lands of the Holy Roman Empire covered by my analysis. In section 3, I introduce the data used in

this project and discuss the use of city sizes as a proxy variable. Section 4 provides econometric evidence on differences between Catholic and Protestant parts of Germany. In section 5, I discuss the endogeneity of religious choice and how this may affect the main empirical results. Section 6 considers competing explanations for the findings. Section 7 offers a conclusion.

2 Historical background

2.1 Protestantism and economic growth: A classic hypothesis

Since the seminal work by Max Weber, various theories about the relationship between Protestantism and economic development have been proposed and discussed. Understanding through which channels Protestantism could possibly affect economic growth will help in formulating hypotheses about where and when to find its potential effects: a specific causal link might only be relevant at a certain point in time, or be valid only for a certain subset of cities.

Weber's theory was motivated by the observation that in Baden (a state of southwest Germany) Protestants earned more than Catholics, and were more likely to attend technical rather than liberal arts schools. While Protestants in Baden were mostly Lutheran, the arguments in Weber's essay revolve for the most part around Calvinism and ascetic branches of Christianity. He hypothesized that—through the doctrine of predestination—Calvinism, and the Puritan sects in particular, were successful in instilling the view that work and money-making should be seen as a vocation, an end in itself. Weber argued that this attitude was central to the initial development of modern capitalism, but also that this role of religious views would not be necessary any more in a successfully industrialized society (Weber, 1904/05, ch. 2).[2]

In fact, other scholars of religious doctrines have also pointed out how Calvinism, emerging in a bourgeois and urban society, was particularly favorable to the instances of business life. Ernst Troeltsch (1931, p. 644) points out Calvinists' "industrious habits, detachment from the world, and rational and utilitarian spirit," which promoted the dedication to commercial activities and the accumulation of capital. Relatedly, attitudes toward usury laws and the charging of interest

[2]Weber's seminal essay has been discussed widely since its publication. Among the innumerable rebuttals, I will only cite Brentano (1916), Tawney (1926), Robertson (1933), and Samuelsson (1961).

have been proposed as an important channel: Calvin approved of lending money against interest in business matters (*Letter on Usury*, 1545), whereas the Catholic church reasserted the prohibition of usury in the bull *Vix pervenit* as late as 1745 (Hauser, 1927). According to these theories, one should expect positive effects of Protestantism on economic growth in Calvinist cities, and in particular in those cities with a potential for trade and commercial activity.

In the territories of the Holy Roman Empire studied in this paper Lutheranism, rather than Calvinism, was the dominant branch of Protestantism. Troeltsch (1931, pp. 554-576) discusses the Lutheran stance towards economic questions. While Luther was generally more conservative in his economic ethic than Calvin—for instance, being opposed to interest on money lending—the doctrines of Lutheranism still had momentous economic consequences: the abolition of monastic orders, of mendicancy, the reduction of Church holidays, and the secularization of church holdings all released large amounts of labor and capital and arguably could have increased output. Furthermore,

> *[. . .] the control of the Church in the sphere of economics was removed, which had brought questions like the fixing of a just price, and of usury, before the judgment seat of the confessional. All matters of that kind were now handed over to the secular authority entirely, and to Natural Law. [. . .] The modern tendency of the Reformers consists essentially in handing over economic matters to the territorial lords, who are obliged and entitled to increase possessions and industry for the good of the whole [. . .] Thus with the blessings of Lutheranism and without ecclesiastical control they entered the path of mercantilism as well as that of an absolutist social policy.* (Troeltsch, 1931, p. 554 and fn. 272)

Thus we should expect Lutheranism to increase economic activity, especially where large Church holdings are dissolved, and to promote the emergence of modern centralized states.

Other researchers have downplayed the importance of Protestantism's economic teachings, while pointing out how other elements of the Protestant religions might have fostered growth-promoting attitudes. Merton (1938) discusses how some branches of Protestantism, such as the English Puritans and the German Pietists, might have favored the rise of modern Western science. Hill (1961) also considers the actual economic teachings of Luther and Calvin marginal, and points out instead how Protestantism, by stressing individual freedom and responsibility toward God, dispensed with the Church hierarchy and thus encouraged Protestants to become more flexible

and open toward new ideas. If these theories are correct, Protestantism should have favored economic growth especially in the period after the Scientific and the Industrial Revolutions.

More recently, many economists have studied the importance of trust, on the assumption that trust is a fundamental element allowing for the establishment of market exchange. Building on Putnam (1993), who claimed that hierarchical religions such as Catholicism discourage "horizontal" ties between people and hence the formation of trust, La Porta et al. (1997) show that countries with hierarchical religions perform comparatively worse on a wide range of contemporary outcomes, relating to government efficiency, civic participation, the quality of social infrastructure, and the formation of large corporations. This relationship is further examined by Guiso et al. (2003) using data from the World Values Survey: compared to Catholics, Protestants are found to be significantly more likely to trust strangers, less likely to cheat on taxes and to accept a bribe. Catholics are, perhaps surprisingly, more likely to teach thrift to their children, and to have a positive view of competition.[3] These findings also suggest a beneficial effect of Protestantism, especially in an urban and commercial setting.

Finally, Becker and Woessmann (2009) have suggested a human-capital based theory of Protestant advantage. They argue that the differences in economic outcomes between Catholics and Protestants in Prussia around 1871 can be explained by differences in literacy. These differences trace back to Luther's exhortation to be able to read and interpret the Bible on one's own, which led to the establishment of elementary schools and thus to the accumulation of human capital all over Protestant territories. If literacy is important for the development of an industrial economy, but is less productivity-enhancing in the agricultural sector, we should expect the Protestants' accumulation of human capital to exert positive effects particularly during the 19th century.[4]

[3]Relatedly, Blum and Dudley (2001) propose a link based on network externalities; they suggest that Protestants are less likely to defect in a game with repeated interactions (because of the absence of easy mechanisms of penance), which in turn favors the establishment of trade networks.

[4]This relationship has also been put forward by Sandberg (1979) to explain Sweden's long-run growth performance. While a classic view downplayed the importance of human capital during the British industrial revolution (see Mitch 1999), Becker et al. (2011) argue that in the case of Prussia pre-existing levels of schooling substantially accelerated industrialization in the 19th century.

2.2 Historical background: Protestantism in Early Modern Germany

The political and religious situation in Germany at the time of the Reformation was peculiar within the European context and is crucial for the empirical strategy to identify the economic effects of the Protestant Reformation. There were three different phases of the spread of Protestantism across the German lands (until 1555; 1555–1624; after 1624); these phases are distinguished by the different legal context determining religious choice.[5]

Institutions and actors. The territory of the Holy Roman Empire occupied mainly the present-day central European states of Germany, Austria, Belgium, Luxembourg, the Czech Republic, Switzerland, and parts of France and Poland. The Emperor was an elected sovereign, chosen by seven princes of the Empire (the Electors).[6] He wielded less power than other contemporary rulers, such as the King of France or the King of England; most elements of sovereignty were exercised by the princes of the Empire instead.[7] There were hundreds of territories ruled by princes, dukes, counts, or Church dignitaries, such as prince-bishops; all of these were sovereign entities but for the largely nominal primacy of the Emperor. Some cities were "Free Imperial cities," being directly subjected only to the suzerainty of the Emperor. Most of the other cities were located in one of the territorial lords' territories and hence were subject to his jurisdiction, while still enjoying some degree of self-government.

Beginning of the Reformation. The sale of indulgences by the Church prompted Martin Luther, a hitherto unknown Augustinian monk and lecturer at the University of Wittenberg, to express his objections to this practice in 95 theses on October 31, 1517. He was not the first one to protest against these practices; however, he could count on a series of fortunate circumstances which would warrant success to his endeavor. Among these circumstances were the power struggles between the Emperor, the Pope, and the territorial lords; the contemporary intellectual networks;

[5]This historical summary is based largely on Schilling (1988). Good English-language introductions to the Reformation in Germany are provided by Scribner (1994) and Dixon (2002).

[6]These were the prince-bishops of Cologne, Mainz, and Trier; as well as the King of Bohemia and the Electors of Brandenburg, Saxony, and the Palatinate.

[7]While in states like England and France the king was able to impose his supremacy over local lords in the late Middle Ages, in the Holy Roman Empire the opposite turned out to be true: regional lords gained power at the expense of the Emperor (North and Thomas, 1973, pp. 79-86).

technological breakthroughs such as Gutenberg's printing press (Rubin, 2011); and the ongoing fight against the Turks in Austria (Iyigun, 2008). At first, many, including the Pope, dismissed his action as an minor protest without consequences. Luther's pamphlets could spread rapidly and be translated in multiple languages.

From the beginning, Protestantism exerted a major attraction on urban dwellers, both in Free Imperial cities and in cities subject to the jurisdiction of a territorial lord. Widespread literacy, the presence of humanist circles, universities, and printing presses, or the ideology of freedom intrinsic to the nature of the city are among the reasons for this phenomenon. By the end of the 1520s the vast majority of Free Imperial cities had become Protestant. Many of the cities on princely territories had also started to replace Catholic priests with Lutheran preachers, thereby putting pressure on their territorial lords who had not yet formally introduced the new faith.[8]

The princes of the Empire were more cautious in joining the bandwagon of Protestantism. They had to balance various factors: on the one hand, the Estates representing the cities and the minor nobility would often push in favor of adopting the new faith. On the other hand, princes were reluctant to unsettle the delicate balance of power between them, the Emperor, and the Church. In that first period, it was not clear whether and how the princes had the right to change the fundamentals of faith in their territories, or even to seize the Church's holdings.

The first green light toward the formal introduction of the Reformation was given at the First Diet of Speyer in 1526,[9] when a new formula was coined: princes should behave in religious matters "as they may hope and trust to answer before God and his imperial Majesty" until the meeting of a general council of the Church. As the general council envisaged by the parties involved failed to materialize, this formula became in practice a *laissez-passer* for the official introduction of Reformation and of separate state churches in German territories.

Peace of Augsburg (1555). In the late 1540s, an attempt undertaken by Emperor Charles V to restore his authority and the Catholic faith proved short-lived. At the Imperial Diet of Augsburg in 1555, the Emperor accepted a peace treaty which included the formula known as *cuius regio, eius*

[8] On this topic, see the works by Ozment (1975), Dickens (1979), and Moeller (1987).
[9] Imperial Diets were assemblies of all princes of the Empire which convened at irregular intervals.

religio: it gave princes the right to impose their preferred denomination upon their subjects. This policy ended 38 years of legal limbo (1517–1555), in which uncertainty had reigned as to whether princes were allowed to introduce the Reformation. Furthermore, it guaranteed 60 years of relative peace until the outbreak of the Thirty Years' War, and sanctioned the primacy of the princes over the Emperor in religious matters. Several more territories converted formally to Protestantism in this period, including some prince-bishoprics.

Peace of Westphalia (1648). The Thirty Years' War (1618–48) would hardly change the denominational split in the Empire, despite its huge toll of lost lives and destruction. The Peace of Westphalia in 1648 established retroactively January 1st, 1624 as the *normal date:* the denomination of a territory at that point in time would have to be maintained; the conversion of a prince to another faith would not entitle him any more to force his conversion upon his subjects. Some conversions of princes occurred in fact in subsequent years, mainly for political reasons. For example, the staunchly Lutheran kings of Saxony converted to Catholicism in the 18th century in the hope of obtaining the Polish crown. This choice had no effect on the citizens of Saxony, who did not see a Catholic church in their cities until well into the 19th century.[10] For the vast majority of the territories in Germany no more denominational changes took place after 1624.

In sum, this unique historical process guaranteed a remarkable degree of confessional homogeneity and continuity within territories or cities until the 19th century, when barriers to the free movement of peasants were finally removed. To show exemplarily how stable these patterns proved to be, Table 1 presents data from the (denominationally mixed) region of Westphalia, in northwest Germany. Using the results from the Prussian census of 1849, reorganized to match historical borders, the table shows how, even 50 years after the collapse of the Holy Roman Empire and after the beginnings of industrialization, most people still resided in denominationally homogeneous areas which reflected the arrangements set by the Peace of Westphalia.

[10]More difficult was the case of Protestant territories conquered in war or through dynastic succession by Catholic princes; most notably, this was the case of the (Rhenish) Palatinate, a Calvinist territory inherited by a Catholic line of the Wittelsbach family. In this case, it depended on the willingness of the institutions of the Empire (notably the Imperial Chamber Court, the *Reichskammergericht*) and the credibility of the other princes' threats whether the new ruler was successful in imposing his faith. In general, cities, with their degree of self-government, could avoid interferences, whereas the broad mass of people in the countryside might have been more easily converted. This motivates the use of the denomination resulting from the normal date in the empirical analysis.

[Table 1 about here]

3 Data: City sizes as a proxy for economic development

Observing the evolution of city sizes provides us with arguably one of the best measures of economic development in pre-industrial times. Cities were the centers of learning, of political administration, and of economic activity. Books were printed in cities, artisans produced their tools and goods in cities, peasants came to cities to exchange their agricultural produce. In a Malthusian world in which population growth reacts to economic conditions, or in a model with unlimited supply of labor from the countryside, improvements in urban total factor productivity should be reflected in city sizes. Hence, if Protestantism did indeed increase the productivity of urban dwellers—by providing them with a peculiar "work ethic," by encouraging the accumulation of human capital, or by approving of modern commercial practices, for example—this should translate into larger city sizes.

Paul Bairoch (1977, 1988) and Jan de Vries (1984) were among the first scholars to illustrate the links between city sizes and economic development. A wide variety of papers in the economics and economic history literature have subsequently used their datasets of city sizes, and showed how likely determinants of long-run economic development affect the growth of cities. For example, DeLong and Shleifer (1993) find that more representative forms of government (oligarchies rather than autocratic princes) had a positive impact on urban growth in the medieval and early modern periods. Relatedly, Acemoglu et al. (2005) have shown that those European cities that could engage in trade relationships with the colonies across the Atlantic grew faster in the period after 1500.

To further validate the use of city sizes as proxy, I use the Prussian manufacturing census of the years 1816–1821, one of the earliest and most detailed comprehensive censuses of population and economic activity (Krug and Mützell, 1825), and compare city sizes with a variety of social and economic outcomes.[11] The results from this census are relevant because they provide evidence on the relationship between city size and economic outcomes in an epoch recent enough to have

[11] Detailed descriptions of the variables used are provided in Appendix A.1.

high-quality statistical data, but early enough for the cities not to be affected yet by the Industrial Revolution.

The regressions of Table 2 show that city size is strongly correlated with indicators of economic development: the supply of education (measured by the teacher-to-student ratio in elementary schools), accumulated capital (embodied by the sums insured with the local fire insurance company), indicators of economic activity (such as the tax on businesses), and with the quality of housing, as represented by the percentage of houses with stone walls (as opposed to timber) and with shingled roofs (as opposed to thatchered). At the same time, city size is not clearly related with any particular branch of economic activity, as emerges from the lack of correlation with the number of looms or merchants (columns (4) and (5)). As evident from panel B, these results also hold when the sample is limited to the smaller subset of those cities in the Prussian manufacturing census that are also featured in the Bairoch et al. (1988) dataset used in the main part of this paper.

[Table 2 about here]

To test the link between Protestantism and economic development, I use the population estimates by Bairoch et al. (1988) to construct a dataset encompassing 272 cities of the former Holy Roman Empire over six centuries—this compilation includes all cities that reached the threshold of 5000 or more inhabitants in or before 1800.[12] The years considered in my panel are spaced in 100 years' intervals from 1300 to 1700, and then in fifty years' intervals from 1750 to 1850, as in Bairoch et al. (1988). In addition, I include city size data for the years 1875 and 1900, which are drawn from national statistics (*Statistik des Deutschen Reiches* for Germany; *Statistisches Jahrbuch* for Austria). The distribution of Catholic and Protestant cities in my dataset is shown in Figure 2. As can be seen, Catholic cities generally cluster in the southeastern part of the Empire, Protestant ones in the northeast, whereas in the Western half of the Empire the picture is mixed.

[Figure 2 about here]

Summary statistics of the variables in the dataset are reported in Table 3.[13] The unconditional

[12]The potential selection bias inherent in this definition is discussed in the context of Table A.i. The definition of the Holy Roman Empire considered here encompasses all territories that were active members of the Empire in the 16th century, and that continued to be part of it until its dissolution in 1803. It thus does not include, for example, Switzerland, the Netherlands, or Northern Italy.

[13]Full descriptions and sources for the data are given in Appendix A.2.

differences in means of city size show that Protestant cities start smaller than their Catholic counterparts in 1300, but later make up for this difference. This comparison, however, is problematic, due to the inclusion of additional cities as time progresses. The second and third panel of the table confirm that there are some differences across the two subsamples. In terms of their geographic characteristics (second panel), Protestant cities are more likely to be in the north of the Empire (higher latitude values) and thus closer to Atlantic ports. They are also closer to Wittenberg, the city where Martin Luther lived and taught, but not to the other centers of the Reformation, such as Geneva and Zurich. The variables in the third panel are used in this paper to investigate the potential heterogeneity of effects of Protestantism (sections 4.4 and 6.2 below); Catholic cities have a stronger presence of the Church (more monasteries as of 1517) and are more likely to be in a region with neighboring cities of different religious denomination.

[Table 3 about here]

4 City growth in Protestant and Catholic territories

4.1 Empirical framework and baseline results

To capture differentials in city growth between Protestant and Catholic cities I use a generalized differences-in-differences setup. The simplest conceivable regression equation relating the outcome of interest, city size u_{it}, to denominational affiliation is the following:

$$\ln(u_{it}) = \chi_i + \zeta_t + \alpha \cdot Prot_i \cdot Post1517_t + \varepsilon_{it} \tag{1}$$

In this baseline differences-in-differences setup, I allow for a full set of city fixed effects (χ_i) and year fixed effects (ζ_t). They will capture the effect of any time-invariant, city-specific characteristic, or of any period-specific shock that affects all cities, respectively. In addition to these, the interaction term between a city's religion, $Prot_i$, and an indicator for the time periods after the inception of the Reformation, $Post1517_t$, captures the effect of Protestantism on city size.[14] The

[14] As in the context of Figure 1, the variable $Prot_i$ is equal to one throughout 1300-1900 if the city became Protestant before the normal year 1624, and zero throughout if it remained Catholic. Note that the counterfactual definition of a

estimated coefficient α will reflect the average difference in log city size between Protestant and Catholic cities in the period after the beginning of the Reformation.

The treatment effects of Protestantism are, however, unlikely to be constant over the whole time period considered, from the beginning of the Reformation in 1517 until 1900. An alternative setup would model the treatment effects as a linear function of time:

$$\ln(u_{it}) \quad = \quad \chi_i + \zeta_t + \alpha_{\text{post}} \cdot Prot_i \cdot Post1517_t + \alpha_{\text{posttrend}} \cdot Prot_i \cdot Post1517_t \cdot Trend_t + \varepsilon_{it} \qquad (2)$$

The coefficient α_{post} represents an average post-treatment difference in city size; in addition to that, $\alpha_{\text{posttrend}}$ captures any linear evolution of city size differences over time. The time trend $Trend_t$ is defined as $(t - 1517)/100$, and is hence measured in centuries.

The most flexible approach would allow the treatment effects of Protestantism to vary arbitrarily in any time period considered, by interacting the variable $Prot_i$ with a full set of dummies for every time period in the dataset (except one):

$$\ln(u_{it}) = \chi_i + \zeta_t + \sum_{\tau \in \Gamma} \alpha_\tau \cdot Prot_i \cdot I_\tau + \varepsilon_{it} \qquad (3)$$

The set Γ of Protestantism/year interactions included in the regression comprises all years in the dataset after the beginning of the Reformation as well as 1300 and 1400, leaving the year 1500 as the omitted category. The counterfactual inclusion of interaction terms relating to the years 1300 and 1400 allows to control for possible pre-trends in the set of cities that would later become Protestant. The coefficients α_t can be seen as the difference in log city size between Protestant and Catholic cities, conditional on city and time fixed effects, relative to the difference in log city size in the omitted year, 1500.

The regression results can be seen in Table 4; panels A–C reflect the setups of equations 1–3, respectively. From the estimates in column (1), there appear to be no economic effects of Protes-

city as "Protestant" already in the years 1300–1500 serves only the purpose of controlling for pre-trends. The variable $Prot_i$ varies over time, switching from one to zero, only for the three cities in the dataset that, after introducing the Reformation in the 16th century, switched their denomination between 1600 and 1624. For ease of exposition, I will use the notation $Prot_i$ instead of $Prot_{it}$. All regressions are substantially unchanged if I drop these switching cities from the database.

tantism. Almost all of the coefficients are far from conventional levels of significance. In the simple differences-in-differences regression of panel A, the estimated effect suggests a minuscule and not significant difference in log city size (0.022). When analyzing how the effect of Protestantism varies over time in the fully flexible setup of panel C, three facts stand out. First, a negative effect appears in 1700: this can be attributed to the greater damage sustained by the Protestant areas during the Thirty Years' War (1618–1648). Second, the coefficients become markedly positive, while still small in magnitude and not significant, towards the end of the 19th century. Finally, there are no indications of a pre-trend, as evidenced by the small and insignificant coefficients relating to 1300 and 1400. A test of joint significance of all post-1517 coefficients (i.e., the interactions of "Protestant" with all year dummies from 1600 onwards) rejects the null (p-value: 0.017); however, this is due largely to the one negative coefficient in 1700. When testing the joint significance of the coefficients relating to the years 1750 and later, the null is not rejected, with a p-value of 0.292.

[Table 4 about here]

As evident from the summary statistics in Table 3, cities that would later become Protestant are different from their Catholic counterparts along a wide array of characteristics. To the extent that these time-invariant characteristics (such as geographic features) have a constant effect on city size, this is captured by the city fixed effects. It is conceivable, though, that these features exert an effect on city size that varies over time; for example, distance to the Atlantic ports may be important only in the period after 1500, after the discovery of the Americas. Following a setup similar to equation (3), we can investigate this and other hypotheses by interacting time-invariant characteristics of cities, $control_i$, with a full set of time dummies:

$$\ln(u_{it}) = \chi_i + \zeta_t + \sum_{\tau \in \Gamma} \alpha_\tau \cdot Prot_i \cdot I_\tau + \sum_{\tau \in \Gamma} \beta_\tau \cdot control_i \cdot I_\tau + \varepsilon_{it} \tag{4}$$

Analogously, a full set of interactions of control variables with time dummies can be included in the regression setups of equations (1) and (2).

Column (2) reports the results of a regression including the full set of interactions of year dummies with latitude and longitude; while the estimates of these interactions (not reported)

are mostly significant, the coefficients capturing the economic effects of Protestantism are mostly unchanged, being generally slightly lower in magnitude than before.

More specifically, one can consider why latitude and longitude should affect economic outcomes, and what they are proxying for. The former can be seen as proxying for the closeness to the Atlantic seaports. The latter is correlated with the age of a city: the further east, the younger cities are, as they were founded during the eastward movement of the Germanic populations during the 10th–13th century. In that sense, any differential growth pattern of cities located further east could be seen as convergence toward a city-specific steady state of cities starting smaller. Column (3) controls for time-varying effects of distance to the Atlantic ports and of log city size in 1300; this is a very flexible way to control for long-run convergence patterns. The results from this setup largely confirm the prior estimates in column (2). In all further regressions, I control for time-varying effects of initial city size and distance to Atlantic ports, unless otherwise noted.

All results discussed so far are based on the 272 cities that lay in the German-speaking parts of the Empire, thereby excluding 25 cities of the Empire which lay in Bohemia, Moravia, Carniola (Slovenia) and parts of Northern Italy. This is motivated by the desire to consider not only a homogeneous legal setting, but also a homogeneous cultural space, where the message of the Reformation could spread without the need for translation. Column (4) shows that the results are virtually unchanged when including the other 25 cities.

The vast majority of the territories considered in the analysis are Lutheran. If we take a more restrictive view of of Weber's original hypothesis, though, a positive effect on economic development should be expected in particular from the Reformed (i.e. Calvinist[15]) denomination, with its view on the doctrine of predestination. If this was true, the previous regressions, which pooled Lutheran and Reformed cities under the label "Protestant," might be misleading, and the estimated coefficient biased downwards.

Only a minority of German states chose to adopt the Reformed faith over the Lutheran alternative: the Rhenish Palatinate, Hesse, and Bremen are some of the few notable examples. These territories comprise 21 cities in my dataset, as opposed to 163 Lutheran cities. Regression results

[15]Perhaps confusingly, not all religious denominations that emerged from the Protestant Reformation are "Reformed;" the latter term is used to classify Calvinist or Zwinglian (as opposed to Lutheran) branches.

in column (5) are based on a definition of "Protestant" that encompasses only these (Reformed) territories. The main finding is unchanged: there is no evidence for pre-trends, but no evidence for any substantial effect, positive or negative, after the inception of the Reformation, either.[16]

Column (6) investigates an alternative hypothesis: in this case, the dependent variable is not total population of a single city, but rather total urban population by territory. Based on the Bairoch et al. (1988) dataset, I aggregate the population of cities at the level of territories; the latter are defined using historical borders, keeping the borders constant over the period analyzed.[17] This specification controls for the extensive margin of urban growth: some territories might have become more urbanized by creating a series of new, smaller cities, rather than by continuously increasing the size of existing cities.[18] The results of the estimates in column (6) are very similar to the regressions which use city size as the dependent variable. All estimated effects are very close to zero, with the only exception of a negative effect in 1700 stemming from the Thirty Years' War in the Protestant territories.

4.2 Interpreting the magnitude of estimated effects

Given the inability to reject the null hypothesis of no effect of Protestantism, it is important to determine whether this inability is due to the small power of the statistical tests applied. In fact, the sample size is comparatively large (almost 1900 observations) and the standard errors relatively small, being in the same order of magnitude as the point estimates. This makes it more likely that the estimated effects are indicative of a true absence of effects, rather than of an inability to reject the null hypothesis. To reinforce this observation, one can try to gauge the precision of the effect by considering the 95% confidence interval around the point estimates, and see which magnitudes

[16] Note that in this regression the implicit comparison group for Reformed (Calvinist) cities are Lutheran and Catholic cities together. The working paper version of this paper (Cantoni, 2010, section 4.4) presents also results with separate interaction terms between a "Lutheran" indicator and time dummies; in this case, the results can be interpreted as the difference between Reformed and Catholic cities only. Results are very similar.

[17] In general, if territories changed hands or lost their independence, they would do so as a whole and would still be treated as distinct units. For example, the Duchy of Cleves was given to the Margraves of Brandenburg as a result of the Treaty of Xanten (1614); however, the Duchy of Cleves continued to exist as a legal unit afterwards, and the Margrave of Brandenburg would simply add "Duke of Cleves" to his collection of titles. Therefore, the Duchy of Cleves is considered a "territory" throughout the period considered in the dataset.

[18] Note, however, that only 11 cities among those in my dataset were founded after 1517. Entry into the dataset occurs mainly because many cities, while already existing, are too small and have no reported population sizes for the earlier dates.

of the effect can be safely excluded.

Figure 3 gives a visual representation of the baseline estimates of Table 4, columns (1) and (3), panel C. In both cases, the upper confidence bounds lie around 0.2–0.4, which would suggest that, conditional on the covariates, Protestant cities are at most 22–49% larger than their Catholic counterparts. A log difference of 0.2–0.4 corresponds to approximately one third of the standard deviation of log city sizes in the dataset for any of the years 1750–1900. That is, even the upper bound of the confidence interval suggests that the implied effect of Protestantism are at best minor.

[Figure 3 about here]

An alternative way to gauge the magnitude of coefficients relating to city sizes is to model explicitly how shocks to urban productivity affect city sizes. In a simple model of a Malthusian economy, population size reacts to shocks in productivity (as they could have arguably occurred through the adoption of Protestantism). The elasticity of city size with respect to productivity shocks is determined by the elasticity of output with respect to the reproducible factor of production, labor.[19] If $\beta < 1$ is the elasticity of output with respect to labor, city sizes react to shocks in urban productivity with an elasticity equal to $1/(1-\beta)$. This implies that, for the case of $\beta = 0.5$, an increase in city size of 0.2–0.4 log points can be caused by an increase to urban productivity of about 0.1–0.2 log points, or 11–22%. Even considering the upper bound of the estimated effects on city size, the implied underlying changes in productivity appear minor.

Finally, one can compare these magnitudes to other estimates of determinants of city size. Acemoglu et al. (2005) use an analogous empirical setup to determine the effect of being located on an Atlantic port on log city size; the sample they consider are cities from the Bairoch et al. (1988) dataset located all across Europe. The corresponding point estimates for the years 1700–1850 vary between 0.7 and 1.1 (table 5, p. 560); these can be directly compared to the estimates of α_τ from regression equations 3 and 4. Thus it appears from this comparison that even the upper bound for the estimated effect of Protestantism is far from the effects that other likely determinants of

[19] Assume, e.g., a production function of the type $Y = AL^{\beta}\Lambda^{1-\beta}$, where Λ is a factor of production in limited supply. There are no property rights over Λ; real incomes are given by the average product of labor and are constant (population adjusts correspondingly to shocks in A). Alternatively, assume that Λ belongs to a landlord who pays the marginal product of labor to workers, and is otherwise extraneous to the Malthusian dynamics of the model (see Galor 2005, p. 240).

growth have on city size.

4.3 Robustness: Results in subsamples, urbanization rates

To investigate the robustness of these results, I apply the regression setup described in equation (4) to a series of subsets of my data. The use of only a subset of the 272 cities can be motivated either on econometric or on historical grounds.

I limit the analysis to the 221 cities west of the river Elbe, as east of the Elbe stronger forms of serfdom persisted until the early 19th century, which hampered free movement of labor to the cities. I control for the population loss occurred as a consequence of the Thirty Years' War (1618–1648), and I allow for differential effects of the war across Protestant and Catholic cities. To take into account the selection/survivorship bias arising from the inclusion criterion of cities in the Bairoch et al. (1988) dataset, I consider first only the balanced sub-panel of 45 cities with recorded population data in all years, and second only those 126 cities that are large enough to feature a population estimate for 1500. I exclude the 38 Free Imperial cities in the dataset, which enjoyed a radically different institutional setup than the territorial states of the Empire. Based on Huppertz (1939, map I), I split the sample into territories with partible and impartible inheritance rules, as this might have arguably affected the potential for city growth. Finally, to make my results comparable with the analysis of Becker and Woessmann (2009), I limit the analysis to those cities that were part of Prussia in 1871. Across all of these specifications, the full thrust of the baseline regressions is preserved: no clear and consistent effect of Protestantism on city size can be detected, neither positive, nor negative, and the precision of the estimates allows to exclude meaningful magnitudes. Full results of these regressions are provided in the supplementary appendix, Table A.i.

Motivated by the literature reviewed in section 3 and the findings of the Prussian manufacturing census of 1816–1821 (Table 2), the analysis has so far relied on city sizes as an indicator of economic development, and measured the impact of Protestantism on city sizes. However, urbanization *rates*, defined as the share of urban dwellers over total population in a region, may be a better indicator of economic development, capturing the shift of an agrarian society towards

commercialization and industrialization.[20] Estimating urbanization rates for periods before 1800 is problematic mostly for the absence of reliable data about total population sizes at the regional level (population censuses were first conducted, for most territories, only in the 19th century). I resort to a dataset of urbanization rates for 20 regions of Germany in the period 1700–1900; for the period before 1700, no sufficient sources for population sizes could be found.[21]

The drawback of the use of urbanization rates as the dependent variable is the impossibility to control for pre-trends in the regions that would later become Protestant. At the same time, urbanization rates can provide a useful check of the patterns detected using city sizes as dependent variable. Table 5 presents results of a regression based on the setup of equation (3). The main explanatory variable is now, instead of a binary indicator of religious affiliation, the share of Protestants among the general population in each of the 20 regions according to the 1900 census.[22] The omitted year, in the set of interaction terms, is 1700, so that the estimated coefficients can be interpreted as the difference in urbanization rates (in percentage points) between a region that is fully Protestant and one that is fully Catholic, relative to 1700.

[Table 5 about here]

The results of Table 5 confirm the findings based on city sizes as the dependent variable. Protestant regions do not feature significant deviations in their evolution of urbanization rates until 1900. The point estimates suggest a difference of at most 5.6 percentage points in favor of Protestant regions; a small effect, relative to a standard deviation of urbanization rates in the dataset of 14.8 percentage points.

4.4 Heterogeneity of effects

While the previous sections have shown that there is no broad impact of Protestantism on city growth over the entire set of cities in the dataset, it could be the case that some cities, sharing a

[20] Urbanization rates are usually defined as the share of people living in cities above 5 000 or 10 000 inhabitants over total population. They have been recently used as indicators of economic development across countries by, among others, Acemoglu et al. (2002), Acemoglu et al. (2005), Nunn and Qian (2011), and Greif and Tabellini (2012).

[21] See appendix A.3 for a description of the dataset.

[22] The 1900 census results are used as they allow for precise matching with the borders of the 20 regions considered. For a subset of regions, the 1900 shares can be compared with the census results of 1820: the correlation coefficient across time is 0.98, which confirms the remarkable persistence of denominational affiliations across Germany.

certain set of characteristics, have benefited from the Protestant faith, whereas cities lacking those characteristics were not able to reap any benefits. This potential heterogeneity of effects across subgroups could plausibly give hints as to which mechanisms are at work.[23]

A general setup suitable for this purpose can be constructed in analogy to to equation (3):

$$\ln(u_{it}) = \chi_i + \zeta_t + \sum_{\tau \in \Gamma} \alpha_\tau \cdot Prot_i \cdot I_\tau + \sum_{\tau \in \Gamma} \beta_\tau \cdot control_i \cdot I_\tau + \sum_{\tau \in \Gamma} \gamma_\tau \cdot control_i \cdot Prot_i \cdot I_\tau + \varepsilon_{it} \qquad (5)$$

While the coefficients β_t capture the baseline, time-varying effect of a certain city characteristic $control_i$ (analogously to equation (4)), the coefficients γ_i relating to the triple interaction report whether Protestantism affects city size when combined with certain city characteristics, and how this effect varies over time. The estimates from regression (5) are unwieldy to present, resulting in 27 estimated coefficients, besides the city and time fixed effects. For this reason, I will discuss the hypotheses in the context of this section by comparing graphically the performance of cities that lie at the upper and lower ends of the distribution of the respective variable $control_i$.[24]

Two potential sources of heterogeneity will be discussed here. First, one can consider the productive structure of cities. If Protestantism is associated with a kind of ethics particularly favorable to commercial enterprise, e.g. by allowing the charging of interest and more sophisticated financial instruments, rather than with a work ethic useful in all kinds of production, we should see a differential effect in those cities with a specific potential for commerce. A proxy for the potential for commerce is the geographic location on a (navigable) river or a seaport. Moreover, Protestant cities located on seaports could have been more rapid in capturing the gains arising from the transatlantic trade (Acemoglu et al., 2005).

In fact, the results of Figure 4 lend no support to this hypothesis. The solid line with a grey shadow refers to the difference in log population between a Protestant and a Catholic city that are both located on a navigable river or on a seaport ($control_i = 1$), the dashed line and dashed confidence interval refers to the difference between a Protestant and a Catholic city located inland and away from rivers ($control_i = 0$). As evident from the picture, cities with rivers or seaports and

[23] It should be noted, however, that any arguable exogeneity of the assignment to Protestantism need not carry through in selected subgroups (Deaton, 2010).

[24] Full regression results can be found in Appendix B.

those without have very similar trajectories.

[Figure 4 about here]

Another form of heterogeneity could arise from the differential presence of the Church before the onset of the Reformation. A commonly held view is that Protestant states enriched themselves through the expropriation of Church holdings; if the confiscated capital is put to better use when in state or private hands, rather than if left to the Church, this would give a growth advantage to those cities that had more Church possessions at the time of the Reformation. A good proxy for the amount of capital that can be seized from the Church is the density of monasteries in a city around 1517 (measured as number of monasteries per 1000 inhabitants); monasteries held both prime pieces of real estate, as well as substantial swathes of agricultural land outside of the city walls.

Again, however, the results in Figure 5 appear to disprove this hypothesis. There, I compare the performance of Protestant cities (relative to Catholic ones) with no monasteries around 1517 (42.6% of cities in the sample had no monasteries) and cities with two monasteries per 1000 inhabitants (75th percentile of the distribution of monasteries per capita). If the ability to seize large amounts of Church capital had been an advantage for Protestant cities, we should see the estimated effects to be larger for cities with a high number of monasteries. In fact, the comparison points again to the absence of differences in the estimated effects of Protestantism.

[Figure 5 about here]

5 Endogenous adoption of the Reformation

To understand the causal nexus between Protestantism and economic growth, we also need to shed light on the circumstances of adoption of the Reformation. For the large majority of the population in the Holy Roman Empire the new religion was imposed from above, enacting the principle of *cuius regio, eius religio*; this is even more true for the generations born after the Peace of Westphalia, whose religion had been determined by some princes' choices decades or centuries

ago. However, in the 16th century rulers could have chosen to follow the new religion out of unobserved reasons that correlate with the potential for economic growth.

Two possible sorts of endogeneity are conceivable here. On the one hand, it could be that cities or territories which were already more inclined to commercial activity saw the growth-promoting potential of the Protestant Reformation and therefore chose to adopt it. For example, Ekelund et al. (2002) argue that Protestantism was more likely to be adopted in emergent, entrepreneurial societies. In that case, cities with a predisposition for economic growth would be those that became Protestant, and OLS estimates would overstate the causal effect of Protestantism. Alternatively, it could be that cities with a higher potential for economic growth around 1500 chose to remain Catholic. The Catholic Church was famed for its rent-extraction practices, but it also guaranteed a legal and cultural framework to be shared with other trading partners; therefore, it could be that cities with more interest in economic activity chose the less risky alternative and remained Catholic.[25]

An instrumental variables strategy may alleviate these concerns about endogeneity. As first suggested by Becker and Woessmann (2009), the distance to Wittenberg—the city where Martin Luther first presented his 95 theses, and where he taught at the local university—can be used as an instrument that predicts the adoption of the Reformation across German territories. Being close to Wittenberg mattered less for the spread of ideas—in fact, thanks to the recent invention of the printing press, Luther's theses were rapidly known all over Germany within months—but rather because of geopolitical considerations (Cantoni, 2012). Introducing the Reformation was a risky venture for a territorial lord, especially in the years until 1555, for the imperial troops under Charles V could have intervened and imposed the return to the old faith. Given this threat, a territory was more likely to embrace the Reformation if its neighbors had already done so; closeness to a powerful Lutheran state, such as Saxony, could have provided easier military defense in case of military conflict. Saxony, the territory around Wittenberg, was an early adopter of Luther's

[25]Weber shared the view that the Catholic Church practiced a form of control over social and economic affairs that was severe in principle, but flexible in practice: *"[. . .] the Reformation meant not the elimination of the Church's control over everyday life, but rather the substitution of a new form of control for the previous one. [. . .] The rule of the Catholic Church, 'punishing the heretic, but indulgent to the sinner,' as it was in the past even more than today, is now tolerated by peoples of thoroughly modern economic character, and was borne by the richest and economically most advanced peoples on earth at about the turn of the fifteenth century."* (Weber 1930, p. 36)

ideas, the first one to reform the Mass, the first one to establish a territorial church, the first one to perform a church visitation already in the 1520s and 30s (Dixon, 2002, p. 122).

In fact, distance to Wittenberg is a robust predictor for the eventual adoption of Protestantism across the cities and territories of the Holy Roman Empire.[26] The simple correlation coefficient is equal to -0.482, indicating a clear negative relationship between distance to Wittenberg and likelihood of adoption of Protestantism. Table 6 shows results from a regression predicting the adoption of the Reformation by 1600 across the 272 cities used in this dataset; this can be seen as conceptually similar to a first-stage in a regression where "Protestantism" is the endogenous variable.[27] The setup is a linear probability model, with a binary dependent variable.

[Table 6 about here]

As evident from all columns, distance to Wittenberg is a strong and robust predictor; a city that is 100km closer to Wittenberg is 14–18% more likely to become Protestant by 1600. The t-statistic on the respective coefficients is always close to or larger than 5, eliminating any concern about weak instruments. Geneva and Zurich, the cities where Calvin and Zwingli lived and taught respectively, do not seem to have exerted a similar spatial influence on the religious decisions of German states (column (2)). This is not surprising, as Lutheranism is the dominant form of Protestantism in Germany. Adding controls for latitude, longitude, or distance to the Atlantic ports and city size in 1300 does not affect the results (columns (3) and (4)). Cantoni (2012) shows that this result holds even after controlling for a large variety of economic and/or institutional covariates.

Is it reasonable to use distance to Wittenberg as an instrumental variable; i.e., are there any other reasons for which distance to Wittenberg might matter for economic growth, except through the promotion of the adoption of Protestantism? Saxony and the region around Wittenberg are unlikely candidates for the role of an economic magnet, exerting a positive (or negative) influence on the growth trajectories of its neighbors. The loss of the electoral privilege in 1547 and

[26] Distance to Wittenberg is computed as great circle distance ("as the crow flies"). Given the absence of major natural obstacles (e.g. large mountainous chains) in Germany's physical geography, this can be taken as a reasonable approximation of actual travel time.

[27] In the setup used to analyze the full panel dataset, the actual first stage will be different due to the presence of city and time fixed effects, and the interaction of "Protestantism" with year dummies. However, the strength and robustness of distance to Wittenberg as predictor of adoption of Protestantism hold as well in the IV setup.

the division into many different lines of succession made Saxony, the territory of Martin Luther, a marginal player in the Empire's economic and political destinies. Moreover, distance from Wittenberg does not correlate with any other geographically distributed factor—such as distance to the commercial centers of Northern Italy or Flanders, distance to Atlantic seaports, or distance to to the iron ore and gold mines of the Bohemian forest—that may, in fact, have an influence on economic potential.[28]

A regression setup taking into account the endogeneity of the decision to adopt the Reformation would be equivalent to equations (1)–(3), but where the interaction terms including $Prot_i$ are instrumented by the respective interaction terms with the instrumental variable instead. For the case of equation (3), this is conceptually equivalent to the following two-stage least squares setup:

$$\ln(u_{it}) = \chi_i + \zeta_t + \sum_{\tau \in \Gamma} \alpha_\tau \cdot \widehat{Prot_i \cdot I_\tau} + \varepsilon_{it} \tag{6}$$

$$Prot_i \cdot I_t = \xi i + \vartheta_t + \sum_{\tau \in \Gamma} \gamma_\tau \cdot (DistanceWittenberg)_i \cdot I_\tau + \eta_{it} \qquad \forall\, t \in \Gamma \tag{7}$$

where ξ_i and ϑ_t are city and time fixed effects respectively.

[Table 7 about here]

Regression results using distance to Wittenberg as an instrument can be seen in Table 7; like Table 4, it is divided in three panels, corresponding to the IV analogues of regression equations (1)–(3). The first column reports the baseline results, whereas the other columns introduce control variables interacted with time dummies. As opposed to the OLS results, now all coefficients of interest in column 1 are positive; however, none of them reaches conventional levels of significance, not even jointly (p-value=0.396). This weakly positive result is further questioned by the results in columns (2)–(3), which show how the estimates are affected by allowing for time-varying effects of city characteristics: latitude, longitude, initial city size and distance to Atlantic ports. Figure 6 gives a visual representation of the IV estimates, both with and without controls; as can be generally expected, the coefficients are estimated less precisely than their OLS counterparts.

[Figure 6 about here]

[28] Becker and Woessmann (2009) discuss the exogeneity of the Wittenberg instrument analyzing the correlation with a variety of plausible economic outcomes of the early 16th century (table 4, p. 561).

Column (4) presents, analogously to Table 4, results including also the cities from outside the German-speaking areas of the Empire. The last column uses aggregate urban sizes at the level of territories as the dependent variable. Again, the results are generally larger than their OLS counterparts, but fail to reach conventional levels of significance. In both cases, one can reject a test of joint significance of all interactions after 1500.

In sum, the findings from instrumental variables regressions in Table 7 shed light on the causality nexus between Protestantism and economic growth. The estimated coefficients for the periods 1600 and onwards are generally larger than their OLS counterparts, suggesting a negative selection in the camp of Protestantism: cities with an intrinsically lower potential for economic growth—those more peripheral relatively to the economic centers of the Empire—chose to adopt the Reformation. However, there seems to be no significantly positive, causal impact of Protestantism on the growth of German cities, even when this negative selection is taken into account.

6 Competing explanations: Fertility, religious interactions, and literacy

6.1 Fertility and religious denomination

One potentially confounding factor in the analysis so far is the behavior of fertility. If, at any given level of real income, Catholics have higher fertility rates than Protestants, inferring local productivity levels from total population size could be misleading. In a Malthusian environment, the increase in population that results from higher productivity levels (stemming, e.g., from a specific "Protestant ethic") can be offset by a lower fertility rate. This is true both for urban fertility rates—if we assume that city growth is mostly attributable urban reproduction rates—and for the fertility rates of the surrounding countryside, if we assume more realistically that most of the observed city growth is due to migration from the neighboring agricultural areas.

While it is known that Protestant areas in Germany went through the fertility transition of the late 19th century earlier than their Catholic counterparts (Galloway et al., 1994; Brown and Guinnane, 2002), there is little evidence on fertility levels across denominations in pre-industrial Germany. In his study of nine villages of the Empire, John Knodel (1978) found no systematic differences in fertility levels and their trends over time across Catholic and Protestant regions.

Evidence for an urban setting in the 17th and 18th centuries is provided by Peter Zschunke (1984), who analyzes the fertility behavior of the population of Oppenheim, a rare tri-denominational city (Catholics, Lutherans and Calvinists). He finds that, in fact, Catholic women are more fertile than Protestant ones. At the same time, though, Catholics had a higher infant mortality, which cannot be simply explained away by differences in income; the latter should have approximately compensated for the difference in fertility.[29] Differences in fertility are hence unlikely to be a major confounding factor when comparing the growth performance of Catholic and Protestant cities.

6.2 Religious interactions and local spillovers

If Protestant cities were indeed endowed with a peculiar worth ethic or other advantages that translated into higher productivity, it is conceivable that other, neighboring cities would have profited from it even while remaining Catholic. The channels through which such a spillover could have occurred are potentially many: trade with Protestant cities, local dissemination of technological or commercial knowledge, spatial spread of practices and values by imitation. In this case, conventional estimates trying to detect a treatment effect of Protestantism would be biased downward because of these local spillovers.

To investigate this hypothesis, I construct a measure of "religious interaction" representing, for each city, the percentage of cities lying within a range of 100km that belong to the opposite religious denomination. This measure varies between 0% (for 65 out of 272 cities) and 100% (only one city: Erfurt). Using the setup of equation 5, one can estimate the differential impact of Protestantism on city size depending on the intensity of religious interactions.[30]

Figure 7, analogously to the figures in section 4.4, displays the treatment effects of Protestantism for two different types of cities: cities that lie in an area with few religious interactions (0% of nearby cities having a different religion) and cities in mixed areas, defined as having half of the neighboring cities with a different religion. If spillover effects were present, we would expect the growth performances of Catholic and Protestant cities in mixed areas to be very similar

[29] Higher fertility among Catholic women was due to both shorter birth intervals and later stopping; the theoretical number of children per woman (neglecting mortality) was 11 for Catholics, 9 for Protestants. Survival at age 10 was 5–6 out of 10 newborn babies for Protestants, 4 out of 10 for Catholics (Zschunke, 1984, pp. 165, 200). Similar conclusions are drawn in Mols (1956, p. 219), who compares Protestants and Catholics in Metz, and in Heller-Karneth (2000).

[30] Full regression results are reported in Appendix B.

(leading to estimated treatment effects close to zero), and the relative performance of cities in religiously homogenous areas to be different. However, the results in the graph show how similar the estimated treatment effects for Protestant cities in either surrounding are, suggesting that local spillovers are not a likely explanation for the absence of effects.

[Figure 7 about here]

6.3 Protestantism and literacy

In an influential paper, Becker and Woessmann (2009) find a positive correlation between Protestantism and economic outcomes across Prussian counties in 1871. They argue that this finding can be explained fully by differences in literacy: Protestants, as a consequence of Martin Luther's exhortation to read the Bible on one's own, were on average more literate than Catholics. What explains the difference between the present paper and the findings of Becker and Woessmann?

At a first level, the research questions examined differ slightly. The present paper examines the long-run performance of cities, including the analysis of potential pre-trends in the period before the introduction of the Reformation; the paper by Becker and Woessmann is a single cross-section of outcomes in 1871. Whereas the analysis in this paper considers all major cities in the Holy Roman Empire, Becker and Woessmann study counties, urban and rural, in Prussia.[31] Yet, if one accepts the premise that city growth is an indicator of economic development, the divergence of results is surprising.

The most likely candidate for an explanation is the different setting. Most of the observations in the dataset of Becker and Woessmann refer to rural, and not urban counties. The relationships found there are much weaker or not present for the subsample of urban counties (cf. Becker and Woessmann, 2009, fns. 25, 41, 42, 44); in fact, the authors' preferred outcome variable, income tax returns, is not available for the 26 largest cities in Prussia.

My findings thus suggest that in an urban setting in the pre-industrial age—the setting where we are most likely to expect religious choice to exert impulses on the commercial and entrepreneurial spirit—Protestantism has no power to explain differentials in economic growth. Cities, with their

[31] Note, however, that the results in this paper hold also when limiting the analysis to cities in 1871 Prussia (cf. Table A.i, column 8).

varied population of artisans, traders, scholars and merchants, might have been just as cosmopolitan and open to new business practices in either a Catholic or a Protestant setting. Moreover, if literacy was, even before the industrial revolution, the key ingredient for economic growth, evidence available for the period before 1800 suggests that in an urban setting literacy rates were relatively high by international standards even in Catholic cities (François, 1977).[32]

In contrast, the findings of Becker and Woessmann can be seen as a test of the importance of Protestantism—and of literacy as the channel through which Protestantism works—in the context of the second industrial revolution. Differences in literacy matter in explaining the take-up of manufacturing and industrial technologies in the second half of the 19th century, in particular outside of the established urban centers (this is consistent with the arguments put forward by Sandberg, 1979 and Becker et al., 2011).

7 Conclusion

Max Weber, in his seminal work, proposed what might be the most famous theory about the impact of cultural factors, namely beliefs about religion and afterlife, on economic growth. Despite its renown, this theory has rarely been tested quantitatively with historical data. The evidence presented in this paper, based on urban growth data of 272 cities of the Holy Roman Empire, points consistently towards the absence of any differences in the long-run performance of Protestant and Catholic regions. This absence of differences cannot be explained by endogenous selection into Protestantism, and is unlikely to arise because of, for example, imitation of best practices and spread of values from Protestant to Catholic territories.

In light of the various theories that suggest that Protestants should be more inclined to economic activity, this result is surprising. One explanation could be that many arguments about Protestant advantage, in particular Max Weber's, are in fact based on an analysis of the doctrines of Calvinism or of minor Protestant sects, such as the Puritans, and not on the teachings

[32] In fact, this result could be a success of the Counter-Reformation movement, which through the institution of the Jesuits and other orders placed importance on the education of the youth and the pursuit of knowledge. The British historian John Bossy summed this up: *"[. . .] the bishops of the Tridentine Church have more positive achievements to their credit than they are often allowed: from the parish register to the primary school they were laying many of the foundations of the modern state, and perhaps they have as good a claim as English Puritanism to have 'eradicate[d] habits which unfitted men for an industrial society' "* (Bossy, 1970, p. 70).

of Lutheranism, the largest denomination in Germany. The analysis in this paper finds no substantial differences, either, in the economic performance of the Calvinist territories of the Holy Roman Empire as opposed to the Catholic/Lutheran ones. Still, one cannot exclude that other, minor religious groups had an ideology that was conducive to economic growth. Testing this latter hypothesis, however, is intrinsically more difficult, as sect membership is likely endogenous (more than the forced imposition of denominations at the hand of a territorial lord), and because it is hard to disentangle the impact of religious beliefs from the status of belonging to a minority.

An alternative theory, namely that Protestantism (in particular, Lutheranism) encouraged literacy and thus economic development, does well in predicting the dissemination of the second industrial revolution in late 19-century Prussia (Becker and Woessmann, 2009), but may not have equal explanatory power for urban growth in the pre-industrial era.

While there are many reasons to expect Protestant cities and states to have been more economically dynamic during the past centuries—because of their work ethic, their attitude toward business, or their encouragement of literacy—the present paper finds that, despite their differing views on religious matters, Protestants and Catholics might not have been so different in their economic performance after all.

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A Appendix: Data description

A.1 Krug and Mützell data (Table 2)

Variable	Description
Business tax p.c.	Tax revenue from business enterprises (*Gewerbesteuer*) per inhabitant, 1821 (in *Thaler*)
Fire insurance p.c.	Total value of buildings insured by the local fire insurance company (*Feuersozietät*) per inhabitant, 1821 (in *Thaler*)
% Houses with stonework	Buildings with masonry outer walls (as opposed to half-timbered or timber) as percentage of total buildings, 1816
% Houses with shingled roofs	Buildings with shingled (metal, stone or clay shingles) roofs (as opposed to wooden shingles or thatchered) as percentage of total buildings, 1816
Looms p.c.	Number of looms in 1819 per inhabitant (population figures: 1816)
Merchants p.c.	Number of merchants (*mit kaufmännischen Rechten*), grocers, and peddlers in 1819 per inhabitant (population figures: 1816)
Teacher-to-student ratio	Number of teachers per student in private and public elementary schools, 1816

Source (for all variables): Krug and Mützell (1825)

A.2 City sizes panel dataset (Tables 3, 4, 6, 7)

Variable	Description and source
City size	Population of a city. Missing values are not imputed, unless otherwise noted. Source: Bairoch et al. (1988) for the years until 1850. Official statistics (German Empire: *Statistik des Deutschen Reiches*, various vols.; Austria-Hungary: *Statistisches Jahrbuch, herausgegeben von der K. K. Statistischen Central-Commission*, various vols.) for the years after 1850.
City size in 1300	Population of a city. Source: Bairoch et al. (1988). Note: this variable is used as a control variable in several regressions. In this case, if there is no population figure available for 1300, city size is assumed to equal 500.
Distance to Atlantic ports	Minimum great circle distance of a city to the Atlantic seaports of either Hamburg or Bremen, measured in 100's of km. Source: own calculations.
Distance to Geneva	Great circle distance of a city to Geneva, measured in 100's of km. Source: own calculations.
Distance to Wittenberg	Great circle distance of a city to Wittenberg, measured in 100's of km. Source: own calculations.
Distance to Zurich	Great circle distance of a city to Zurich, measured in 100's of km. Source: own calculations.
Latitude	Latitude of the city in degrees. Source: Wikipedia.
Longitude	Longitude of the city in degrees. Source: Wikipedia.

Continued on next page

Variable	Description and source
Number of monasteries p.c.	Number of monasteries (not belonging to mendicant orders) in existence around 1517 within 5km from the city center (great circle distance), divided by total population in 1500 (in 1000's). If there is no population figure available for 1500, city size is assumed to equal 500. Source: Jürgensmeier and Schwerdtfeger, eds (2005-2008).
Protestant	Binary, 1 if Protestantism is the only or dominant religious denomination in a territory, as resulting from the normal year 1624. Sources: Schindling and Ziegler, eds (1993) and Keyser (1939-1974). For years prior to 1600, "Protestantism" is coded as 1 in city *i* if *i* was Protestant in 1600.
Religious interaction	Share of cities located within 100km (great circle distance) that have the opposite religious denomination (Catholic if Protestant, and vice versa), as resulting from the normal year 1624. Source: own calculations.
River/Port	Location on a navigable river or sea port. Source: Kunz, ed (1999).
Trend	Linear time trend, starting in 1517. Measured in centuries.
Urban population in a territory	Total population of all cities listed in Bairoch et al. (1988) belonging to a given territory; definition of a "territory" is discussed on page 16, footnote 17 and is time-invariant. Missing values are not imputed.

A.3 Urbanization rates panel dataset (Table 5)

This dataset is largely based on the data used in Acemoglu et al. (2011); details on the construction of the data can be found in the online appendix to the cited paper. The 20 regions considered in this dataset are: Baden, the Bavarian Palatinate, Brandenburg, Brunswick, Bavaria ("Altbayern"), Hessen-Darmstadt (incl. Nassau), Hessen-Kassel, Hanover (incl. Bremen), Mecklenburg-Schwerin, Minden, Mark, Oldenburg, Pomerania, Rhineland, Saxony (Kingdom), Saxony (Province), Silesia, Schleswig-Holstein (incl. Lübeck), Westphalia (excl. Mark and Minden), Württemberg.

Variable	Description and source
Share Protestant	Share of Protestants over total population. Source: German population census, 1900 (Statistik des Deutschen Reichs. Neue Folge, Band 150: "Die Volkszählung am 1. Dezember 1900")
Urbanization rate	Share of population living in cities above 5000 inhabitants. Source: City sizes are from Bairoch et al. (1988). Total population of regions is based on own estimates from a variety of sources; refer to Acemoglu et al. (2011), online appendix.

B Figures and Tables

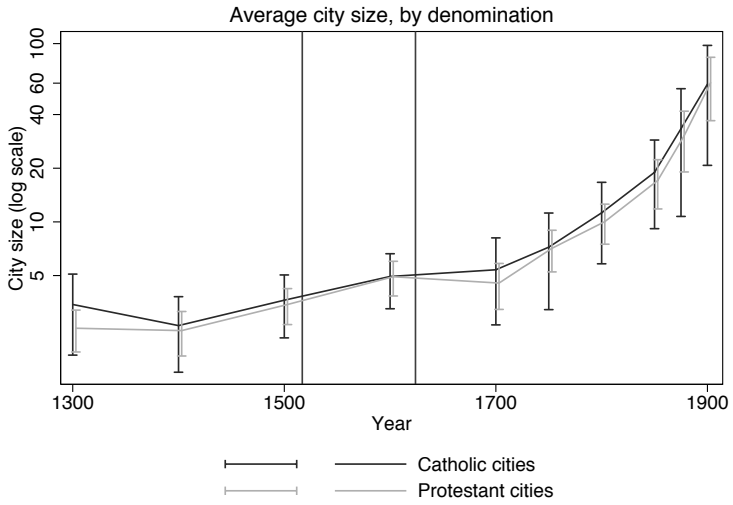

Figure 1: Average population of cities, by denomination. *Population figures in thousands. Vertical bars indicate the onset of the Reformation (1517) and the "normal year" set by the Peace of Westphalia (1624). Capped spikes denote 95% confidence intervals around the sample average. Population is assumed to be equal to 500 inhabitants if the actual value is missing in Bairoch et al. (1988).*

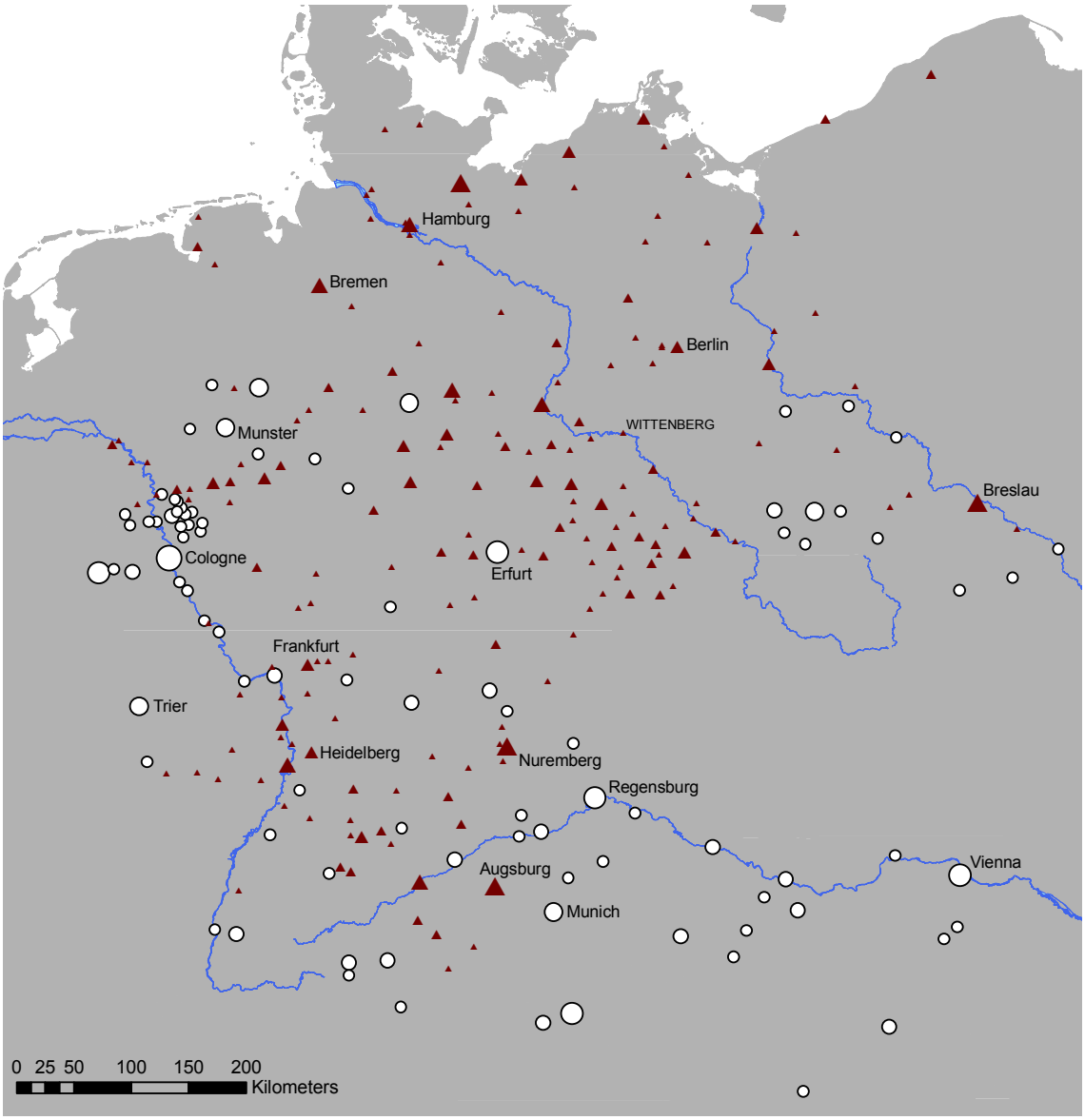

Figure 2: Cities in the dataset. *Circles correspond to Catholic cities, triangles to Protestant cities (symbol size proportional to population in 1500). Selected cities labeled.*

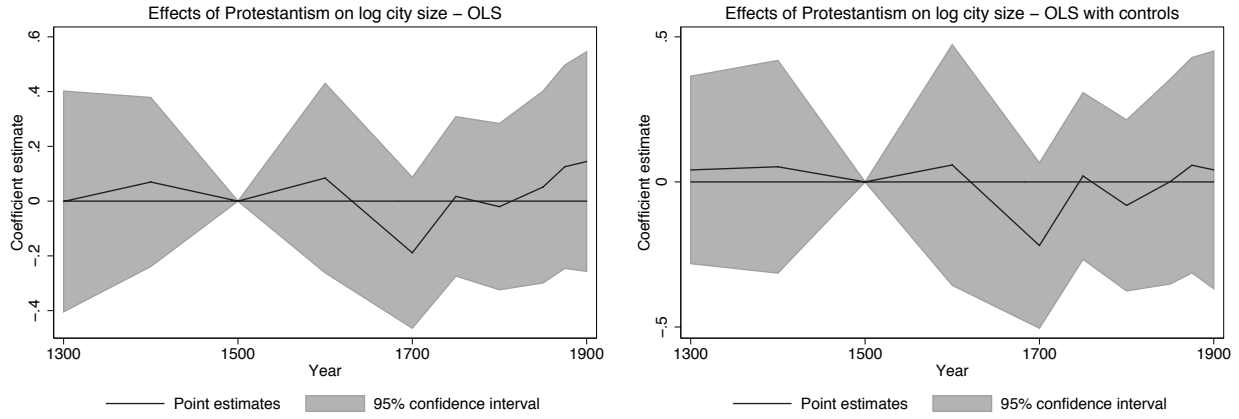

Figure 3: Estimated coefficients and 95% confidence intervals. *Results from the baseline OLS estimates in Table 4, columns (1) and (3), panel C.*

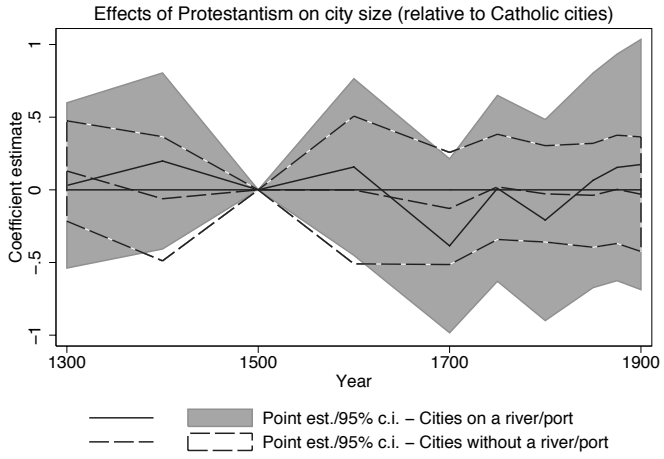

Figure 4: Heterogeneity of estimated effects and 95% confidence intervals: Rivers and ports. *Results from the OLS estimates of section 4.4, equation (5).*

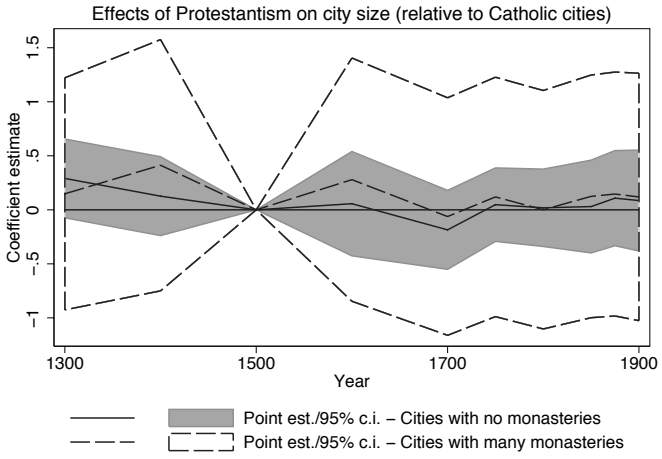

Figure 5: Heterogeneity of estimated effects and 95% confidence intervals: Presence of monasteries. *Results from the OLS estimates of section 4.4, equation (5).*

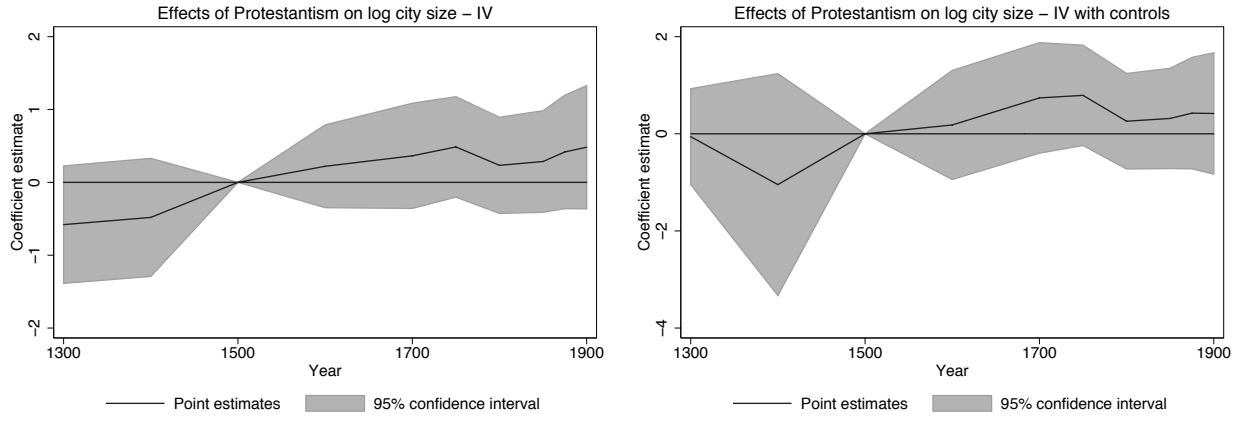

Figure 6: Estimated coefficients and 95% confidence intervals. *Results from the baseline IV estimates in Table 7, columns (1) and (3), panel C.*

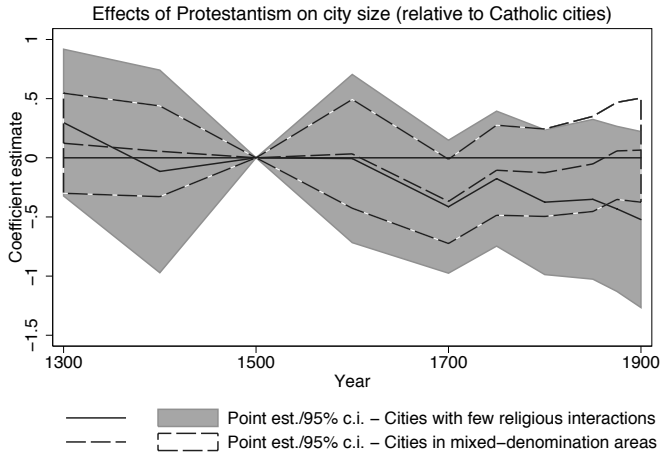

Figure 7: Heterogeneity of estimated effects and 95% confidence intervals: Religious interactions. *Results from the OLS estimates of equation (5), section 6.2.*

Table 1: Homogeneity of religious affiliation after 1624

Territory	Population (1849)	Religion (after 1624)	% Prot. (1849)	% Cath. (1849)
Prince-Bishopric of Münster	329 081	Cat	4.3	94.9
Duchy of Westphalia	191 425	Cat	8.7	90.0
Prince-Bishoprics of Paderborn and Corvey Abbey	160 404	Cat	4.7	92.9
Vest Recklinghausen	46 940	Cat	1.3	98.2
County of Mark	305 182	Pro	78.1	21.0
Principality of Minden and County of Ravensberg	260 096	Pro	97.2	2.1
Principality of Siegen	44 885	Pro	82.3	17.5
Counties of Wittgenstein-Berleburg and W.-Hohenstein	21 463	Pro	94.1	3.9
Free Imperial city of Dortmund	10 515	Pro	71.1	27.1
Lippstadt	4 845	Pro	40.5	58.0
Counties of Tecklenburg and Lingen	42 123	Pro / Cat	55.8	43.6

Source: Reekers (1964).

Table 2: City size and economic outcomes, Prussia 1821

Dependent Variable	Teacher-to-student ratio	Fire Insurance p.c.	Business Tax p.c.	Looms p.c.	Merchants p.c.	% Houses with stonework	% Houses with shingled roofs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: All cities in the Prussian manufacturing census of 1816–1821							
ln(City size)	0.380***	19.226***	0.153***	-0.041	0.078	0.093***	0.082***
	[0.127]	[2.413]	[0.023]	[0.259]	[0.054]	[0.027]	[0.027]
	0.211	*0.260*	*0.619*	*-0.013*	*0.060*	*0.220*	*0.176*
Observations	157	999	66	168	941	162	162
R-squared	0.044	0.068	0.383	0.000	0.004	0.048	0.031
Panel B: Only cities present in the Prussian manufacturing census of 1816–1821 and in the Bairoch et al. (1988) city size dataset							
ln(City size)	0.341**	22.289**	0.117***	0.096	0.147	0.082**	0.022
	[0.150]	[9.641]	[0.032]	[0.348]	[0.116]	[0.035]	[0.030]
	0.226	*0.271*	*0.509*	*0.026*	*0.115*	*0.181*	*0.062*
Observations	83	100	29	90	98	87	87
R-squared	0.051	0.073	0.259	0.001	0.013	0.033	0.004

*: Significant at 10%; **: 5%; ***: 1%. Robust standard errors in brackets. Standardized beta coefficient in italics. A constant term is included in all regressions. Source: Krug and Mützell (1825). Variable definitions: see Appendix A.1.

Table 3: Summary statistics

	N. Obs.	Mean	Std.dev.	Catholic cities	Protestant cities	Difference
City size in 1300	80	8400	8577	11167	7214	3952
City size in 1500	126	6984	7183	8529	6413	2116
City size in 1800	268	10584	20868	11244	10250	995
City size in 1900	271	60216	169798	59227	60708	-1482
Latitude	272	50.82	1.69	49.94	51.22	-1.28***
Longitude	272	10.64	2.77	10.40	10.76	-0.36
Distance to Atlantic ports	272	335.9	166.5	422.1	295.4	126.7***
Distance to Wittenberg	272	285.0	147.9	383.9	238.5	145.4***
Distance to Geneva	272	458.2	185.5	409.0	481.4	-72.4***
Distance to Zurich	272	641.5	191.2	582.6	669.1	-86.5***
River/Port	272	0.360	0.481	0.310	0.384	-0.073
Number of monasteries p.c.	272	1.134	1.859	1.562	0.932	0.630**
Religious interaction	272	0.272	0.255	0.411	0.206	0.205***

*: Difference significant at 10%; **: 5%; ***: 1%. P-values based on t-tests of differences in means, allowing for unequal variances. Variable definitions: see Appendix A.2. Distances measured in km.

Table 4: OLS estimation

Dependent Variable	ln(City size)					ln(Urban pop. in a territory)
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Differences-in-Differences						
Protestant × Post1517	0.022	-0.042	-0.035	0.002	0.094	-0.077
	[0.152]	[0.153]	[0.146]	[0.148]	[0.261]	[0.225]
Panel B: Structured setup						
Protestant × Post1517	-0.127	-0.112	-0.107	-0.106	0.074	-0.182
	[0.184]	[0.173]	[0.222]	[0.225]	[0.389]	[0.175]
Protestant × Post1517 × Trend	0.054	0.025	0.026	0.039	0.007	0.038
	[0.078]	[0.088]	[0.099]	[0.100]	[0.091]	[0.073]
p-value for joint significance Protestant	0.761	0.769	0.860	0.895	0.928	0.568
Panel C: Fully flexible setup						
Protestant × Year 1300	-0.001	-0.015	0.041	-0.015	-0.052	-0.015
	[0.206]	[0.185]	[0.165]	[0.168]	[0.501]	[0.238]
Protestant × Year 1400	0.070	0.009	0.052	0.035	0.144	0.091
	[0.158]	[0.172]	[0.187]	[0.186]	[0.231]	[0.172]
Protestant × Year 1600	0.084	0.003	0.058	0.065	0.131	-0.030
	[0.177]	[0.175]	[0.212]	[0.212]	[0.257]	[0.152]
Protestant × Year 1700	-0.189	-0.237*	-0.219	-0.256*	-0.002	-0.288
	[0.141]	[0.128]	[0.145]	[0.150]	[0.279]	[0.174]
Protestant × Year 1750	0.017	0.014	0.021	0.035	0.227	0.013
	[0.149]	[0.132]	[0.147]	[0.146]	[0.264]	[0.200]
Protestant × Year 1800	-0.020	-0.110	-0.081	-0.044	0.140	-0.114
	[0.155]	[0.148]	[0.150]	[0.153]	[0.249]	[0.210]
Protestant × Year 1850	0.052	-0.039	0.001	0.025	0.096	-0.035
	[0.179]	[0.185]	[0.180]	[0.180]	[0.226]	[0.221]
Protestant × Year 1875	0.126	0.008	0.058	0.079	0.100	-0.034
	[0.190]	[0.188]	[0.189]	[0.188]	[0.227]	[0.231]
Protestant × Year 1900	0.144	0.011	0.042	0.072	0.174	0.040
	[0.205]	[0.201]	[0.209]	[0.207]	[0.234]	[0.243]
p-value for joint significance Protestant	0.017	0.045	0.013	0.008	0.121	0.059
p-value for joint significance Latitude		0.010				
p-value for joint significance Longitude		0.002				
p-value for joint significance Dist. to Atlantic			0.029	0.002	0.086	0.245
p-value for joint significance City size in 1300			0.000	0.000	0.000	0.012
Controls Latitude	N	Y	N	N	N	N
Controls Longitude	N	Y	N	N	N	N
Controls Distance to Atlantic ports	N	N	Y	Y	Y	Y
Controls City size in 1300	N	N	Y	Y	Y	Y
Sample including all cities of the HRE	N	N	N	Y	N	N
Only Reformed (Calvinist) defined as Protestant	N	N	N	N	Y	N
Observations	1876	1876	1876	1990	1876	986
Number of cities/territories	272	272	272	297	272	128

*: Significant at 10%; **: 5%; ***: 1%. All regressions contain a full set of city and year fixed effects. Control variables are entered as a full set of control × year dummy interactions in all three panels. P-values refer to a joint test significance of all coefficients relating to the post-Reformation period (interactions of respective variable with year dummies, 1600 and onwards) and are reported only for the setup of Panel C. Robust standard errors, clustered by territory, in brackets.

Table 5: Urbanization rates

Dependent Variable	Urbanization rate (%)
	(1)
Share Protestant × Year 1750	3.687
	[4.081]
Share Protestant × Year 1800	2.300
	[4.475]
Share Protestant × Year 1850	5.634
	[3.924]
Share Protestant × Year 1875	3.791
	[6.209]
Share Protestant × Year 1900	-1.645
	[9.244]
Observations	115
R-squared	0.852
Number of regions	20
p-value for joint significance Protestant	0.361

*: Significant at 10%; **: 5%; ***: 1%. Regression contains a full set of territory and year fixed effects. P-value refers to a joint test significance of all the interaction terms with "Share Protestant". Robust standard errors, clustered by territory, in brackets.

Table 6: Determinants of adoption of Protestantism

Dependent Variable	City Protestant in 1600			
	(1)	(2)	(3)	(4)
Distance to Wittenberg	-0.158***	-0.179***	-0.183***	-0.140***
	[0.029]	[0.036]	[0.032]	[0.037]
Distance to Geneva		0.058		
		[0.170]		
Distance to Zurich		-0.100		
		[0.162]		
Latitude			0.007	
			[0.032]	
Longitude			-0.031	
			[0.024]	
ln(City size in 1300)				-0.047
				[0.034]
Distance to Atlantic ports				-0.001
				[0.024]
Constant	1.068***	1.216***	1.121	1.174***
	[0.078]	[0.452]	[1.700]	[0.081]
Observations	272	272	272	272
R-squared	0.230	0.254	0.256	0.253

*: Significant at 10%; **: 5%; ***: 1%. Linear probability model (OLS estimation). Robust standard errors, clustered by territory, in brackets.

Table 7: Instrumental variables estimates

Dependent Variable	ln(City size)				ln(Urban pop. in a territory)
	(1)	(2)	(3)	(4)	(5)
Panel A: Differences-in-Differences					
Protestant × Post1517	0.621*	0.075	0.636	0.611	1.009
	[0.361]	[0.408]	[0.520]	[0.567]	[0.792]
Panel B: Structured setup					
Protestant × Post1517	0.468	-0.110	0.642	0.681	0.970
	[0.372]	[0.388]	[0.528]	[0.573]	[0.862]
Protestant × Post1517 × trend	0.054	0.065	-0.002	-0.024	0.014
	[0.145]	[0.150]	[0.240]	[0.256]	[0.313]
p-value for joint significance Protestant	0.182	0.908	0.273	0.337	0.368
Panel C: Fully flexible setup					
Protestant × Year 1300	-0.580	-0.335	-0.059	-0.067	-1.133
	[0.411]	[0.532]	[0.504]	[0.587]	[0.746]
Protestant × Year 1400	-0.481	-0.614	-1.046	-1.038	-1.228
	[0.414]	[0.491]	[1.166]	[1.245]	[0.981]
Protestant × Year 1600	0.221	-0.461	0.182	0.176	-0.109
	[0.290]	[0.446]	[0.573]	[0.583]	[0.696]
Protestant × Year 1700	0.364	-0.224	0.739	0.902	0.497
	[0.369]	[0.484]	[0.580]	[0.702]	[0.704]
Protestant × Year 1750	0.486	0.213	0.791	0.772	0.871
	[0.352]	[0.470]	[0.527]	[0.543]	[0.691]
Protestant × Year 1800	0.234	-0.253	0.259	0.138	0.328
	[0.337]	[0.490]	[0.502]	[0.527]	[0.743]
Protestant × Year 1850	0.286	-0.213	0.316	0.276	0.358
	[0.356]	[0.479]	[0.527]	[0.548]	[0.765]
Protestant × Year 1875	0.418	-0.195	0.426	0.390	0.219
	[0.397]	[0.518]	[0.586]	[0.616]	[0.833]
Protestant × Year 1900	0.482	-0.035	0.419	0.378	0.340
	[0.432]	[0.568]	[0.637]	[0.676]	[0.908]
p-value for joint significance Protestant	0.396	0.010	0.614	0.593	0.250
p-value for joint significance Latitude		0.001			
p-value for joint significance Longitude		0.002			
p-value for joint significance Dist. to Atlantic			0.184	0.165	0.156
p-value for joint significance City size in 1300			0.000	0.000	0.016
Instrument	Distance to Wittenberg				
Sample including all cities of the HRE	N	N	N	Y	N
Controls Latitude	N	Y	N	N	N
Controls Longitude	N	Y	N	N	N
Controls Dist. to Atlantic	N	N	Y	Y	Y
Controls City size in 1300	N	N	Y	Y	Y
Observations	1876	1876	1876	1990	986
Number of cities/territories	272	272	272	297	128

*: Significant at 10%; **: 5%; ***: 1%. All regressions contain a full set of city and year fixed effects. Control variables are entered as a full set of control × year dummy interactions in all three panels. P-values refer to a joint test significance of all coefficients relating to the post-Reformation period (interactions of respective variable with year dummies, 1600 and onwards) and are reported only for the setup of Panel C. Robust standard errors, clustered by territory, in brackets.

Supplementary appendix: Additional results (TO BE POSTED ONLINE)

Supplementary appendix 1 Results in subsamples (section 4.3)

As described in section 4.3, I apply the regression setup described in equation (4) to a series of subsets of my data. First, it is questionable to what extent city size can be used as an indicator of economic progress when free movement of labor from the countryside is hampered. In the territories east of the Elbe stronger forms of serfdom persisted until the early 19th century. Given that almost all cities east of the Elbe are Protestant, this may explain why their economic performance as reflected in city growth was not too strong. However, column (1) in Table A.i, which reports results from a regression corresponding to the setup in equation (4), seems to disprove this conjecture. Even considering only cities west of the Elbe, the basic pattern is unaffected.

The substantial disruptions of the 17th century motivate another robustness check: controlling explicitly for the handicap caused by the Thirty Years' War (1618–1648) in Protestant parts of the Empire. For those cities that have reported population sizes for both 1600 and 1700 (this reduces the number of cities in the sample to 114), I interact the log-difference in population sizes from 1600 to 1700 with all time dummies relating to the years 1750 onward. This controls in a flexible fashion for the catchup process necessary in those cities that have experienced the largest levels of destruction during the Thirty Years' War. In addition, I include a set of triple interactions of "destruction during the 17th century," "Protestantism," and year dummies. These interactions test the hypothesis that Protestant cities were faster/slower in recovering from their destructions. In fact, while the estimates of the main coefficients on the Protestantism/year interactions are now generally larger (see column (2)), especially in the 19th century, they still fail to reach conventional levels of significance.

The panel dataset with city sizes is unbalanced, with only a small part of the cities having population sizes reported for all years. In column (3) I report results from a regression on the balanced dataset of cities for which population sizes are reported in all years.[33] The results are now more clearly negative for Protestant cities, relative to the baseline regressions. In almost all years after the Reformation the coefficients are negative.

Additionally, column (4) checks whether the selection of cities into the dataset drives the results. Bairoch et al. (1988) include all cities that reach the threshold of 5000 inhabitants at any time before 1800. Therefore, presence in the dataset is already conditional on successful city growth. Instead, one could limit the regression to those cities that were already successful by 1500, as measured by the fact that they have a population size reported for that year in Bairoch et al. (1988). This leaves 126 cities in the dataset, and hence excludes all localities that were very small or did not exist in 1500. Reassuringly, the results are not very different from the baseline estimates.

The 38 Free Imperial cities in the dataset enjoyed a radically different institutional setup than the territorial states of the Empire. In those cities, the decision whether to become Protestant was taken by a city council representing the urban elites, and not imposed by princely fiat. Furthermore, these cities (which were by a large majority Protestant) are often considered a relic of the medieval structure of the Empire, structurally unable to compete with the dominant polity of the early modern era, the territorial state. The results in column (5), which exclude Free Imperial cities from the sample, suggest that their growth performance in the years after the Reformation was in-

[33] Due to the Black Death which hit Europe in the 14th century, most cities have missing data for the year 1400; I therefore exclude the year 1400 from the balanced sub-dataset. Imposing the condition that the panel be balanced for all years, including 1400, would have further reduced the number of cities from 45 to 26.

deed below average. The estimated coefficients are now larger and mainly positive, but again not significant.

To increase their size, cities relied mostly on migration from the surrounding countryside; the institutional structure of land tenure could therefore be a determining factor of city growth. In early modern Germany, regions with partible inheritance existed alongside areas with impartible inheritance. Based on Huppertz (1939, map I), I determine the prevailing inheritance rule in the region surrounding each city in the dataset; in general, the Rhineland, Baden, Württemberg, and parts of Hesse and Thuringia had partible inheritance rules, whereas the north, the east, and the southeast of the Empire had impartible inheritance rules. Columns (6) and (7) report results from regressions in the subsets of cities with impartible and partible inheritance rules separately. In fact, it appears that inheritance rules do not affect the main results substantially, as the estimates are similar in both cases, and comparable to the baseline case of Table 4.

Finally, column (8) looks only at the subset of cities that were part of Prussia in 1871, after the unification of Germany; this is the region considered in the analysis of Becker and Woessmann (2009). While the Electorate of Brandenburg-Prussia was originally Lutheran, it acquired several Catholic regions over the course of the centuries, in particular after the Congress of Vienna (1815). Here, again, there appears to be no strong effect of Protestantism on city size.

Table A.i: OLS estimation, subsamples

Dependent Variable	ln(City size)							
	(1) West of the Elbe	(2) 30 Years' War	(3) Balanced Sample	(4) Sample Selection	(5) Without Free cities	(6) Impartible Inheritance	(7) Partible Inheritance	(8) Prussia only (as of 1871)
Protestant × Year 1300	0.086	-0.137	-0.276	0.043	-0.012	0.094	0.094	-0.046
	[0.198]	[0.173]	[0.168]	[0.163]	[0.169]	[0.185]	[0.290]	[0.170]
Protestant × Year 1400	0.070	-0.053		0.101	-0.001	0.216	-0.441	0.240
	[0.211]	[0.212]		[0.180]	[0.250]	[0.198]	[0.506]	[0.204]
Protestant × Year 1600	0.143	-0.052	-0.066	0.041	0.144	0.210	-0.398*	0.334
	[0.213]	[0.142]	[0.148]	[0.130]	[0.245]	[0.272]	[0.218]	[0.274]
Protestant × Year 1700	-0.252	-0.103	-0.318	-0.173	-0.030	-0.016	-0.689**	0.186
	[0.156]	[0.118]	[0.268]	[0.155]	[0.147]	[0.143]	[0.327]	[0.191]
Protestant × Year 1750	0.047	0.133	-0.188	0.026	0.237	0.191	-0.295	0.311*
	[0.164]	[0.145]	[0.219]	[0.152]	[0.156]	[0.168]	[0.311]	[0.185]
Protestant × Year 1800	-0.112	0.034	-0.243	-0.070	0.127	0.073	-0.460	0.076
	[0.160]	[0.170]	[0.233]	[0.156]	[0.169]	[0.190]	[0.287]	[0.222]
Protestant × Year 1850	-0.030	0.171	-0.163	-0.034	0.256	0.095	-0.237	0.157
	[0.198]	[0.202]	[0.291]	[0.184]	[0.216]	[0.241]	[0.266]	[0.266]
Protestant × Year 1875	0.033	0.303	-0.064	-0.020	0.339	0.141	-0.155	0.205
	[0.210]	[0.251]	[0.305]	[0.201]	[0.228]	[0.248]	[0.261]	[0.274]
Protestant × Year 1900	0.029	0.343	-0.064	-0.044	0.330	0.069	-0.030	0.108
	[0.236]	[0.297]	[0.342]	[0.221]	[0.253]	[0.278]	[0.278]	[0.315]
p-value for joint significance Protestant	0.000	0.010	0.419	0.568	0.018	0.007	0.008	0.032
p-value for joint significance Dist. to Atlantic	0.015	0.613	0.213	0.049	0.053	0.001	0.595	0.022
p-value for joint significance City size in 1300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
p-value for joint significance 30-Yrs-War's effects		0.000						
p-value for joint significance 30-Yrs-War's effects, interacted with Protestantism		0.006						
Controls Distance to Atlantic ports	Y	Y	Y	Y	Y	Y	Y	Y
Controls City size in 1300	Y	Y	Y	Y	Y	Y	Y	Y
Observations	1527	965	405	1040	1579	1436	440	879
Number of cities	221	114	45	126	234	207	65	131

*: Significant at 10%; **: 5%; ***: 1%. All regressions contain a full set of city and year fixed effects. Control variables are entered as a full set of control × year dummy interactions. P-values refer to a joint test significance of all coefficients relating to the post-Reformation period (interactions of respective variable with year dummies, 1600 and onwards). Robust standard errors, clustered by territory, in brackets. The regression in column (3) omits observations relative to the year 1400 due to reduced data availability (cf. footnote 33).

Supplementary appendix 2 Full results of regressions in sections 4.4 and 6.2

Table A.ii: Interactions of Protestantism and city characteristics

Dependent Variable	ln(City size)		
Control Variable	River or Port	Monasteries (p.c.)	Religious Interaction
Corresponding to	Figure 4	Figure 5	Figure 7
	(1)	(2)	(3)
Protestant · Year 1300	0.130	0.291	0.297
	[0.176]	[0.186]	[0.316]
Protestant · Year 1400	-0.061	0.126	-0.115
	[0.218]	[0.186]	[0.437]
Protestant · Year 1600	-0.001	0.057	-0.006
	[0.259]	[0.246]	[0.363]
Protestant · Year 1700	-0.128	-0.185	-0.414
	[0.197]	[0.186]	[0.287]
Protestant · Year 1750	0.020	0.048	-0.176
	[0.185]	[0.174]	[0.291]
Protestant · Year 1800	-0.028	0.019	-0.375
	[0.169]	[0.183]	[0.312]
Protestant · Year 1850	-0.038	0.030	-0.351
	[0.182]	[0.219]	[0.344]
Protestant · Year 1875	0.003	0.108	-0.432
	[0.190]	[0.225]	[0.356]
Protestant · Year 1900	-0.030	0.086	-0.522
	[0.201]	[0.238]	[0.380]
Control · Year 1300	-0.016	0.371**	0.515
	[0.251]	[0.143]	[0.460]
Control · Year 1400	-0.234	0.264*	-0.219
	[0.312]	[0.156]	[0.634]
Control · Year 1600	0.155	0.178	-0.114
	[0.325]	[0.154]	[0.494]
Control · Year 1700	0.610*	0.167	-0.691
	[0.338]	[0.165]	[0.442]
Control · Year 1750	0.325	0.155	-0.596
	[0.347]	[0.156]	[0.495]
Control · Year 1800	0.586	0.193	-0.640
	[0.357]	[0.159]	[0.566]
Control · Year 1850	0.418	0.167	-0.791
	[0.352]	[0.158]	[0.589]
Control · Year 1875	0.395	0.164	-0.997*
	[0.370]	[0.156]	[0.589]
Control · Year 1900	0.404	0.154	-1.123*
	[0.393]	[0.156]	[0.598]
Protestant · Control · Year 1300	-0.099	-0.071	-0.349
	[0.324]	[0.305]	[0.656]
Protestant · Control · Year 1400	0.260	0.143	0.341
	[0.371]	[0.323]	[0.902]
Protestant · Control · Year 1600	0.158	0.111	0.080

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Table A.ii, continued

Dependent Variable	ln(City size)		
Control Variable	River or Port	Monasteries (p.c.)	Religious Interaction
Corresponding to	Figure 4	Figure 5	Figure 7
	(1)	(2)	(3)
	[0.367]	[0.303]	[0.722]
Protestant · Control · Year 1700	-0.257	0.062	0.090
	[0.390]	[0.312]	[0.545]
Protestant · Control · Year 1750	-0.010	0.036	0.142
	[0.399]	[0.308]	[0.667]
Protestant · Control · Year 1800	-0.180	-0.009	0.498
	[0.408]	[0.312]	[0.670]
Protestant · Control · Year 1850	0.103	0.047	0.598
	[0.411]	[0.310]	[0.701]
Protestant · Control · Year 1875	0.151	0.019	0.980
	[0.431]	[0.310]	[0.714]
Protestant · Control · Year 1900	0.204	0.017	1.174
	[0.463]	[0.310]	[0.766]
Controls Distance to Atlantic ports	Y	Y	Y
Controls City size in 1300	Y	Y	Y
Observations	1876	1876	1876
R-squared	0.708	0.704	0.702
Number of cities	272	272	272
p-value for joint significance Protestant	0.292	0.037	0.079
p-value for joint significance triple interactions	0.242	0.095	0.532

*: Significant at 10%; **: 5%; ***: 1%. All regressions contain a full set of city and year fixed effects. P-values refer to a joint test significance of all coefficients relating to the post-Reformation period (interactions of respective variable with year dummies, 1600 and onwards). Robust standard errors, clustered by territory, in brackets.