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LANGUAGE CHOICE IN THE HOLY
ROMAN EMPIRE**

Christine Binzel, Andreas Link and Rajesh
Ramachandran

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Abstract

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JEL Classification: E02, N13, Z12, Z13

Keywords: N/A

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the University of Cologne, Bayreuth University, Heidelberg University, University of Namur, Göttingen University, Passau University, Regensburg University, Utrecht University, and Ashoka University. We thank Jens Südekum and co-authors for sharing their data on German dialects. We also would like to thank Nakul Heroor, Henrike Claes, and Maria Kliem for excellent research assistance. All errors remain our own.

The Protestant Reformation and Language Choice in the Holy Roman Empire

Christine Binzel, Andreas Link, and Rajesh Ramachandran*

January 2023

Abstract

A distinct feature of the Protestant Reformation was Martin Luther’s intentional use of the vernacular (German), rather than Latin, in his writings in order to engage the laity in theological discussions. This paper studies the impact of the Protestant Reformation on the use of the vernacular in the Holy Roman Empire. We show that immediately after 1517, there was a sharp rise in religious vernacular printing output, especially in Protestant but also in Catholic printing cities. Moreover, and importantly, we find similar patterns for printed texts outside the religious realm. In turn, within decades after the Reformation vernacular works became widely available throughout the Holy Roman Empire. Exploiting variation within Catholic and within Protestant printing cities, we provide evidence on the underlying mechanism. We document that the Reformation, by increasing religious competition, reduced the Catholic Church’s influence on language use in printing, and that it contributed to the standardization of the German language. We then turn to language change in education and show that the Reformation led to a significant increase in the number of German schools in Protestant printing cities relative to Catholic ones. All in all, our results suggest that the Reformation played a decisive role in promoting the use of the vernacular in two important domains – printing and education – in the Holy Roman Empire.

Keywords: Protestant Reformation, vernacularization, education, institutions

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1 Introduction

The Protestant Reformation in the 16th century is thought of as one of the most transformative events in European history. This view is supported by a growing body of quantitative work on the consequences of the Reformation (e.g. Becker and Woessmann, 2009; Cantoni et al., 2018; Dittmar and Meisenzahl, 2020; for recent reviews, see Becker et al., 2016, 2021). Yet, one aspect of the Reformation has received little attention to date, namely Martin Luther and his followers’ intentional use of the vernacular (German), rather than Latin, in their writings. By using the vernacular, Luther aimed at spreading his ideas to the masses and at involving the general public – not just the elite – in the religious discourse (e.g. Burke, 2004; Pettegree, 2015; Schilling, 2017). Also, he translated the Bible into German (the New Testament appeared in 1522; the Old Testament appeared in 1534), and he demanded from rulers the provision of universal basic education using German as the language of instruction (Schilling, 1998, 2017).

This paper provides the first empirical evidence on the role of the Reformation in promoting the use of the vernacular in the Holy Roman Empire, the birthplace of the Reformation. We first document the effects of the Reformation on the use of the vernacular in printing, both in the religious realm and beyond. We show that the Reformation led to an immediate and permanent rise in vernacular works particularly in Protestant printing cities but also in Catholic ones. We also provide evidence for the underlying causal mechanism, namely an increase in religious competition and a reduction in the costs to language standardization following the Reformation. In a next step, we move beyond the effects on the printing industry and examine the implications of the Reformation for the establishment of German schools. We document that within a few decades after the Reformation, Protestant printing cities experienced a strong rise in German schools relative to those printed in Catholic ones, significantly improving the provision of education.

Prior to the Reformation, the German language (and other European vernaculars at the time) were far from being standardized. In fact, it was only in 1852, more than 300 years after the Reformation, that the first comprehensive dictionary in the German language was published (Sasaki, 2017). For purposes such as administration, education, and law, Latin was generally used, though few people were literate in Latin (Houston, 2011). This linguistic situation, the parallel existence of a high variety (Latin in medieval Europe), and a low variety (the vernaculars), is often referred to as “diglossia” (Ferguson, 1959; Versteegh, 2014). Despite higher literacy rates in the vernacular (Houston, 2011) and the profit orientation of the printing sector (Dittmar, 2011), only 33% of works were printed in the vernacular in the decade prior to the Reformation (based on the USTC). We argue that the development of the vernaculars required significant investment of time and skills, and that such investment can essentially be thought of as a public good. Yet, those in power, both secular leaders and the Catholic Church, had little incentives in promoting the use of the vernacular; on the contrary. Latin constituted an important source of political and economic power for the ruling elites (compare Weinstein, 1983; Tollefson and Tsui, 2003). We argue that the

Reformation had several implications for language use in society. First was the loss of the Catholic Church’s monopoly power in the market for religion, which resulted in secular leaders being less reliant on the Church to secure their legitimacy (Ekelund et al., 2002; Rubin, 2017; Cantoni et al., 2018) and which likely implied a loss of influence over language use for the Church. Second, Luther and his collaborators significantly contributed to language standardization at the time, something fellow writers and printers could draw on. In particular, Luther created a pan-regional written form, close to the spoken word, that would be accessible to ordinary people (e.g. Burke, 2004; Schilling, 2017). Further, by legitimizing the use of the vernacular in the religious realm, the reformers elevated its status in society (Burke, 2004; Sheehan, 2005; Pollock, 2006). Finally, by demanding the establishment of German schools, Luther created future demand for vernacular writings. More broadly, German schools likely contributed to the general language change from Latin to the vernacular in the Holy Roman Empire.

To examine the impact of the Reformation on language use in printing, we draw on the Universal Short Title Catalogue (USTC), a repository of all known titles (books and pamphlets) published in Europe in the first two centuries after the invention of the movable-type printing press in 1451. The USTC contains information on the year a title was printed, the printing place, subject classification, and the language, in which it was written. We use this information to create a city-year panel that gives the number of religious and non-religious vernacular works printed in a given city and year. We restrict the sample to cities located in the Holy Roman Empire and aggregate printing output over 10-year intervals.¹ We then use a difference-in-differences approach similar in spirit to Cantoni et al. (2018) and compare religious and non-religious vernacular printing output over time across cities that would adopt Protestantism in the course of the 16th century with those that would remain Catholic, while controlling for city and decade fixed effects.

Our results document the following. First, following the Reformation, there was a large differential increase in religious works printed in the vernacular in Protestant printing cities relative to those printed in Catholic ones. Compared to the reference period (1508–1517), their relative output in religious vernacular texts increased by 50% in the first decade after the Reformation and by on average 48% in the first three post-Reformation decades. Moreover, even Catholic printing cities experienced a rise in religious works in the vernacular with printing output in the last two decades of our observation period (1558–1577) being over 50% above the pre-Reformation level. Second, we find a similar pattern for vernacular works outside the religious realm, albeit less pronounced. Protestant printing cities saw a differential rise in non-religious vernacular works by 26% on average in the first three post-Reformation decades compared with Catholic ones, relative to the pre-Reformation mean. Catholic printing cities also observed a significant rise in non-religious vernacular works, yet with some delay. Nonetheless, even for non-religious works, printing output in the last two decades of our observation period was over 45% above the level of the decade before

¹ Our sample includes cities that were part of the Holy Roman Empire at the beginning of our study period, in the mid-15th century. For details see Section 3.

the Reformation. Importantly, the rise in both religious and non-religious printing output was not confined to the city of Wittenberg and neighboring towns.² All in all, our results suggest that within a short time after the Reformation vernacular works became widely available throughout the Holy Roman Empire.

Our difference-in-differences analysis relies on the assumption that, in the absence of the Protestant Reformation, Protestant and Catholic printing cities would have experienced similar changes in the production of religious and non-religious vernacular texts over time, controlling for city and decade fixed effects. One concern with our empirical strategy may be that cities with a preference for using the vernacular were more likely to adopt Protestantism. We address this concern in several ways. First, we show parallel trends (even levels) in outcomes prior to the Reformation. Second, we allow city-specific geographic and historical characteristics to have time-varying effects by including interactions between these characteristics and decade fixed effects. Third, we consider printing output in Latin. We show similar trends for religious and non-religious Latin printing output in Protestant and Catholic printing cities both prior to and after the Reformation. Furthermore, the Reformation had no differential effect on Latin printing output across Protestant and Catholic cities. Hence, the differential change we document for religious works following the Reformation is specific to printing in the vernacular. The estimates also suggest that vernacular printing output increased not just in absolute terms but also relative to Latin printing output such that, at least in Protestant cities, vernacular works dominated Latin works in the decades after the Reformation.³ Fourth, we document parallel trends in printing press adoption across Protestant and Catholic printing cities until 1517 and thereafter. Fifth, we examine potential self-selection into Protestantism more directly. We compare early adopters of the new religion (cities that adopted Protestantism by 1530) with cities that adopted the new religion later in the 16th century or remained Catholic under the assumption that early adoption of the new religion was more exogenous to vernacular printing than later adoption. Alternatively, we drop cities from our sample whose share of pre-Reformation vernacular printing output is at the 75th percentile or higher, conditional on having printed at least 10 works during this period. The rationale is that these cities potentially had a strong interest in promoting the vernacular and hence in adopting the new religion. Finally, we replace the Protestant dummy with a city's distance to Wittenberg, the city where Luther lived and worked, as distance to Wittenberg was an early determinant of city-level adoption of Protestantism (Becker and Woessmann, 2009; Cantoni, 2012). Throughout, our various robustness analyses support a causal interpretation of the relationship between the Reformation and vernacular printing output.

Why did the Reformation contribute in such a significant way to the increased use of the

² Indeed, our results are robust to dropping cities located close to the city of Wittenberg (below the 25th percentile, or 217km).

³ The USTC indicates a strong rise in Latin works towards the end of the 16th century, such that Latin works outnumber vernacular works again. This reversal was temporary, however. According to linguists, the permanent shift in language use from Latin to German occurred in the mid-17th century (von Polenz, 2013).

vernacular in printing? We first show that Catholic printing cities that were in the vicinity of a Protestant city (high religious competition cities) experienced a stronger increase in religious works in the vernacular in the first two decades following the Protestant Reformation compared with Catholic cities that were located further away (low religious competition cities). This is in line with the idea that in Catholic cities with greater competition in the market for religion, the Catholic Church was less able to preserve the use of Latin in printing (see Ekelund et al., 2002; Cantoni et al., 2018). We next provide evidence that among German-speaking Protestant printing cities, those with a dialect similar to the one spoken in Wittenberg (cities with low linguistic distance), experienced larger increases in vernacular printing output after the Reformation relative to cities with a dialect distinct from the one spoken in Wittenberg (cities with high linguistic distance). This suggests that the costs to language standardization were an important barrier to vernacularization in the Holy Roman Empire, and that the Reformation significantly reduced this barrier.

In the last part of our empirical analysis, we turn to the establishment of German schools following the Reformation. Luther’s new understanding about the relationship between man and God implied an obligation of the individual believer to read the Bible (Schilling, 1998). For Luther, this required not only that the Bible should be made available in a version of the German language that allowed ordinary people to access it directly. He also demanded from rulers to build and maintain German schools. Drawing on information provided in the *Deutsches Städtebuch*, we use the same difference-in-differences approach as before, comparing over time the number of German schools in Protestant printing cities with those in Catholic printing cities. Prior to the Reformation, there is no differential trend in the establishment of German schools. In fact, few German schools existed in both Protestant and Catholic printing cities. Two decades after the Reformation, we find a strong rise in German schools in Protestant printing cities compared with the number in Catholic ones. The Reformation thus contributed significantly to reducing the extent of diglossia at lower tiers of education.

The results presented in this paper demonstrate that the Reformation had a major impact on the use of the vernacular throughout the Holy Roman Empire. This had important consequences. First, because literacy rates were higher in the vernacular than in Latin, ideas and knowledge in all kinds of fields became more widely available for the general public. Second, as we show in a related work (Binzel et al., 2023), the increased use of the vernacular led to greater diversity in authorship composition and in book content. New fields principally in the vernacular came into being, but also more traditional fields saw a significant increase in vernacular works with few fields remaining exclusively Latin. Over time, the increased use of the vernacular likely contributed to greater social participation of the less privileged classes and eventually to creating more inclusive institutions. Indeed, in Binzel et al. (2023), we provide causal evidence of a growth-promoting effect of vernacularization.

Our paper contributes to several strands of the literature. First, our paper is closely related

to the literature on the Protestant Reformation – see Becker et al. (2016, 2021) for recent reviews.⁴ More specifically, Becker and Woessmann (2009) show that higher literacy in the Protestant counties of 19th-century Prussia explain their greater economic prosperity. They hypothesize that this is because the Protestant reformers favored “universal schooling in order to enable all Christians to read the Gospel by themselves” (Becker and Woessmann, 2009, p. 531). We complement this work by providing further evidence for their proposed mechanism, namely the increased use of the vernacular in printing and the establishment of German schools following the Reformation. Both developments enabled the acquisition of literacy by a much larger share of the population. Cantoni et al. (2018) show that the Reformation resulted in the reallocation of resources from religious to secular purposes. Our work complements theirs by highlighting another important consequence of the Reformation, namely, the increased use of the vernacular, which likely further eroded the power of the Catholic Church in the market for religion. Interestingly, similar to Cantoni et al. (2018) who document spillovers from Protestant to Catholic printing cities in the reallocation of resources (upper-tail human capital and construction activities) from religious to secular purposes, our work also shows important spillovers from Protestant to Catholic cities. Such spillovers may help reconcile the findings presented by Cantoni (2015) – who finds no statistically significant differences in city growth across Protestant and Catholic cities using city-level data from 1300 to 1900 – with the idea that the Protestant Reformation had important implications for Europe’s institutional architecture and, ultimately, for European economic development (Becker et al., 2016). Finally, Dittmar and Meisenzahl (2020) show that in the wake of the Reformation, some Protestant cities adopted city laws (church ordinances, *Kirchenordnungen*), which expanded state capacity and led to public goods provision, including schools. They provide evidence that city law adoption had important consequences for human capital and growth. Our work suggests that the establishment of German rather than Latin schools potentially underlay the increase in the human capital they document.

Second, our paper is related to the literature on the origins of national consciousness (Breuilly, 1993; Gellner, 1983; Hroch, 2000; Anderson, 2006). Our paper complements previous work by providing the first empirical evidence on a key process in European history, the consolidation of the modern European vernaculars, which soon led to the replacement of Latin by the vernaculars in printing (Binzel et al., 2023). The emergence of the spoken tongues as national languages has been viewed as a key factor in the process of creating “imagined communities” and as the basis of the modern nation states of Europe (Anderson, 2006).

Third, our paper connects to the literature that examines religious monopolies and the use of religion for political legitimization (Iannaccone, 1998; Coşgel et al., 2012; Chaney, 2013, 2016; Rubin, 2017). Our work suggests a concrete mechanism – the use of Latin – that helped the Catholic Church secure its monopoly position in the market for religion.

⁴ These studies are part of a rapidly growing field in economics, the economics of religion (McCleary and Barro, 2006; Iyer, 2016).

Finally, though our focus is not on documenting the growth-promoting effect of vernacularization, our work complements the literature that tries to explain the “rise of the West” over other regions, such as the Middle East (e.g. McNeil, 1990; Mokyr, 2005; Acemoglu et al., 2005; Buringh and van Zanden, 2009; e.g. Kuran, 2011; Blaydes and Chaney, 2013; Rubin, 2017; Platteau, 2017). As we show in Binzel et al. (2023), the increased use of the vernacular had important implications not only for knowledge consumption, but also for the production and dissemination of knowledge and ideas, with important consequences for longer-run development. The removal of diglossia was likely also crucial for the emergence of inclusive institutions in Europe (Acemoglu et al., 2001).

The rest of this paper is structured as follows: In Section 2 we describe the historical background to our study. In Section 3 we introduce our data sources while we present and discuss our empirical strategy in Section 4. In Section 5, we empirically test the impact of the Protestant Reformation on vernacular printing and examine the robustness of our results. In Section 6 we provide further evidence of a causal relationship between the Reformation and vernacular printing by studying potential mechanisms. Finally, in Section 7, we study how the Reformation changed the supply side of education in the Holy Roman Empire. We conclude in Section 8.

2 Historical Background

2.1 Vernacularization and Printing Prior to the Reformation

The German vernacular was first written down in the 8th century using the Latin alphabet (Colin, 1999). Several centuries passed until the most important text of this period, the Bible, was translated into German in 1466 (Lewis et al., 2009). Yet the German language was far from being standardized, and it took another 400 years until the first comprehensive dictionary was published, in 1852 (Sasaki, 2017).⁵ For purposes such as public administration, formal education, law, and literature, Latin was generally used, a language that was not employed for normal everyday conversation.⁶ This linguistic situation, in which within a speech community two languages exist – a high variety (in our context Latin) and a low variety (German) – has been referred to as “diglossic” (Ferguson, 1959; Versteegh, 2014). As instruction in Latin was confined to a few institutions such as monasteries and grammar schools (Graff, 1991), with the Catholic Church holding a dominant position in matters of education (Bowen, 1981; Woolf, 2004; Kertcher and Margalit, 2005), merely an estimated 1% to 2% of the population were literate in Latin and few comprehended spoken Latin (Houston, 2011). By contrast, literacy rates in the vernacular were generally significantly higher than literacy rates in Latin and on the rise, though we lack good estimates for reading and writing abilities in the population (Graff, 1991; von Polenz, 2013). Increasing levels of literacy

⁵ As we explain in the next section (Section 2.2), early translations of the Bible largely constituted word-by-word translations into a specific dialect. The results were therefore incomprehensible in part (Sonderegger, 1998).

⁶ At lower tiers of administration the vernacular was used as well – for example in court records or announcements – and sometimes appeared beside Latin (Kadens, 2001; Van Bavel, 2010; von Polenz, 2013).

in the vernacular are attributable in part to the rise of the merchant classes, craft persons, and artisans following the growth of commerce and trade as well as the rise of towns from the 11th and 12th centuries onward. These classes were typically literate in the vernaculars; only few possessed knowledge of Latin (Houston, 2011). Several developments around the beginning of the 15th century further increased reading and writing abilities in the vernacular in the Holy Roman Empire (for details see von Polenz, 2013). This includes the production and use of paper. In contrast to parchment, paper was much cheaper and could be produced and stored in large quantities. In turn, it was used for all kinds of secular everyday use texts such as letters, account books, merchant reports, and city books. Furthermore, books and pamphlets started to be commercially produced in writing workshops, where texts were dictated to multiple writers at the same time. Finally, affordable reading glasses became available, increasing readership numbers. With it came an increase in the demand for certain book genres as well as greater demand for works in the vernacular (von Polenz, 2013).

Prior to the invention of the movable-type printing press, and outside commercial writing workshops, the production of books was carried out manually by monks (Eisenstein, 1980). This changed with the invention and spread of the movable-type printing press throughout Europe, with 205 cities having adopted the printing press by 1500 (Dittmar, 2011). Printing presses led to a two-third reduction in the price of books between 1450 and 1500 (Dittmar, 2011, p. 1133, 1144). Also, from the start, the printing sector was profit-oriented (Dittmar, 2011). Printers had a strong economic interest in printing works in the vernacular as literacy rates were higher in the vernacular, and individual printers even contributed to language standardization (Burke, 2004). The spread of the printing press thus dramatically changed the supply side of the market for printed texts.⁷ Nonetheless, Latin works still dominated vernacular works in the decade prior to the Reformation. Based on the USTC, 33% of books and pamphlets printed during this decade (1508–1517) in the Holy Roman Empire were printed in the vernacular. What may explain this fact?

Writing (and printing) in the vernacular requires the development and standardization of an orthography, including the development of grammars and dictionaries, which can be seen as a public good. While individual printers could contribute to this, large investments of time and skills were required to make significant advancements. Yet for the Catholic Church, Latin functioned as a communication and coordination device. For example, Burke (2004, p. 52) writes of the Catholic Church’s fear that “...divergent translations from Latin into different languages would lead to a fragmentation of the Church into what we might describe as different ‘communities of

⁷ There have been several attempts to explain why the Catholic Church did not block the spread of the printing press. One is that the Church was one of the early enthusiasts and users of the printing press especially due to its “desire to free clerics from time-consuming earthly tasks” (Landes, 2006, p. 9), and its early demand to print indulgences for sale, which was an important source of revenue (Pettegree, 2015). A second is the fragmented political situation, which made it difficult for the Catholic Church to prevent the spread of the printing press (Coşgel et al., 2012, Rubin, 2017). A third is that the Catholic Church did not recognize early enough the inherent danger the press posed to maintaining its hegemony (Kertcher and Margalit, 2005).

interpretation’.” Such a fragmentation and loss of unity would likely also have implied a loss of power for the Catholic Church, which at that time essentially held a monopoly position in the market for religion (e.g. Ekelund et al., 2002; Rubin, 2017; Cantoni et al., 2018). With its power to interpret religious texts, the Catholic Church could confer divine legitimacy on the ruling class. The doctrine of “the divine right of kings,” the notion that the monarch derived the right to rule directly from God rather than from any worldly authority, was supported by the Biblical interpretations of the Catholic Church in medieval Europe. Thus, the Church crucially undergirded the legitimacy of monarchical rule (Rietbergen, 2014). It was also a key player in the management of the state because Latin texts were the medium for administration and law.⁸ Thus, for the Catholic Church, the use of Latin likely also constituted an important source of political and economic power (see Weinstein, 1983; Tollefson and Tsui, 2003). Indeed, it is against this backdrop that we should understand the Catholic Church’s opposition to vernacular Bibles. The councils of Toulouse (1229), Trier (1231), Tarragona (1233), and Beziers (1246) all prohibited vernacular translations to varying degrees (Lea, 1961). As long as the Catholic Church held a monopoly position in the market for religion, secular leaders had little incentive to advance the vernacular.

2.2 The Protestant Reformation, the Use of the Vernacular, and Schooling

The beginning of the Reformation is marked by Martin Luther’s 95 Theses, in which he – an hitherto unknown monk who taught at the University of Wittenberg (Cantoni, 2012, 2015) – criticized the Catholic Church. Further writings followed, disseminated widely thanks to the recent invention of the printing press and to the fact that Luther deliberately chose to write many of his pamphlets and books in German rather than in Latin (Edwards Jr., 2004). His writings sold extremely well (e.g. Schilling, 2017). Data from Edwards Jr. (2004, p. 501) reveal that, by 1523, some 89% of 390 new and reprint editions of Luther’s works were in German. Similarly, between 1518 and 1544, 2,551 printings of Luther’s works, or 83.5% of his works in circulation, were in German. By writing in German, Luther attempted to involve the general public, not just the religious elite, in the religious discourse (e.g. Schilling, 2017). This was a radical shift as Becker et al. (2020, p. 869) note when discussing the use of the German language in letters: “Corresponding in German reduced the spiritual status difference between a cleric and a layman, an important principle of Luther’s new theology, which sought to abolish the priesthood and rejected the ontological superiority of the Catholic vocations. In this, he was practicing a radical innovation because, according to orthodox norms, priests were not supposed to engage in theological discussion with laypeople or conduct these discussions in vernacular languages.” In order to make his texts accessible to ordinary people, he created a written form close to the spoken word. He also wrote in a short and concise manner. For example, the *Sermon on Indulgence and Grace* consisted of 20 short paragraphs that would fit

⁸ The position of the cardinal and of the prime minister was often held by the same person in pre-Reformation England, France, the Holy Roman Empire, and Spain, indicating the central role of the Catholic Church in the political and religious sphere (Rietbergen, 2014, Table 1, p. 50).

into a pamphlet of eight pages (Pettegree, 2015). According to Pettegree (2015, p. 81), this “was a revolution in theological writing.” The sheer amount of works Luther produced is impressive. In part, this stemmed from his fear of being imprisoned or even killed. Through his writings, and by writing in German and circulating his works widely, he wanted to ensure that his new understanding of the holy scripture would live on (Schilling, 2017).

Luther’s new understanding about the relationship between man and Good required that the individual reads the Bible (Schilling, 1998). This had several implications. First, Luther translated the Bible into German. The New Testament was first printed in 1522; the Old and New Testament first appeared together in German translation in 1534 (e.g. Graff, 1991; Edwards Jr., 2004; O’Malley, 2013). While the Bible, or parts of it, had been translated into various German dialects before, these were essentially word-by-word translations based on the Latin Vulgate and were incomprehensible in part (Sonderegger, 1998). Luther, by contrast, wanted to achieve broad engagement with the Bible (Burke, 2004). He translated from the Greek and Hebrew texts and developed the German language as a pan-regional standard rather than a local dialect, adding many new words and phrases in consultation with colleagues and experts (von Polenz, 2000; Burke, 2004; Schilling, 2017). Luther also added glossaries and preambles with additional explanations. Besides the Bible, his Protestant hymnbook (published in 1524), Bible commentaries (*Postillen*, from 1527 onwards), and the *German Catechism* constitute important works (von Polenz, 2013). The impact that Luther’s Bible and writings had for centuries on the German language have been well-documented by linguists (e.g. Sonderegger, 1998; von Polenz, 2000; Burke, 2004; Pettegree, 2015; Schilling, 2017).

Second, he demanded that ordinary people learn how to read and write in German. In 1524, Luther wrote the pamphlet “To the Councilmen of All Cities in Germany That They Establish and Maintain Christian Schools”, in which he argued that education was important *per se* – irrespective of any economic rationale – and that it was the duty of those in power to build and run schools (Graff, 1991; Schilling, 2017). While education used to be a privilege for the elite, Luther essentially argued for universal basic education for both boys and girls (see also Becker and Woessmann, 2009). In pamphlets published in 1530 and 1541, he addressed parents, urging them to send their children to school (Schilling, 2017). Thus, through his writings, Luther essentially addressed both the supply and the demand side of education.

Why was the Reformation important in spurring vernacularization in the Holy Roman Empire? We argue that the Reformation reduced the barriers to using the vernacular in writing and printing. Using the vernacular as the language of the Bible and of other religious texts likely played an important role in legitimizing the vernaculars for writing purposes and thus helped elevate their status in society (Burke, 2004; Sheehan, 2005; Pollock, 2006). Moreover, the success of the reformers meant a loss of the Catholic Church’s monopoly power in the market for religion. This loss of power likely had important implications for the secondary market in which political

leaders secured their legitimacy from religious elites, as Ekelund et al. (2002), Rubin (2017), and Cantoni et al. (2018) have argued. With their bargaining power rising due to the availability of alternative providers of religious services, secular leaders could reduce the price paid for obtaining legitimacy (Rubin, 2017). Accordingly, secular leaders were thus likely less inclined to protect the Church’s long-held market power in printing, particularly in the non-religious sphere. Thus, the market for printing was increasingly motivated by profit considerations rather than by the interests of the Catholic Church, leading to an increase in the use of the vernacular in printing. Finally, Martin Luther created a pan-regional written form, close to the spoken word, that enabled readers (and listeners) to comprehend written content. He thereby played a key role in standardizing the German language, which benefited other writers and printers in German. In Section 6 we examine these channels empirically.

With the decreased barriers to using the vernaculars in mind, printers were likely to have understood that they could tap a new market by targeting ordinary people, rather than the elite. Recall that Luther’s works sold well and print-runs were often high (Schilling, 2017). The sector’s pursuit of profit might help explain the quick adjustment of printers to using the vernacular that we document in later sections.

3 Data

Our sample consists of printing cities that were part of the Holy Roman Empire in the mid-15th century. This includes areas of today’s Germany, Austria, Belgium, Czech Republic, other parts of Central Europe, and Switzerland (see Figure 1).⁹

3.1 The Universal Short Title Catalogue (USTC)

The Universal Short Title Catalogue is an online catalog that aims to include all printed works (books and pamphlets) after the invention of the printing press in the early 1450s up to (in its current version) 1650. By using various search criteria, detailed information about the various titles can be retrieved from the database, in particular printing place (city), language, and subject classification.¹⁰ The USTC has been used by several other studies, including Dittmar and Seabold (2022) and Becker and Pascali (2019).

We retrieved the data in November 2016 and updated it in March 2019 using web scraping, resulting in a total of 354,354 works printed between 1451 and 1600. We first dropped entries for which information about the printing place is missing (4.26% of entries). We then restricted the sample to works printed in cities located in the Holy Roman Empire. For 1.31% of these works the USTC does not provide information about the language in which the work was printed; for 3.69%

⁹ Our results are robust to the dropping of printing cities in Switzerland, which broke away from the Holy Roman Empire in 1499.

¹⁰ The number of print runs is not available.

of works the USTC does not provide any subject classification. These works have been dropped from the sample.¹¹ Our final dataset comprises 114,738 works.

Any work not printed in Latin is referred to as being printed in the vernacular. At the time, 71 dialects/“languages” existed in Europe (for a list, see Burke, 2004, p. 173ff). The USTC assigns works the closest modern European language such as Dutch, English, French, German, and Spanish. Based on this information, close to 75% of all vernacular works in our sample were printed in German with the other major languages being Dutch (11%) and French (10%). We classify a given work as religious if any of the subject classifications falls under “Bibles” or “religious.”¹² Figure 2 plots the total number of religious and non-religious works printed in the vernacular in the Holy Roman Empire from the invention of the printing press until 1600. It shows that early on, overall printing output was low. This is due to the fact that it took several decades for the printing press to spread and city-level printing output was low in the early days (for more details, see e.g. Dittmar, 2011). Immediately after the Reformation, there was a sharp surge (and subsequent drop) in religious vernacular works, followed by a significant increase in non-religious vernacular works. Two decades after the Reformation, religious and non-religious vernacular printing output reached levels significantly above those before the Reformation.

We aggregated these book and pamphlet entries by printing place (city) and year to create a city-year panel dataset with information about the number of religious and non-religious works printed in the vernacular and in Latin in a given city and year. For the period we consider in our empirical analysis (1478 to 1577), we obtain a sample of 154 printing cities.

3.2 Schooling Data from the *Deutsches Städtebuch*

We hand code information about the existence of schools from the *Deutsches Städtebuch*, which was edited by Keyser (1974). The *Deutsches Städtebuch* contains detailed information about a wide range of topics for over 2,200 towns. For all printing cities we collect information about the existence of schools in section 17, titled “Education, Schools, Theater, Cultural” (“Bildungswesen, Schulen, Theater, Kulturelles”).

100 cities from our sample of 154 printing cities are included in the *Deutsches Städtebuch*. In these cities, a total of 262 schools are mentioned for the first time between 1450 and 1600. For 129 schools, the *Deutsches Städtebuch* explicitly states whether it was a German or Latin school. For the remainder, we use information about the type of school in order to determine whether instruction in the school took place in German or in Latin. In particular, we classify elementary schools, writing schools, numeracy schools, and other educational institutions, where instruction was almost always in German (Bleumer, 2000; Zymek, 2008; Nonn, 2012) as German schools. We

¹¹ We also exclude 0.97% of works that are written in classical Greek.

¹² For 14.52% of works, more than one subject classification is used to describe a given work. In total, there are 37 subject classifications, such as art and architecture, drama, educational books, literature, and science and mathematics.

also classify girls' schools as German schools. In early modern Germany, girls' schools usually referred to German schools that were open to both males and females (Hellekamps and Musolff, 2014). Church-related schools such as monastery schools or cathedral schools are classified as Latin schools. In medieval and early modern Germany, instruction in these schools was in Latin (Zymek, 2008). Finally, we classify high schools as Latin schools because at that time the language of instruction in high schools was exclusively Latin. For 47 schools, classification was not possible. These schools were dropped, leaving us with 215 schools. 146 of these schools (68%) are German schools.

Figure 3 shows the total number of German and Latin schools by year in printing cities of the Holy Roman Empire. It documents that prior to the Reformation, the vast majority of schools were Latin schools. Although German schools started to emerge towards the end of the 15th century, very few existed at the time of the Reformation. Following the Reformation, we observe a sharp rise in German schools from a total of 35 schools in 1517 to a total of 172 schools in 1600.

3.3 Data on When Cities Adopted Protestantism

For most of our cities, we draw on data from Rubin (2014) to determine a city's religious denomination in the years 1530, 1560, and 1600. For the remainder – 12 out of the 154 printing cities – we collect this information from historical sources.¹³ Note that information about the exact year in which a city adopted Protestantism is not always available. In part, this is related to the adoption process. “[T]he introduction of the Reformation,” (Cantoni, 2012, p. 518) observes, “was a long process involving a multitude of steps: performing a church visitation to verify the state of each parish; hiring a known scholar of the Reformation to oversee the implementation of reform; writing a church ordinance (a constitution for the newly-formed territorial church); allowing the priests to marry; and to dispense the Holy Communion in the Protestant way (*sub utraque specie*); etc.” 40 printing cities had adopted the new religion by 1530, 80 by 1560, and 87 by 1600. Hence the vast majority of Protestant printing cities had adopted the new religion by 1560. Note that with the Peace of Augsburg in 1555, princes had the right to determine their territory's religious denomination (“*cuius regio, eius religio*” – whose realm, his religion). After 1624, few denominational changes took place for centuries due to the Peace of Westphalia in 1648 (Cantoni, 2012).

For our empirical analysis, we classify a city as Protestant if it adopted the new religion over the course of the 16th century. This reflects the fact that the adoption of the new religion occurred incrementally and that little denominational changes occurred in the second half of the 16th century (between 1560 and 1600). In doing so, we follow Cantoni et al. (2018). As part of the robustness analysis, we alternatively compare early adopters of the new religion (cities that adopted Protestantism by 1530) with those that adopted Protestantism later or remained Catholic

¹³ Rubin (2014) considers only cities for which population data is available or can be interpolated for 1500, while we consider all cities of the Holy Roman Empire that had some printing output over the 1478–1577 period.

(see Section 5.3). Four cities in our sample (Konstanz, Paderborn, Valenciennes, and Vienna) first adopted Protestantism but converted back to Catholicism later in the 16th century. These cities are classified as Catholic cities in our sample.¹⁴

Out of the 154 printing cities, 87 (56%) are classified as Protestant cities and 67 (44%) are classified as Catholic cities. Figure 1 shows the geographic distribution of Protestant and Catholic printing cities located in the Holy Roman Empire with red circles indicating Protestant and blue circles indicating Catholic printing cities.

3.4 Further City-Level Variables

From Nüssli (2008) we take information on each city’s territorial affiliation in 1500, which we use to cluster standard errors (see Section 4). For our robustness analysis in Section 5.3, we first draw on city-level information provided in Rubin (2014). City-level variables include dummies for whether a city hosted a bishop or archbishop before or in 1517 and whether it was an independent city in 1517, as well as a city’s geographic coordinates. The latter we use to compute several geographic measures, such as a city’s distance to Wittenberg. For the 12 printing cities that are not included in Rubin (2014), we collect information about the first two variables from available online sources; none of these cities hosted a bishop or archbishop in 1517 and none of these cities was independent in 1517. We complement this with data on the founding dates of universities from Darby (1970) and Jedin et al. (1970) and geocode data from Ciolek (2004) to determine a city’s nearest distance to the main trade routes in Europe over the 1300–1500 period. To determine a city’s distance to water (river or coast), we additionally draw on river information from Nüssli (2008). We then determine a city’s shortest distance to either a river or the coast. Finally, we draw on population figures from Bairoch et al. (1988). Because we have printing cities with missing population information, we follow Dittmar and Meisenzahl (2020) and create dummy variables for missing data; 0–5,000; 6,000–10,000; 11,000–20,000; and 20,000+.

4 Empirical Strategy

We aim to estimate the causal effect of the Protestant Reformation on religious and non-religious vernacular printing output by comparing outcomes over time between Protestant and Catholic printing cities. In the spirit of Cantoni et al. (2018), we therefore estimate the following difference-in-differences model:

$$Y_{i,t} = \alpha + \sum_{t=1478}^{1577} \beta_t (Prot_i * decade_t) + \phi_t + \delta_i + \epsilon_{i,t}, \quad (1)$$

where $Y_{i,t}$ is the natural log of one plus the number of religious (or non-religious) vernacular

¹⁴ Dropping these four cities does not change our results qualitatively.

works in city i and decade t .¹⁵ We aggregate printing output over 10-year intervals as few cities had a printing press early on and printing output was low in the first few decades following the invention of the printing press (see Figure 2). $Prot_i$ is an indicator variable equal to one if city i adopted Protestantism over the course of the 16th century (for details, see Section 3.3). $decade_t$ are dummy variables for each decade t – from 1478–1487 to 1568–1577 – with the omitted decade being 1508–1517, the decade prior to the Reformation. ϕ_t are decade fixed effects and δ_i are city fixed effects. Standard errors are clustered at the territory \times decade level with $N = 33$ territories. Our coefficients of interest are the β_{ts} , which measure the difference in religious/non-religious vernacular printing output in Protestant cities compared with Catholic ones, relative to the omitted period (1508–17).¹⁶

Following Cantoni et al. (2018), we additionally estimate a difference-in-differences model where we aggregate printing output over three decades: 1478–1507 (prior to the Reformation) and 1518–1547 and 1548–1577 (after the Reformation). The reference period remains the decade 1508–1517. We hence estimate the following model:

$$Y_{i,t} = \alpha + \sum_{h=1}^3 \beta_t (Prot_i * period_h) + \phi_t + \delta_i + \epsilon_{i,t}, \quad (2)$$

where $period_h$ refers to the periods 1478–1507 (1), 1518–47 (2), and 1548–77 (3), and all other variables are defined as before. While the first specification is more flexible, the second specification emphasizes the general trend in printing output before and after the Reformation.

The key identifying assumption for our difference-in-differences approach is that in the absence of the Protestant Reformation, Protestant and Catholic cities would have experienced similar changes in the production of religious/non-religious vernacular texts over time. Note that city fixed effects control for all time invariant factors that differ across cities while period fixed effects control for any secular trends in religious/non-religious vernacular printing output. One concern is that cities with a preference for using the vernacular may have been more likely to adopt Protestantism. Thus, our estimates may in fact be capturing the effect of selection rather than the causal effect of the Reformation. To address this concern, we next discuss relevant historical evidence and then turn to the empirical evidence.

Historical evidence. Historically, even though Martin Luther could draw on existing political and economic grievances at the time, the split of the Church can be viewed as an unexpected event (Becker et al., 2016; Schilling, 2017). The split of the Church was also not Luther’s intention, not early on at least. Martin Luther himself began as an unknown monk who over time developed his new understanding about the relationship between men and God (Schilling, 2017). He explicitly sought to engage with the Catholic Church but was disappointed by the Church’s response. The

¹⁵ Our results are robust to the transformation of the dependent variable using the inverse hyperbolic sine transformation of the number of religious (non-religious) vernacular works in city i and decade t .

¹⁶ Note that the city fixed effects absorb all time-invariant factors, including the $Prot_i$ dummy.

unwillingness of the Church to engage with his critique contributed to him involving the wider public in the religious dispute. Martin Luther’s personality was likely important in this respect: he perceived it as his duty to inform the lay people about his new insights and the errors of the Catholic Church (Schilling, 2017).

While the event itself was unexpected, a city’s adoption of Protestantism may still be related to vernacular printing. Historically, however, this seems unlikely. The first city to adopt Protestantism was the city of Wittenberg. Additional cities adopted the new religion following largely a concentric pattern around Wittenberg (Becker and Woessmann, 2009; Cantoni, 2012). Cantoni (2012) argues that the concentric pattern of adoption is consistent with strategic neighborhood interaction rather than the costs of information diffusion. More specifically, Saxony, the territory to which Wittenberg belonged, was a large state. The fact that the Elector of Saxony backed Martin Luther and adopted the new religion made it politically less risky for neighboring territorial lords to adopt the new religious denomination.

It is widely agreed that Luther’s success heavily depended on the existence of the movable-type printing press. Past empirical work has shown that cities that adopted the printing press early, by 1500, were more likely to adopt the new religion (Rubin, 2014) and that cities with more competition in printing had a greater number of Protestant publications and were in turn more likely to adopt Reformation laws (Dittmar and Seabold, 2022). Yet none of these papers discusses the role of the pre-Reformation printing language in increasing the probability of adopting the Reformation. More recently, Becker et al. (2021) draw on data regarding Luther’s correspondence, Luther’s visits, and student enrollments at Wittenberg University to show that Luther’s personal ties together with spatial/structural diffusion via trade routes help explain the early spread of Protestantism (by 1530). Overall, there is little historical evidence suggesting that a city’s language preferences played a role in the decision to adopt the new religion.

Empirical evidence. We also draw on our data to empirically address the concern that the adoption of Protestantism was endogenous. As the USTC is available for several decades prior to the Reformation, we can examine the existence of pre-trends. The parallel-trend assumption requires that β_1 , β_2 , and β_3 , the estimated differences in religious/non-religious vernacular printing output across Protestant and Catholic cities in the periods preceding the Reformation, are statistically insignificant. Throughout, we find no pre-trends. In fact, outcomes for Protestant and Catholic cities are even at similar levels.

We additionally examine the robustness of our results in Section 5.3. First, we add as further controls interactions between (time-invariant) city-specific characteristics and decade fixed effects. Second, we examine the impact of the Reformation on Latin printing output. We do so to test for pre-trends in religious and non-religious Latin printing output across Protestant and Catholic cities and to assess how far changes in vernacular printing are specific to printing in the vernacular, rather than to printing in general. Third, we assess potential self-selection into printing and self-

selection into Protestantism. As part of the latter, we compare early adopters of the new religion with late adopters and cities remaining Catholic. We also assess the robustness of our results to the dropping of cities whose share of pre-Reformation vernacular printing output is at the 75th percentile or higher, conditional on having printed at least 10 works. Finally, we replace our Protestant dummy with the log of one plus a city’s distance to Wittenberg given the concentric pattern of adoption around the city of Wittenberg and the fact that the city of Wittenberg played no important role for printing prior to the Reformation. Overall, our findings lend credibility to our identification strategy and thus to our causal interpretation.

5 Effects of the Protestant Reformation on Vernacular Printing in the Holy Roman Empire

This section first examines how religious and non-religious printing output in the vernacular changed in Protestant printing cities relative to Catholic ones over the course of the 15th and 16th centuries (Sections 5.1 and 5.2). The analysis is based on the difference-in-differences approach described in the previous section. We then provide further empirical evidence supporting the plausibility of our identification strategy (Section 5.3).

5.1 The Use of the Vernacular for the Religious Discourse

Figure 4 shows the results from estimating equations 1 and 2 with the dependent variable being the natural log of one plus the number of religious vernacular works in printing city i and decade t . Panel A plots the difference-in-differences estimates on the interactions between the Protestant dummy and decade fixed effects as dots (with the omitted period being 1508–1517) with their 90% confidence intervals indicated with vertical lines. The point estimates from the more aggregated model (equation 2) are shown as horizontal lines with their 90% confidence intervals indicated as boxes. (The regression results are reported in column (1) of Appendix Tables A1 and A2.) Panel B plots the predicted values of the dependent variable for Protestant and for Catholic cities as dots with their 90% confidence intervals indicated with vertical lines. The vertical line in the year 1517 marks the onset of the Protestant Reformation.

Prior to the Reformation, we find no differential trend in religious vernacular printing output across cities that would adopt Protestantism over the course of the 16th century and those that would not; all three point estimates are statistically insignificant. Even more, printing output in Protestant and Catholic printing cities was similar in level, as the predicted values in Panel B show. In the decades following the Reformation, there is a strong and statistically significant differential increase in religious vernacular printing output in Protestant cities compared with Catholic ones (relative to the omitted decade, 1508–1517). In the first three decades following the Reformation, Protestant cities print on average 48% more religious works in the vernacular compared with

Catholic ones relative to the pre-Reformation mean (column 1 of Appendix Table A2).

The predicted values shown in Panel B illustrate two further facts. First, the differential change in religious vernacular output following the Reformation is indeed the result of a surge in religious vernacular printing output in Protestant cities compared with Catholic ones. Second, Catholic printing cities also experience an increase in religious vernacular printing output, although to a smaller degree.

All in all, these results suggest that following the Reformation, a massive amount of religious texts in the vernacular suddenly became available to readers and the wider public in the Holy Roman Empire. Indeed, the increase in vernacular printing in Protestant and Catholic printing cities following the Reformation remains economically and statistically significant when excluding the city of Wittenberg and printing cities located close to Wittenberg (printing cities located within the 25th percentile, or 217km), see column (4) of Appendix Table A3 and Panel A of Appendix Figure A1. Thus, Luther’s prolific writing and printing was not only felt in Wittenberg and the neighboring towns. Rather, printing cities throughout the Holy Roman Empire – especially Protestant ones – observed a significant rise in religious vernacular works in the immediate aftermath of the Reformation.

5.2 Vernacular Printing Outside the Religious Domain

We now examine how printing in the vernacular changed outside the religious domain. Using the same specifications as before, equations 1 and 2, the dependent variable now is the natural log of one plus the number of non-religious vernacular works in printing city i and decade t .

Panel A of Figure 5 plots, as before, the difference-in-differences estimates while Panel B plots the predicted values of the dependent variable for Protestant and Catholic printing cities. (The regression results are reported in column (2) of Appendix Tables A1 and A2.) Again, we observe parallel trends and even similar levels in printing output prior to the Reformation.¹⁷ The pattern changes, however, with the start of the Protestant Reformation. We observe a differential increase in non-religious vernacular printing output in Protestant printing cities compared with Catholic ones (relative to 1508–1517). Standard errors are relatively large such that only some interactions between the Protestant dummy and decade fixed effects are significantly different from zero. We should therefore interpret the differential increase with some caution. Still, when considering the estimates from the more aggregated difference-in-differences model, the interactions between the Protestant dummy and each post-Reformation period (1518–1547 and 1548–1577) are statistically significant. Moreover, the estimated differential increase in printing output of over 26% is economically large. Finally, and importantly, we observe a secular rise in non-religious vernacular works following the Reformation, i.e. Catholic printing cities also see a rise in such works, albeit somewhat delayed. Nonetheless, even for non-religious vernacular works, printing

¹⁷ If anything, differences between Protestant and Catholic printing cities were declining prior to the Reformation.

output in Catholic printing cities in the last two decades (1558–1577) of the period is over 45% above the pre-Reformation decade (column 2 of Appendix Table A2).

These results constitute an important finding that has received little attention in the historical literature to date, namely that the Reformation led to a sudden and permanent rise in printing output also outside the religious realm, particularly in Protestant but also in Catholic printing cities. Once again, changes in printing output are not confined to the city of Wittenberg and neighboring towns (cities located within the 25th percentile), see column (4) of Appendix Table A4 and Panel B of Appendix Figure A1. Hence, after the Reformation, non-religious writings in the vernacular also became widely available throughout the Holy Roman Empire.

5.3 Robustness Analysis

In this section, we summarize a series of additional analyses that explore the plausibility of our identifying assumption and the robustness of our results by manipulating our baseline specifications (equations 1 and 2). Readers interested in a more detailed discussion may consider consulting Appendix Section A.2 instead.

Additional Control Variables. We first assess the extent to which our results change when we allow for city-specific features to have time-varying effects. To this end, we add interactions between (time-invariant) city-specific characteristics – population fixed effects, historical characteristics, and geographic characteristics – and decade fixed effects to our baseline specifications. Our results are robust to the inclusion of these controls, see columns (2) and (3) of Appendix Tables A3 and A4.

The Reformation and Latin Printing Output. Our analysis so far considered solely works in the vernacular. One question that arises is to what extent the differences we observe for vernacular printing output reflect overall changes in printing following the Reformation. We therefore now examine the impact of the Reformation on religious and non-religious printing output in Latin. That is, the dependent variable now is the natural log of one plus the number of religious (non-religious) works in Latin in printing city i and decade t . The results, shown in Appendix Figures A2 and A3, document the following. First, there are no pre-Reformation trends in religious and non-religious Latin printing output across Protestant and Catholic cities. Thus, together with our previous results on vernacular printing, we can rule out different trends in overall printing prior to the Reformation. Second, the Reformation had no immediate differential effect on Latin printing output across Protestant and Catholic cities. Third, following the Reformation, Latin printing output remained at levels similar to those before the Reformation. Thus, vernacular printing output rose not just in absolute but also in relative terms, such that vernacular printing output even outweighed Latin printing output, at least in Protestant cities.

Selection into Printing. Our results so far rule out differential pre-trends in vernacular and Latin printing output. We now address the concern that the adoption of the movable-type

printing press varied across Protestant and Catholic printing cities. Thus, as the dependent variable we use a binary variable equal to one if city i had adopted the printing press by decade t . Appendix Figure A4 shows no differential adoption of the printing press prior (or post) the Reformation.

Selection into Protestantism. Our causal interpretation assumes that a city’s preference for using the vernacular, something we do not observe, did not influence its decision to adopt Protestantism. To address this concern more directly, we now compare early adopters of Protestantism (cities that had adopted the new religion by 1530) with those that adopted Protestantism later or remained Catholic. Previously we classified cities as Protestant if they adopted the new religion by 1600; the remainder we classified as Catholic (see Section 3.3). The idea of this exercise is that early adoption was likely more exogenous than later adoption of the new religion. The results are shown in Appendix Figures A5 and A6. We find a larger differential increase in vernacular printing output immediately after the Reformation. The increase vanishes over time, when late adopters (classified as Catholic) experience a rise in vernacular works. This supports a causal interpretation of the relationship between the Reformation and vernacular printing output. In order to rule out that cities with a strong preference for using the vernacular in printing – and hence with an interest in adopting Protestantism – are driving our results, we alternatively remove cities from our sample whose share of pre-Reformation vernacular printing output is in the 75th percentile or higher (conditional on having printed at least 10 works over this time period). Reassuringly, our results are robust to the dropping of these cities (see column 5 of Appendix Tables A3 and A4).

Cities’ Distance to Wittenberg and Vernacular Printing Output. As noted earlier, the adoption of the new religion followed a concentric pattern around Wittenberg, implying that a city’s distance to Wittenberg can be seen as an important determinant of the adoption of Protestantism, especially early on (e.g. Becker and Woessmann, 2009; Cantoni, 2012). Moreover, the city of Wittenberg played no important role in the printing industry prior to the Reformation. As a final robustness check, we therefore replace the Protestant dummy in our baseline specifications with the log of one plus a city’s distance to Wittenberg. The results from our preferred specification, shown in columns (3) and (6) of Appendix Table A5, illustrate two facts. First, there were no differences in vernacular printing output based on a city’s distance to Wittenberg prior to the Reformation, suggesting that at that time Wittenberg was indeed unimportant for the printing industry, at least as concerns vernacular works. Second, following the Reformation, the estimates on the interactions between a city’s distance to Wittenberg and decade fixed effects are negative and statistically significant, implying that printing cities located further away experienced smaller increases in vernacular printing output compared with printing cities located close to Wittenberg.

All in all, the various robustness checks and the additional analyses lend credibility to our identification strategy.

6 Understanding the Role of the Reformation for Printing in the Vernacular

In this section we provide further empirical evidence in support of our causal claim. We provide evidence consistent with the idea that the Reformation reduced the Catholic Church’s influence on language choice in writing and printing and that the Reformation led to significant advancement in the standardization process of the German language.

6.1 Religious Competition

We first test the hypothesis that Catholic cities that were located in the vicinity of a Protestant city experienced a larger increase in vernacular printing output after the Reformation compared with Catholic cities located further away from a Protestant city. The rationale is that Catholic cities that were located close to a Protestant city were exposed to greater competition in the market for religion (Ekelund et al., 2002; Cantoni et al., 2018). Consequently, the Catholic Church was less able to preserve the use of Latin in printed works in both the religious and the non-religious realm. These cities were also more exposed to the reformers’ ideas and their use of the vernacular to discuss theological issues, which, as we argued earlier, contributed to its legitimization (see also Section 2.2 above).

We classify Catholic printing cities as high competition cities if they have at least one Protestant printing city in their vicinity (located within 50km). The remainder we classify as low competition cities.¹⁸ Out of the 59 Catholic printing cities, 21 are classified as high competition cities and 39 are classified as low competition cities. We aggregate printing output over 10-year intervals and estimate the following difference-in-differences model:

$$Y_{i,t} = \alpha + \sum_{t=1478}^{1577} \beta_t (HighCompetition_i * decade_t) + \phi_t + \delta_i + \epsilon_{i,t}, \quad (3)$$

where $Y_{i,t}$ is the natural log of one plus the number of religious (non-religious) vernacular works in city i and decade t . *HighCompetition* is a dummy variable that takes the value one for high religious competition Catholic cities and zero otherwise. ϕ_t are decade fixed effects – from 1478–1497 to 1558–1577 – with the omitted period being 1498–1517, and δ_i are city fixed effects. Standard errors are clustered at the territory \times period level with $N = 18$ territories. As before, we additionally estimate a more aggregated difference-in-differences model where we aggregate printing output over three decades: 1478–1507, 1518–1547, and 1548–1577.

¹⁸ The results are similar when using the following two definitions. First, we alternatively classify Catholic cities as high competition cities if at least one Protestant city is located within 25km; otherwise, it is classified as a low competition city. Second, following Cantoni et al. (2018), we alternatively classify high competition Catholic cities as those whose nearest city is a Protestant city and the remainder as low competition cities.

Figure 6 plots the difference-in-differences estimates in Panels A and the predicted values of the dependent variable for high and low competition cities in Panels B.¹⁹ As regards religious works in the vernacular (Panel a.), high and low competition Catholic printing cities show parallel trends in printing output prior to the Reformation. Following the Reformation, there is a sharp rise in religious vernacular works in high but not in low competition cities. More precisely, in the first (second) decade after the Protestant Reformation (relative to 1498–1517), there is a statistically significant increase in religious vernacular printing output of 61% (29%) in high competition Catholic cities relative to low competition Catholic cities (column 1 of Appendix Table B1). This differential increase in religious vernacular printing is temporary, which suggests that changes in the printing market in high competition Catholic cities soon spread to low competition Catholic cities. This is confirmed by the predicted values in Panel B, which illustrate a delayed rise in vernacular works for low competition cities.

The pattern for non-religious vernacular works is qualitatively similar, but the differential increase is smaller in magnitude. As a result, we find no statistically significant increase in vernacular printing output for high competition cities above the increase observed for low competition cities (see Panel b.). Overall, these results suggest that the Catholic Church lost its influence on language choice in printing for non-religious works immediately after the Reformation while for religious works the Catholic Church continued to exert some influence in low competition cities compared with high competition cities.

6.2 Costs of Language Standardization

In this section we turn to an additional channel through which the Reformation potentially impacted writing in the vernacular, namely the costs of language standardization. In particular, we test the hypothesis that Protestant printing cities with a dialect closer to the one Martin Luther employed saw larger increases in vernacular printing output following the Reformation compared with those with a dialect that was more distinct. The rationale is that the reformers’ writings and the translation of the Bible provided a corpus for standardization, which was particularly beneficial for dialects close to the one employed by the reformers.

To this end, we restrict our analysis to Protestant cities that had some printing output over the 1478–1577 period. Data on the linguistic features of German districts are taken from Falck et al. (2012). These linguistic features originate from a unique language survey conducted between 1879 and 1888 in some 45,000 German schools by the linguist Georg Wenker. They were later assembled into the *Sprachatlas* by Wenker’s successor Ferdinand Wrede (Wrede et al., 1927), who determined 66 prototypical characteristics to describe the structural subdivisions of German (for details, see Falck et al., 2012). We merge this data with our city-level data on book production and obtain a sample of 72 German-speaking Protestant printing cities (disregarding the city of

¹⁹ The regression results are reported in Appendix Tables B1 and B2.

Wittenberg, which we drop in this analysis). To measure the closeness of a city’s dialect to the dialect employed by Luther, we use its linguistic distance to the dialect spoken in Wittenberg, the place where Luther lived and worked.²⁰ To this end, we follow the approach by Falck et al. (2012) and determine a city’s linguistic distance to Wittenberg by counting how many of the identified 66 prototypical characteristics a particular city shares with Wittenberg. This measure ranges from a minimum value of 22 to a maximum value of 66, with a mean of 36 and a standard deviation of 10.

Following Bauernschuster and Falck (2015), we aim to create a measure of linguistic similarity that is stripped of the variation arising due to the geographic distance to Wittenberg. We therefore regress the standardized value of this dialect similarity measure on distance to Wittenberg and its square. Appendix Table B3 shows that geographic distance to Wittenberg explains around 59% of the variation in this measure of dialect similarity to Wittenberg. We then predict and store the residuals arising from the regression results reported in column (2), which we then use as our measure of dialect similarity to Wittenberg. Lastly, we define Protestant cities as having a low linguistic distance if their linguistic similarity to the dialect of Wittenberg is at the 50th percentile or higher, with the remainder being high linguistic distance cities.

As before, we aggregate printing output over 10-year intervals and then estimate the following difference-in-differences model:

$$Y_{i,t} = \alpha + \sum_{t=1478}^{1577} \beta_t (LowLinguisticDistance_i * decade_t) + \phi_t + \delta_i + \epsilon_{i,t}, \quad (4)$$

where *LowLinguisticDistance* is an indicator variable equal to one for low linguistic distance Protestant cities and zero otherwise. All other variables are defined as in equation 3. Additionally, we again estimate a more aggregated difference-in-differences model, aggregating printing output over three decades (1478–1507, 1518–1547, and 1548–1577).

Note that ideally we could measure cities’ linguistic similarity to the dialect of Wittenberg before or at the time of the Reformation. Unfortunately, we lack such data. One concern of using linguistic data from the late 19th century may be reverse causality as Luther’s writings might have impacted not only the written form but also the spoken word. In this case, we would overestimate the differential effect. Another concern may be that dialects may assimilate over time, say through contact between people or through the development and standardization of a pan-regional written form. As a result, the linguistic variation in our sample would be lower relative to the actual linguistic variation in the 16th century. In this case, our estimates can be seen as providing a lower bound of the differential change in vernacular printing output across low and high linguistic Protestant cities following the Reformation. However, while spoken languages may to some extent change over time, dialect borders tend to be highly persistent. For example, the so-called “second

²⁰ Alternatively, we use a city’s linguistic distance from the dialect of Meissen, the center of the “chancery language” of Saxony (*sächsische Kanzleisprache*). Doing so, we obtain similar results.

consonant shift,” which was completed by the 9th century, did not occur in the northern parts of Germany, thereby separating Low German from other German dialects. This dialect border still exists today and is referred to as the “Bernrather Line” (Samir, 2019; Waldenberger, 2022).

Panel A of Figure 7 plots the difference-in-differences estimates on the interaction terms, which allow for differential changes in vernacular printing output across low and high linguistic distance cities over time. Panel B plots the predicted values of the dependent variable for low and high linguistic distance cities.²¹ Prior to the Reformation, Protestant cities with low and high linguistic distance show similar trends in the number of religious and non-religious works printed in the vernacular (Panel A). Vernacular output level across low and high linguistic distance cities is even similar (Panel B). After 1517, however, both religious and non-religious works in the vernacular experience a strong boost in low relative to high linguistic distance cities (Panel A). During the first three decades after the Reformation, relative printing output had increased by approximately 45% on average (relative to 1508–1517). The predicted values in Panel B show that this differential increase is the result of a strong rise in vernacular works in low linguistic distance cities, while in high linguistic distance cities the rise in vernacular printing output is more muted (religious works) or vernacular printing output remains flat (non-religious works). Hence, almost the entire increase in vernacular output in this subsample of Protestant printing cities is driven by low linguistic distance cities. The fact that differences in vernacular printing between low and high linguistic distance cities persist until the end of the observation period suggests that the costs to language standardization were significant in our context. This is consistent with data from Sasaki (2017), which shows that for European vernaculars several centuries passed on average from the publication of the first vernacular Bible to the first comprehensive dictionary.

7 The Protestant Reformation and the Rise of German Schools

So far, we documented that the Reformation altered language choice in printing and thus the supply side of the market for printed texts. In this section, we examine the supply side of education. As described above in Section 2.2, Luther demanded that those in power build and maintain schools such that both boys and girls could learn how to read and write.

Drawing on data from the *Deutsches Städtebuch* (see Section 3.2), we test whether the Reformation led to a differential increase in German schools in Protestant relative to Catholic printing cities. To this end, using the same difference-in-differences approach as before, we examine the number of German schools in Protestant printing cities compared with Catholic ones over the 1478–1577 period. That is, we estimate the following model:

$$Y_{i,t} = \alpha + \sum_{t=1478}^{1577} \beta_t (Prot_i * decade_t) + \phi_t + \delta_i + \epsilon_{i,t}, \quad (5)$$

²¹ The regression results are reported in Appendix Tables B4 and B5.

where $Y_{i,t}$ now is the natural log of one plus the number of German schools in city i and decade t .²² All other variables are defined as in equation 1. As before, we also estimate the following, more aggregated difference-in-differences model:

$$Y_{i,t} = \alpha + \sum_{h=1}^3 \beta_t (Prot_i * period_h) + \phi_t + \delta_i + \epsilon_{i,t}, \quad (6)$$

where $period_h$ refers to the periods 1478–1507 (1), 1518–1547 (2), and 1548–1577 (3), and all other variables are defined as before.

Figure 8 shows the results from estimating equations 5 and 6. As before, Panel A plots the difference-in-differences estimates on the interactions between the Protestant dummy and decade fixed effects as dots (with the omitted period being 1508–1517). (The regression results are reported in column (1) of Appendix Tables C1 and C2.) The point estimates from the more aggregated model are shown as horizontal lines. Vertical lines and boxes indicate the 90% confidence intervals of the estimates. Panel B plots the predicted values of the dependent variable for Protestant and for Catholic cities as dots with their 90% confidence intervals indicated with vertical lines. The vertical line in the year 1517 marks the beginning of the Protestant Reformation.

Panel A of Figure 8 shows that prior to the Reformation, cities that would adopt Protestantism over the course of the 16th century experienced a similar trend in the establishment of German schools as cities that would remain Catholic (relative to 1508–1517). The number of German schools was even similar in level, as the predicted values in Panel B document. One to two decades after the Reformation, however, Protestant cities began to establish more German schools compared with Catholic cities (relative to the omitted period). Between 1548 and 1577, Protestant cities observe a relative increase in the number of German schools by 20% on average. As the predicted values show, this differential increase is indeed due to a strong and sustained rise in the number of German schools in Protestant cities while significantly fewer German schools are founded in Catholic cities.

Appendix Table C3 examines the robustness of our results. Column (1) shows our baseline results. In column (2) we add interactions between city-specific historical characteristics – population fixed effects and indicator variables for whether the city had a university in 1450, hosted a bishop or archbishop before or in 1517, and was an independent city in 151 – and decade fixed effects. In column (3) we add interactions between city-specific geographic characteristics – the natural log of one plus a city’s distance to Mainz, the natural log of one plus a city’s distance to water (river or coast), and the natural log of one plus a city’s distance to a trade route – and decade fixed effects. In column (4) we remove cities from the sample that are located within 217km (within the 25th percentile) from the city of Wittenberg. Finally, in column (5) we remove cities

²² Our results are also robust to the use of the inverse hyperbolic sine transformation of the number of German schools in city i and decade t as dependent variable.

from our sample whose share of pre-Reformation vernacular printing output (1451–1517) is in the 75th percentile or higher, conditional on having printed at least 10 works during this time period. Overall, our results are similar across the different specifications.

Luther stressed the importance of education at all levels of schooling, from primary education up to universities (Schilling, 2017). While he was committed to the use of the vernacular at lower tiers of education, Latin was and remained for a long time the language of education at higher tiers of education. In Figure 9 we therefore consider Latin schools. Once again, there is no evidence of a differential trend in school construction prior to the Reformation. Further, the parallel trend continues after the Reformation (column 2 of Appendix Tables C1 and C2). Instead, both Protestant and Catholic cities record an increase in the number of Latin schools of more than 10% for the last three decades (1548–1557 to 1568–1577).

The strong increase in German schools implied a steady rise in active readers and writers of the German language in the population. It ensured future demand for vernacular works, thereby changing the demand side of the market for printed texts. It also increased the pool of people able to employ the vernacular for all kinds of secular uses. While Latin schools still outnumbered German schools by the end of the 16th century, differences had almost vanished (see Figure 3).²³ Thus, at least at the lower tiers of education, it can be argued that the Reformation mitigated the diglossic situation.

8 Conclusion

This paper provides evidence that the Reformation played an important role in promoting the use of the vernacular in the Holy Roman Empire. It showed that the impact of the Reformation on vernacular printing output was not confined to printing in the religious realm, nor was it confined to Protestant cities. Rather, both religious and non-religious works in the vernacular became widely available throughout the Holy Roman Empire. Furthermore, the Reformation led to a strong increase in German schools in Protestant relative to Catholic cities. By promoting the use of the vernacular in these two important domains – printing and education – the Reformation significantly contributed to general language change in the Holy Roman Empire with the eventual removal of diglossia in the longer run.

Why did the Reformation have such an impact on vernacularization in the Holy Roman Empire? We argue that the Reformation significantly reduced the barriers to vernacularization. Vernacularization requires the provision of a particular public good, language standardization. Those in power, both secular leaders and the Catholic Church, however, had few incentives in promoting the rise of the vernaculars in order to preserve Latin as the language of formal contexts. Exploiting differences in religious competition across Catholic cities and differences in the linguistic

²³ If the data allowed us to focus exclusively on primary education, the pattern would likely be even more pronounced.

distance of Protestant cities to the city of Wittenberg, we present empirical evidence in support of our argument.

The existence of barriers to vernacularization may help explain why diglossic linguistic situations have been a stable hallmark of many societies over extended periods of time (often centuries). For instance, for the larger part of the first millennium until the early centuries of the second millennium, Sanskrit, a high variety, was the language of the royal courts and literary culture across large swathes of Asia, from Afghanistan to Java (Pollock, 2006). Similar to Latin, Sanskrit was not a spoken language but was the language of writing and societal institutions. Diglossia is also not merely a historical phenomenon. It also describes, for example, the linguistic situation in the Middle East and North Africa today, where Classical Arabic (or Modern Standard Arabic) constitutes the official language, while everyday interactions take place in the various vernaculars (Versteegh, 2014). We hope that future research will shed light on the process of vernacularization in other contexts.

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Figures and Tables

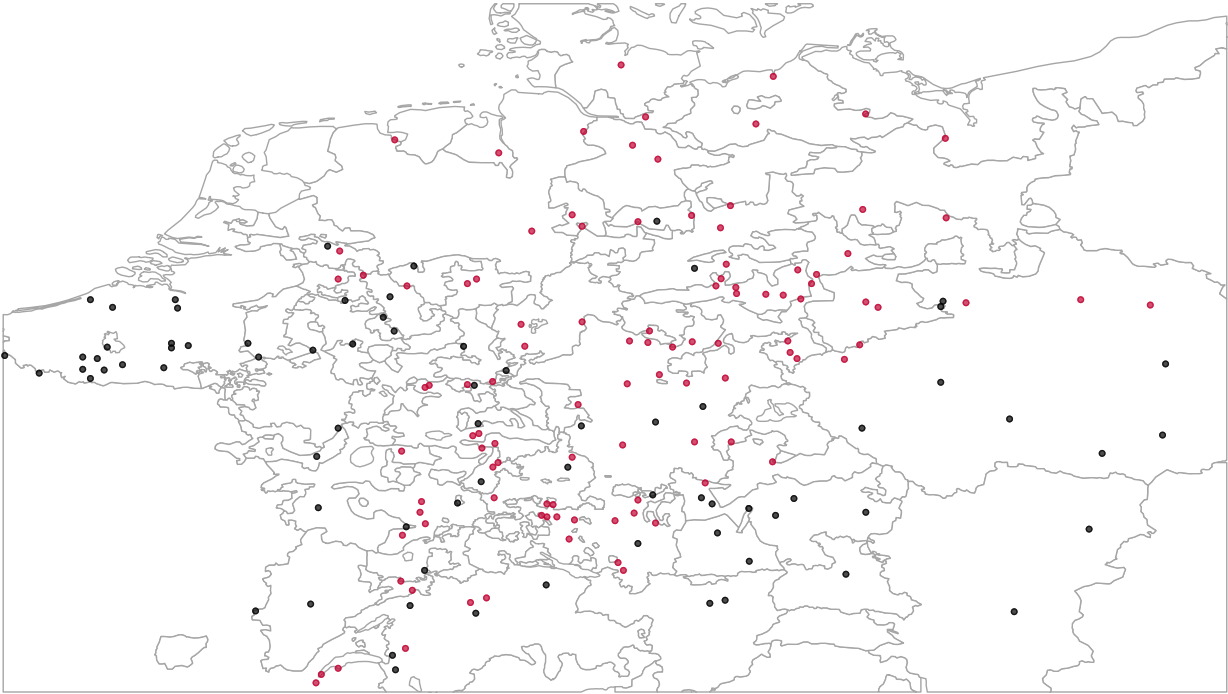


Figure 1: Protestant and Catholic Printing Cities Located in the Holy Roman Empire
Notes: Red circles indicate Protestant printing cities, blue circles indicate Catholic printing cities.

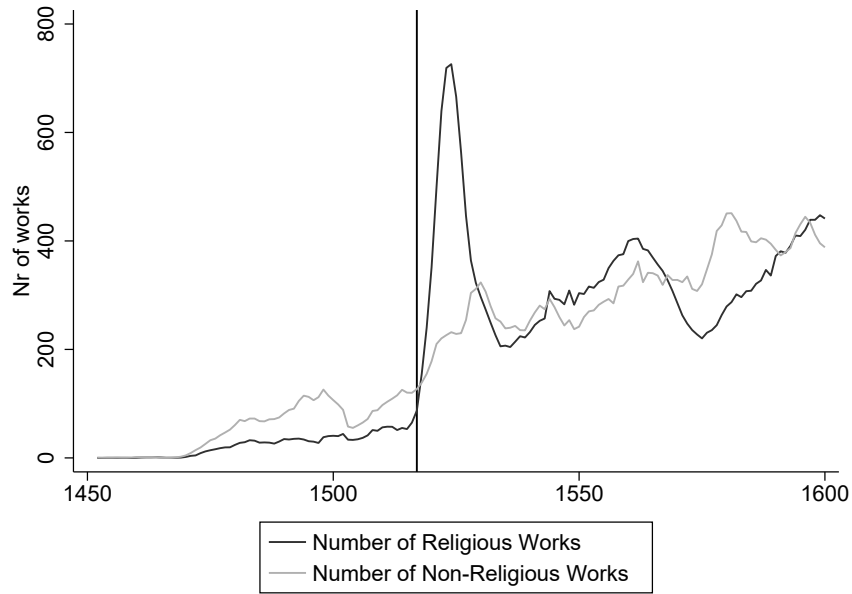


Figure 2: Total Number of Works Printed in the Vernacular in the Holy Roman Empire, by Year
 Notes: Universal Short Title Catalogue (USTC). 5-year moving average. The vertical line indicates the onset of the Protestant Reformation in 1517.

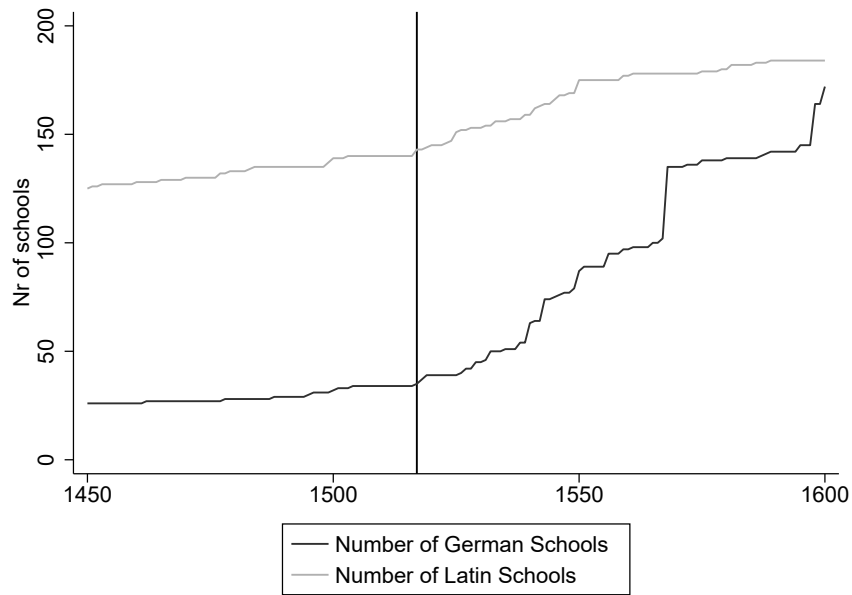


Figure 3: Total Number of Schools in Printing Cities of the Holy Roman Empire, by Year
 Notes: Information collected from the *Deutsches Städtebuch*. 5-year moving average. The vertical line indicates the onset of the Protestant Reformation in 1517.

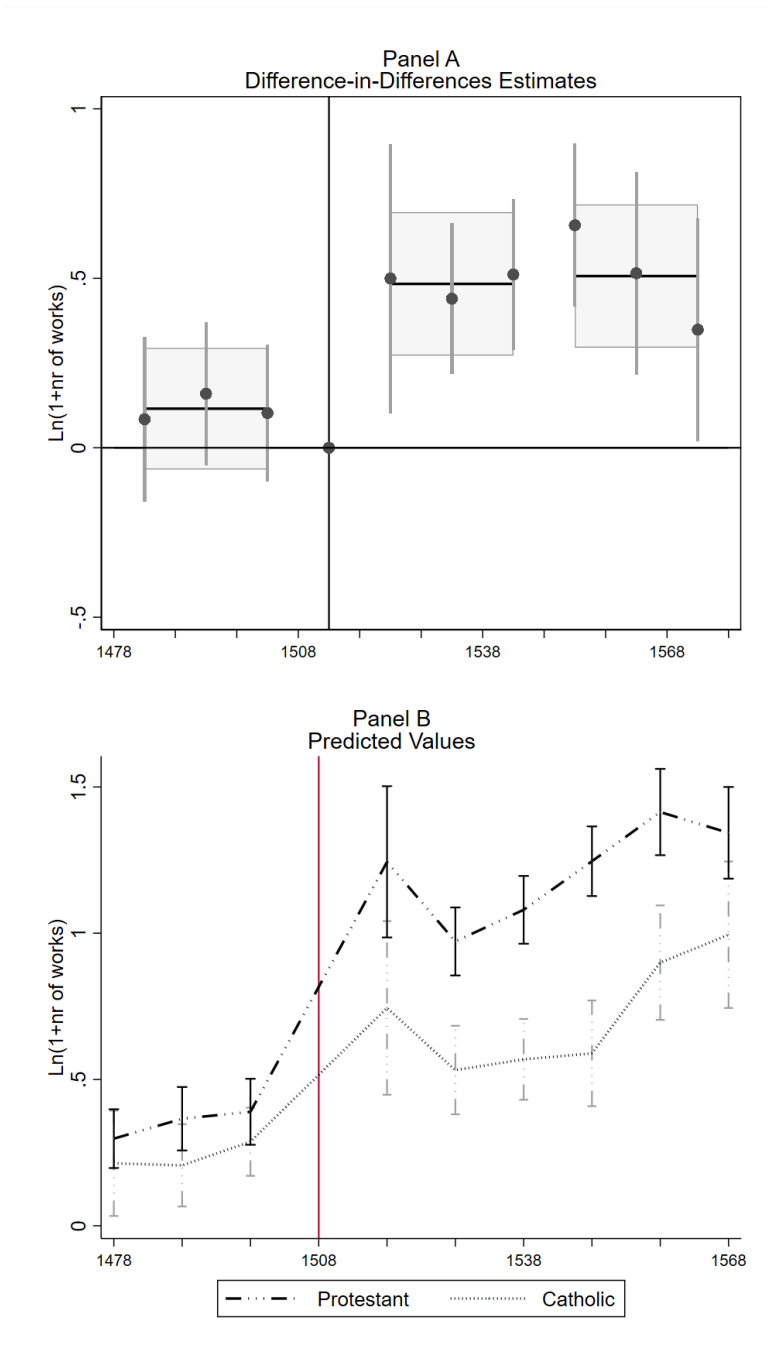


Figure 4: Effects of the Reformation on Cities' Religious Vernacular Printing Output

Notes: Difference-in-differences estimates on the interactions between a dummy for Protestant by 1600 and decade fixed effects, with the omitted period being 1508–1517, are shown as dots in Panel A with their 90% confidence intervals indicated with vertical lines. Panel A also shows the point estimates from the more aggregated model as horizontal lines with their 90% confidence intervals indicated as boxes. Panel B plots the predicted values of the dependent variable for Protestant and Catholic printing cities as dots with their 90% confidence intervals indicated with vertical lines. The dependent variable is $\ln(1+\text{number of religious works printed in the vernacular in city } i \text{ and decade } t)$. The regression includes city and decade fixed effects and is restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period. Standard errors are clustered at the territory \times decade level. The vertical line marks the onset of the Protestant Reformation in 1517. The regression results are reported in column (1) of Appendix Tables A1 and A2.

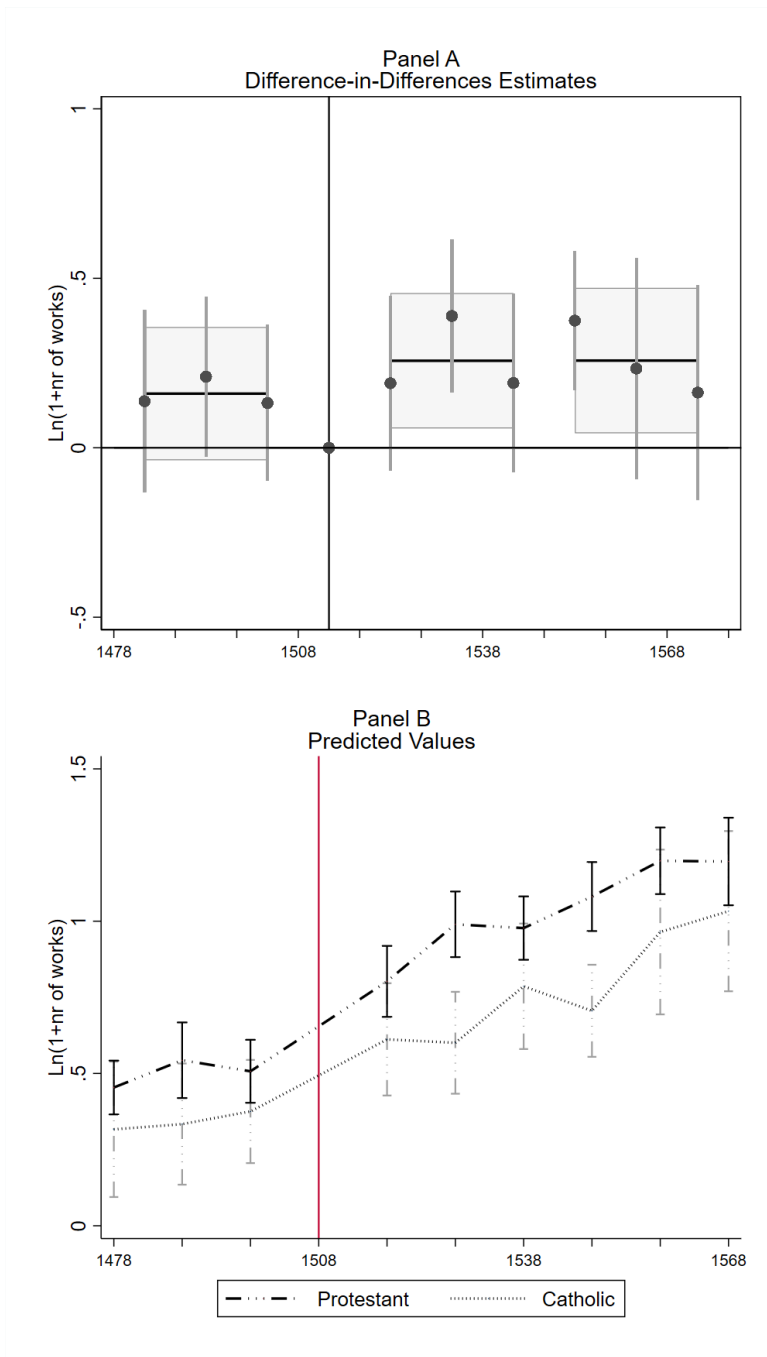


Figure 5: Effects of the Reformation on Cities' Non-Religious Vernacular Printing Output

Notes: Difference-in-differences estimates on the interactions between a dummy for Protestant by 1600 and decade fixed effects, with the omitted period being 1508–1517, are shown as dots in Panel A with their 90% confidence intervals indicated with vertical lines. Panel A also shows the point estimates from the more aggregated model as horizontal lines with their 90% confidence intervals indicated as boxes. Panel B plots the predicted values of the dependent variable for Protestant and Catholic printing cities as dots with their 90% confidence intervals indicated with vertical lines. The dependent variable is $\ln(1+\text{number of non-religious works printed in the vernacular in city } i \text{ and decade } t)$. The regression includes city and decade fixed effects and is restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period. Standard errors are clustered at the territory \times decade level. The vertical line marks the onset of the Protestant Reformation in 1517. The regression results are reported in column (2) of Appendix Tables A1 and A2.

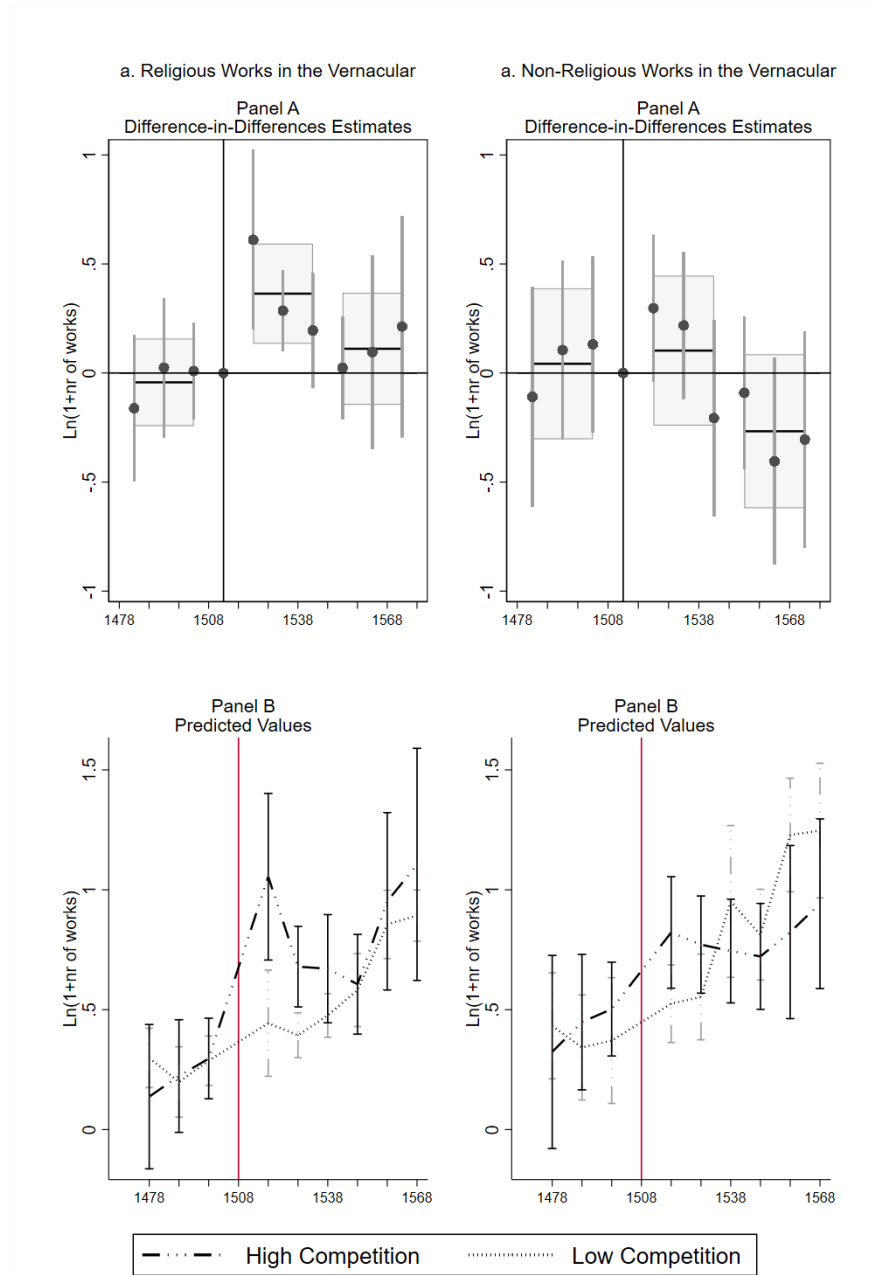


Figure 6: Effects of Religious Competition on Cities' Vernacular Printing Output

Notes: Difference-in-differences estimates on the interactions between a dummy for high competition Catholic cities and decade fixed effects, with the omitted period being 1508–1517, are shown as dots in Panel A with their 90% confidence intervals indicated with vertical lines. Panel A also shows the point estimates from the more aggregated model as horizontal lines with their 90% confidence intervals indicated as boxes. Panel B plots the predicted values of the dependent variable for high competition and low competition Catholic cities as dots with their 90% confidence intervals indicated with vertical lines. The dependent variable is $\ln(1 + \text{number of religious works printed in the vernacular in city } i \text{ and period } t)$ in a. (left) and $\ln(1 + \text{number of non-religious works printed in the vernacular in city } i \text{ and period } t)$ in b. (right). The regressions include city and period fixed effects and are restricted to Catholic cities with some printing output over the 1478–1577 period and located in the Holy Roman Empire. Catholic cities are classified as high competition cities if they have at least one Protestant city in their vicinity (located within 50km); the remainder are classified as low competition cities (for details see Section 6.1). Standard errors are clustered at the territory \times decade level. The regression results are reported in Appendix Tables B1 and B2.

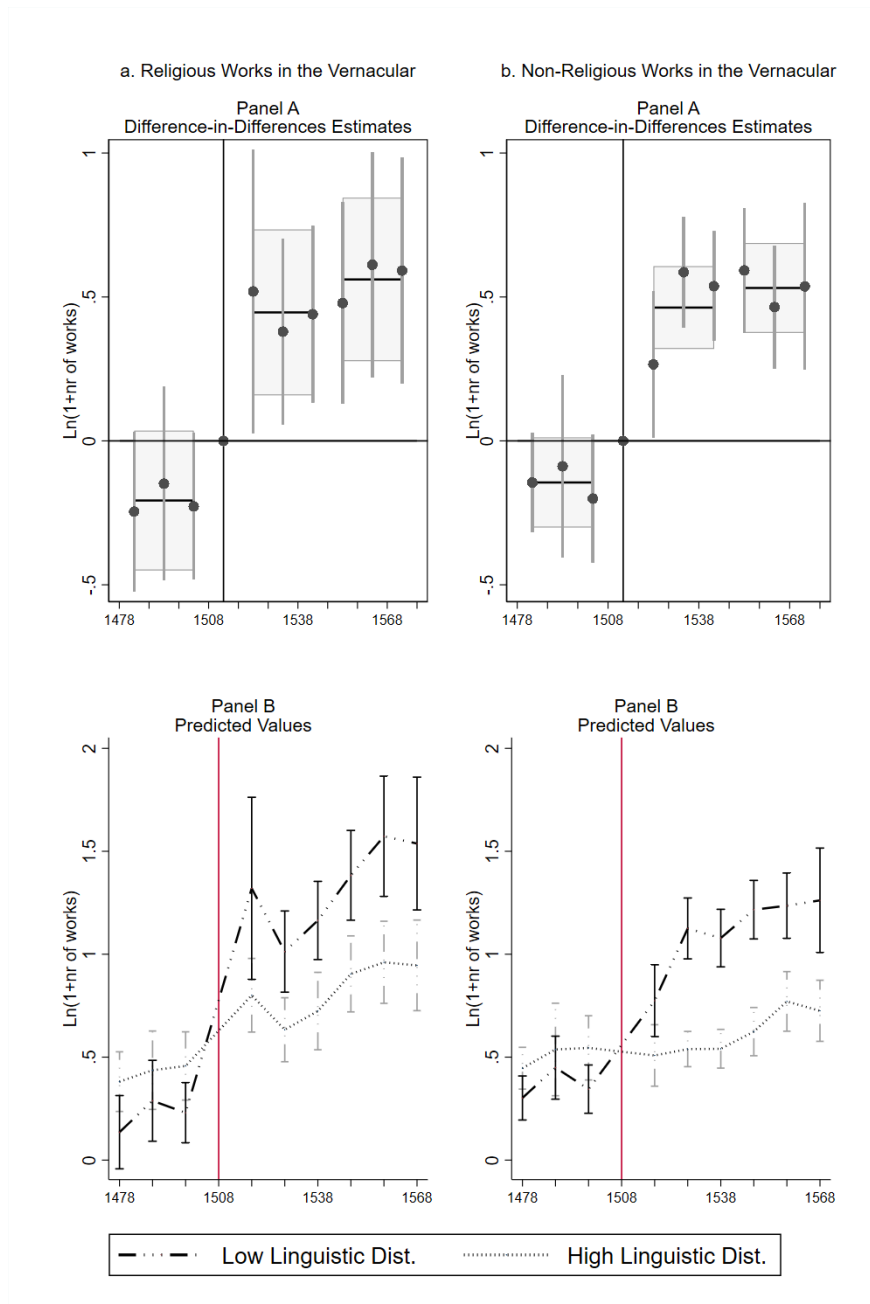


Figure 7: Effects of Linguistic Distance on Cities' Vernacular Printing Output

Notes: Difference-in-differences estimates on the interactions between a dummy for low linguistic distance to the dialect of Wittenberg and decade fixed effects, with the omitted period being 1508–1517, are shown as dots in Panel A with their 90% confidence intervals indicated with vertical lines. Panel A also shows the point estimates from the more aggregated model as horizontal lines with their 90% confidence intervals indicated as boxes. Panel B plots the predicted values of the dependent variable for low linguistic and high linguistic distance Protestant cities as dots with their 90% confidence intervals indicated with vertical lines. The dependent variable is $\ln(1 + \text{number of religious works printed in the vernacular in city } i \text{ and period } t)$ in a. (left) and $\ln(1 + \text{number of non-religious works printed in the vernacular in city } i \text{ and period } t)$ in b. (right). The regressions include city and period fixed effects and are restricted to German-speaking Protestant cities with available information on linguistic distance, with some printing output over the 1478–1577 period and located in the Holy Roman Empire. The subsample of Protestant cities that are classified as low (high) linguistic distance have a linguistic similarity to the dialect of Wittenberg equal to or above (below) the 50th percentile (for details see Section 6.2). Standard errors are clustered at the territory \times decade level. The regression results are reported in Appendix Tables B4 and B5.

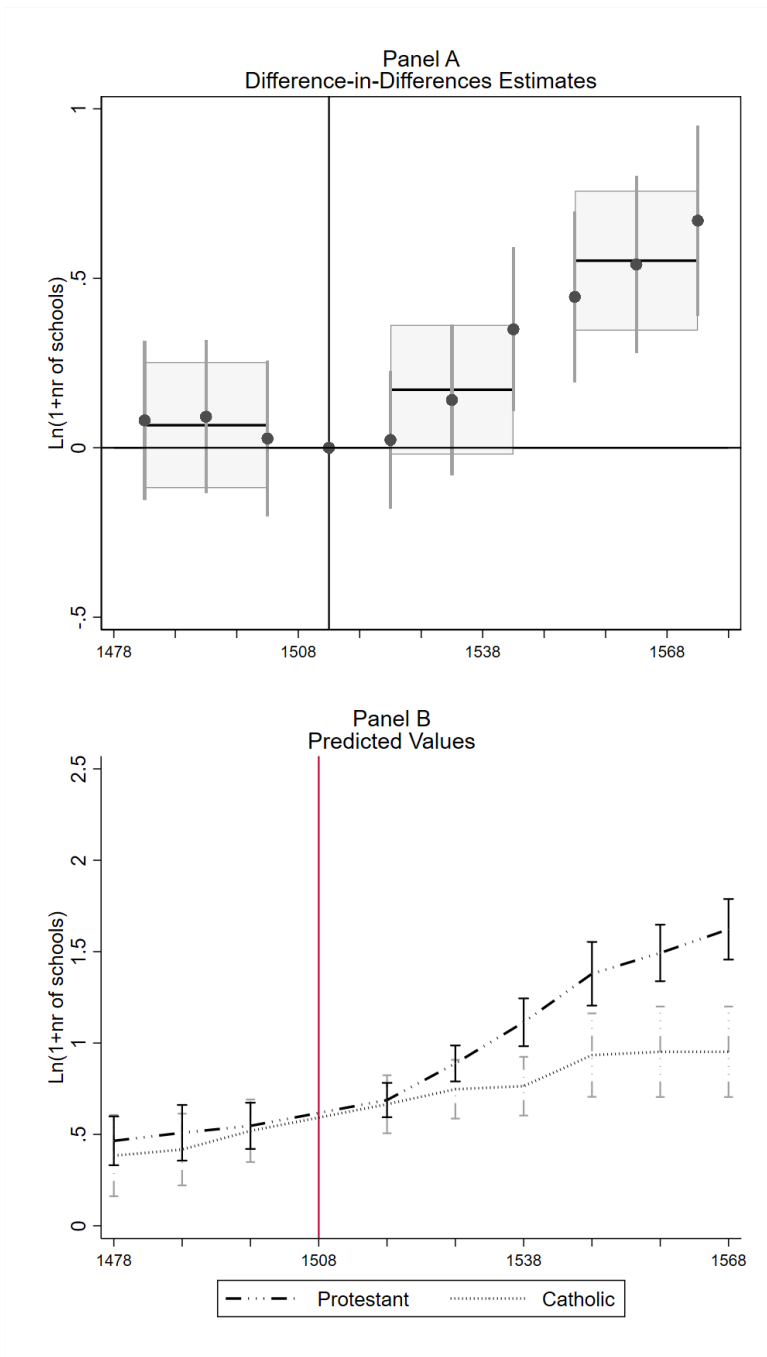


Figure 8: Effects of the Reformation on the Establishment of German Schools

Notes: Difference-in-differences estimates on the interactions between a dummy for Protestant by 1600 and decade fixed effects, with the omitted period being 1508–1517, are shown as dots in Panel A with their 90% confidence intervals indicated with vertical lines. Panel A also shows the point estimates from the more aggregated model as horizontal lines with their 90% confidence intervals indicated as boxes. Panel B plots the predicted values of the dependent variable for Protestant and Catholic printing cities as dots with their 90% confidence intervals indicated with vertical lines. The dependent variable is $\ln(1 + \text{number of German schools in city } i \text{ and decade } t)$. The regression includes city and decade fixed effects and is restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period. Standard errors are clustered at the territory \times decade level. The vertical line marks the onset of the Protestant Reformation in 1517. The regression results are reported in column (1) of Appendix Tables C1 and C2.

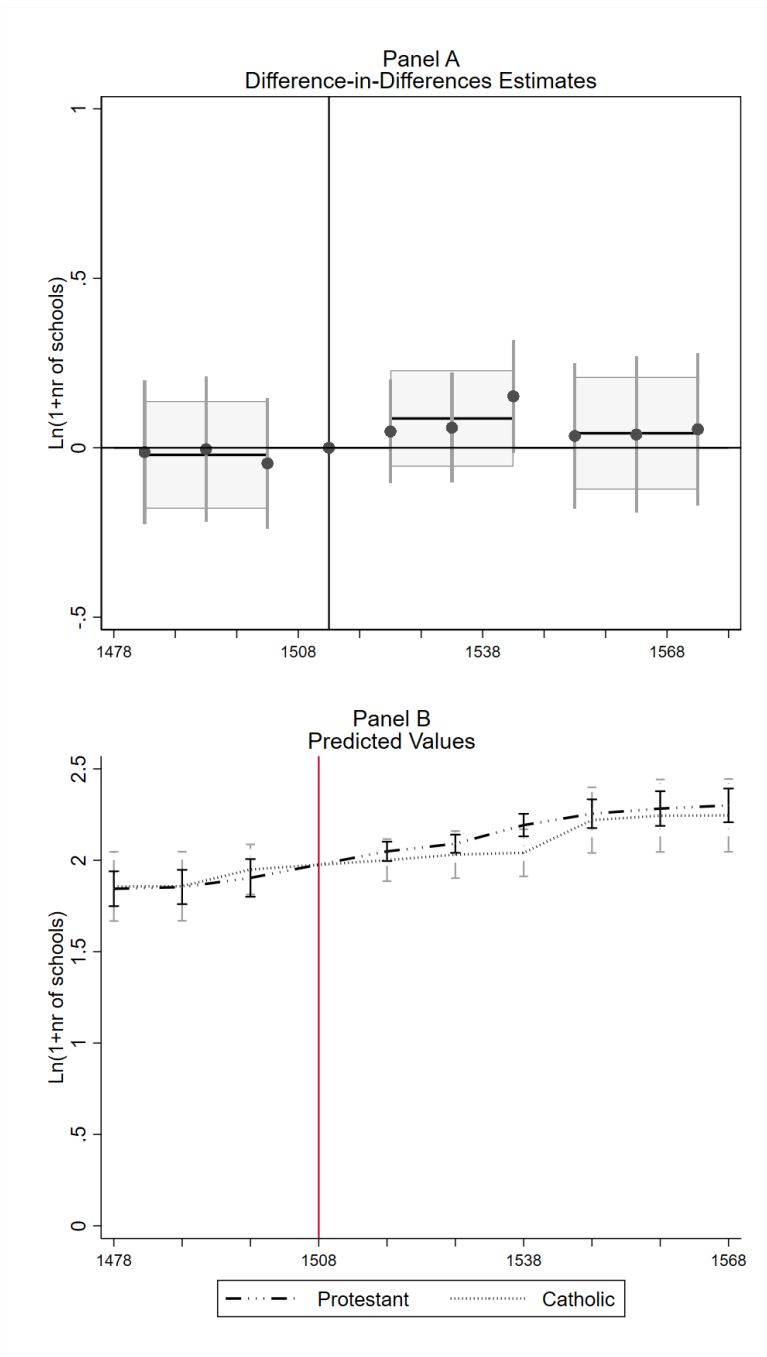


Figure 9: Effects of the Reformation on the Establishment of Latin Schools

Notes: Difference-in-differences estimates on the interactions between a dummy for Protestant by 1600 and decade fixed effects, with the omitted period being 1508–1517, are shown as dots in Panel A with their 90% confidence intervals indicated with vertical lines. Panel A also shows the point estimates from the more aggregated model as horizontal lines with their 90% confidence intervals indicated as boxes. Panel B plots the predicted values of the dependent variable for Protestant and Catholic printing cities as dots with their 90% confidence intervals indicated with vertical lines. The dependent variable is $\ln(1+\text{number of Latin schools in city } i \text{ and decade } t)$. The regression includes city and decade fixed effects and is restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period. Standard errors are clustered at the territory \times decade level. The regression results are reported in column (1) of Appendix Tables C1 and C2.

Appendix

Table of Contents

A	The Protestant Reformation and Printing in the Vernacular	41
A.1	Main Results	41
A.2	Robustness Analysis	44
B	Religious Competition and the Costs of Language Standardization	57
C	The Protestant Reformation and German Schools	63
C.1	Main Results	63
C.2	Robustness Analysis	65

A The Protestant Reformation and Printing in the Vernacular

A.1 Main Results

Table A1: Effects of the Reformation on Vernacular and Latin Printing Output

	<i>Ln(1+Number of Works)</i>			
	<i>Vernacular</i>		<i>Latin</i>	
	<i>Religious</i>	<i>Non-Religious</i>	<i>Religious</i>	<i>Non-Religious</i>
	(1)	(2)	(3)	(4)
Protestant X 1478–1487	0.084 (0.147)	0.137 (0.163)	-0.007 (0.166)	-0.025 (0.149)
Protestant X 1488–1497	0.159 (0.127)	0.210 (0.143)	0.084 (0.158)	0.040 (0.172)
Protestant X 1498–1507	0.102 (0.122)	0.132 (0.139)	0.172 (0.152)	0.181 (0.148)
Protestant X 1518–1527	0.499** (0.240)	0.190 (0.156)	-0.002 (0.227)	-0.153 (0.166)
Protestant X 1528–1537	0.440*** (0.135)	0.389*** (0.136)	0.119 (0.147)	0.114 (0.131)
Protestant X 1538–1547	0.511*** (0.135)	0.191 (0.160)	0.219 (0.148)	0.160 (0.143)
Protestant X 1548–1557	0.657*** (0.145)	0.375*** (0.124)	0.240 (0.159)	0.180 (0.141)
Protestant X 1558–1567	0.515*** (0.180)	0.234 (0.198)	0.129 (0.184)	0.048 (0.146)
Protestant X 1568–1577	0.348* (0.199)	0.163 (0.191)	0.122 (0.201)	0.193 (0.186)
1478–1487	-0.161 (0.105)	-0.187 (0.145)	0.072 (0.144)	-0.087 (0.107)
1488–1497	-0.168** (0.080)	-0.170 (0.132)	-0.012 (0.106)	-0.083 (0.119)
1498–1507	-0.088 (0.065)	-0.129 (0.116)	-0.109 (0.105)	-0.188* (0.110)
1518–1527	0.370** (0.178)	0.108 (0.124)	0.113 (0.144)	0.106 (0.098)
1528–1537	0.157* (0.087)	0.097 (0.114)	-0.074 (0.094)	-0.058 (0.083)
1538–1547	0.194** (0.079)	0.282** (0.136)	-0.031 (0.096)	0.013 (0.088)
1548–1557	0.215** (0.106)	0.202* (0.106)	0.009 (0.116)	0.073 (0.090)
1558–1567	0.524*** (0.115)	0.461*** (0.172)	0.267* (0.150)	0.342*** (0.123)
1568–1577	0.620*** (0.149)	0.529*** (0.168)	0.346* (0.178)	0.364** (0.152)
N	1790	1790	1790	1790
R ²	0.652	0.719	0.719	0.752

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: OLS regressions at the city level with standard errors clustered at the territory \times decade level in parentheses, with the omitted decade being 1508–1517. The regressions include city fixed effects and are restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period. The dependent variable in columns (1) and (2) is the natural log of one plus the total number of religious works and non-religious works in the vernacular, respectively. The dependent variable in columns (3) and (4) is the natural log of one plus the total number of religious works and non-religious works in Latin, respectively. For a graphical representation, see Figures 4 (column 1), 5 (column 2), A2 (column 3), and A3 (column 4).

Table A2: Effects of the Reformation on Vernacular and Latin Printing Output (More Aggregated Model)

	<i>Ln(1+Number of Works)</i>			
	<i>Vernacular</i>		<i>Latin</i>	
	<i>Religious</i>	<i>Non-Religious</i>	<i>Religious</i>	<i>Non-Religious</i>
	(1)	(2)	(3)	(4)
Protestant X 1478–1507	0.115 (0.109)	0.160 (0.119)	0.083 (0.139)	0.066 (0.132)
Protestant X 1518–1547	0.483*** (0.128)	0.257** (0.121)	0.112 (0.149)	0.040 (0.135)
Protestant X 1548–1577	0.507*** (0.128)	0.257** (0.130)	0.164 (0.148)	0.140 (0.135)
1478–1487	-0.180** (0.078)	-0.200* (0.112)	0.019 (0.132)	-0.140 (0.102)
1488–1497	-0.143** (0.070)	-0.141 (0.116)	-0.011 (0.112)	-0.098 (0.106)
1498–1507	-0.095 (0.064)	-0.145 (0.101)	-0.057 (0.099)	-0.121 (0.098)
1518–1527	0.379*** (0.135)	0.069 (0.101)	0.046 (0.102)	-0.007 (0.084)
1528–1537	0.132 (0.082)	0.174 (0.107)	-0.070 (0.100)	-0.015 (0.089)
1538–1547	0.210*** (0.077)	0.244** (0.111)	0.032 (0.100)	0.083 (0.085)
1548–1557	0.303*** (0.089)	0.271** (0.106)	0.054 (0.106)	0.096 (0.088)
1558–1567	0.529*** (0.086)	0.447*** (0.127)	0.246** (0.119)	0.287*** (0.109)
1568–1577	0.527*** (0.109)	0.474*** (0.133)	0.321** (0.139)	0.395*** (0.116)
N	1790	1790	1790	1790
R^2	0.651	0.718	0.718	0.751

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: OLS regressions at the city level with standard errors clustered at the territory \times decade level in parentheses. The regressions include city fixed effects and are restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period. The omitted decade is 1508–1517. The dependent variable in columns (1) and (2) is the natural log of one plus the total number of religious works and non-religious works in the vernacular, respectively. The dependent variable in columns (3) and (4) is the natural log of one plus the total number of religious works and non-religious works in Latin, respectively. For a graphical representation, see Figures 4 (column 1), 5 (column 2), A2 (column 3), and A3 (column 4).

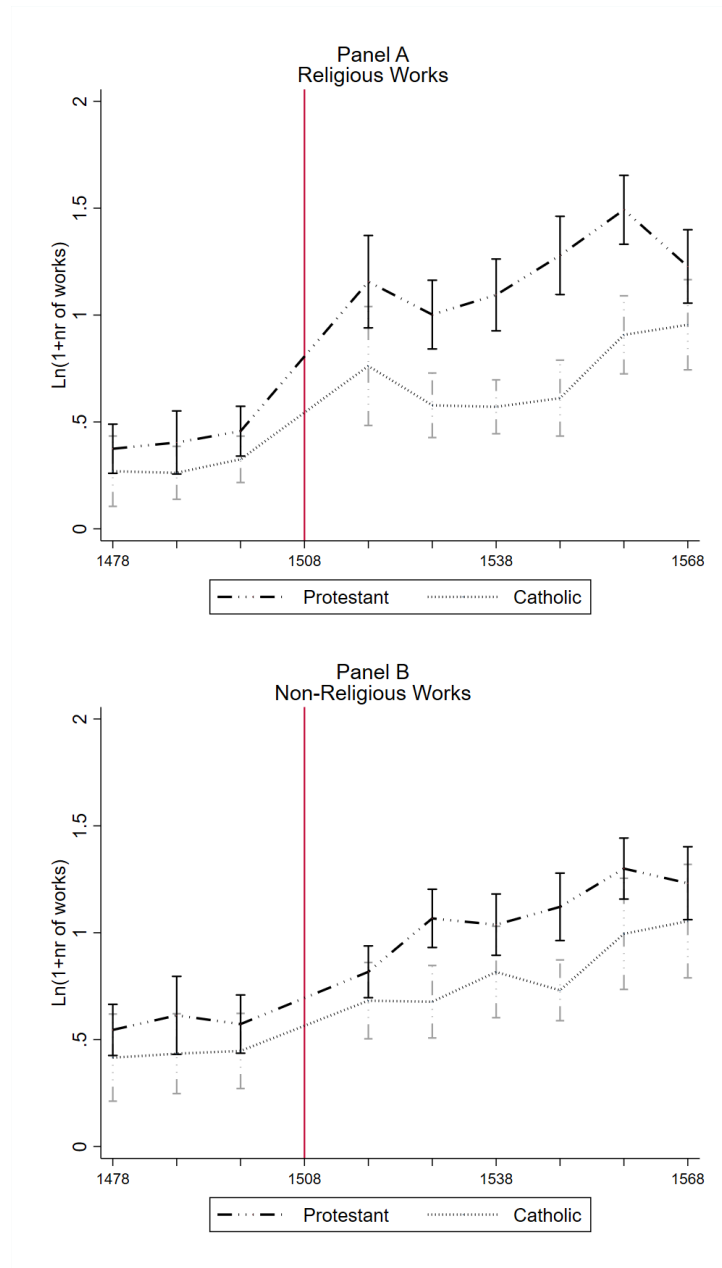


Figure A1: Effects of the Reformation on Cities' Vernacular Printing Output: Dropping Cities within 217km of Wittenberg (Predicted Values)

Notes: Based on the estimates reported in column (4) of Tables A3 and A4, the predicted values of the dependent variable are shown for Protestant and Catholic printing cities as dots with their 90% confidence intervals indicated with vertical lines. The dependent variable is $\ln(1+\text{number of religious/non-religious works printed in the vernacular in city } i \text{ and decade } t)$. Cities that are located close to the city of Wittenberg (within the 25th percentile, or 217km) are dropped from the sample. The regressions include city and decade fixed effects and are restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period. Standard errors are clustered at the territory \times decade level. The vertical line marks the onset of the Protestant Reformation in 1517.

A.2 Robustness Analysis

A.2.1 Additional Control Variables

We first assess the extent to which our results change when we allow for city-specific features to have time-varying effects. We do so by adding interactions between (time-invariant) city-specific characteristics and decade fixed effects to our baseline equations 1 and 2 (for details on the variables, see Section 3.4). As city-specific characteristics, we first consider population fixed effects and a set of historical variables, including indicator variables for whether the city had a university in 1450, hosted a bishop or archbishop before or in 1517, and was an independent city in 1517. We then add interactions between geographic variables and decade fixed effects. Geographic variables include the natural log of one plus a city’s distance to Mainz, the natural log of one plus a city’s distance to water (river or coast), and the natural log of one plus a city’s distance to a trade route. All specifications include, as before, city and period fixed effects. The results are shown in columns (2) and (3) of Tables A3 and A4. Reassuringly, the coefficient estimates on the interactions between the Protestant dummy and decade fixed effects are similar to those from our baseline specification (see column 1). Also, and importantly, we do not observe any differential pre-trend in religious or non-religious vernacular printing prior to the Reformation.

Table A3: Robustness Analysis: Religious Works Printed in the Vernacular

	<i>Ln(1+Nr of Religious Works in the Vernacular)</i>				
	(1)	(2)	(3)	(4)	(5)
Protestant X 1478–1487	0.084 (0.147)	-0.011 (0.176)	0.059 (0.151)	0.107 (0.139)	-0.054 (0.127)
Protestant X 1488–1497	0.159 (0.127)	0.073 (0.143)	0.096 (0.140)	0.144 (0.134)	-0.002 (0.122)
Protestant X 1498–1507	0.102 (0.122)	0.061 (0.136)	0.090 (0.128)	0.133 (0.115)	0.024 (0.117)
Protestant X 1518–1527	0.499** (0.240)	0.586** (0.231)	0.523** (0.226)	0.389** (0.180)	0.499** (0.238)
Protestant X 1528–1537	0.440*** (0.135)	0.480*** (0.135)	0.428*** (0.137)	0.422*** (0.153)	0.320* (0.169)
Protestant X 1538–1547	0.511*** (0.135)	0.543*** (0.141)	0.549*** (0.165)	0.521*** (0.154)	0.330** (0.129)
Protestant X 1548–1557	0.657*** (0.145)	0.768*** (0.151)	0.762*** (0.144)	0.664*** (0.144)	0.425*** (0.132)
Protestant X 1558–1567	0.515*** (0.180)	0.628*** (0.183)	0.631*** (0.190)	0.578*** (0.173)	0.344* (0.178)
Protestant X 1568–1577	0.348* (0.199)	0.377* (0.217)	0.173 (0.224)	0.265 (0.166)	0.198 (0.201)
Historical controls	No	Yes	Yes	No	No
Geographic controls	No	No	Yes	No	No
Removing cities < 217km to Wittenberg	No	No	No	Yes	No
Removing cities with high share of pre-1517 vernacular printing output	No	No	No	No	Yes
N	1790	1790	1790	1340	1570
R ²	0.652	0.678	0.689	0.669	0.570

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: OLS regressions at the city level with standard errors clustered at the territory \times decade level in parentheses. The dependent variable is $\ln(1+\text{total number of religious works in the vernacular})$, and the table shows the estimates on the interactions between Protestant by 1600 and decade fixed effects. Column (1) shows our main results (see column 1 of Table A1). Columns (2) and (3) add interactions between city-specific historical and geographic characteristics and decade fixed effects. City-specific characteristics in column (2) are dummies for population in 1500 (population fixed effects) and indicator variables for whether the city had a university in 1450, hosted a bishop or archbishop before or in 1517, and was an independent city in 1517. Geographic characteristics in column (3) include the natural log of one plus a city's distance to Mainz, the natural log of one plus a city's distance to water (river or coast), and the natural log of one plus a city's distance to a trade route. In column (4) we remove cities from the sample that are located close to the city of Wittenberg (within the 25th percentile, or 217km). In column (5) we remove cities from our sample whose share of pre-Reformation vernacular printing output (1451–1517) is at the 75th percentile or higher, conditional on having printed at least 10 works during this period. All regressions include city and decade fixed effects and are restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period.

Table A4: Robustness Analysis: Non-Religious Works Printed in the Vernacular

	<i>Ln(1+Nr of Non-Religious Works in the Vernacular)</i>				
	(1)	(2)	(3)	(4)	(5)
Protestant X 1478–1487	0.137 (0.163)	0.105 (0.162)	0.182 (0.150)	0.132 (0.160)	0.006 (0.149)
Protestant X 1488–1497	0.210 (0.143)	0.191 (0.118)	0.221 (0.134)	0.181 (0.160)	0.039 (0.127)
Protestant X 1498–1507	0.132 (0.139)	0.090 (0.121)	0.084 (0.123)	0.128 (0.154)	0.047 (0.133)
Protestant X 1518–1527	0.190 (0.156)	0.264* (0.138)	0.249* (0.136)	0.133 (0.150)	0.186 (0.140)
Protestant X 1528–1537	0.389*** (0.136)	0.487*** (0.126)	0.426*** (0.119)	0.388*** (0.149)	0.341** (0.156)
Protestant X 1538–1547	0.191 (0.160)	0.322** (0.129)	0.360** (0.140)	0.218 (0.176)	0.042 (0.167)
Protestant X 1548–1557	0.375*** (0.124)	0.482*** (0.114)	0.477*** (0.123)	0.388*** (0.132)	0.223 (0.135)
Protestant X 1558–1567	0.234 (0.198)	0.377** (0.157)	0.369** (0.168)	0.299 (0.188)	0.039 (0.189)
Protestant X 1568–1577	0.163 (0.191)	0.304* (0.170)	0.264 (0.178)	0.170 (0.187)	0.029 (0.174)
Historical controls	No	Yes	Yes	No	No
Geographic controls	No	No	Yes	No	No
Removing cities < 217 to Wittenberg	No	No	No	Yes	No
Removing cities with high share of pre-1517 vernacular printing output	No	No	No	No	Yes
N	1790	1790	1790	1340	1570
R^2	0.719	0.743	0.747	0.725	0.646

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: OLS regressions at the city level with standard errors clustered at the territory \times decade level in parentheses. The dependent variable is $\ln(1+\text{total number of non-religious works in the vernacular})$, and the table shows the estimates on the interactions between the log of one plus a city’s distance to Wittenberg and decade fixed effects. Column (1) shows our main results (see column 2 of Table A1). Columns (2) and (3) add interactions between city-specific historical and geographic characteristics and decade fixed effects. City-specific characteristics in column (2) are dummies for population in 1500 (population fixed effects) and indicator variables for whether the city had a university in 1450, hosted a bishop or archbishop before or in 1517, and was an independent city in 1517. Geographic characteristics in column (3) include the natural log of one plus a city’s distance to Mainz, the natural log of one plus a city’s distance to water (river or coast), and the natural log of one plus a city’s distance to a trade route. In column (4) we remove cities from the sample that are located close to the city of Wittenberg (within the 25th percentile, or 217km). In column (5) we remove cities from our sample whose share of pre-Reformation vernacular printing output (1451–1517) is at the 75th percentile or higher, conditional on having printed at least 10 works during this period. All regressions include city and decade fixed effects and are restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period.

A.2.2 The Reformation and Latin Printing Output

In this section we assess changes in Latin printing output across Protestant and Catholic cities over time by reestimating equations 1 and 2 where the dependent variable now is the natural log of one plus the number of religious (non-religious) works in Latin in printing city i and decade t .

The results are presented in Figures A2 and A3. Panels A plot the difference-in-differences estimates on the interaction terms between the Protestant dummy and decade or period fixed effects (with the omitted period being 1508–1517). (The regression results are reported in columns (3) and (4) of Tables A1 and A2.) Panels B plot the predicted values of the dependent variable for Protestant and for Catholic cities. As before, the vertical line in the year 1517 marks the onset of the Protestant Reformation.

Based on Figures A2 and A3, we can document the following. First, there are no pre-Reformation trends in religious and non-religious Latin printing output across Protestant and Catholic cities. As we already ruled out pre-trends in vernacular printing, we can now also rule out different trends in overall printing prior to the Reformation. Second, the Reformation had no immediate differential effect on Latin printing output across Protestant and Catholic cities. Thus, the differential increase in religious vernacular printing output that we observe following the Reformation is specific to printing in the vernacular, not to printing in general. Third, the sharp secular rise in religious and non-religious vernacular printing output after the Reformation is confined to printing in the vernacular; Latin printing output remains at levels similar to those before the Reformation. Only towards the mid of the 16th century do cities experience an increase in Latin printing. In turn, vernacular printing output rises not just in absolute terms but also relative to Latin printing output with the implication that, at least in Protestant cities, vernacular printing output even outweighs Latin printing output in the decades following the Reformation.

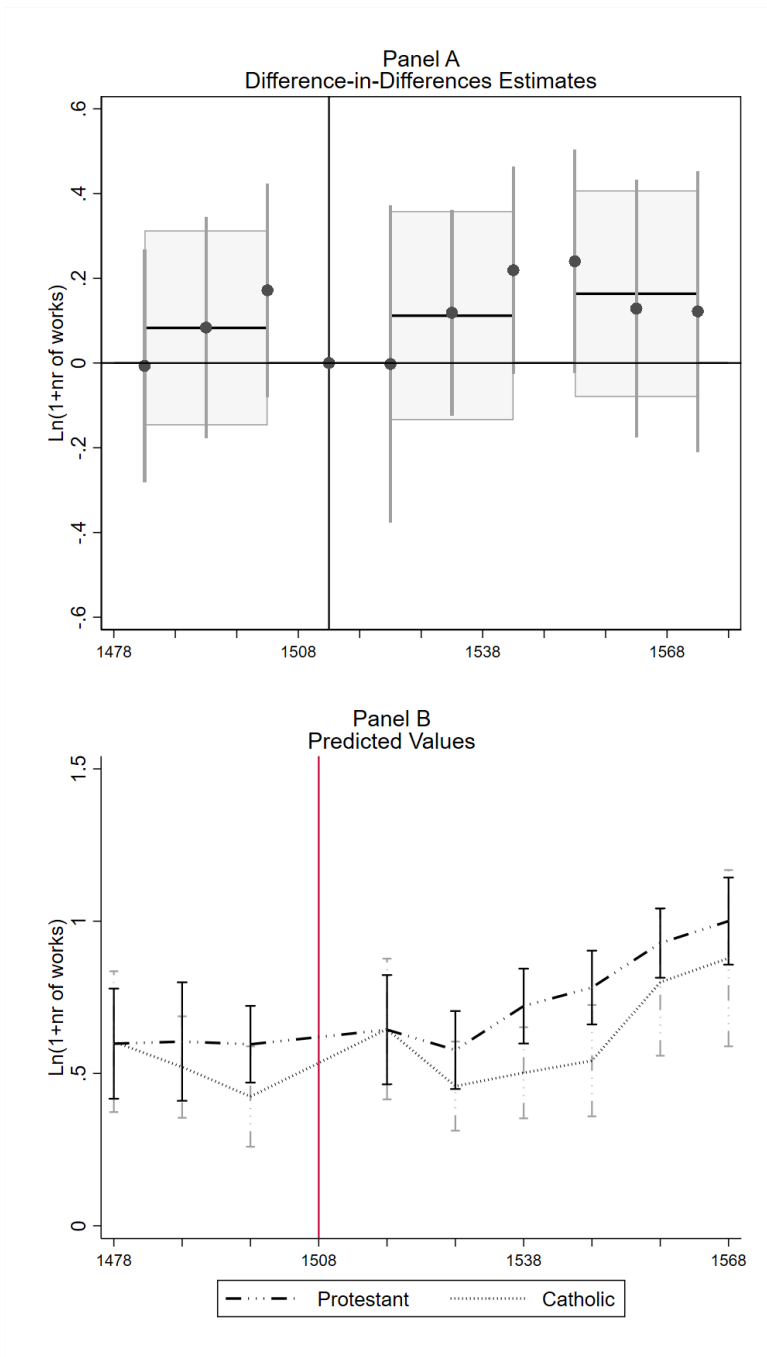


Figure A2: Effects of the Reformation on Cities' Religious Latin Printing Output

Notes: Difference-in-differences estimates on the interactions between a dummy for Protestant by 1600 and decade fixed effects, with the omitted period being 1508–1517, are shown as dots in Panel A with their 90% confidence intervals indicated with vertical lines. Panel A also shows the point estimates from the more aggregated model as horizontal lines with their 90% confidence intervals indicated as boxes. Panel B plots the predicted values of the dependent variable for Protestant and Catholic printing cities as dots with their 90% confidence intervals indicated with vertical lines. The dependent variable is $\ln(1+\text{number of religious works printed in Latin in city } i \text{ and decade } t)$. The regression includes city and decade fixed effects and is restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period. Standard errors are clustered at the territory \times decade level. The vertical line marks the onset of the Protestant Reformation in 1517. The regression results are reported in column (3) of Appendix Tables A1 and A2.

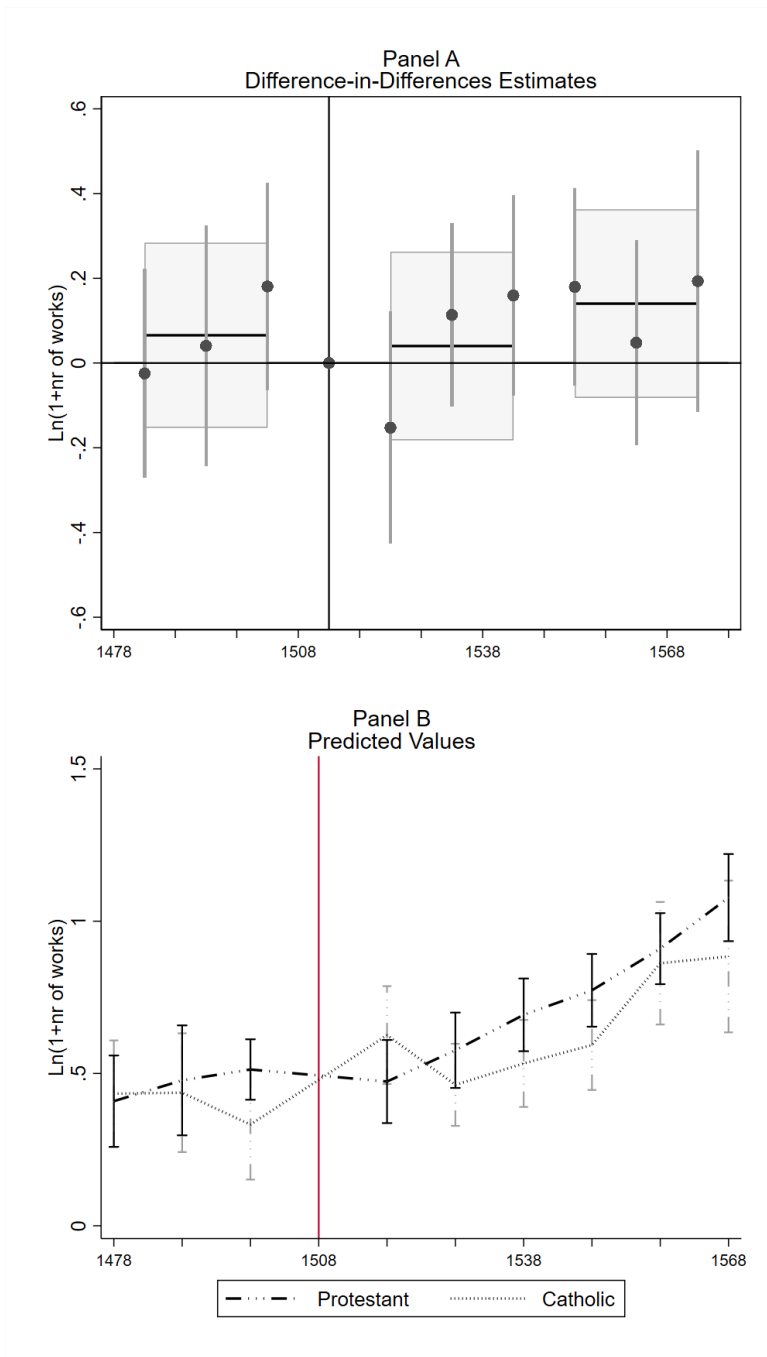


Figure A3: Effects of the Reformation on Cities' Non-Religious Latin Printing Output

Notes: Difference-in-differences estimates on the interactions between a dummy for Protestant by 1600 and decade fixed effects, with the omitted period being 1508–1517, are shown as dots in Panel A with their 90% confidence intervals indicated with vertical lines. Panel A also shows the point estimates from the more aggregated model as horizontal lines with their 90% confidence intervals indicated as boxes. Panel B plots the predicted values of the dependent variable for Protestant and Catholic printing cities as dots with their 90% confidence intervals indicated with vertical lines. The dependent variable is $\ln(1+\text{number of religious works printed in Latin in city } i \text{ and decade } t)$. The regression includes city and decade fixed effects and is restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period. Standard errors are clustered at the territory \times decade level. The vertical line marks the onset of the Protestant Reformation in 1517. The regression results are reported in column (4) of Appendix Tables A1 and A2.

A.2.3 Selection into Printing

Our results so far show that, prior to the Reformation, trends and even levels in vernacular and in Latin printing output were similar across Protestant and Catholic cities. While we restrict our sample throughout to cities with some printing output over the 1478–1577 period, 42% of printing cities in our sample had not adopted the printing press by the time of the Reformation, i.e. had not printed any works by 1517. We therefore now address the concern that the adoption of the movable-type printing press may have varied across Protestant and Catholic printing cities prior to the Reformation. To this end, we estimate equations 1 and 2 where the dependent variable is now defined as a binary variable equal to one if city i had adopted the printing press by decade t .

Figure A4 plots the difference-in-differences estimates on the interaction terms between the Protestant dummy and decade fixed effects in Panel A and the predicted values of the dependent variable for Protestant and Catholic cities in Panel B. Reassuringly, the estimates suggest no differential adoption of the printing press across Protestant and Catholic printing cities prior to the Reformation. Even the share of cities with a printing press is similar for Protestant and Catholic printing cities before the Reformation.

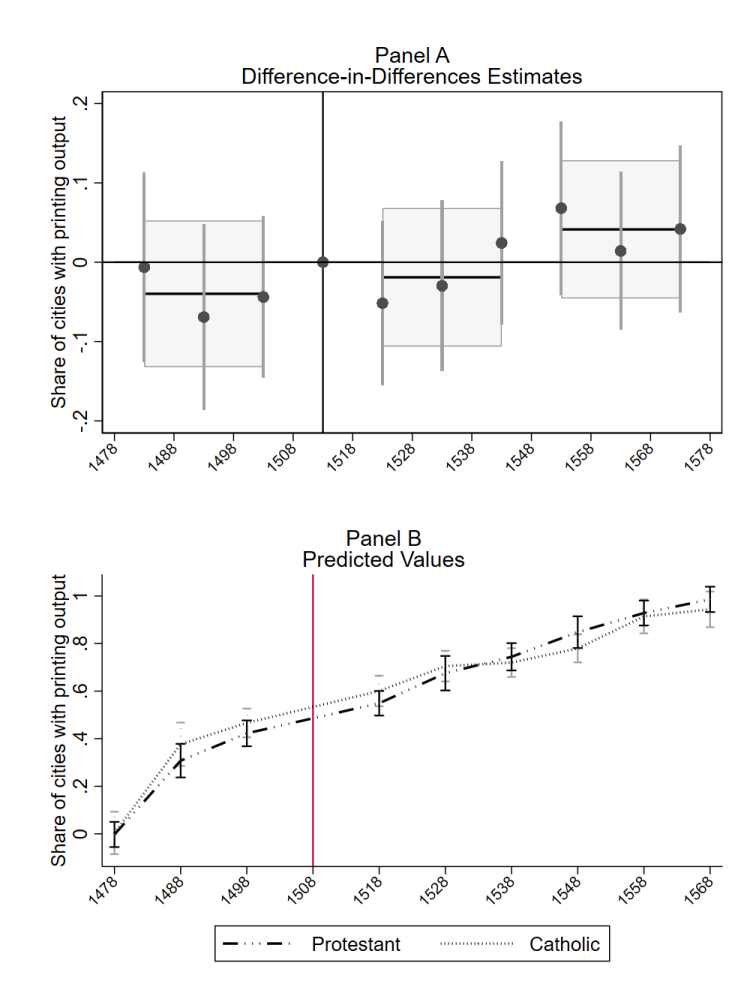


Figure A4: Printing Press Adoption Across Protestant and Catholic Printing Cities over Time

Notes: Difference-in-differences estimates on the interactions between a dummy for Protestant by 1600 and decade fixed effects, with the omitted period being 1508–1517, are shown as dots in Panel A with their 90% confidence intervals indicated with vertical lines. Panel A also shows the point estimates from the more aggregated model as horizontal lines with their 90% confidence intervals indicated as boxes. Panel B plots the predicted values of the dependent variable for Protestant and Catholic printing cities as dots with their 90% confidence intervals indicated with vertical lines. The dependent variable is a binary variable equal to one if city i had adopted the printing press by decade t . The regression includes city and decade fixed effects and is restricted to cities with some printing output over the 1478–1577 period. Standard errors are clustered at the territory \times decade level. The vertical line indicates the onset of the Protestant Reformation in 1517.

A.2.4 Selection into Protestantism

Our causal interpretation assumes that a city’s preference for using the vernacular, something we do not observe, did not influence its decision to adopt Protestantism. As we discuss in Section 4 above, existing work gives little indication that we need to be concerned, and the results presented so far also lend credibility to our identification strategy. Nonetheless, as a further robustness check, we now compare early adopters of Protestantism (cities that had adopted the new religion by 1530) with those that adopted Protestantism later or remained Catholic using the same specifications as before (1 and 2), assuming that early adoption was likely more exogenous than later adoption of the new religion.

Figures A5 and A6 show the results of this exercise. We find no pre-Reformation trend for religious and non-religious vernacular output. Protestant and Catholic printing cities even show similar levels in religious and non-religious vernacular printing output prior to the Reformation. Immediately after the Reformation, we observe a strong differential increase in vernacular works, particularly for religious works. This differential increase appears even larger than the increase we document using cities that adopted Protestantism by 1600 as the treated group. Differences in vernacular printing output across Protestant and Catholic cities vanish in later decades, when late adopters (which are now classified as Catholic) see a rise in vernacular works. This pattern is overall in line with our causal interpretation, namely that the Reformation spurred vernacular printing rather than the opposite, i.e. that vernacular printing led to the adoption of Protestantism.

As an alternative robustness exercise, we drop cities from our sample whose share of pre-Reformation vernacular printing output is at the 75th percentile or higher, conditional on having printed at least 10 works over this time period. This implies removing cities where more than 50% of works were printed in the vernacular between 1451–1517. The results of this exercise, which are shown in column (5) of Tables A3 and A4, support our main findings. First, we find no evidence for a differential trend prior to the Reformation in religious and non-religious vernacular printing output across cities that would become Protestant over the course of the 16th century and those that would remain Catholic. Second, the observed differential trend in vernacular printing output after the Reformation is similar to the one obtained for the full sample of printing cities (column 1 of Tables A3 and A4).

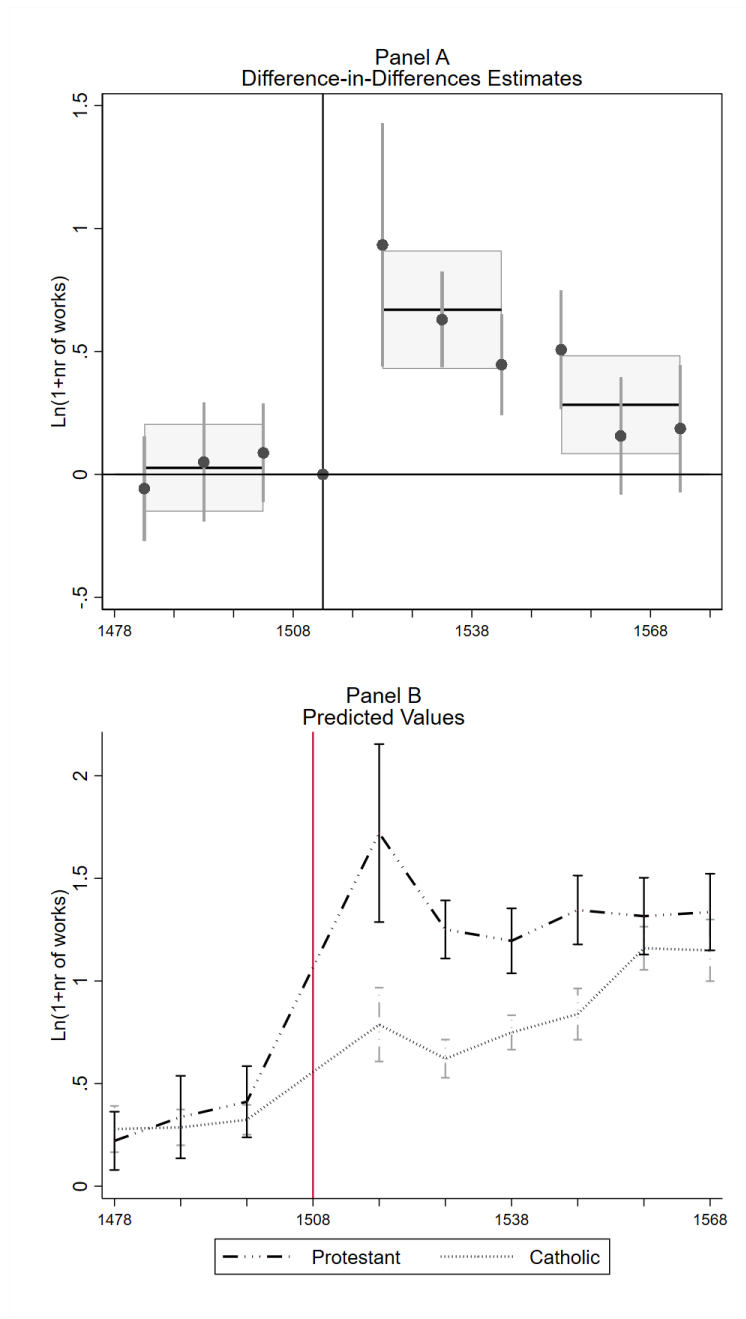


Figure A5: Effects of the Reformation on Cities' Religious Vernacular Printing Output: Protestant by 1530

Notes: Difference-in-differences estimates on the interactions between a dummy for Protestant by 1530 and decade fixed effects, with the omitted period being 1508–1517, are shown as dots in Panel A with their 90% confidence intervals indicated with vertical lines. Panel A also shows the point estimates from the more aggregated model as horizontal lines with their 90% confidence intervals indicated as boxes. Panel B plots the predicted values of the dependent variable for Protestant and Catholic printing cities as dots with their 90% confidence intervals indicated with vertical lines. The dependent variable is $\ln(1+\text{number of religious works printed in the vernacular in city } i \text{ and decade } t)$. The regression includes city and decade fixed effects and is restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period. Standard errors are clustered at the territory \times decade level. The vertical line marks the onset of the Protestant Reformation in 1517.

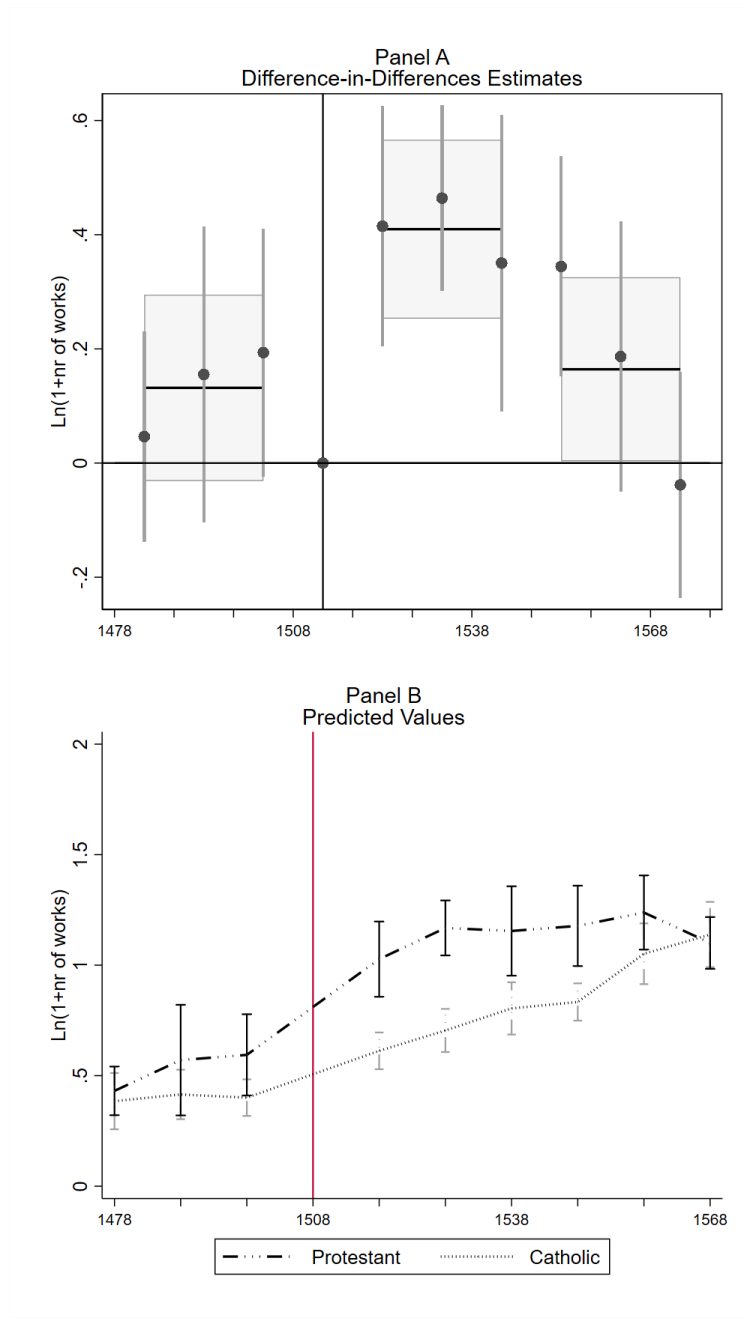


Figure A6: Effects of the Reformation on Cities' Non-Religious Vernacular Printing Output: Protestant by 1530

Notes: Difference-in-differences estimates on the interactions between a dummy for Protestant by 1530 and decade fixed effects, with the omitted period being 1508–1517, are shown as dots in Panel A with their 90% confidence intervals indicated with vertical lines. Panel A also shows the point estimates from the more aggregated model as horizontal lines with their 90% confidence intervals indicated as boxes. Panel B plots the predicted values of the dependent variable for Protestant and Catholic printing cities as dots with their 90% confidence intervals indicated with vertical lines. The dependent variable is $\ln(1+\text{number of non-religious works printed in the vernacular in city } i \text{ and decade } t)$. The regression includes city and decade fixed effects and is restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period. Standard errors are clustered at the territory \times decade level. The vertical line marks the onset of the Protestant Reformation in 1517.

A.2.5 Cities' Distance to Wittenberg and Vernacular Printing Output

In our last exercise we replace the Protestant dummy in equation (1) with the log of one plus a city's distance to Wittenberg. As noted in Section 4, the adoption of the new religion followed a concentric pattern around Wittenberg, implying that a city's distance to Wittenberg can be seen as a key determinant of adoption of Protestantism, in particular early on (e.g. Becker and Woessmann, 2009; Cantoni, 2012). Moreover, the city of Wittenberg was unimportant for the printing industry prior to the Reformation.²⁴

Table A5 reports the results. Columns (1) and (4) are based on our baseline specification. Similar to our earlier robustness exercise (see Section A.2.1), we then add different sets of time-varying controls. Column (2) adds interactions between population and historical variables and decade fixed effects, and column (3) further adds interactions between geographic variables and decade fixed effects. Our most preferred specification includes geographic * time interactions (columns 3 and 6) as distance to Wittenberg may otherwise partly capture the time-varying effect of other geographic city-specific characteristics.

Reassuringly, we do not observe differences in vernacular printing output by a city's distance to Wittenberg prior to the Reformation, suggesting that at that time, Wittenberg was indeed unimportant for the printing industry. Yet following the Reformation, the estimate on a city's distance to Wittenberg is negative and statistically significant, implying that cities located further away experienced smaller increases in religious and non-religious vernacular printing output after the Reformation compared to cities located close to Wittenberg. As we would expect, the relationship between distance to Wittenberg and vernacular printing output is particularly strong for religious works printed in the first decade after the Reformation. Overall, these results indicate that a city's distance to Wittenberg became important only after the onset of the Reformation, which supports a causal interpretation of the relationship between adoption of Protestantism and vernacular printing.

²⁴ Interestingly, prior to the Reformation, only 4% of printed works in the city of Wittenberg were printed in German.

Table A5: Distance to Wittenberg and Vernacular Printing Output

	<i>Ln(1+Number of Works Printed in the Vernacular)</i>					
	<i>Religious Works</i>			<i>Non-Religious Works</i>		
	(1)	(2)	(3)	(4)	(5)	(6)
Log Distance to Wittenberg X 1478–1487	0.103** (0.040)	0.117* (0.068)	0.100 (0.067)	-0.008 (0.047)	0.014 (0.062)	-0.074 (0.071)
Log Distance to Wittenberg X 1488–1497	0.028 (0.052)	0.049 (0.072)	0.062 (0.089)	-0.058 (0.066)	-0.050 (0.066)	-0.111 (0.087)
Log Distance to Wittenberg X 1498–1507	0.067 (0.050)	0.079 (0.066)	0.126* (0.067)	-0.056 (0.070)	-0.040 (0.066)	-0.045 (0.072)
Log Distance to Wittenberg X 1518–1527	-0.465*** (0.125)	-0.550*** (0.115)	-0.730*** (0.092)	-0.193*** (0.057)	-0.223*** (0.058)	-0.321*** (0.069)
Log Distance to Wittenberg X 1528–1537	-0.283*** (0.087)	-0.344*** (0.089)	-0.417*** (0.112)	-0.278*** (0.065)	-0.339*** (0.060)	-0.400*** (0.075)
Log Distance to Wittenberg X 1538–1547	-0.267*** (0.045)	-0.320*** (0.060)	-0.478*** (0.071)	-0.202** (0.092)	-0.254*** (0.089)	-0.471*** (0.074)
Log Distance to Wittenberg X 1548–1557	-0.259*** (0.064)	-0.298*** (0.081)	-0.383*** (0.082)	-0.227*** (0.053)	-0.246*** (0.061)	-0.323*** (0.054)
Log Distance to Wittenberg X 1558–1567	-0.226*** (0.043)	-0.270*** (0.060)	-0.364*** (0.085)	-0.159** (0.067)	-0.194*** (0.058)	-0.257*** (0.098)
Log Distance to Wittenberg X 1568–1577	-0.358** (0.161)	-0.360** (0.154)	-0.274** (0.115)	-0.132* (0.080)	-0.161** (0.063)	-0.181** (0.077)
Historical controls	No	Yes	Yes	No	Yes	Yes
Geographic controls	No	No	Yes	No	No	Yes
N	1790	1790	1790	1790	1790	1790
R ²	0.658	0.684	0.695	0.720	0.745	0.749

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: OLS regressions at the city level with standard errors clustered at the territory \times decade level in parentheses. The dependent variable is $\ln(1+\text{total number of religious/non-religious works in the vernacular})$. The table shows the estimates on the interactions between the log of one plus a city's distance to Wittenberg and decade fixed effects. Columns (1) and (4) correspond to our baseline specification. Columns (2) and (3) and (5) and (6) add interactions between city-specific historical and geographic characteristics and decade fixed effects. City-specific characteristics in columns (2) and (4) are dummies for population in 1500 (population fixed effects) and indicator variables for whether the city had a university in 1450, hosted a bishop or archbishop before or in 1517, and was an independent city in 1517. Geographic characteristics in columns (3) and (5) include the natural log of one plus a city's distance to Mainz, the natural log of one plus a city's distance to water (river or coast), and the natural log of one plus a city's distance to a trade route. All regressions include city and decade fixed effects and are restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period.

B Religious Competition and the Costs of Language Standardization

Table B1: Effects of Religious Competition on Cityies' Vernacular Printing Output

	<i>Ln(1+Nr of Works in the Vernacular)</i>	
	<i>Religious Works</i>	<i>Non-Religious Works</i>
	(1)	(2)
High Competition X 1478–1487	-0.162 (0.203)	-0.109 (0.304)
High Competition X 1488–1497	0.024 (0.193)	0.106 (0.247)
High Competition X 1498–1507	0.009 (0.133)	0.131 (0.244)
High Competition X 1518–1527	0.611** (0.249)	0.297 (0.203)
High Competition X 1528–1537	0.286** (0.112)	0.218 (0.203)
High Competition X 1538–1547	0.195 (0.160)	-0.207 (0.273)
High Competition X 1548–1557	0.024 (0.142)	-0.091 (0.211)
High Competition X 1558–1567	0.096 (0.269)	-0.405 (0.286)
High Competition X 1568–1577	0.213 (0.307)	-0.305 (0.299)
1478–1487	-0.080 (0.078)	-0.133 (0.166)
1488–1497	-0.181 (0.091)	-0.223 (0.165)
1498–1507	-0.092 (0.066)	-0.194 (0.187)
1518–1527	0.064 (0.136)	-0.040 (0.139)
1528–1537	0.014 (0.060)	-0.012 (0.146)
1538–1547	0.096 (0.059)	0.386* (0.216)
1548–1557	0.202** (0.094)	0.247 (0.151)
1558–1567	0.476*** (0.086)	0.663*** (0.174)
1568–1577	0.513*** (0.068)	0.682*** (0.196)
N	740	740
R ²	0.648	0.692

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: OLS regressions with standard errors clustered at the territory \times decade level in parentheses, with the omitted period being 1508–1517. The sample is restricted to Catholic cities located in the Holy Roman Empire with some printing output over the 1478–1577 period. The dependent variable in columns (1) and (2) is the natural log of one plus the total number of religious works and non-religious works in the vernacular, respectively. For a graphical representation and variable definitions, see Figure 6.

Table B2: Effects of Religious Competition on Cities' Vernacular Printing Output (More Aggregated Model)

	<i>Ln(1+Nr of Works in the Vernacular)</i>	
	<i>Religious Works</i>	<i>Non-Religious Works</i>
	(1)	(2)
High Competition X 1478–1507	-0.043 (0.121)	0.043 (0.209)
High Competition X 1518–1547	0.364*** (0.139)	0.103 (0.208)
High Competition X 1548–1577	0.111 (0.155)	-0.267 (0.213)
1478–1487	-0.140 (0.094)	-0.209 (0.172)
1488–1497	-0.147* (0.084)	-0.191 (0.168)
1498–1507	-0.066 (0.078)	-0.150 (0.169)
1518–1527	0.188 (0.147)	0.057 (0.159)
1528–1537	-0.025 (0.086)	0.045 (0.156)
1538–1547	0.012 (0.094)	0.231* (0.207)
1548–1557	0.159 (0.118)	0.335** (0.155)
1558–1567	0.469*** (0.101)	0.594*** (0.183)
1568–1577	0.564*** (0.119)	0.662*** (0.184)
N	740	740
R^2	0.648	0.692

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: OLS regressions with standard errors clustered at the territory \times decade level in parentheses, with the omitted period being 1508–1517. The sample is restricted to Catholic cities located in the Holy Roman Empire with some printing output over the 1478–1577 period. The dependent variable in columns (1) and (2) is the natural log of one plus the total number of religious works and non-religious works in the vernacular, respectively. For a graphical representation and variable definitions, see Figure 6.

Table B3: Linguistic Distance vs. Geographical Distance to Wittenberg (German-Speaking Protestant Cities)

	Standardized Measure of Dialect Similarity to Wittenberg	
	(1)	(2)
Distance to Wittenberg	-0.005*** (0.001)	-0.018*** (0.003)
[Distance to Wittenberg] squared		0.000*** (0.000)
N	87	87
R^2	0.587	0.587

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: OLS regressions with standard errors clustered at the territory level in parentheses. The sample is restricted to German-speaking Protestant printing cities with information on dialects. The dependent variable in both columns is the standardized value of the similarity of the dialect to Wittenberg's dialect.

Table B4: Effects of Linguistic Distance on Cities' Vernacular Printing Output

	<i>Ln(1+Nr of Works in the Vernacular)</i>	
	<i>Religious Works</i>	<i>Non-Religious Works</i>
	(1)	(2)
Low Linguistic Distance X 1478–1487	-0.246 (0.167)	-0.145 (0.103)
Low Linguistic Distance X 1488–1497	-0.148 (0.203)	-0.088 (0.192)
Low Linguistic Distance X 1498–1507	-0.227 (0.154)	-0.201 (0.134)
Low Linguistic Distance X 1518–1527	0.519* (0.297)	0.266* (0.153)
Low Linguistic Distance X 1528–1537	0.380* (0.195)	0.586*** (0.117)
Low Linguistic Distance X 1538–1547	0.440** (0.185)	0.538*** (0.115)
Low Linguistic Distance X 1548–1557	0.479** (0.212)	0.592*** (0.131)
Low Linguistic Distance X 1558–1567	0.612** (0.237)	0.465*** (0.129)
Low Linguistic Distance X 1568–1577	0.592** (0.237)	0.537*** (0.175)
1478–1487	0.069 (0.136)	0.031 (0.083)
1488–1497	0.124 (0.155)	0.122 (0.147)
1498–1507	0.145 (0.145)	0.130 (0.109)
1518–1527	0.488*** (0.150)	0.093 (0.106)
1528–1537	0.321** (0.140)	0.125 (0.076)
1538–1547	0.412*** (0.154)	0.126 (0.079)
1548–1557	0.592*** (0.153)	0.209** (0.090)
1558–1567	0.649*** (0.159)	0.356*** (0.104)
1568–1577	0.634*** (0.169)	0.310*** (0.105)
N	870	870
R^2	0.646	0.736

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

OLS regressions with standard errors clustered at the territory \times decade level in parentheses, with the omitted period being 1508–1517. The sample is restricted to German-speaking Protestant cities located in the Holy Roman Empire with information on dialects and with some printing output over the 1478–1577 period. The dependent variable in columns (1) and (2) is the natural log of one plus the total number of religious works and non-religious works in the vernacular, respectively. For a graphical representation and variable definitions, see Figure 7.

Table B5: Effects of Linguistic Distance on Cities' Vernacular Printing Output (More Aggregated Model)

	<i>Ln(1+Nr of Works in the Vernacular)</i>	
	<i>Religious Works</i>	<i>Non-Religious Works</i>
	(1)	(2)
Low Linguistic Distance X 1478–1507	-0.207 (0.167)	-0.144 (0.103)
Low Linguistic Distance X 1518–1547	0.446** (0.203)	0.464*** (0.174)
Low Linguistic Distance X 1548–1577	0.561*** (0.154)	0.531*** (0.172)
1478–1487	0.049 (0.134)	0.031 (0.081)
1488–1497	0.154 (0.140)	0.151 (0.106)
1498–1507	0.135 (0.140)	0.102 (0.091)
1518–1527	0.523*** (0.150)	-0.006 (0.091)
1528–1537	0.287** (0.140)	0.187** (0.075)
1538–1547	0.409*** (0.151)	0.164** (0.077)
1548–1557	0.551*** (0.145)	0.240*** (0.083)
1558–1567	0.674*** (0.155)	0.322*** (0.098)
1568–1577	0.649*** (0.169)	0.313*** (0.104)
N	870	870
R^2	0.646	0.736

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

OLS regressions with standard errors clustered at the territory \times decade level in parentheses, with the omitted period being 1508–1517. The sample is restricted to German-speaking Protestant cities located in the Holy Roman Empire with information on dialects and with some printing output over the 1478–1577 period. The dependent variable in columns (1) and (2) is the natural log of one plus the total number of religious works and non-religious works in the vernacular, respectively. For a graphical representation and variable definitions, see Figure 7.

C The Protestant Reformation and German Schools

C.1 Main Results

Table C1: Effects of the Reformation on the Establishment of German and Latin Schools

	<i>Ln(1+Nr of Schools)</i>	
	<i>German Schools</i>	<i>Latin Schools</i>
	(1)	(2)
Protestant X 1478–1487	0.034 (0.054)	0.004 (0.053)
Protestant X 1488–1497	0.034 (0.054)	0.004 (0.053)
Protestant X 1498–1507	0.022 (0.051)	-0.016 (0.048)
Protestant X 1518–1527	0.019 (0.046)	0.013 (0.039)
Protestant X 1528–1537	0.085* (0.049)	0.041 (0.039)
Protestant X 1538–1547	0.155*** (0.057)	0.070 (0.047)
Protestant X 1548–1557	0.157*** (0.058)	0.033 (0.051)
Protestant X 1558–1567	0.190*** (0.062)	0.028 (0.055)
Protestant X 1568–1577	0.237*** (0.070)	0.040 (0.052)
1478–1487	-0.065 (0.055)	-0.041 (0.040)
1488–1497	-0.043 (0.050)	-0.041 (0.040)
1498–1507	-0.022 (0.046)	-0.000 (0.029)
1518–1527	0.043 (0.043)	0.022 (0.027)
1528–1537	0.043 (0.043)	0.022 (0.027)
1538–1547	0.078* (0.044)	0.040 (0.030)
1548–1557	0.150** (0.058)	0.105*** (0.037)
1558–1567	0.171*** (0.065)	0.115*** (0.042)
1568–1577	0.171*** (0.065)	0.115*** (0.042)
N	1170	1170
R^2	0.762	0.901

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: OLS regressions at the city level with standard errors clustered at the territory \times decade level in parentheses. The dependent variable is $\ln(1+\text{number of German/Latin schools in city } i \text{ and decade } t)$. The regressions include city fixed effects and are restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period. For a graphical representation, see Figures 8 (column 1) and 9 (column 2).

Table C2: Effects of the Reformation on the Establishment of German and Latin Schools

	<i>Ln(1+Nr of Schools)</i>	
	<i>German Schools</i>	<i>Latin Schools</i>
	(1)	(2)
Protestant X 1478–1507	0.030 (0.042)	-0.003 (0.040)
Protestant X 1518–1547	0.086** (0.043)	0.041 (0.037)
Protestant X 1548–1577	0.195*** (0.048)	0.034 (0.041)
1478–1487	-0.062 (0.048)	-0.036 (0.030)
1488–1497	-0.041 (0.047)	-0.036 (0.030)
1498–1507	-0.028 (0.045)	-0.010 (0.029)
1518–1527	-0.006 (0.044)	0.001 (0.026)
1528–1537	0.043 (0.042)	0.022 (0.026)
1538–1547	0.128*** (0.047)	0.061** (0.026)
1548–1557	0.122** (0.053)	0.105*** (0.030)
1558–1567	0.168*** (0.055)	0.111*** (0.031)
1568–1577	0.202*** (0.055)	0.119*** (0.032)
N	1170	1170
R^2	0.761	0.901

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: OLS regressions at the city level with standard errors clustered at the territory \times decade level in parentheses. The dependent variable is $\ln(1+\text{number of German/Latin schools in city } i \text{ and decade } t)$. The regressions include city fixed effects and are restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period. For a graphical representation, see Figures 8 (column 1) and 9 (column 2).

C.2 Robustness Analysis

Table C3: Robustness Analysis: German Schools

	<i>Ln(1+Nr of German Schools)</i>				
	(1)	(2)	(3)	(4)	(5)
Protestant X 1478–1487	0.034 (0.054)	0.040 (0.061)	0.047 (0.070)	0.032 (0.057)	-0.005 (0.067)
Protestant X 1488–1497	0.034 (0.054)	0.028 (0.060)	0.033 (0.072)	0.045 (0.061)	0.018 (0.066)
Protestant X 1498–1507	0.022 (0.051)	0.010 (0.057)	0.007 (0.075)	0.024 (0.061)	0.000 (0.056)
Protestant X 1518–1527	0.019 (0.046)	0.004 (0.053)	0.007 (0.070)	0.027 (0.054)	0.000 (0.049)
Protestant X 1528–1537	0.085* (0.049)	0.072 (0.053)	0.072 (0.072)	0.106* (0.057)	0.061 (0.050)
Protestant X 1538–1547	0.155*** (0.057)	0.136** (0.057)	0.137** (0.068)	0.178*** (0.057)	0.111* (0.061)
Protestant X 1548–1557	0.157*** (0.058)	0.108 (0.066)	0.135* (0.082)	0.196*** (0.061)	0.115* (0.060)
Protestant X 1558–1567	0.190*** (0.062)	0.133* (0.070)	0.176** (0.083)	0.221*** (0.070)	0.139** (0.071)
Protestant X 1568–1577	0.237*** (0.070)	0.197** (0.081)	0.246** (0.097)	0.272*** (0.083)	0.174** (0.079)
Historical controls	No	Yes	Yes	No	No
Geographic controls	No	No	Yes	No	No
Removing cities < 217km to Wittenberg	No	No	No	Yes	No
Removing cities with high share of pre-1517 vernacular printing output	No	No	No	No	Yes
N	1170	1170	1170	780	1000
R ²	0.762	0.776	0.792	0.791	0.748

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: OLS regressions at the city level with standard errors clustered at the territory \times decade level in parentheses. The dependent variable is $\ln(1+\text{number of German/Latin schools in city } i \text{ and decade } t)$, and the table shows the estimates on the interactions between Protestant by 1600 and decade fixed effects. Column (1) shows our main results (see column (1) of Table C1). Columns (2) and (3) add interactions between city-specific historical and geographic characteristics and decade fixed effects. City-specific characteristics in column (2) are dummies for population in 1500 (population fixed effects) and indicator variables for whether the city had a university in 1450, hosted a bishop or archbishop before or in 1517, and was an independent city in 1517. Geographic characteristics in column (3) include the natural log of one plus a city's distance to Mainz, the natural log of one plus a city's distance to water (river or coast), and the natural log of one plus a city's distance to a trade route. In column (4) we remove cities from the sample that are located close to the city of Wittenberg (within the 25th percentile, or 217km). In column (5) we remove cities from our sample whose share of pre-Reformation vernacular printing output (1451–1517) is in the 75th percentile or higher, conditional on having printed at least 10 works during this period. All regressions include city and decade fixed effects and are restricted to cities located in the Holy Roman Empire with some printing output over the 1478–1577 period.