# Origins of Growth
# Health Shocks, Institutions, and Human Capital in the Protestant Reformation*

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January 8, 2016

**Preliminary and Incomplete. Do not cite.**

**Abstract**

We study the long-run impact of the legal institutions of the Protestant Reformation on growth across German cities. We compare Protestant cities that formalized the Reformation in municipal law to Protestant cities that did not and to cities that remained Catholic. Cities with reformed legal institutions grew significantly faster over subsequent centuries. We show that local exposure to disease epidemics in the immediate run-up to the Reformation generated exogenous variation in institutional change. Using these health shocks as an instrument for institutional change we find support for a causal interpretation of the relationship between municipal institutions and growth. These institutions established pioneering experiments in mass public schooling and narrative evidence strongly suggests the growth effects ran through a human capital channel. We use novel microdata to show that after the passage of legal reforms cities with Reformation laws began differentially producing more residents with upper tail human capital. Similarly, Protestant cities with new legal institutions attracted more high skilled migrants.

JEL Codes:

Keywords: Institutions, Growth, Education, Public Health, Human Capital, Persistence.

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"The revolutionary program came to rest in an established religion; the pamphlet became a church ordinance...The new Protestant institutions persisted."

– Ozment (1975), *The Reformation in the Cities*

"With respect to schools and schooling, the purview of territorial and urban governments in Germany was fixed at an early juncture in the chain of events leading to the established Reformation"

– Strauss (1988), "The Social Function of Schools in the Lutheran Reformation in Germany."

# 1 Introduction

In this research we study the causal impact of the municipal institutions of the Protestant Reformation on city growth and on the formation and location of highly educated talent in German-speaking Europe. The municipal institutions we study were city-level ordinances codified in law over the period 1522-1600. These laws increased the public goods provision responsibilities and administrative capabilities of municipal governments. These laws institutionalized Europe's first large scale experiments with mass public education and increased the social welfare bureaucracies. These institutions varied across Germany and across cities in the same territory subject to the same territorial ruler and the same territory-level laws. Moreover, they were adopted in only some of the cities where Protestantism became the dominant religion, allowing us to discriminate between the generalized relationship between Protestantism and growth and the relationship specific to formal institutions. We examine the relationship between these institutions and city growth as a measure of economic dynamism at the local level (Acemoglu et al., 2005b; Glaeser et al., 1995; De Long and Shleifer, 1993). We then study novel micro-data on the most important economic and cultural figures in German history 1300-1800 and use these data to document that the local formation and inter-city migration of upper tail human capital responded to the introduction of Reformation laws. No previous economic research has documented how the institutions of the Reformation impacted city growth or has examined these micro-data, to the best of our knowledge.[1]

We analyze the Protestant Reformation of the 1500s as a canonical setting in which local variations in popular movements delivered profound differences in institutions. Prior to 1517, the

[1]The existing literature on the economic impact of Protestantism in German-speaking Europe is extensive, but has not studied the impact of the formal institutions of the Reformation. For example, Cantoni (2015) documents that the diffusion of Protestantism as the dominant religion at the city-level in the 1500s had no impact on city growth 1500-1800, using a measure of non-institutional diffusion. In contast, Becker and Woessmann (2009) find that religion was was strongly associated with education and economic development across counties in early 1800s Prussia, studying as their measure of religion the Protestant share of county population. We discuss how our research supports, reconciles, and extends these arguments below. In other recent research, Cantoni et al. (2015) find that locations where Catholic monasteries were closed saw human and physical capital reallocated away from church use (1517-1600) and Basten et al. (2013) find differences in preferences in Switzerland along the border between historically Protestant and Catholic territories. A larger literature looks at how religion explains differences in performance across countries (Barro and McCleary, 2003) and differences in preferences across individuals in contemporary settings (Guiso et al., 2003). We focus our discussion here on the economics literature. However, a large body of non-quantitative scholarship studies the nature and consequences of Protestant institutions (Strauss, 1978; Witte, 2002; Rittgers, 2012; Grell, 2002; Ozment, 1975, 1980).

Catholic church in Europe enjoyed something approaching a monopoly in organized religion. After Martin Luther circulated his famous theses in 1517, religious competition emerged. Luther and other reformers became public intellectuals. The early reformers introduced new ideas – and novel combinations of existing ideas – concerning religious practices, safeguards against corruption in the church, and the provision of public goods. These ideas first developed, diffused, and were adopted in cities (Hamm, 1994; Schilling, 1983; Ozment, 1975). A defining feature of the Reformation was that urban citizens adopted reformist arguments and pressed them on their local city governments (Cameron, 1991). Where citizens' movements pressed for institutional change and were strong, city councils passed laws institutionalizing the provision of health care, education, social insurance, and religious services.[2] These institutional reforms began to be implemented at the city-level starting in 1522. Significantly, only about 50% of Protestant cities formalized these institutional changes bearing on the provision of public goods. In many cities Protestantism became the dominant religion, but no laws formalized the establishment of public schools and social welfare provision.

We document the impact of the laws of the Reformation on long run growth as follows. First, we document how changes in municipal institutions explain subsequent variations in growth across cities within the same territory. Second, we show how city growth responded to institutional changes induced by exogenous variations in demand. The specific variation we study arose from the timing of plague outbreaks, and specifically how the timing of outbreaks interacted with the introduction of political-religious competition in the Reformation. The arrival of city-level plague outbreaks was random in the short-run. Short-run variations in plague had minimal impact on institutional change or long-run outcomes over the entire 15th century. With the introduction of competition between Protestantism and Catholicism matters changed. Plague shocks became salient, shifting demand for Protestant institutions, predicting institutional change and long run growth. Third, we use microdata to study how cities which adopted the institutions of the Reformation began differentially attracting and producing more upper tail human capital only after they adopted the legal infrastructure. The microdata provide evidence on the channels through which institutions impacted local growth. They also provide an alternate – higher frequency – body of evidence in which to explore the timing of institutional effects using difference-in-differences designs.

Our first finding is that cities that adopted the institutions of the Reformation subsequently grew significantly faster than cities that did not. Cities that adopted legal change grew approximately 0.1% faster per year than both Protestant cities that did not formalize social change in municipal law and Catholic cities. This growth advantage lasted over several centuries. As a result, cities exposed to reformed legal institutions grew to be significantly larger in 1800. This relationship between municipal institutions and long-run growth holds across all cities and within-territories. We find no growth effect from the non-institutionalized diffusion of Protestantism, consistent with

[2]The social history literature provides extensive evidence on the critical role of popular demand and documents that the emergence and diffusion of the Reformation in the early 1500s was driven by citizen's movements, not "from above" by city council fiat or by lords' preferences (Hamm, 1994; Cameron, 1991; Broadhead, 1979; Ozment, 1975; Schilling, 1983; Scribner, 1979). However, in our empirical work below we examine institutional variation across cities in the same territory, to study variations in outcomes that are not driven by lords. We discuss the historical evidence and our empirical set up in detail below.

Cantoni (2015). Instead we find the relevant variation in formal institutional change and evidence consistent with the view that the "interdependent web of an institutional matrix...produces massive increasing returns." (North, 1990, p. 27)

This finding naturally raises a question about cause and effect: did cities selectively adopt different institutional arrangements and are there sources of exogenous variation? This finding also raises a question about channels: how did the institutions of the Reformation impact growth?

To address the question about cause and effect, we document exogenous variation in the adoption of Reformation institutions due to plague outbreaks in the early 1500s. The variation we study arises from the way the randomness in plague outbreaks interacted with the timing of the Reformation in the early 1500s. The interaction between local shocks and the broader introduction of religious competition shifted demand for the Protestant institutional agenda. We use an instrumental variable design to isolate this variation in treatment and find support for a causal interpretation of the relationship between the municipal institutions of the Reformation and city growth. We thus study both a treatment (municipal institutions) and a source of variation (exposure to health shocks) that have not been explored in the previous economics literature.[3]

Our instrumental variable argument has three parts. The first concerns the nature of plague shocks. The Reformation spread across cities exposed to localized outbreaks of the plague, whose short-run timing was random and highly irregular. The plague typically hit some but not all cities within a region; individual cities could go decades between outbreaks or experience several in a matter of years (Slack, 1988; Biraben, 1975).[4] For example, Frankfurt and Mainz never experienced outbreaks in the same periods despite being located less than 50 kilometers apart. These irregular outbreaks caused extreme, unparalleled increases in mortality and suffering (Slack, 2012).

The second part of our instrumental variable argument relates to the divergence between Protestant and Catholic ideas on the plague. Divergences between Protestants and Catholics on the plague were differentiating features in the market for religion and institutions. In broad terms, where Catholics suggested that epidemic disease was divine punishment for sin, Protestants tended to argue that Jesus had died to absolve human sin, to support more extensive pastoral care, and to advocate measures to promote public health and relieve suffering (Rittgers, 2012; Lindemann, 2010; Roeck, 1999).[5] Protestant writers and preachers developed a policy agenda for a desired

[3] Becker and Woessmann (2009) study the relationship between the Protestant share of population and economic development across counties in the 1800s using distance to Luther as a source of variation in Protestantism. Cantoni (2015) studies the relationship between the the non-institutionalized diffusion of Protestantism and city growth in a difference and differences set up. Dittmar and Seabold (2015) study shocks to local media markets with printing as a determinant of the diffusion of ideas in the media, but restrict their focus to the smaller set of historical printing cities in German-speaking Europe, including cities in Switzerland, Poland, and other territories not covered in the current research. Our research is very different, in being able to examine the diffusion of the Reformation across all cities in Germany, because the plague shocks we study here are orthogonal to the firm-level shocks previously studied in Dittmar and Seabold (2015), and because not one of those firm-level shocks was caused by the city-level plagues we study. Rubin (2014) documents that cities with printing in 1500 were more likely to adopt Protestantism, studying a measure of Protestantism that includes non-institutionalized diffusion, similar to Cantoni et al. (2015).

[4] We discuss this variation in detail below. It is notable that this variation is observed even during the great wave of plague outbreaks during the Black Death 1349-1350. Several of the largest and most connected German cities were entirely spared during the Black Death (Jankrift, 2008), which is believed to have killed 1/5 of the overall population.

[5] We provide further discussion of the nuances within and across Protestants and Catholics below.

"Christian Commonwealth" in which institutions to promote public health and alleviate suffering figure prominently (Grell, 2002; Cameron, 1991). The Protestant institutional agenda promised to shift resources towards public health and the alleviation of suffering. The municipal institutions we study in some cases even contain detailed provisions governing the location, financing, quarantine protocols, treatment eligibility rules, and staffing arrangements for hospitals, with special reference to the plague.

The third part of our instrumental variable argument consists of the evidence that connects plague shocks, institutional change, and growth. In the data, we document that cities which experienced plague outbreaks just before the ideas of the Reformation hit the market in 1517 and in the early Reformation years were more likely to enact institutional change. Cities exposed to outbreaks in the revolutionary period, and which were more likely to experience institutional change, grew relatively quickly over long time horizons. In contrast, similar shocks in other periods have little explanatory power over which cities adopted legal change. Similar plague outbreaks in other periods – when there were no analogous institutional changes – do not explain subsequent economic development.

To address the question about the channels through which institutions impacted growth, we study individual-level micro-data on human capital and migration. While the institutions of the Reformation were designed to impact multiple dimensions of social life, the historical evidence suggests that their impact on education was particularly consequential for the subsequent development of cities. The ordinances we study contain educational provisions that established Europe's first large scale experiments with mass public education.[6] These provisions shifted schooling from the private sector to the public sector and from being voluntary to compulsory (Strauss, 1978). We show that cities that adopted the legal institutions of the Reformation subsequently produced differentially more people with upper-tail human capital, using novel microdata on over 2,000 of the most important economic and historical cultural figures in German-speaking Europe 1300-1800 using data from the *Deutsche Biographie* (Bayerischen Akademie der Wissenschaften, 2015). We also show that cities with the legal institutions of the Reformation differentially attracted high skilled migrants, even within territories subject to the same ruler, using individual-level microdata from *Deutsche Biographie* and the Prussian Census. While we cannot rule out growth effects running through other channels, the microdata and narrative evidence strongly suggest that the new legal institutions shaped the trajectory of city development through their effects on education, the acquisition of skill, and associated incentives to migration. It is notable in this respect, that there is not equivalently compelling evidence to suggest a growth impact through the direct effects of public health interventions on mortality.[7]

The Reformation was one of the most important social transformations in European history, but

[6]For example, in Venice in 1587, only 5 of 245 schools observed in 1587 were public and throughout Renaissance Italy education was principally privately organized (Grendler, 1989, p.43). In France, a considerable number of city and independent secondary schools emerged piecemeal over the later 1500s, to a considerable extent as a response to the perceived failures of the clerical school system. See Huppert (1984).

[7]Migration itself was regulated in the period we study. Cities had formal residence procedures and eligibility for social services including medical care typically required some form of registration. We discuss this in detail below.

prior research has not documented the effects of the legal changes at the heart of the Reformation process. We construct evidence on the municipal laws of the Reformation and document that cities with this legal infrastructure grew significantly larger than other cities that did not adopt similar legal changes, including neighboring cities. This finding raises a question about cause and effect. This question is also motivated by the fact that the Reformation was process in which popular religion played a fundamental role in the development of state capacity.

The literatures on institutions and state capacity emphasize variation from the supply side, but the establishment of the Reformation in municipal law was shaped by local variations in demand.[8] The demand for institutions is typically not random. Preferences over institutions notably vary with economic interests and culture. The Reformation is an example of how variation in some of the potentially most consequential social institutions appears to be driven by demand-side dynamics.[9] We use historical data on public health shocks to isolate exogenous variation in demand and study the impact of the legal changes of the Reformation. By focusing on cities we are able to study how institutional variation within territories was associated with differences in urban dynamism and to examine quasi-experimental variation in the adoption of Protestant institutions induced by plague outbreaks.[10] Our identification strategy contributes to the literature studying how exposure to shocks in a moment of revolutionary change can deliver lasting changes in institutions and in outcomes (Pierson, 2011; Dell, 2012).

Historical evidence suggests that the educational provisions of Protestant laws had first order consequences, but economic research has not produced conclusive evidence on the growth impact of education before the industrial revolution. By studying microdata on the formation and migration of individuals with upper tail human capital, we provide new evidence on the channels through which historic institutions have shaped economic growth. A remarkable feature of the laws of the Reformation is that they provided institutional support for the production of human capital.

The broader social science debate on the impact of the Reformation stretches back to Weber (1904), who suggested that Protestantism promoted economic activity via its impact on preferences and behavior, and Marx, who suggested the Reformation shaped development by reducing institutional barriers to market activity. Our evidence indicates the importance of an institutional interpretation, but highlights the public goods provision dimensions of the new institutions.[11]

[8] For example, Acemoglu et al. (2001) study the consequences of institutional differences across countries that arose in the colonial era and Tilly (1992) and Besley and Persson (2009) examine variations in state capacity that emerged due to the exigencies of war, both of which can be conceptually thought of as supply driven sources of variation.

[9] For example, Fujiwara (2015) analyses how a quasi-experimental change in voting technology in 1990s Brazil delivered a positive shift in effective demand for low income Brazilians, but not a shift in preferences per se. In a design more closely related to ours, Dell (2012) studies how weather shocks shifted rural insurgency during the Mexican revolution of the early 1900s, leading to persistent differences in institutions and outcomes.

[10] Municipalities developed institutional innovations that territorial governments were arguably unable to implement as effectively due to their limited state capacity (Whaley, 2012; Strauss, 1978).

[11] The historical literature following Marx has framed the institutional changes of the Reformation as an "early bourgeois revolution," but has devoted relatively limited attention to the expansion of public goods and education provision. See Brady (2009) and Dorpalen (1985).

## 2 History

What factors influenced how the ideas of the Reformation diffused and why some cities adopted the institutions of the Reformation and others did not? To answer this question we draw on a rich body of social, cultural, religious and economic history evidence. We use this research to characterize the Reformation movement, ideas, and policy goals, and the political economy processes that led to institutionalization and non-institutionalization. The historical characterization we present here motivates the empirical work in the following sections.

### 2.1 Diffusion of the Reformation

The Protestant Reformation began as a movement of churchmen calling for the reform of practices and institutions within the Catholic and became a broad social movement for religious and social reform (Cameron, 1991). Within months of the initial circulation of Martin Luther's famous theses in 1517, Reformation ideas swept across Germany. Historians identify the printing press as critical to the diffusion of Protestant ideas (Eisenstein, 1980; Pettegree, 2005). Recent quantitative research confirms a sharp and discontinuous shift in media content, as well as a significant increase in the share of printing in German as opposed to Latin (Dittmar and Seabold, 2015).

The Reformation was simultaneously a movement for religious renewal, an anti-corruption movement, and a movement to transform and expand public goods provision. The reforms that were at the heart of the Reformation included moves to reduce and set up safeguards against church corruption, to extend public goods provision, and to transform the provision of education. The reformists also moved to eliminate clerical tax exemptions and economic privileges.[12] More generally, reformers called for moral renewal within cities (Moeller, 1972), argued that biblical authority was paramount over and above the authority of existing Catholic church institutions (Brady, 2009), and were frequently anti-clerical (Dykema and Oberman, 1993).

The local adoption of Protestantism and of Reformation institutions reflected city politics and was largely from below. We focus attention on how institutions were related to growth across cities in the same territory, and hence subject to the same territorial policy environment and laws, in our empirical work below. However, it is important to observe that the city Reformations were popular citizens movements that emerged without initial support from oligarchic city governments or territorial lords. Cameron (1991, p. 240) observes, "As a rule neither the city patricians nor the local princes showed any sympathy for the Reformation in the crucial period in the late 1520s and early 1530s; they identified themselves with the old Church hierarchy and accordingly shared its unpopularity. Popular agitation on a broad social base led to the formation of a 'burgher committee'." (Dickens, 1979, p. 20) confirms that city councils did not initiate local Reformations. The constituency for reform came from citizens who were excluded from political power by oligarchic

[12] Besides exemption from taxes and civic duties, religious orders enjoyed monopolies on priced religious services (e.g. funeral services) and on the production of products like beer. Reformist arguments and agitational literature frequently raised objections to high prices for essential religious services and to religious tax exemptions (Cameron, 1991; Ozment, 1975).

elites, typically lesser merchants and guild members (Ozment, 1975; Schilling, 1983). More detailed discussion on the histories of individual towns, is provided below and in the appendix.

The question of why some cities adopted Reformation institutions while others did not is a political economy question and a question about supply and demand, broadly conceived.

On the demand side, several features of social landscape shaped how reformist ideas were received. Notable shifters of demand included: (1) the nature and extent of local Catholic church corruption and monopolies, (2) the salience of local public health concerns and challenges, (3) the size and self-organization pro-Reform constituencies, including guilds and merchants not on the city council (Ozment, 1975; Cameron, 1991; Dittmar and Seabold, 2015), (4) the nature of local culture, including Germanic humanism. We examine a rich set of measures and proxies for these determinants of demand in our empirical work below, but we share the fundamental question of whether cities where Reformation ordinances were adopted were different on other unobservable dimensions that may directly account for their subsequent superior growth. For this reason, we develop an instrumental variable strategy that uses exposure to public health crises on the eve of the Reformation to isolate exogenous variation in institutional change, as discussed below.

Cities were also exposed to variation in the supply of reformist ideas. The evidence indicates that the new media of printing was critical to the diffusion of Protestant ideas. Both historians (Eisenstein, 1980; Brady, 2009) and economists (Rubin, 2014) argue that this information technology shifted the supply of Reformist ideas. Recent research argues that the diffusion of Protestantism in the media was driven by competition in the use of the new printing technology rather than the technology per se (Dittmar and Seabold, 2015). Our research is fundamentally differentiated from this research in that it studies a larger set of cities, including more cities without printing, and examines shocks that were orthogonal to the supply-side shocks the research on printing has previously examined.[13] Another supply-side factor was distance. People travelled to Wittenberg to access Lutheran ideas and Lutheran ideas diffused to other parts of Germany from Wittenberg. These facts motivate a literature that examines distance to Wittenberg as a factor that shifted the supply of Protestant ideas (Becker and Woessmann, 2009).

## 2.2 The Municipal Institutions of the Reformation

Protestant reformers designed interlocking institutions to formalize and reinforce the new system of beliefs and to transform the provision of religious and social services. The Reformers' key institutional innovation was the church ordinance (*Kirchenordnung*). The name "church ordinances" if taken literally is somewhat misleading. These ordinances became the civil and religious law of cities. The *Kirchenordnungen* (plural) changed municipal institutions by transferring control of service provision from the Catholic church to the temporal rulers, establishing

[13] We study shocks to cities from plagues which shifted demand. In contrast, Dittmar and Seabold (2015) study shocks to firms and the local competitive environment which shifted supply. Because these shocks are deaths of individual printers it is natural to wonder whether their deaths were in fact caused by the plagues we study in this research, however every printer death documented in Dittmar and Seabold (2015) occurred outside of plague outbreaks studied here.

binding guidelines for a new society, and initiating fixed investment commitments.[14]

Church ordinances institutionalized the Protestant policy agenda. The ordinances contain provisions covering: (1) how to conduct mass, (2) the provision of and rules governing public education, (3) the provision of health care, including the establishment, staffing, funding, and eligibility requirements for treatment at hospitals and hospices, (4) the expansion of social insurance and transfers such as poor relief, as well as revenues, (5) the regulation public life and behavior, (6) compensation for priests, teachers, and their assistants, and (7) quality control of priests and teachers. In general, the ordinances institutionalized the redistribution resources towards low income families, and ensured some measure of equal opportunity by providing public assistance for education. A key policy innovation in the ordinances is the introduction of a "common chest" – a literal lock-box for funds that support public goods provision.

The education provisions are of special interest because of the channels through which Protestantism shaped long-run outcomes. The most fundamental provisions established compulsory public schooling.[15] The Protestant educational ordinances had two primary aims: (1) to produce public servants who would staff expanding Reformation church and state bureaucracies and (2) to cement the Reformation by producing disciplined Protestant subjects. The principal motivation for the schooling ordinances was *not* the view that all citizens or even all men should read the bible. Bible reading was not a center-piece in Lutheran education; most elementary school curricula make no mention of bible reading and instead focus on catechism lessons (Strauss, 1978).[16]

While we highlight the importance of legal interventions in education, the consequences of Reformation ordinances arguably flowed from the interlocking nature of these institutional innovations. The church ordinance of Wittenberg provides an example of how specific institutional innovations addressing potentially distinct challenges were related and made mutually reinforcing in law. In 1522, the town council of Wittenberg adopted a Reformation ordinance establishing a common chest. The ordinance stipulates that all church income is to be collected under one administration, equally shared by the town council, community, and pastors. The ordinance indicates that these resources will be used to pay for the care for the poor and sick. The ordinance also indicates that low-income parents are to be given financial support so they can afford to send their children to school or university, respectively.

Historical evidence suggests these institutional changes transformed public and economic life where they were adopted. Legally, not the church but the temporal rulers became the relevant authority. Spiritually, suffering was not longer seen as necessary for redemption. Intellectually, education was emphasized and accessible to all. Financially, resources were redistributed to benefit society at large. Given the scope of the institutional change, we study whether church ordinances

[14] For a detailed discussion on how the Reformation impacted the law and legal institutions, see Witte (2002).

[15] In Ulm written excuses were required from parents for truant children. In Stralsund, the beadle (a church official) was sent to locate absent children. In Hamburg, municipal authorities began paying for school heating when it was discovered that parents were reluctant to have their kids go to cold school in winter. See (Strauss, 1978).

[16] The evidence suggests that Lutherans were concerned that the complexity of the Bible and independent reading might yield unorthodox views and practices. "This is why so little encouragement was given in the pupil's formal education to individual Bible reading. Most school plans make no mention of it at all" (Strauss, 1988, p. 202).

had a long run effect on economic growth.

## 3 Definition of Institutional Treatment

Our baseline measure of institutional treatment is exposure to city-level ordinances that established institutions that survived until at least 1600. We study institutional innovations that had not been reversed by 1600 in order to focus on the effects of changes that were not short-lived. In this section we discuss how our classification protocol treats cities which reverted to Catholicism or experienced more complicated institutional and confessional trajectories. We also discuss how our classification protocol distinguishes Protestant cities which adopted the legal institutions of the Reformation from cities where Protestantism became the dominant religion but where the legal institutions of the Reformation were not adopted.

Cities where the institutions of the Reformation did not survive to 1600 are classified as untreated in our analysis. Not all city-level ordinances passed in the 1500s survived to 1600. Two prominent examples of cities that adopted Reformation laws but experienced early institutional reversals due to re-Catholicization are Münster and Beckum.[17] In both cities Protestant city councils adhering to Anabaptist ideas passed city-level Reformation laws in the mid-1530s. These Anabaptist experiments – which were atypical in fusing Protestant theology with radical egalitarianism – were crushed militarily by 1536. Both cities reverted to Catholicism and their institutional experiments were quickly undone.

Cities which adopted the institutions of the Reformation and in which these institutions survived to 1600 are classified as treated in our baseline analysis. Where we observe institutions established by Reformation laws in effect through 1600, these institutions were typically persistent. Our basic findings on the relationship between institutional change and city growth are robust to different classifications of cities with persistent institutions but complicated religious trajectories.

The city of Amberg in Bavaria provides an instructive example showing how Reformation institutions typically persisted in "treated" cities once long-run benefits of Reformation institutions became clear, even if a city or its territory came under Catholic rule in the 17th century. Amberg passed a Protestant ordinance in the 1540s and eyewitness accounts from 1564 record boys' and girls' schools, "in which the German Catechism, reading, writing, and arithmetic are diligently taught" (Johnson, 2009, quoted on p. 32). The Catholic authorities preserved the institutional legacy that they inherited when Amberg and the surrounding territory of Upper Palatine (Oberpfalz) was absorbed by Catholic Bavaria in the early 1600s. During the 1620s, the Jesuits took over formerly Calvinist and Lutheran higher schools in Amberg. More broadly, "the educational infrastructure of the territory impressed Counter-Reformation Catholics when they inherited it after 1621; summing up his reflections...after his visitation in 1656, the (Catholic) Regensburg vicar general noted approvingly that 'in nearly every village, schools are to be found, of which in [Catholic] Bavaria there [otherwise] seems to be a great shortage and decline'." (Johnson, 2009, quoted on p. 35)

[17] Many cities that had adopted Protestantism in Westphalia reverted to Catholicism.

The city of Augsburg provides another example of institutional persistence in a city our classification designates as "treated". In Augsburg, the Reformation was formally adopted 1534-1537, and municipal social services were reorganized, when Protestant guildsmen gained control of the city council (Broadhead, 1979). In 1548, the Holy Roman Emperor Charles V re-established a form of Catholic rule in Augsburg that allowed Protestant institutions to persist: rule by an elite of Catholic patricians, with reserved control of key government positions, over a Protestant majority city with active public services institutions shaped by the Reformation. Under this arrangement Augsburg experienced peaceful co-existence without institutional reversals into the 1600s. Stein (2009, p. 73) observes: "At no point did the Catholic-dominated patrician council attempt to re-catholicise the city; instead it governed with discretion in order to minimise tensions with the Protestant community...The admission practices of all the city-run health care institutions reflected this strategy of confessional tolerance."[18]

Our measure of legal change distinguishes between the formal institutionalization and informal diffusion of Protestantism as the dominant city-level religion. The distinction is significant because previous research has documented that the diffusion of Protestants as the dominant religion had no impact on city growth (Cantoni, 2015). An example of a city that became predominantly Protestant but did not adopt a Reformation law is Bautzen. The citizens of Bautzen embraced Lutheranism in the 1520s. The Catholic bishop of the time defied Catholic church doctrine and invited Protestants to begin sharing the Cathedral in 1524. In 1543, Protestants and Catholics signed a formal contract that still governs times of worship and use of Cathedral space today. Despite becoming a predominantly Protestant city, Bautzen did not adopt a Reformation ordinance.[19] Bautzen is an example of a city that became predominantly Protestant and is classed as such in Cantoni (2012), but did not adopt Protestant law.

Given that we focus on city-level Protestant church ordinances as our key measure of institutional change, it is natural to wonder whether there were Catholic institutional innovations over the period we cover. While there were some territorial Catholic policy interventions in the counter-reformation that adopted innovations from the Protestant policy agenda (Strauss, 1978), the broad consensus among historians is that policy ordinances developed "much more clearly and earlier in Protestant than in Catholic Germany" (Roeck, 1999, p. 282). In addition, historians observe that the presence of Catholic interventions that borrowed from and responded to Protestant innovations will lead us to conservatively underestimate the impact of Protestant institutional change (Grell, 2002). We provide further discussion of Catholic institutions in the Appendix.

[18] In 1620 – during the Thirty Years War (!) – the nurses' head matron of the Hospital of the Holy Ghost in Augsburg was instructed "every day...to go from bed to bed and to enquire whether the patients are lacking anything in their care and comfort...or whether indeed they require the attentions of a Catholic priest or Protestant pastor."

[19] On the absence of a law, Speer (2014, p. 51) observes: "wird allein daran deutlich, dass er sich in Sachen Ehegerichtsbarkeit noch dem (katholischen) Offizial in Bautzen unterstellte und keine Kirchenordnung erließ. Erst seit 1565 finden sich in den Stadtstatuten vereinzelt Ratsbeschlüsse zu Kirchenangelegenheiten, eine Kirchenordnung im eigentlichen Sinne konnte vor 1617 bisher nicht nachgewiesen werden."

# 4 Data

### Definition of Sample

To analyze the relationship between the institutions and city growth, we focus this study on Protestant church ordinances adopted in cities and towns.[20] We limit the analysis to cities within contemporary Germany because they form the overwhelming majority of historically German-speaking locations and because we are able to use the evidence in the *Deutsches Städtebuch* to construct city-level evidence on a rich set of characteristics for these cities, as described below. For our principal analysis we study ordinances across the set of 239 German-speaking cities with population data observed in 1800 from Bairoch et al. (1988) and with the non-institutionalized diffusion or non-diffusion of Protestantism recorded in Cantoni (2012). However, we also study ordinances across the over 2,000 German historic towns recorded in the *Deutsches Städtebuch*. We describe all these sources below.

### Legal institutions of the Reformation

Our key measure of institutional change is the presence of a Protestant church ordinance in 1600, which can be taken as a measure of lasting institutional change. Our principal data source on Protestant church ordinances is the 21 volume collection *Die evangelischen Kirchenordnungen des XVI. Jahrhunderts* edited by Sehling (1911).[21] We also examine Richter (1846a,b), *Die evangelischen Kirchenordnungen des sechszehnten Jahrhunderts* and other sources described in the Appendix.In our sample of 239 cities with population observed in 1800, 102 had Reformation laws and 137 did not.[22] Across 2,000+ towns in *Deutsches Städtebuch* we identify over 250 towns with laws.

Figure 1 maps the cities in our data and illustrates the local variation in which cities had Reformation laws. Figure 2 shows the cumulative share of cities with Reformation ordinances in each year. Most cities passed their first ordinance by 1545. In 1546, the Schmalkaldic War broke out between Protestant and Catholic princes, and largely arrested the city-level diffusion of the Reformation. The Augsburg Settlement (1555) ended hostilities and established a new religious and institutional equilibrium. The settlement included a provision, *cuius regio, eius religio,* which allowed local rulers to dictate the religion in their realm, but maintained a complicated set of exceptions for cities where magistracies and offices were to be shared (Dittmar and Seabold, 2015).

### City Level Characteristics

Data on whether and when cities acquired formal market rights and dates of city foundation and city incorporation are from Cantoni and Yuchtman (2014), based on the *Deutsches Städtebuch*. Data on the number of university graduates from each city receiving a university degree in Germany

[20] We do not study ordinances adopted in castles, religious establishments, and small villages. We also defer analysis of laws passed at the territorial level and emphasize within-territory variation.

[21] These volumes were published 1902-2015. We refer to them in the text as Sehling (1911) as a shorthand. A complete list these volumes is provided in the Appendix, which provides for description of the data.

[22] We restrict our sample to cities in the Holy Roman Empire as of 1500, following Cantoni et al. (2015).

in every 10 year period 1398-1517 are from Cantoni et al. (2015), and are constructed from university registries that list individual-level degree recipients. Data on the number of books printed in each city pre-Reformation are from Dittmar and Seabold (2015). Evidence on the presence of navigable rivers, the ecclesiastical status of cities, monasteries and mendicant orders at the city level, and the adoption of Protestantism as the dominant city-level religion is from Cantoni (2012).

**City Populations and Upper Tail Human Capital**

We use city population data from Bairoch et al. (1988). Bairoch et al. (1988) provide population data on urban agglomerations that ever reached 5,000 inhabitants between 1000 and 1800. The data record populations in thousands. Our baseline data comprise 239 cities of German-speaking Europe with population observed in 1800 and with data available from the *Deutsches Städtebuch*. We construct data on individuals with upper tail human capital from the *Deutsche Biographie* (Bayerischen Akademie der Wissenschaften, 2015). We identify over 2,400 individuals born 1200-1800 in our baseline set of cities. We use evidence on the settlement locations of Huguenot migrants from Birnstiel and Bernat (2001) and Hornung (2014), who provide data on the number of Huguenot migrants who settled in different towns in Brandenburg-Prussia in the early 1700s.

**Plague Outbreaks**

We construct city-year level data on major plagues outbreaks from Biraben (1975), *Les Hommes et La Peste*, which provides quantitative data designed to characterize the frequency, duration, and variations in incidence of the plague in European history (Biraben, 1975, p. 22). Biraben (1975) constructs city-year evidence on major plague outbreaks, motivated by the fact that the plague outbreaks were highly public events that left a mark in the historical record, and because the evidence on mortality embodies measurement error and is not available for a large proportion of outbreaks. The Biraben (1975) data record over 500 major outbreaks of the plague in German cities 1350-1600. These plagues are recorded in our data because they were large enough to leave a trace in the historical record. Because it is natural to wonder about measurement error even in evidence that records just the 1/0 presence of major outbreaks, our empirical work below controls for long-run city-level propensity to experience plague, in order to absorb time invariant differences across cities in record-keeping and to identify off of within-city, time-varying shifts in plague shocks.

# 5 Institutions and Long-Run City Growth

In this section we document the relationship between the municipal institutions of the Protestant Reformation and city population growth. We study city population as an important outcome in and of itself and because city population is a key measure of local economic activity in European history, where direct measures of industrial output or municipal tax revenues are not available. Our study of city population is motivated by the literature on city growth (De Long and Shleifer,

1993; Glaeser et al., 1995; Acemoglu et al., 2005a).[23]

We test the hypothesis that cities with city-level Reformation laws by 1600 experienced more rapid population growth and were larger by 1800. Our key finding is that cities exposed to the reformation institutions grew to be significantly larger in 1800 than cities that were observably similar in 1500 but were not treated by these institutions. In contrast, we find that non-institutionalized Protestantism was not associated with growth, consistent with Cantoni (2015).

Table 1 shows the summary statistics of our key regression variables and shows that 40 percent of cities in our sample have a Reformation law. Table 2 splits the sample by law status and shows that cities with laws are larger in 1800 and that Reichstädte were more likely to adopt a law.

To document the relationship between the city-level Reformation law and long-run city growth, we estimate the following regression.

$$Log\ Population_{i,1800} = c + \alpha \cdot Reformation\ Law_{i,pre-1600} + \beta \cdot X_i + \epsilon_i, \tag{1}$$

where $Reformation\ Law_{i,pre-1600} = 1$ if city $i$ had a city-level church ordinance by 1600 and $X_i$ contains control variables.

We first document the baseline correlation between city size in 1800 and the institutions of the Protestant Reformation. We then introduce a series of controls to show that the significance and magnitude of the estimated relationship between institutions and subsequent city size is robust to controlling for a rich array of observables, including time invariant city characteristics, and time varying measures of human capital production in the run-up to the Reformation.

Table 3 shows the results from estimating equation (1). In column 1 we control only for territory fixed effects and population in 1500 using 5 indicator variables: population in 1500 unobserved; 1,000-5,000; 6,000-10,000; 11,000-20,000; and more than 20,000. We control for the territory to address the possibility that our city-level measure of institutions may be correlated with, and pick up variation in urban growth driven by, variations in territory-level policy or institutions. The within-territory estimate implies that cities with Reformation law by 1600 were 26 percent larger in 1800 – that is, cities with a Reformation law grew 0.12 percent faster annually. Our baseline estimates cluster standard errors at the territory level. Because our data contain cities in 31 territories, we also report 95% confidence intervals estimated using the Wild bootstrap methodology of Cameron et al. (2008) and find that the significance of our key parameter estimates is robust. This local within territory variation we observe is consistent with a large body of narrative evidence indicating that territorial lords had limited state capacity and that important institutional and development heterogeneity is observed at the city level (Whaley, 2012).

A natural question is whether the baseline relation between growth and institutions reflects observable pre-Reformation differences between cities that subsequently did and did not adopt Reformation laws. To address the question of selection on observables present regressions

[23] De Long and Shleifer (1993) and Acemoglu et al. (2005a) study city population as a measure of long run economic dynamism in history. Glaeser et al. (1995) document that U.S. cities with more schooling in 1960 experienced a faster income and population growth rate over the next 30 years.

documenting the robustness of our results to a rich array of controls. We also show that cities that adopted Reformation laws did not have a population advantage before the Reformation.[24]

Given the importance of human capital in the Reformation, it is particularly notable that we do not observe systematic differences in human capital before the Reformation across (i) cities that turned Protestant and adopted a Reformation law, (ii) cities that turned Protestant but did not adopt a Reformation law, and (iii) cities that remained Catholic during the Reformation. Table 2 shows that there are no significant differences between treated and untreated cities in having a university or number of books printed at the eve of the Reformation. Perhaps more importantly, the difference in the number of students is not significant. Consistent with this univariate test, Figure 3 documents that there are no differential pre-trends in the total number of university students coming from each set of cities by plotting the relative number of students decade by decade over the 100 years before the Reformation.

To show that our main result holds controlling for initial conditions, we add large set of control variables. We use market rights by 1517 and town incorporated by 1517 to proxy for commercial activity, four categorical indicators for number of books that were printed in a city by 1517 (0, 1-100, 101-1000, more than 1000), an indicator for the presence of a university by 1517, and the average number of plagues 1400-1499 to control for health shocks potentially affecting city population and growth prospects in 1500. We also control flexibly for the number of university students from city $i$ enrolling in any German university in each decade from 1398-1508 to proxy for pre-Reformation human capital and tastes for education at the local level. The point estimates, shown in column 2, remains the same. The point estimate of Reformation law also remains unchanged when we use longitude, latitude and their interaction as proxies to control for potential growth advantages of proximity to Atlantic ports and city age in column 3.[25] We also show that conditional on observables, cities that adopted Reformation laws in the 1500s were not significantly bigger than other cities in 1500.

It remains natural to wonder whether Reformation laws capture variation in the general but not strictly institutional diffusion of Protestantism. To disentangle variations in growth explained by institutional change from variations explained by the diffusion of non-institutionalized Protestantism we do two things. First, given evidence that Protestantism spread in concentric circles around Wittenberg (Becker and Woessmann, 2009), we control for distance to Wittenberg. Second, given Cantoni (2012) constructs data on which cities adopted Protestantism as the dominant religion and finds these cities did not grow faster, we study the relationship between Reformation law and growth conditional on inclusion of Cantoni's measure of which cities had Protestantism as the dominant religion. Here we also use the same controls as Cantoni.[26] Column 4 shows the results of estimating equation (1) with measures of diffusion of Protestantism

[24] Below we study microdata on famous people and document period-by-period growth effects in the microdata.

[25] Our inclusion of this variables is motivated by Cantoni's (2015) argument that longitude proxies for city age because of the historic Eastward movement of Germanic settlers and that latitude proxies for distance to Atlantic ports, which fostered growth 1600-1800 (Acemoglu et al., 2005b).

[26] The controls are year city turned Protestant, river indicator, Hanse indicator, Reichsstadt indicator, year city founded, monastery indicator, university indicator, and printing press indicator.

as explanatory variables. Consistent with Cantoni (2015), we do not find that diffusion of Protestantism effected city growth. In column 5, we also add Reformation laws. Controlling for the diffusion of Protestantism, the point estimate on Reformation laws remains positive and significant. In this subsample with Cantoni (2012) controls, the point estimate implies that cities with Reformation law by 1600 were 31 percent larger in 1800.

One potential concern our baseline set up raises is whether we introduce measurement error or sample selection effects by controlling for population in 1500 categorically in bins, one of which comprises cities with unobserved 1500 population. To explore this possibility, we restrict our sample to cities for which population in 1500 is known and control for log population in 1500. In this subsample we find a larger point estimate on Reformation laws that is significant when we construct standard errors using the Wild bootstrap but not significant when we cluster at the territory level.

To ensure that Reformation laws do not just proxy for city size, picking up residual unobserved variation in city size not captured by our control variables, we regress Reformation laws on population in 1500. If Reformation laws are the good measure of institutional change after 1517 then these laws should not explain city size in 1500. Column 7 shows that this is the case.[27]

# 6 Public Health Crises as a Source of Exogenous Variation

The fact that cities that adopted innovations in municipal institutions subsequently grew more raises a fundamental question: Did cities selectively adopt Reformation laws based on unobservable characteristics that are the true underlying drivers of variations in growth?

In this section, we use random variation in transitory health shocks to isolate plausibly exogenous variation in treatment in an instrumental variable setting. We provide evidence that exposure to plague outbreaks on the eve of the Reformation exogenously shifted the probability of adopting a Reformation law and use variation in laws induced by plagues to study the impact of legal institutions on growth.

## 6.1 Why Public Health Crises Provide Exogenous Variation

Sharp variations in the health environment can precipitate social responses that change institutions. We study the implications of random variation in transitory health shocks in the early 1500s. We formalize, test, and provide evidence that supports a key hypothesis in the literature on the plague: that the long run impacts of historic outbreaks operated through their effects on local social organization rather than direct demographic channels, and are specifically observed when the timing of outbreaks interacts with other factors that make social change more likely.[28]

[27] The appendix examines the data as a panel in greater detail. Section 7 uses panel micro-data on the formation of notable, high-skill historical figures observed 1300-1800 to show another margin along which differences in populations respond to the timing of Reformation laws.

[28] Biraben (1975, p. 189) specifically observes of the plague, "Son influence lointaine n'apparaît que par les conséquences indirectes...en particulier, losque'lle intervient à une moment difficile."

We study variation in institutions induced by transitory health shocks in the early 1500s for several reasons. First, the epidemiological and historical literature strongly indicates that the short-run distribution of plague outbreaks was random, conditional on observables. Second, by studying short-run variation we are able to control for long run differences in city-level plague propensity that might be correlated to differences in city characteristics and locations – e.g. openness to trade – that could directly shape economic development. We are also able to document how the timing of the interaction between plague and political competition delivers variation that is uniquely predictive for both long run growth and the intermediate institutional outcome. Third, by focusing on shocks in the early 1500s we show how the Reformation reflects a broader logic observed in the literature on path dependence, in which shocks in moments of more revolutionary potential may shift development trajectories in consequential and persistent ways (Pierson, 2011).

Our identification strategy is motivated by the scale of historic plague shocks. Urban plague outbreaks cause extreme increases in mortality. It was not unusual for 1/4 of a town's population to die (Slack, 2012). "The critical nature of the phenomenon to which early modern Europeans had to respond can be summarized briefly. The mortality levels reached during outbreaks of the plague were unparalleled." (Slack, 1988, p. 434) Deaths due to plague were in addition especially painful. Typical symptoms included delirium, fevers, painful swelling of the lymphnodes, and the expulsion of putrid matter.[29]

Our identification strategy is also motivated by the short-run randomness in historic plague outbreaks. The quantitative and historical evidence strongly supports the view that plague outbreaks were distributed randomly over periods as long as a generation, conditional on observables such as cities' long run plague propensity (Biraben, 1975; Slack, 1988). Historians observe that a given historic plague outbreak is characteristically observed in "compartimentalised" locations and not as spreading neighbor-to-neighbor.[30] Among the "puzzling features in the spread of plague" was that it "missed some towns in its transit along major highways" and was characterized by its "irregular timing." (Slack, 1988, p. 435) Consistent with the observation, there is no clear pattern on the city-level, shown in Figure 5. Some cities experienced outbreaks frequently but with considerably differences in the timing. For instance, Augsburg and Nürnberg despite being geographically close experienced a considerable number of outbreaks at different points in time. Other cities experienced few or no major outbreaks despite being important places, e.g. Frankfurt and Regensburg. Figure 4 shows the total number of plague outbreaks for the cities in our sample. After the arrival of the Black Death (1350), major localized plague outbreaks happened frequently but there is no obvious trend or periodicity in the time series 1400-1600.

Variation in plague outbreaks in the early 1500s shifted the probability of adopting a Reformation law. We present evidence suggesting that these effects worked through a demand

[29]Towards the end of the 15th century, the plague was a central feature of life and German culture. Plague saints became popular. Saint Rochus, previously unknown in historical Germany, become popular as protector against the plague. Newly commissioned altars often featured the plague, as so-called Pestaltare (Dormeier, 1989).

[30]Biraben (1975, p. 285): "si l'on porte sur une carte tous les lieux touché par l'epidemie...loin de s'étendre par voisinage, elle est compartimentée en foyers, presque tous isolés les uns des autres."

channel.[31]

Plague outbreaks shifted the demand for the institutionalization of reform because the plague and public health provision figured prominently in the Protestant institutional agenda. Protestants explicitly endorsed municipal public health interventions and developed institutions to provide health care. Almost all church ordinances contain provisions on directing priests to visit the sick and offer consolation. In some cities health care provision was a central part of church ordinances, notably in ordinances written by Johannes Bugenhagen, who was Luther's confessor and part of the team that produced the German language translation of the Bible. Indeed, "Initially Bugenhagen's church orders appear to have concentrated exclusively on the need to establish plague hospitals." (Grell, 2002, p. 58) The Catholic position on the provision of health care was different: most Catholic theologians "rejected public participation entirely or wanted to allow it in only very reduced measure." (Roeck, 1999, p. 286) The divergence in the response to plague outbreaks between the Reformers and the Catholic church is similarly highlighted by the debate between Andreas Osiander, a Protestant theologian, jurist, and academic, and Johannes Eck, arguably the most prominent Catholic theologian, inquisitor, and academic of the Reformation era in Germany (Rittgers, 2012). In 1533, Osiander preached a famous "Plague Sermon" and authored the influential Nürnberg Reformation ordinance. Osiander's message in the sermon and provisions he wrote into the law emphasized consolation, the reduction of suffering, and the argument that humans do not need to suffer as god suffered for us. In contrast, Eck argued that suffering is necessary penance for our sins.

Differences in religious views thus characterize a setting in which health shocks drove important innovations in institutions. "It was during outbreaks of bubonic plague that the towns of early modern Europe first developed sophisticated mechanisms intended to control the spread of infectious disease and to mitigate its effects...this necessitated the growth of local administrative machines and an expansion of state power." (Slack, 1988, p. 433) Protestant reformers delivered effective institutional blueprints for these local administrative machines and an institutional bundle that was more likely to be adopted in places experiencing such shocks.

### 6.2 Instrumental Variable Estimates

For our instrumental variable design, we estimate the following baseline first stage regression:

$$Reformation\ Law_{i,pre-1600} = c + \alpha \cdot Number\ of\ Plagues_{i,1500-1522} + \beta \cdot X_i + \epsilon_i, \qquad (2)$$

The key variable shifting treatment is local exposure to plague 1500-1522, the year the first Reformation law was passed. The vector $X_i$ contains the same control variables as in Section 5, including the total number of plague outbreaks between 1400-1499. Identification thus runs off short-run variation, because it is natural to wonder whether over the long run outbreaks may have

[31] Dell (2012) uses a similar identification strategy to study how regions experiencing severe draughts on the eve of the Mexican revolution of 1910-1920 were more likely to experience insurgent activity and land reform, and uses these shocks to study the impact of rural institutions on economic performance across Mexican localities.

occurred more often in cities that were "open" or "good" and already bound to grow.

Table 4 shows the results from estimating equation (2) and then equation (1) with the variation in $Reformation\ Law_{i,pre-1600}$ induced by plague outbreaks. Column 1 shows that $Number\ of\ Plagues_{i,1500-1522}$ is a strong predictor for the adoption of a Reformation law. Each additional plague outbreak between 1500 and 1522 increases the propensity of adopting a Reformation law by 13 percentage points. The F-statistic on the excluded instrumental variable is above 38. The point estimate of the second stage (shown in column 2) implies that a city with a Reformation law by 1600 was 164 log points larger in 1800 than a city without a law. Adding territory fixed effects does not change this result (columns 3 and 4).

We repeat the instrumental variable regressions studying the subset of cities for which population in 1500 is known and control for log population in 1500. This reduces the sample size to 110 cities. In the specification without territory fixed effects, $Number\ of\ Plagues_{i,1500-1524}$ remains a strong predictor for Reformation law (column 5) and the IV estimate suggests that having a Reformation law increased city size by 246 log points over a 200+ year period (column 6). Including territory fixed effects significantly reduces the statistical significance of the first stage (column 7). However, the point estimate of having a Reformation law increases even further.

We next extend our baseline IV analysis to examine the evolving way exposure to plague shaped institutional choice and growth over the course of the Reformation. We estimate rolling 2SLS regressions, studying how recent plague shocks shift institutions and growth in the set of cities that "survive" as candidates to adopt a Reformation law in a given year. Figure 6 presents these estimates by plotting year by year (i) the first stage estimates of the relationship between institutional change and plagues and (ii) the 2SLS estimates of the growth impact of induced variation in institutions. Figure 6 shows that the relationship between plague and institutional change strengthened over the first decades of the Reformation and declined. It also shows that the relationship between institutions and growth is slowly declines over time and then collapses to zero in the early 1540s, just before the Schalkaldic war, which initiated a new era in which relatively few cities adopted institutional change, as discussed above.

The instrumental variable estimates are larger than the OLS estimates reported in Section 5. The OLS results imply that cities with Reformation law by 1600 were about 0.25 log points larger in 1800 than comparable untreated cities. The instrumental variable design estimates a growth advantage of about 2 log points. The OLS estimates imply an annual growth rate advantage of 0.1% for the typical treated city. The IV estimate implies an annual growth rate advantage of 0.7%.

There are several possible explanations for the fact that the IV estimates are much larger than the OLS estimates. The first possibility is that IV estimates isolate exogenous variation in treatment and that unobserved city characteristics work to attenuate the OLS estimate. It is natural to assume that because legal change was associated with a growth advantage that cities would have positively selected into treatment. The historical evidence is not so clear. There is little evidence that the Reformation was adopted for directly economic reasons. In a few notable wealthy and well-connected cities, the municipal leadership was motivated to take an anti-Reformation position

by economic considerations, and were successful in preventing Protestant institutional change. Cologne is the classic example where an interest in preserving trade relationships motivated anti-Protestant behavior (Scribner, 1976). A second possibility is that the instrumental variable design recovers a cleaner measure of the true the nature or intensity of treatment. The legal institutions of the Reformation produced what North (1990) would recognize as local "institutional matrices." Our simple binary classification of institutions is a proxy for more nuanced variation in local rules and arrangements. It is possible that the IV captures underlying variation in institutions that are lost in proxy measurement error implicit in the binary treatment variable on which OLS relies. A third possibility is that the IV recovers underlying heterogeneity in the returns to treatment across cities. In the next section we present evidence to document the unique relationship between long-run growth and plague shocks in the early 1500s as opposed to plagues in other periods. The next section also shows that the adoption of Reformation institutions is explained by plague shocks in the early 1500s but not by plagues in other periods. This evidence weighs against the possibility that cities with plagues in the early 1500 were special places and supports the exogeneity and exclusion restrictions on which the research design rests.

### 6.3 Evidence in Support of Exclusion Restriction and Exogeneity

Our identification strategy requires that plague outbreaks in the early 1500s be random, conditional on observables, and only impact long run growth through their impact on institutions. In this section we document the unique relationship observed in the in the early 1500s between plagues and the long-run growth outcome, and between plagues of the early 1500s and the intermediate institutional outcome. We do this by flexibly estimating the period-by-period relationship between plague and these outcomes.

To assess whether plagues outbreaks are a plausible instrument, we first study the relationship between city growth and historic plague outbreaks from all pre-Reformation periods 1350-1525. We test the hypothesis that plagues in the early 1500s had a special relationship with long-run growth. We then similarly study the period-by-period relationship between historic plague outbreaks and the adoption of a Reformation law. This allows us to test a second hypothesis: that plagues in the early 1500s had a unique relationship with the intermediate institutional outcome. To test the first hypothesis, we estimate the following regression:

$$Log\ Population_{i,1800} = c + \sum_{t=1350}^{1500} \alpha_t \cdot plague_{i,t} + \beta \cdot X_{i,1300} + \epsilon_i, \tag{3}$$

where $plague_{i,t}$ is the number of plague outbreaks in city $i$ during period $t$, covering 25 year intervals. The parameters of interest are the $\alpha_t$ and our hypothesis is that $\alpha_{1500}$ is significant and positive. The $X_i$ contains control variables as of 1300: market rights by 1300, incorporation by 1300, 5 indicators for population (population in 1300 unobserved; 1,000-5,000; 6,000-10,000; 11,000-20,000; more than 20,000). We test the second hypothesis with a parallel regression set-up in which the outcome is the binary variable 1/0 for presence of a city-level Reformation law.

Table 5 presents the regression results of estimating equation (3) that support our instrumental variable design. Table 5 shows that city size in 1800 is only consistently predicted by plague outbreaks between 1500-1524 and plague outbreaks during the Black Death mega-shock of 1350-1374. Consistent with the historical evidence and our instrumental variable setup, plague outbreaks on the eve of the Reformation – when the introduction of religious competition made institutional responses feasible – had a unique relationship with long run growth when compared to outbreaks of similar severity across the entire 15th century. The finding that the Black Death is positively associated with long run city growth is consistent with Voigtländer and Voth (2013), who identify this shock as a critical juncture that led to faster growth in the European economy as a whole.[32]

We argue that plague outbreaks between 1500-1524 shifted the demand for Reformation laws because these transitory heath shocks were experienced by the generation in place when Reformation ideas hit the market. By this argument, plague outbreaks immediately before and during the Reformation should predict the adoption of Reformation laws.[33]

To test the second hypothesis, that Reformation era shocks had a special relationship with institutional change, we estimate equation (3) with an indicator variable whether a city had any ordinance by 1600 ($Reformation\ Law_{i,pre-1600}$). Table 5, columns 4-6 present the results. Consistent with our instrumental variable setup, plague outbreaks between 1500-1524 have a large positive effect on the propensity to adopt a Reformation law, while plagues in other periods across 1400s have limited predictive power. One additional plague outbreak in the early 1500s increases the probability of adopting a Reformation law by about 9 percentage points. Without additional controls, we can reject that plague outbreaks between 1350 and 1499 had no effect on the adoption of Reformation laws (column 4). Once we control for population in 1300, market rights by 1300 and town incorporation, we cannot reject that plagues between 1350 and 1499 had no effect on the adoption of Reformation laws (column 5 and 6).

## 7 The Formation and Location of Upper Tail Human Capital

In this section we examine how the production of upper tail human capital and migration decisions of the high skilled responded to the institutional changes of the Reformation. Our focus on the formation and location of high skilled individuals is motivated by the literatures on upper-tail human capital and historical economic development (Meisenzahl and Mokyr, 2012; Squicciarini and Voigtländer, 2015), the central role of migration in European city growth (Bairoch, 1991; De Vries, 2006), and human capital as a channel for the impact of the Protestant Reformation

[32] Voigtländer and Voth (2013) argue that the Black Death pushed Europe as a whole onto a faster growth path. Voigtländer and Voth (2013) argue that the Black Death by reducing labor supply, the Black Death increased wages including of female workers, that this shock led to a reallocation of labor within agriculture and to fertility restrictions that supported increased investments in human capital and ultimately faster economic and demographic growth. Our suggests the positive relationship between the Black Death and subsequent growth is observed even at the local level, in within-Europe variation.

[33] We cannot rule out a priori the possibility of intergenerational transmission of ideas bearing public health. To the extent these ideas were transmitted across generations, we would expect to see lagged shocks predict institutional change in the Reformation. The evidence suggests that any such effects were extremely limited.

(Becker and Woessmann, 2009; Strauss, 1988, 1978).

Our key finding is that Reformation institutions explain subsequent variations in the formation and location of talented and high skilled individuals. This evidence is consistent with Becker and Woessmann's (2009) finding that Protestantism was associated with literacy in the 1800s. However, unlike previous research, our evidence highlights the importance of human capital for local economic growth before the Industrial Revolution.[34]

### 7.1 Formation of Upper Tail Human Capital

We study the local formation of talent as a proxy for human capital and as an intermediate outcome connected to growth.

To examine how the legal institutions of the Reformation were related to the formation of talent and upper tail human capital we collect biographical data on over 3,000 notable individuals born 1200-1800 in the 239 cities in our sample and recorded in the *Deutsche Biographie*. The *Deutsche Biographie* provides what is to our knowledge the most comprehensive record of upper tail human capital individuals in German history.[35] There is no evidence that *Deutsche Biographie* selected on confession. Moreover, for selection to threaten our research design what would be required is that the *Deutsche Biographie* differentially included people born in Protestant cities with laws.[36]

We test whether cities with Reformation laws by 1600 produced more upper tail human capital in two ways. We first collapse the data in a pre-period and a post-period. The pre-period spans 1220-1519 and the post-period 1520-1820. We measure upper tail human capital with the number of people in the *Deutsche Biographie* and estimate the following regression, studying variations in the number of talented high skill achievers born in city $i$.

$$People_{it} = c_i + \alpha \cdot Post_t + \beta \cdot (Post_t \times Reformation\ Law_i) + \epsilon_{it}, \tag{4}$$

Table 6 shows the results of estimating equation (4). All cities are more likely to "produce" upper tail human capital, measured by having at least one person in the *Deutsche Biographie* born in a city between 1520-1820, and having a Reformation law does not increase this probability (column 1). However, cities with Reformation laws were 37 percent more likely to produce an above-median number of individuals with upper tail human capital between 1520-1820 (column 2). Similarly, cities with Reformation laws were 32 percent more likely to produce at least 6 such

[34] Meisenzahl and Mokyr (2012) and Squicciarini and Voigtländer (2015) document that the upper tail of the human capital distribution mattered for growth during the Industrial Revolution. These recent studies examining upper tail human capital are in part motivated by the finding that basic literacy appears to have had little effect on development during the British Industrial Revolution (Mitch, 1998).

[35] The *Deutsche Biographie* was originally produced by the historical commission of the Bayerischen Akademie der Wissenschaften in Bavaria.

[36] On the nature of the documentary evidence, Parker (1997, p. 187) observes, "Seventeenth-century Germans were scrupulous record-keepers, and the Thirty Years' War did little to change their habits of meticulous documentation. Here and there crucial records were destroyed by negligence or acts of war, but enough documents have survived to provide vast amounts of data about local conditions." Note that if anything war-time record losses would be biased against cities with laws.

people, the 75th percentile of the post-period distribution (column 3). The advantage also holds in the far upper tail of the post-period distribution. Cities with Reformation laws were 21 percent more likely to produce more than 10 high human capital people and 15 percent more likely to produce at least 16, the 90th percentile of the post-period distribution (columns 4 and 5).

We then then more flexibly examine the relative formation of upper tail human capital by studying the advantage cities ever treated by laws had in period by period. We assign individuals to the 50 year period in which they were the larger of 40 years old or their age at death. We then estimate regressions of the form:

$$People_{it} = \alpha_i + \delta_t + \sum_s \beta_s (Reformation\ Law_{i,pre-1600} \times Time_s) + \epsilon_{it}, \tag{5}$$

Figure 7 documents that the differential formation of upper tail human capital emerged only after the Reformation by plotting the time fixed effects common to all cities ($\delta_t$) and the incremental time fixed effects for cities that were ever treated by Reformation law ($\beta_s$).

### 7.2 Migration of Upper Tail Human Capital

Most pre-industrial city growth was driven by migration (De Vries, 2006; Bairoch, 1991). Hence it is natural to ask whether cities with Reformation laws attracted more migrants in general or only after after the establishment of legal institutions. To study how migration responded to the institutions we examine two sources of evidence: (1) data on migrants from the *Deutsche Biographie* and (2) the settlement decisions of Huguenot migrants in the late 1600s.

We first study the *Deutsche Biographie* as a source of rich evidence on the evolution of inter-city migration over time. In these data, we class as a migrant any individual who died in city $i$ but was born in some other location $j$.

Figure 8 shows that there is a sharp and discontinuous increase in the total number of migrants observed in cities with laws in the 1520s, whereas the evolution in the number of migrants in cities without laws does not change during the Reformation. Figure 8 plots the raw data on the number of migrants by city type and decade. To examine the variation controlling for time invariant city effects, we re-estimate equation (5) with the number of migrants on the left hand side. In Figure 9 we plot the parameter estimates on interaction terms as above. When we compare the pre-Reformation period to the post-Reformation period, we see that cities with laws experienced a larger positive shift in the level of migration in-flows and that a differential increase in the rate of growth in the number of migrants, as reflected in the steeper positive slope.

We next study Huguenot migrants as high skilled workers and entrepreneurs that a considerable literature suggests that profoundly shaped local development (Hornung, 2014). The Huguenots were Reform (Calvinist) Protestant refugees exiled from Catholic France in the late 1600s, known for their high level of skill and education. The Huguenots were invited by rulers of several German territories to settle in their lands. The Huguenots were offered various financial and other incentives to migrate

to Prussia. The Huguenots thus enjoyed considerable choice in where to settle (Lotz-Heumann, 2012; Hornung, 2014) and economic theory leads us to expect that migration decisions reflect selection over locations. In particular, it is natural to hypothesize that Huguenots chose locations in which their skills had the highest returns, where they would find qualified workers and apprentices, and which promised good education for their children. Locations with Reformation laws appear to have had these characteristics and hence to be places highly skilled religious refugees may have preferred to settle. To the extent that cities with Reformation laws were already differentially growing by the time the Huguenots arrived, these cities had most likely a higher demand for consumption goods and therefore a higher skill premium.[37]

To formally test whether Huguenots differentially migrated to cities that had adopted Reformation laws, we study cross-sectional data on the number of Huguenots observed in cities and towns across the principality of Brandenburg-Prussia around 1700 (Birnstiel and Bernat, 2001).[38] We examine two sets of Prussian cities. First, we restrict attention to cities in Bairoch et al. (1988) that were on Prussian territory in 1700.[39] Since this restriction reduces the sample to 35 cities, also examine the set of 83 cities in historic Brandenburg-Prussia that are listed in the subsequent Prussian census (Mützell, 1825).[40]

To document the relationship between settlement locations and institutions, we estimate the following regression:

$$Huguenots_i = c + \alpha \cdot Reformation\ Law_{i,pre-1600} + \beta \cdot X_i + \epsilon_i, \tag{6}$$

where Huguenots is an indicator variable equal to 1 if the number of Huguenots settling in city $i$ crosses a threshold. We first examine whether any Huguenots settled, then whether 100+ settled, then whether 200+ settled.[41]

Table 7 shows the results of estimating equation (6). In the Bairoch sample, the point estimate on having a Reformation law is positive and highly significant (column 1), implies that a Prussian city with a Reformation law was 66 percent more likely to attract Huguenot settlers than Prussian cities without law. We repeat the estimation on the Prussian cities in Mützell (1825). In this sample, cities with Reformation law were 49 percent more likely to be chosen as settlement locations by Huguenots (column 2). Similarly, cities with laws were 48 percent more likely to attract at least 100 Huguenots (column 3) and 17 percent more likely to attract a community of 200+ Huguenots.

[37] Our results examining high skilled workers in the panel and results on city-level panel data in the appendix suggest cities with Protestant institutions were differentially growing over this period. Hornung (2014) argues that, while Huguenots were generally free to choose their place of settlement, the Huguenots repopulated area that were particularly hard hit by the Thirty Years War (1618-1648).

[38] Local authorities compiled detailed cross-sectional evidence on the number of Huguenots settling in different cities and towns.

[39] We restrict the sample of cities to those on the territories Pommern, Brandenburg, Mark-Kleve, Hohnstein-Halberstadt, Ravensberg, Minden, Mecklenburg, Lingen, Moers, Magdeburg, and Preussisch Geldern.

[40] The larger set of cities in (Mützell, 1825) includes cities with population under 5,000 which as a result do not enter the Bairoch et al. (1988) data.

[41] In the appendix we show that our results are robust to estimating the relationship using a regression model for count data and to examining alternate datasets on Huguenot settlement patterns.

# 8 Conclude

We construct new evidence on the municipal laws of the Protestant Reformation. We document that these laws strongly predict future city growth over long time horizons. We show that plague outbreaks worked as demand shifters for institutional change. Plague was a feature of the European social landscape since the 1300s. But with the introduction of religious and institutional competition during the Reformation, the plague suddenly increased the probability of fundamental institutional changes that had long-run growth implications. Cities that experienced plague outbreaks in the early 1500s were significantly more likely to adopt Protestant laws. Cities that adopted the legal infrastructure of the Reformation enjoyed a persistent population growth advantage of between 0.1% and 0.7% per year over two centuries.

The institutions we study were laws that bundled religious, anti-corruption, educational, and social welfare interventions, and significantly increased state capacity at the local level. Narrative evidence strongly suggests the importance of innovations in mass public education. We document the impact of Reformation laws on upper tail human capital. We find that cities that adopted the laws of the Reformation subsequently produced and attracted more individuals with upper tail human capital over the long period running from the early 1500s through 1800. No previous research has documented the impact of these legal instititutions or indeed of the human capital channel on local growth before the industrial revolution.

## References


Acemoglu, D., Johnson, S., Robinson, J. A., 2001. The colonial origins of comparative development: An empirical investigation. American Economic Review 91, 1369–1401.

Acemoglu, D., Johnson, S., Robinson, J. A., 2005a. Institutions as fundamental cause of long-run growth. In: Aghion, P., Durlauf, S. N. (eds.), *Handbook of Economic Growth, Vol. 1A*, Elsevier, New York.

Acemoglu, D., Johnson, S., Robinson, J. A., 2005b. The rise of europe: Atlantic trade, institutional change, and economic growth. American Economic Review 95, 546–579.

Bairoch, P., 1991. Cities and Economic Development: From the Dawn of History to the Present. University of Chicago Press.

Bairoch, P., Batou, J., Chèvre, P., 1988. Population des villes européennes de 800 à 1850 : banque de données et analyse sommaire des résultats (la). Librairie Droz, Genève.

Barro, R. J., McCleary, R. M., 2003. Religion and economic growth across countries. American Sociological Review 68, 760–781.

Basten, C., Betz, F., et al., 2013. Beyond work ethic: Religion, individual, and political preferences. American Economic Journal: Economic Policy 5, 67–91.

Bayerischen Akademie der Wissenschaften, 2015. Deutsche biographie.

Becker, S. O., Woessmann, L., 2009. Was weber wrong? a human capital theory of protestant economic history. Quarterly Journal of Economics 124, 531–596.

Besley, T., Persson, T., 2009. The origins of state capacity: Property rights, taxation, and politics. American Economic Review 99, 1218–44.

Biraben, J., 1975. Les hommes et la peste en France et dans les pays européens et méditerranéens: La peste dans l'histoire. Civilisations et societes ; 35-36, Mouton.

Birnstiel, E., Bernat, C., 2001. La Diaspora des Huguenots: Les Réfugiés Protestants de France et Leur Dispersion dans le Monde, XVIe-XVIIIe Siècles. Champion, Paris.

Brady, T., 2009. German Histories in the Age of Reformations, 1400-1650. Cambridge University Press.

Broadhead, P., 1979. Popular pressure for reform in augsburg, 1524-1534. In: Mommsen, W. (ed.), *Stadtbürgertum und Adel in der Reformation*, Ernst Klett, Stuttgart.

Cameron, A. C., Gelbach, J. B., Miller, D. L., 2008. Bootstrap-based improvements for inference with clustered errors. Review of Economics and Statistics 90, 414–427.

Cameron, E., 1991. The European Reformation. History Reference Center, Clarendon Press.

Cantoni, D., 2012. Adopting a new religion: the case of protestantism in 16th century germany*. The Economic Journal 122, 502–531.

Cantoni, D., 2015. The economic effects of protestant reformation: Testing the weber hypothesis in the german lands. Journal of the European Economic Association 13, 561–598.

Cantoni, D., Dittmar, J., Yuchtman, N., 2015. Reformation and reallocation: Human capital, employment, and economic growth in the german lands. In: *Working Paper*.

Cantoni, D., Yuchtman, N., 2014. Medieval universities, legal institutions, and the commercial revolution. Quarterly Journal of Economics 129, 823–887.

De Long, J. B., Shleifer, A., 1993. Princes and merchants: European city growth before the industrial revolution. Journal of Law and Economics, 36, 671–702.

De Vries, J., 2006. European Urbanization, 1500-1800. City (Routledge (Firm))))), Routledge.

Dell, M., 2012. Path dependence in development: Evidence from the mexican revolution. In: *Working Paper*.

Dickens, A., 1979. Intellectual and social forces in the german reformation. In: Mommsen, W. (ed.), *Stadtbürgertum und Adel in der Reformation*, Ernst Klett.

Dittmar, J. E., Seabold, S., 2015. New Media, Religion, and Economic Change: Printing and the Protestant Reformation. unpublished manuscript, LSE, London.

Dormeier, H., 1989. Laienfrömmigkeit in den bestzeiten des 15./16. jahrhunderts. In: Bulst, N., Delort, R. (eds.), *Maladie et Société (XII-XVIII siecèles*, Centre National de la Recherche Scientifique, Paris.

Dorpalen, A., 1985. German History in Marxist Perspective: The East German Approach. I.B. Tauris.

Dykema, P., Oberman, H., 1993. Anticlericalism: in late medieval and early modern Europe. E.J. Brill.

Eisenstein, E., 1980. The Printing Press as an Agent of Change. Cambridge University Press.

Fujiwara, T., 2015. Voting technology, political responsiveness, and infant health: Evidence from brazil. Econometrica 83, 423–464.

Glaeser, E. L., Scheinkman, J. A., Shleifer, A., 1995. Economic growth in a cross-section of cities. Journal of Monetary Economics 36, 117–143.

Grell, O. P., 2002. The protestant imperative of christian care and neighborly love. In: Cunningham, A., Grell, O. P. (eds.), *Health Care and Poor Relief in Protestant Europe 1500-1700*, Routledge, London.

Grendler, P., 1989. Schooling in Renaissance Italy: Literacy and Learning, 1300-1600. No. pt. 1 in ACLS Humanities E-Book, Johns Hopkins University Press.

Guiso, L., Sapienza, P., Zingales, L., 2003. People's opium? religion and economic attitudes. Journal of monetary economics 50, 225–282.

Hamm, B., 1994. The urban reformation in the holy roman empire. In: Brady, T., Oberman, H., Tracy, J. (eds.), *Visions, Programs and Outcomes*, Brill.

Hornung, E., 2014. Immigration and diffusion of technology: The huguenot diaspora in prussia. American Economic Review 104, 84–122.

Huppert, G., 1984. Public schools in Renaissance France. University of Illinois Press.

Jankrift, K. P., 2008. 2 the language of plague and its regional perspectives: The case of medieval germany. Medical History 52, 53–58.

Johnson, T., 2009. Magistrates, Madonnas and Miracles: The Counter Reformation in the Upper Palatinate. St. Andrews studies in Reformation history, Ashgate.

Lindemann, M., 2010. Medicine and Society in Early Modern Europe. New Approaches to European History, Cambridge University Press.

Lotz-Heumann, U., 2012. Reformierte konfessionsmigration: Die hugenotten.

Meisenzahl, R. R., Mokyr, J., 2012. The rate and direction of invention in the industral revolution: Incentives and institutions. In: Lerner, J., Stern, S. (eds.), *The Rate and Direction of Inventive Activity Revisited*, University of Chicago Press, Chicago.

Mitch, D., 1998. The role of education and skill in the british industrial revolution. In: Mokyr, J. (ed.), *The British Industrial Revolution: An Economic Perspective*, Westview Press, Boulder, CO.

Moeller, B., 1972. Imperial Cities and the Reformation: Three Essays. Fortress Press.

Mützell, A. A., 1825. Neues topographisch-statistisch-geographisches Wörterbuch des Preussischen Staats, vol. 6. Kümmel, Halle.

North, D., 1990. Institutions, Institutional Change and Economic Performance. Political Economy of Institutions and Decisions, Cambridge University Press.

Ozment, S., 1980. The Age of Reform, 1250-1550: An Intellectual and Religious History of Late Medieval and Reformation Europe. Yale University Press.

Ozment, S. E., 1975. The Reformation in the Cities: The Appael of Protestantism to Sixteenth Century Germany and Switzerland, vol. 357. Yale University Press.

Parker, G., 1997. The Thirty Years War. Routledge, London.

Pettegree, A., 2005. Reformation and the Culture of Persuasion. Cambridge University Press.

Pierson, P., 2011. Politics in Time: History, Institutions, and Social Analysis. Princeton University Press.

Richter, A. L., 1846a. Die evangelischen Kirchenordnungen des sechszehnten Jahrhunderts: Urkunden und Regesten zur Geschichte des Rechts und der Verfassung der evangelischen Kirche in Deutschland, Band 1. Weimar: Verlag des Landes Industriecomptoirs.

Richter, A. L., 1846b. Die evangelischen Kirchenordnungen des sechszehnten Jahrhunderts: Urkunden und Regesten zur Geschichte des Rechts und der Verfassung der evangelischen Kirche in Deutschland, Band 2. Weimar: Verlag des Landes Industriecomptoirs.

Rittgers, R., 2012. The Reformation of Suffering: Pastoral Theology and Lay Piety in Late Medieval and Early Modern Germany. Oxford Studies in Historical Theology, OUP USA.

Roeck, B., 1999. Health care and poverty relief in counter-reformation catholic germany. In: Grell, O., Cunningham, A., Arrizabalaga, J. (eds.), *Health Care and Poor Relief in Counter-Reformation Europe*, Routledge, Studies in the social history of medicine.

Rubin, J., 2014. Printing and protestants: an empirical test of the role of printing in the reformation. Review of Economics and Statistics 96, 270–286.

Schilling, H., 1983. The reformation in the hanseatic cities. The Sixteenth Century Journal 14, pp. 443–456.

Scribner, R., 1976. Why was there no reformation in cologne?1. Historical Research 49, 217–241.

Scribner, R., 1979. The reformation as a social movement. In: Mommsen, W. (ed.), *Stadtbürgertum und Adel in der Reformation*, Ernst Klett, Stuttgart.

Sehling, E., 1911. Die evanglischen Kirchenverordnungen des XVI. Jahrhunderts, multiple volumes. O.R. Reisland, Leipzig.

Slack, P., 1988. Responses to plague in early modern europe: The implications of public health. Social Research 55, 433–453.

Slack, P., 2012. Plague: A Very Short Introduction. Very Short Introductions, OUP Oxford.

Speer, C., 2014. Strategian des machterhalts in zeiten des umbruchs: Der görlizter rat zu beginn des 16. jahrhunderts. In: Heimann, H., Neitmann, K., Tresp, U., Eberhard, W., Müller, W., Speer, C., Dannenberg, L., Franke, E., Wüst, W., Bergmann, J., et al. (eds.), *Die Nieder- und Oberlausitz – Konturen einer Integrationslandschaft: Band II: Frühe Neuzeit*, Lukas Vlg Fuer Kunst Und, Studien zur brandenburgischen und vergleichenden Landesgeschichte.

Squicciarini, M., Voigtländer, N., 2015. Human capital and industrialization: Evidence from the age of enlightenment. Quarterly Journal of Economics 130, 1825–1883.

Stein, C., 2009. Negotiating the French Pox in Early Modern Germany. The history of medicine in context, Ashgate.

Strauss, G., 1978. Luther's House of Learning: Indoctrination of the Young in the German Reformation. John Hopkins University Press, Baltimore.

Strauss, G., 1988. The social function of schools in the lutheran reformation in germany. History of Education Quarterly 28, 191–206.

Tilly, C., 1992. Coercion, Capital, and European States, AD 990-1990. Studies in social discontinuity, Blackwell.

Voigtländer, N., Voth, H.-J., 2013. How the west. The American Economic Review 103, 2227–2264.

Weber, M., 1904. Die protestantische ethik under 'geist' des kapitalismus. Archiv für Sozialwissenschaft 20, 1–54.

Whaley, J., 2012. Germany and the Holy Roman Empire: Volume I: Maximilian I to the Peace of Westphalia, 1493-1648. Germany and the Holy Roman Empire, OUP Oxford.

Witte, J., 2002. Law and Protestantism: The Legal Teachings of the Lutheran Reformation. Cambridge University Press, New York.

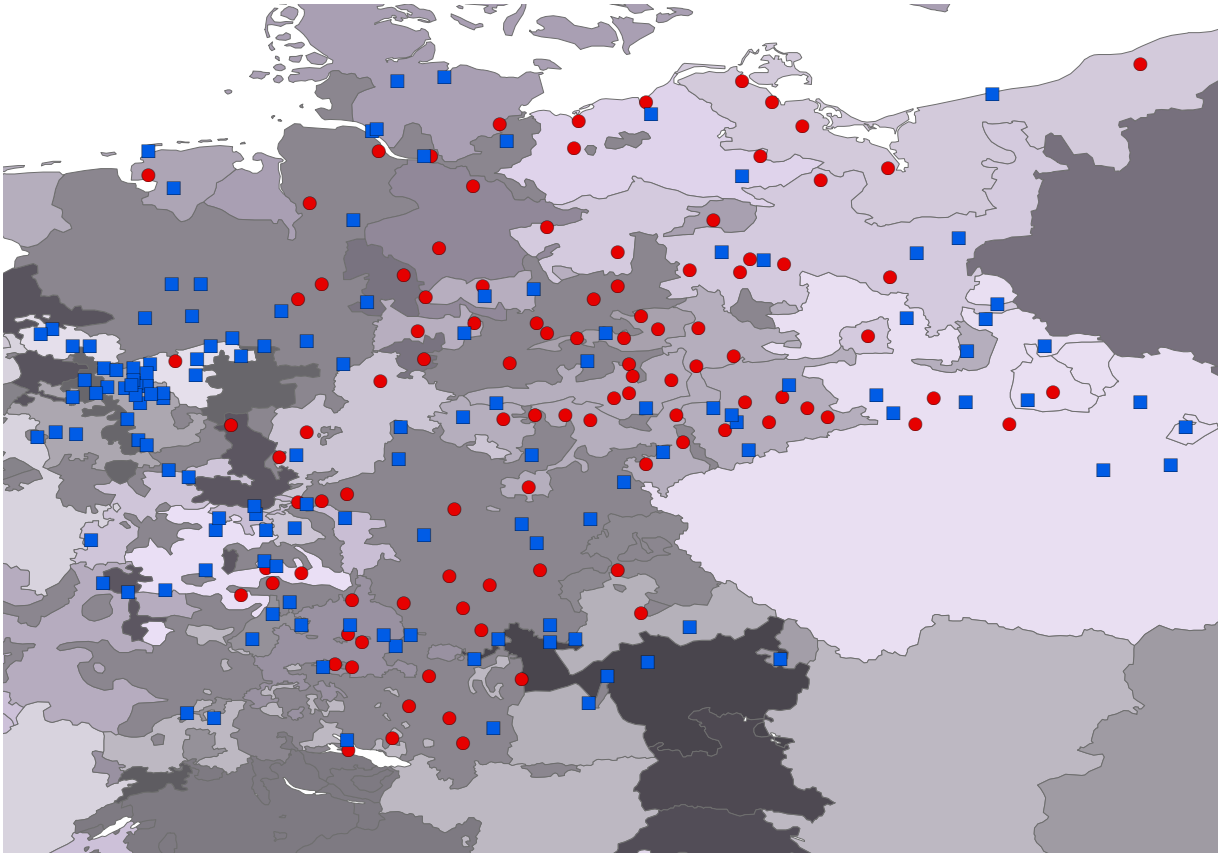

Figure 1: **Cities with and without Reformation Laws**: This map shows cities with Reformation Laws (red circles) and without these laws (blue squares). Cities without laws include Catholic cities.

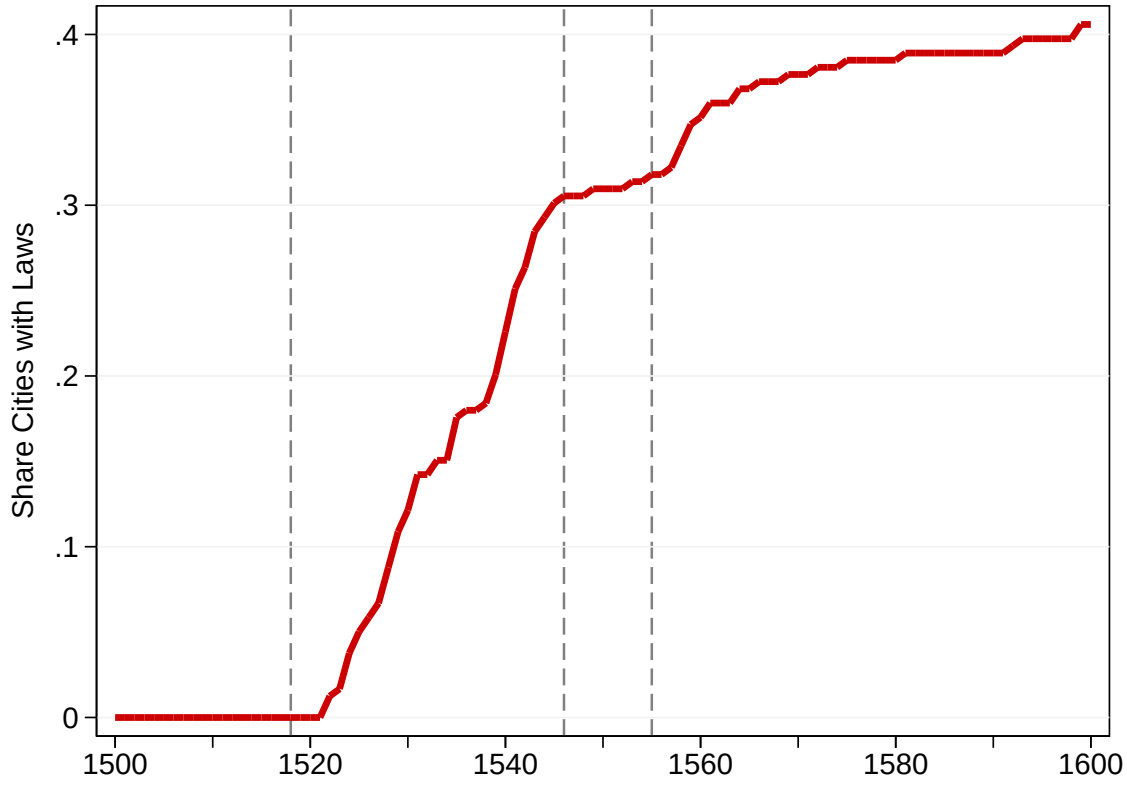


Figure 2: **The Share of Cities with Protestant Laws**: This graph shows the share of cities having passed a Reformation Law. The vertical line at 1518 marks the initial mass circulation of Luther's ideas. The line at 1546 marks the date of the Schmalkaldic War between Catholic and Protestant princes. The line at 1555 marks the Peace of Augsburg which established a new religious equilibrium in law, with provisions for lords' religious perogatives in their territories and for cities with mixed control over churches and magistracies.

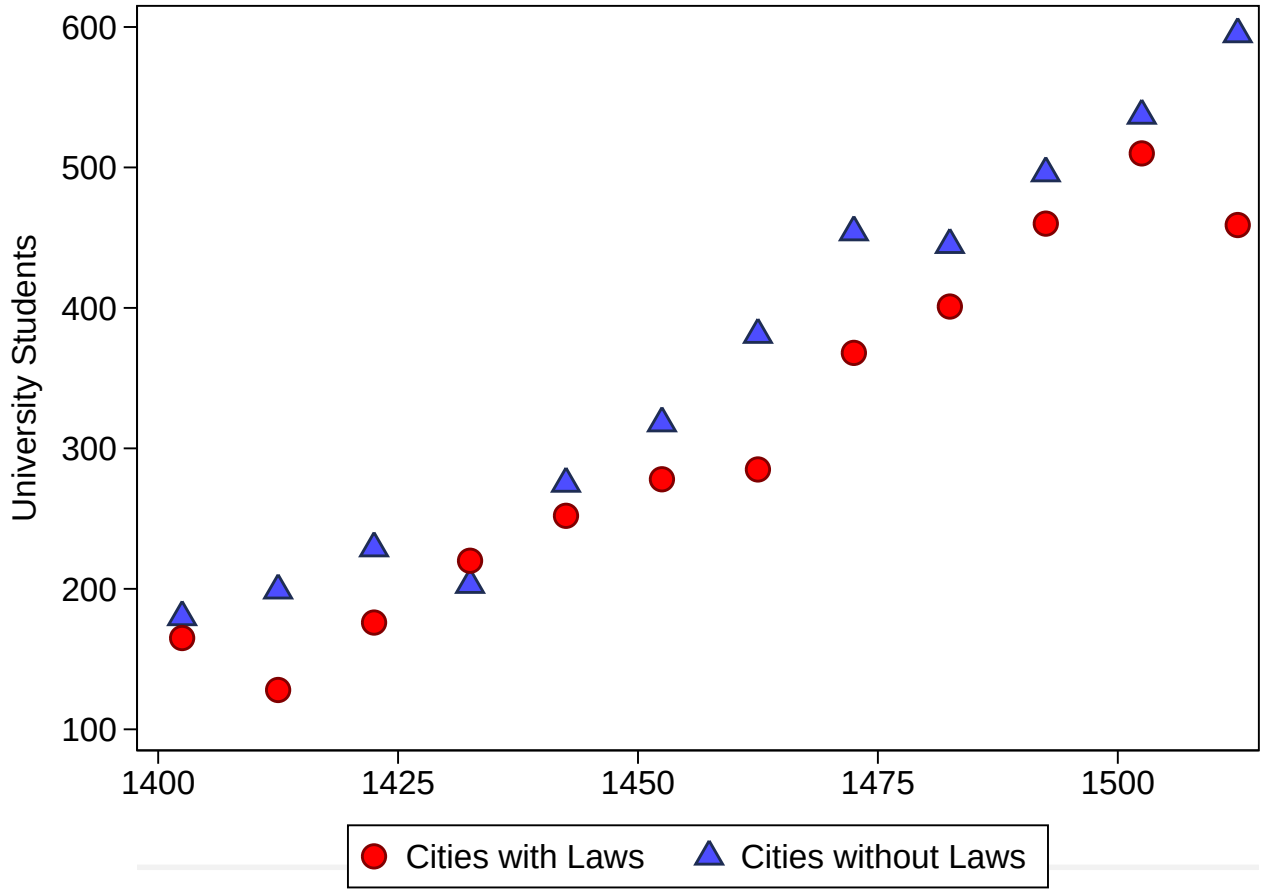


Figure 3: **Pre-Trends in University Degrees:** This graph shows the number of students from subsequently treated and untreated cities who received university degrees each 10-year period before the Reformation. Source: Micro-data on degree recipients from German universities 1400-1517 from Cantoni et al. (2015).

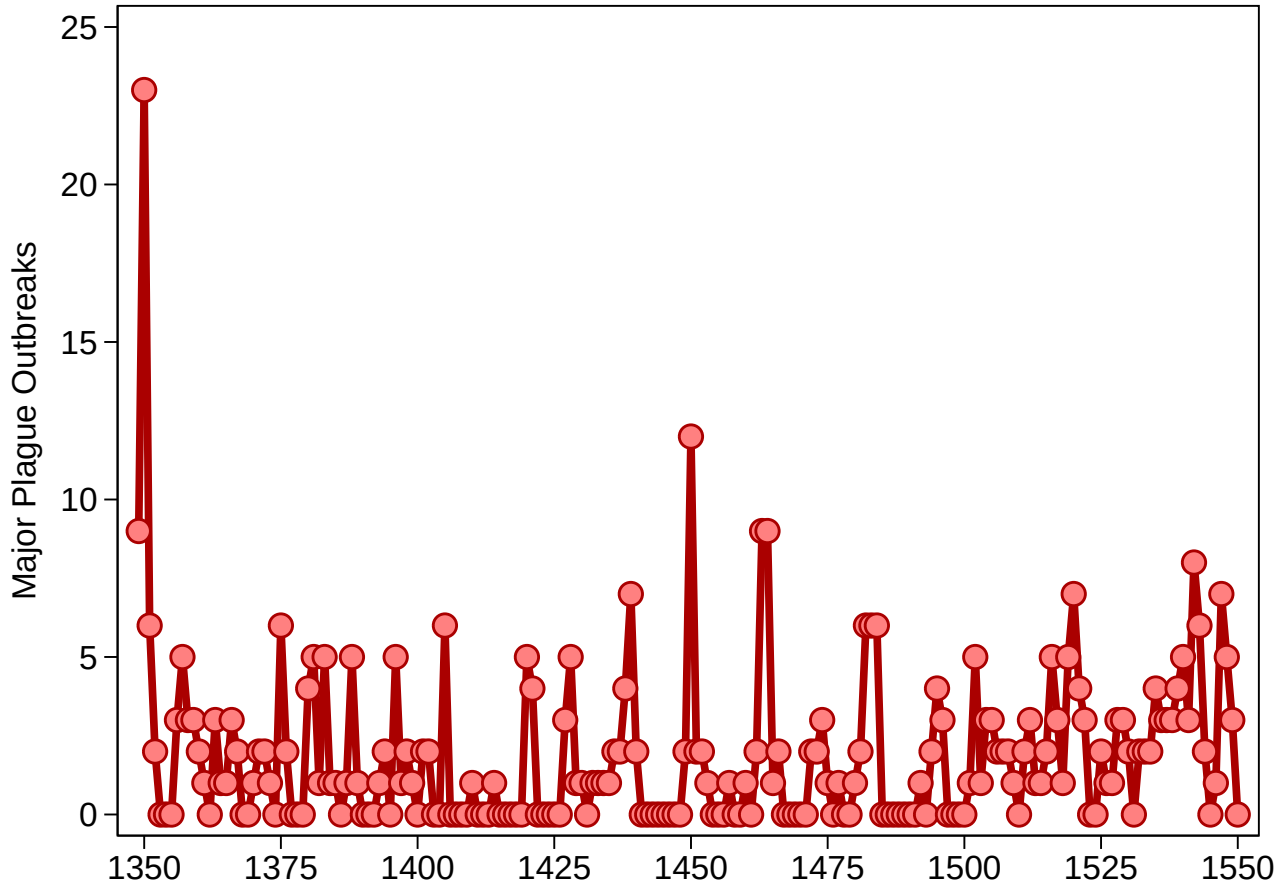


Figure 4: **Aggregate Plague Outbreaks**: This graph shows the total number of plagues between 1350-1550 in cities in our sample. Source: Biraben (1975).

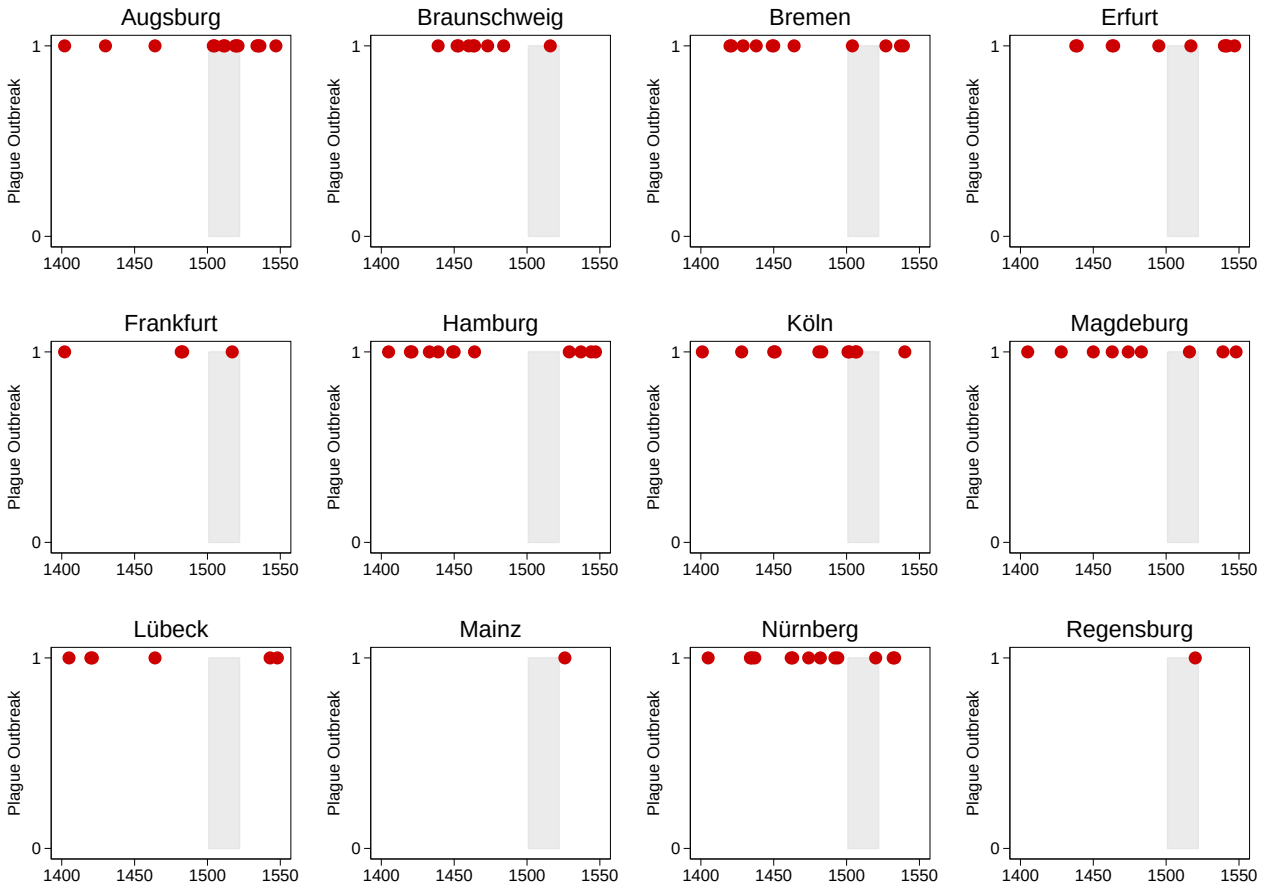


Figure 5: **City-Level Plague Outbreaks**: This graph shows major plague outbreaks in selected cities between 1350-1550. Source: Biraben (1975).

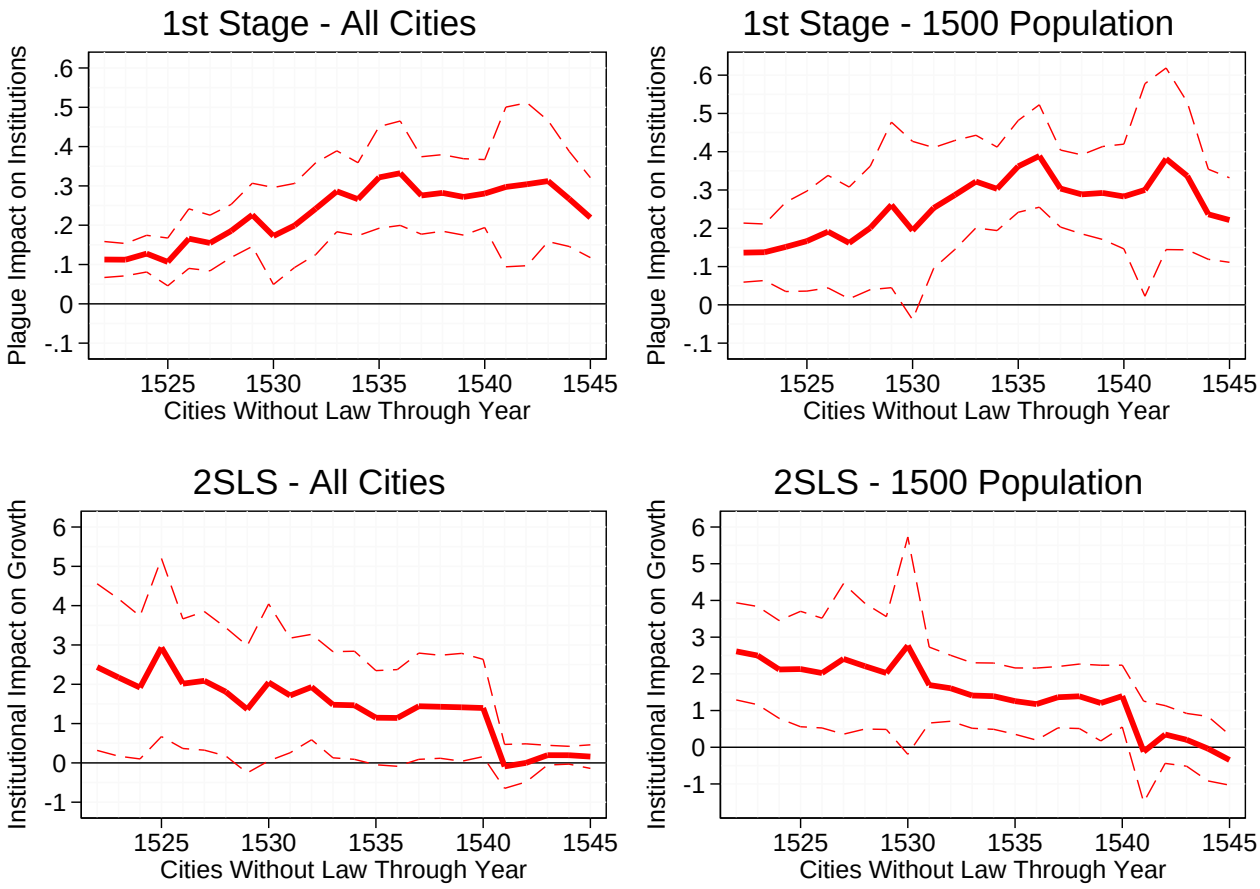


Figure 6: **Rolling IV regressions**: The top row shows the first stage estimates of the effect of plagues on the adoption of Reformation laws. For each year, only cities that have not adopted a law by the respective year are in the sample. Plagues are the number of plagues in the 20 years before the respective year. The left panel is estimated over all cities in the data, and includes territority fixed effects and categorical controls for 1500 population ("All Cities"). The right panel is estimated over cities with population in 1500 observed, controls for log population in 1500 and does not include territory fixed effects ("1500 Population"). The bottom panel shows corresponding IV estimates of the impact of institutions on growth, using variation in Reformation laws induced by recent exposure to plague. All regressions include the same control variables as in section 6.2. Standard errors are clustered at the territory level. The red dashed line represents the 90 percent confidence interval for the "All Cities" specifications and the 95 percent confidence interval for the "1500 Population" specifications.

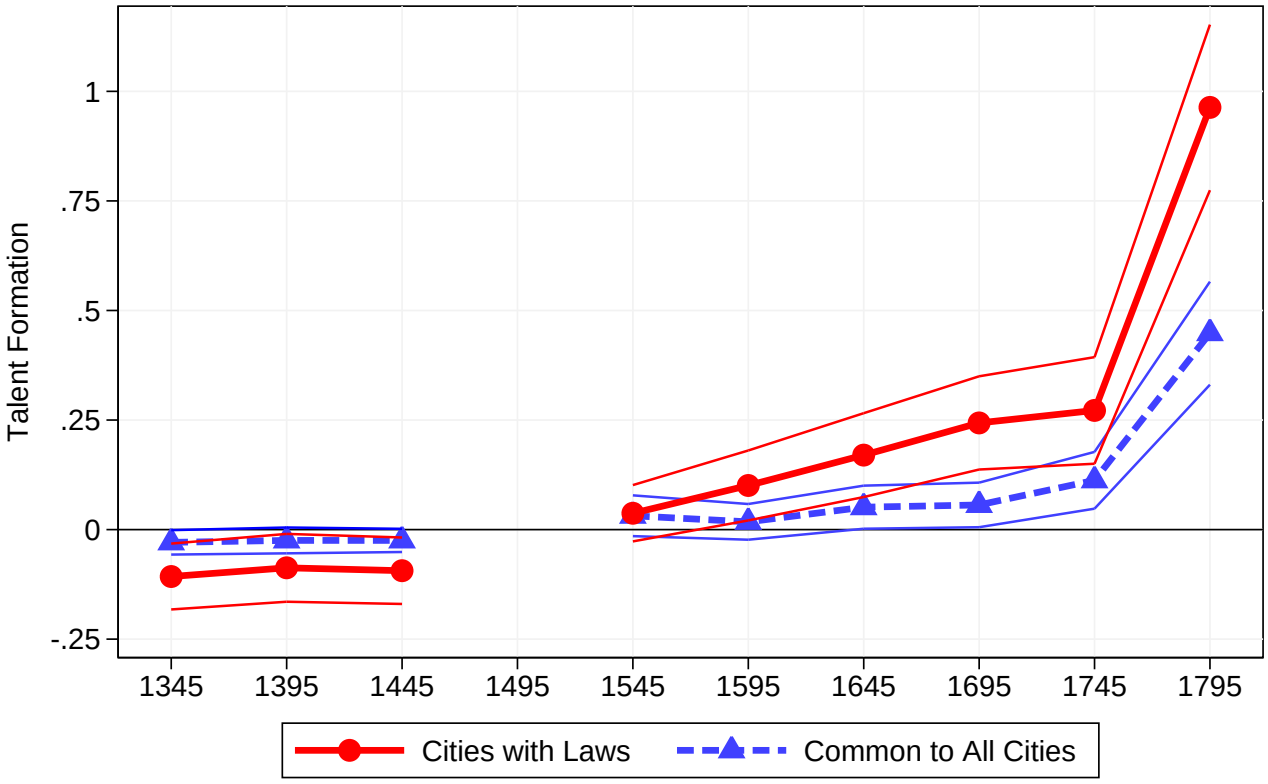


Figure 7: **Regression analysis of the formation of upper tail human capital**: This graph plots the estimated regression parameters on the interaction between "ever having Reformation Law" and time period fixed effects from estimating equation (5). The dependent variable is an indicator for having at least 2 individuals born in city $i$ in period $t$ in the *Deutsche Biographie*. The regression model controls for city and time period fixed effects and examines the baseline set of 239 historic cities. The omitted time category is 1470-1519. The variation common to all cities is $\delta_t$. The incremental variation specific to cities with laws is $\beta_s$.

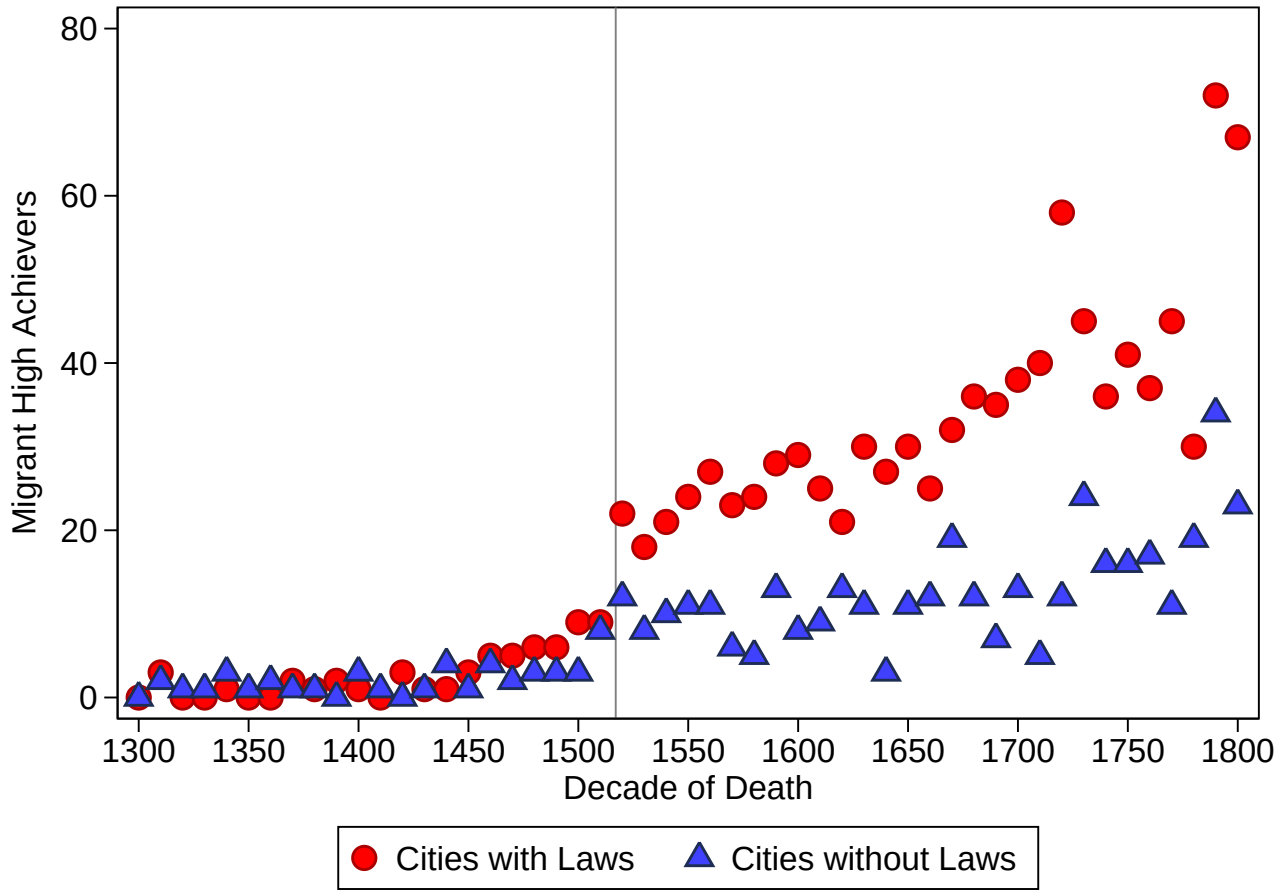


Figure 8: **The migration of upper tail human capital**: This graph plots the absolute number of talented and high skill migrants observed at the decade level in cities with and without laws. Data from the *Deutsche Biographie* on people migrating to the 239 cities in our baseline data. Migrants are identified as people living and dying in town $i$ but born in some other location $k$. The vertical line is at 1518, the year Luther's theses began circulating widely.

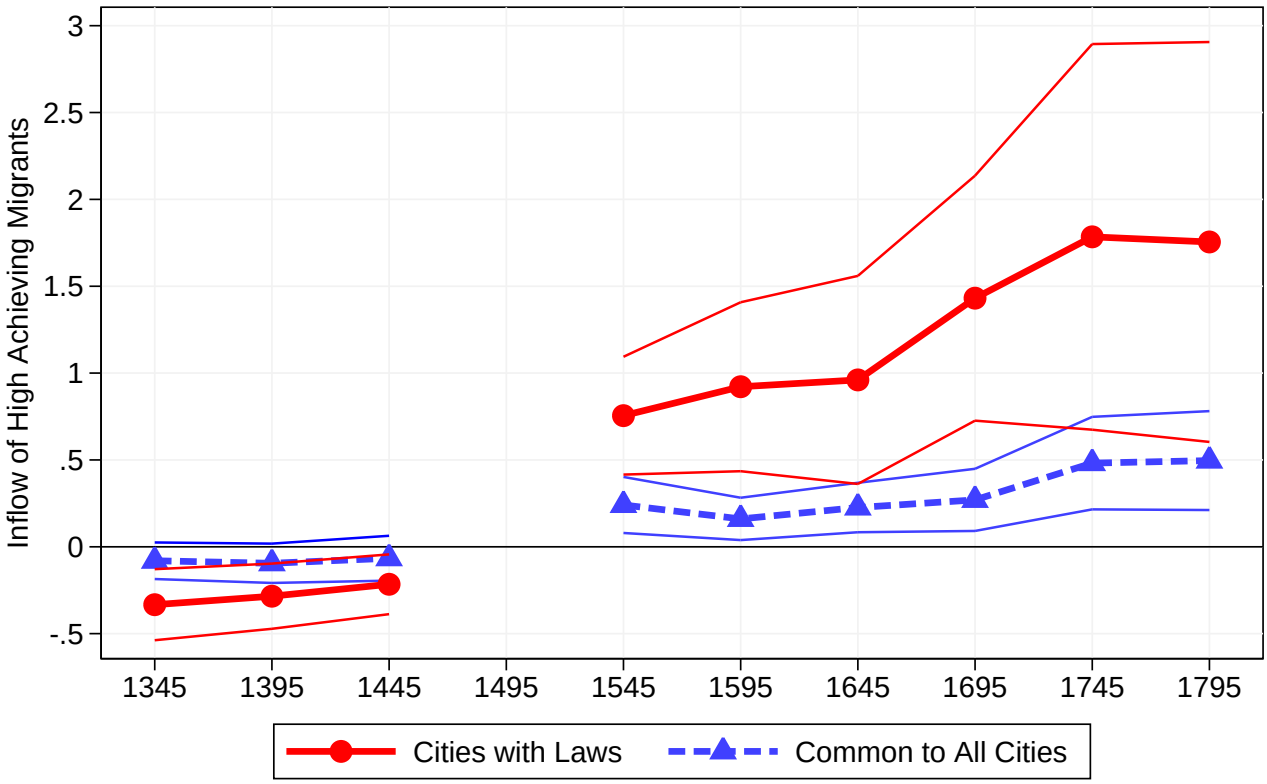


Figure 9: **Regression analysis of the migration of upper tail human capital**: This graph plots the estimated regression parameters on the interaction between "ever having Reformation Law" and time period fixed effects from estimating equation (5). The regression model controls for city and time period fixed effects and examines the baseline set of 239 cities. The omitted time category is 1470-1519. The variation common to all cities is $\delta_t$. The incremental variation specific to cities with laws is $\beta_s$.

Table 1: Summary Statistics

This table presents the summary statistics for our main regression variables. Reformation law is an indicator variable whether a city had any ordinance by 1600. Number of university students is the number of students coming from each city.

| | N | Mean | Sd | 25% | 50% | 75% |
|---|---|---|---|---|---|---|
| Reformation Law Indicator | 239 | 0.43 | 0.50 | 0 | 0 | 1 |
| Log (Population$_{1800}$/1000) | 239 | 1.92 | 0.73 | 1.61 | 1.79 | 2.20 |
| Log (Population$_{1500}$/1000) | 110 | 1.60 | 0.86 | 1.10 | 1.61 | 2.20 |
| Town Incorporation pre-1517 Indicator | 239 | 0.41 | 0.49 | 0 | 0 | 1 |
| Market Rights pre-1517 Indicator | 239 | 0.40 | 0.49 | 0 | 0 | 1 |
| Number of Books printed pre-1517 | 239 | 95.81 | 567.91 | 0 | 0 | 0 |
| Reichsstadt Indicator | 239 | 0.18 | 0.38 | 0 | 0 | 0 |
| University Pre-1517 Indicator | 239 | 0.05 | 0.22 | 0 | 0 | 0 |
| Number of University Students 1398-1508 | 239 | 31.01 | 47.13 | 6 | 18 | 39 |
| Number of Plagues 1400-1499 | 239 | 0.44 | 1.55 | 0 | 0 | 0 |
| Number of Plagues 1500-1522 | 239 | 0.17 | 0.71 | 0 | 0 | 0 |

Table 2: Summary Statistics by Reformation Law Status

This table presents the summary statistics for our main regression variables by Reformation law status. Reformation law is an indicator variable whether a city had any ordinance by 1600. Number of university students is the number of students coming from each city.

| | Cities with Law | | | Cities without Law | | | Difference |
|---|---|---|---|---|---|---|---|
| | N | Mean | Sd | N | Mean | Sd | |
| Log (Population$_{1800}$/1000) | 102 | 2.17 | 0.77 | 137 | 1.73 | 0.64 | 0.45*** |
| Log (Population$_{1500}$/1000) | 68 | 1.75 | 0.84 | 42 | 1.35 | 0.84 | 0.40** |
| Town Incorporation pre-1517 Indicator | 102 | 0.42 | 0.50 | 137 | 0.41 | 0.49 | 0.01 |
| Market Rights pre-1517 Indicator | 102 | 0.39 | 0.49 | 137 | 0.41 | 0.49 | 0.02 |
| Number of Books printed pre-1517 | 102 | 159.23 | 724.96 | 137 | 48.64 | 410.90 | 110.59 |
| Reichsstadt Indicator | 102 | 0.29 | 0.46 | 137 | 0.09 | 0.28 | 0.21*** |
| University Pre-1517 Indicator | 102 | 0.07 | 0.25 | 137 | 0.04 | 0.21 | 0.03 |
| Number of University Students 1398-1508 | 102 | 36.07 | 39.48 | 137 | 27.24 | 51.93 | 8.83 |
| Number of Plagues 1400-1499 | 102 | 0.87 | 2.21 | 137 | 0.12 | 0.61 | 0.76*** |
| Number of Plagues 1500-1522 | 102 | 0.32 | 0.97 | 137 | 0.05 | 0.37 | 0.27*** |

Table 3: City Size and Reformation Laws

This table presents the regression results of estimating the effect of reformation laws on log population in 1800. "Reformation Law" is an indicator variable whether a city had any ordinance by 1600. Distance from Wittenberg is measured in kilometers. "Protestant" is an indicator for cities where Protestantism became the dominant religion and is from Cantoni (2012). Controls are: Market rights by 1517, town incorporated by 1517, four indicators for number of books that were printed in a city by 1517 (0, 1-100, 101-1000, more than 1000), university by 1517 indicator, Reichsstadt indicator, number of university students in each decade from 1398-1508, and average number of plagues 1400-1499. Geographical controls are longitude, latitude, and the interaction of longitude and latitude. Cantoni controls are year city turned Protestant, river indicator, Hanse indicator, Reichsstadt indicator, year city founded, monastery indicator, university indicator, and printing press indicator. Population bins are 5 indicator variables (population in 1500 data missing, 1,000-5,000, 6,000-10,000, 11,000-20,000, and more than 20,000). Population bins in column 8 are for population in 1400. ***, **, * denotes 1%, 5%, and 10% statistical significance. Standard errors are clustered at the 1500 territory level. Territories are from Euratlas. Wild bootstrap confidence intervals estimated using the methodology of Cameron et al. (2008).

| | Main Specification Ln Population in 1800 | | | | | | Placebo Ln Population in 1500 |
|---|---|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] | [6] | [7] |
| Reformation Law | 0.26** | 0.26** | 0.25** | | 0.31*** | 0.34 | 0.18 |
| Clustered SE | (0.11) | (0.11) | (0.00) | | (0.09) | (0.22) | (0.18) |
| Wild Bootstrap 95% CI | [0.08, 0.47] | [0.08, 0.45] | [0.07, 0.38] | | [0.16, 0.46] | [0.06, 0.63] | -0.04,0.40] |
| Distance from Wittenberg | | | | -0.05 | -0.02 | | |
| Clustered SE | | | | (0.09) | (0.07) | | |
| Wild Bootstrap 95% CI | | | | [-0.21, 0.09] | [-0.14, 0.10] | | |
| Protestant | | | | -0.00 | -0.04 | | |
| Clustered SE | | | | (0.16) | (0.16) | | |
| Wild Bootstrap 95% CI | | | | [-0.28, 0.27] | [-0.31, 0.23] | | |
| Population Bin FE | Yes | Yes | Yes | Yes | Yes | No | Yes |
| Controls | No | Yes | Yes | No | No | Yes | Yes |
| Geo Controls | No | No | Yes | No | No | No | Yes |
| Cantoni Controls | No | No | No | Yes | Yes | No | No |
| Log Population in 1500 | No | No | No | No | No | Yes | No |
| Territory FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 239 | 239 | 239 | 239 | 239 | 110 | 110 |
| $R^2$ | 0.46 | 0.52 | 0.52 | 0.49 | 0.51 | 0.64 | 0.79 |

Table 4: Instrumental Variable Regression: City Size and Reformation Laws

This table presents the instrumental variable regression results of estimating the effect of reformation laws on log population in 1800. Reformation law is an indicator variable whether a city had any ordinance by 1600. The instrument is average number of plagues 1500-1522. Controls are: Market rights by 1517, town incorporated by 1517, four indicators for number of books that were printed in a city by 1517 (0, 1-100, 101-1000, more than 1000), university by 1517 indicator, Reichsstadt indicator, number of university students in each decade from 1398-1508, and average number of plagues 1400-1499. Population bins are 5 indicator variables (population in 1500 data missing, 1,000-5,000, 6,000-10,000, 11,000-20,000, and more than 20,000). ***, **, * denotes 1%, 5%, and 10% statistical significance. Standard errors are clustered at the 1500 territory level.

| | Full Sample | | | | Population in 1500 available | | | |
|---|---|---|---|---|---|---|---|---|
| | Reform Law | Ln Population in 1800 | Reform Law | Ln Population in 1800 | Reform Law | Ln Population in 1800 | Reform Law | Ln Population in 1800 |
| Plagues 1500-1522 | 0.13*** | | 0.12*** | | 0.14*** | | 0.10* | |
| | (0.02) | | (0.02) | | (0.04) | | (0.06) | |
| Reformation Law | | 1.64* | | 2.03* | | 2.46*** | | 3.97** |
| | | (0.88) | | (1.09) | | (0.72) | | (1.59) |
| F-Statistic on IV | 38.74 | | 26.00 | | 11.14 | | 2.82 | |
| Population Bin FE | Yes | Yes | Yes | Yes | No | No | No | No |
| Log Population in 1500 | No | No | No | No | Yes | Yes | Yes | Yes |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Territory FE | No | No | Yes | Yes | No | No | Yes | Yes |
| Observations | 239 | 239 | 239 | 239 | 110 | 110 | 110 | 110 |

Table 5: Plagues, City Size, and Reformation Laws

This table presents the regression results of estimating the effect of plagues on log population in 1800 and on the adoption of Reformation laws. Reformation law is an indicator variable whether a city had any ordinance by 1600. Plagues are the average number of plagues of the respective 25 years. Controls are indicators for market rights by 1300 and incorporation by 1300. Population bins are 5 indicator variables (population in 1300 data missing, 1,000-5,000, 6,000-10,000, 11,000-20,000, and more than 20,000). ***, **, * denotes 1%, 5%, and 10% statistical significance. Standard errors are clustered at the region level.

| | Ln Population in 1800 | | | Reformation Law | | |
|---|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] | [6] |
| Plagues 1350-1374 | 0.45*** | 0.32*** | 0.33*** | -0.00 | -0.11** | -0.11* |
| | (0.06) | (0.08) | (0.08) | (0.05) | (0.05) | (0.05) |
| Plagues 1375-1399 | 0.08 | 0.10 | 0.09 | 0.09 | 0.11 | 0.09 |
| | (0.09) | (0.10) | (0.10) | (0.04) | (0.07) | (0.07) |
| Plagues 1400-1424 | -0.03 | -0.00 | -0.00 | -0.02 | 0.00 | 0.02 |
| | (0.16) | (0.18) | (0.18) | (0.12) | (0.10) | (0.09) |
| Plagues 1425-1449 | 0.13 | 0.12 | 0.15* | 0.09** | 0.09 | 0.09** |
| | (0.09) | (0.09) | (0.08) | (0.04) | (0.06) | (0.04) |
| Plagues 1450-1474 | 0.01 | -0.00 | -0.01 | 0.03 | 0.03 | 0.02 |
| | (0.10) | (0.08) | (0.08) | (0.05) | (0.06) | (0.05) |
| Plagues 1475-1499 | 0.21 | 0.14 | 0.14 | 0.06 | 0.02 | 0.03 |
| | (0.24) | (0.20) | (0.20) | (0.07) | (0.06) | (0.06) |
| Plagues 1500-1524 | 0.25*** | 0.23** | 0.23** | 0.09** | 0.08*** | 0.08** |
| | (0.08) | (0.08) | (0.08) | (0.03) | (0.03) | (0.03) |
| Population Bin FE | No | Yes | Yes | No | Yes | Yes |
| Controls | No | No | Yes | No | No | Yes |
| Observations | 239 | 239 | 239 | 239 | 239 | 239 |
| $R^2$ | 0.41 | 0.45 | 0.46 | 0.08 | 0.18 | 0.20 |

Table 6: Upper Tail Human Capital

This table presents the regression results of estimating the effect of Reformation laws on the production of upper tail human capital measured as crossing a specified threshold of people in the *Deutsche Biographie*. "Reformation Law" is an indicator variable whether a city had any ordinance by 1600. The pre-period is 1220-1519. The post period is 1520-1820. The 50th, 75th, and 90th percentiles of the post-period achievers distribution are 3, 7, and 16 people with upper tail human capital, respectively. ***, **, * denotes 1%, 5%, and 10% statistical significance. Standard errors are clustered at the territory level. Territories are from Euratlas. Regression examines human capital formation in baseline set of 239 historic cities.

| | Any | More than 2 | More than 6 | More than 10 | More than 16 |
|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] |
| Post | 0.67*** | 0.35*** | 0.13*** | 0.06** | 0.04 |
| | (0.06) | (0.05) | (0.04) | (0.02) | (0.02) |
| Post x Reformation Law | 0.01 | 0.37*** | 0.32*** | 0.21*** | 0.15** |
| | (0.13) | (0.07) | (0.09) | (0.06) | (0.05) |
| City FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 478 | 478 | 478 | 478 | 478 |
| $R^2$ | 0.78 | 0.73 | 0.65 | 0.62 | 0.59 |

Table 7: Determinants of Huguenot Migrant Settlement in Historic Prussia

This table presents the regression results of estimating the effect of Reformation laws on the location decisions of Huguenot migrants settling in the cities and towns of historic Prussia. The binary outcome records whether Huguenot settlement in a given city or town reached a given threshold size. "Reformation Law" is an indicator variable whether a city had any ordinance by 1600. Controls are: Market rights by 1517, town incorporated by 1517, and Reichsstadt indicator. Population bins are 5 indicator variables (population in 1500 data missing, 1,000-5,000, 6,000-10,000, 11,000-20,000, and more than 20,000). ***, **, * denotes 1%, 5%, and 10% statistical significance. Standard errors are clustered by territory. Territories are from Euratlas. Huguenot data are from Birnstiel and Bernat (2001). In column [1] we study cities of Brandenburg-Prussia observed in the Bairoch data. In columns [2] to [4] we study cities of Brandenburg-Prussia that appear in Mützell (1825).

| | Binary Dependent Variable | | | |
|---|---|---|---|---|
| | Any Huguenots [1] | Any Huguenots [2] | 100+ Huguenots [3] | 200+ Huguenots [4] |
| Reformation Law | 0.66*** | 0.49*** | 0.48*** | 0.17** |
| | (0.15) | (0.13) | (0.13) | (0.06) |
| Population Bin FE | Yes | Yes | Yes | Yes |
| Controls | Yes | Yes | Yes | Yes |
| Territory FE | Yes | Yes | Yes | Yes |
| Observations | 34 | 83 | 83 | 83 |
| $R^2$ | 0.58 | 0.38 | 0.45 | 0.58 |
| Prussian Cities in: | Baseline Bairoch Data | Prussian Census of 1825 | Prussian Census of 1825 | Prussian Census of 1825 |