Printing and Protestants: reforming the economics of the Reformation

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Abstract

The causes of the Protestant Reformation have long been debated. This paper attempts to revive and econometrically test the theory that the spread of the Reformation is linked to the spread of the printing press. The proposed causal pathway is that the printing press permitted the ideas of the Reformation to reach a broader audience. I test this hypothesis by analyzing data on the spread of the press and the Reformation at the city level. An econometric analysis which instruments for omitted variable bias suggests that within the Holy Roman Empire, cities within 10 miles of a printing press by 1500 were 57.4 percentage points more likely to be Protestant by 1600. These results are robust, though the effects are weaker, across Western Europe. The analysis also suggests that the early spread of press affected religious choice into the 19th century.

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1. Introduction

The century between 1450 and 1550 is one of incredible importance in European economic history. A far from exhaustive list of important events of this period include the "finding" of the New World, the invention of the printing press, the Ottoman conquering of Constantinople and threatening of Vienna, the height of the Renaissance, and the Protestant Reformation. Many economists have pointed to at least one of these phenomena as heralding the "rise of the West" (Weber 1905; Tawney 1926; Pomeranz 2000; Mokyr 1990, 2002; Acemoglu, Johnson, and Robinson 2001, 2005; Greif 2006; Becker and Wößmann 2008, 2009; Iyigun 2008; Buringh and Van Zanden 2009; Dittmar 2011).

The problem for the economic historian is disentangling these events. Which events were facilitated by other historical events, and, more importantly, which events were the true "prime movers" of this momentous period of economic history? In this paper, I focus on the relationship between the spread of printing press and the Protestant Reformation. Baten and Van Zanden (2008), Buringh and Van Zanden (2009) and Dittmar (2011) are recent additions to the literature stressing the importance of the printing press as an independent factor contributing to subsequent European economic growth.[1] Alternatively, Becker and Wößmann (2008, 2009, 2010), in the tradition of Max Weber (1905), connect the spread of Protestantism to subsequent economic growth – though unlike Weber, they emphasize the Reformers stress on literacy as the causal factor.[2] If these two events are related, then the true impact on subsequent economic growth of either (or both) may be overstated.[3]

[1] Classic studies providing a similar linkage include Febvre and Martin (1958) and Eisenstein (1979).
[2] In a related work, Buringh and van Zanden (2009) show that conversion to Protestantism is strongly related to subsequent literacy outcomes. Other recent works connecting religion to human capital accumulation include Berman (2000), Botticini and Eckstein (2005, 2007), and Chaudhary and Rubin (2011).
[3] Cantoni (2010) employs a similar methodology to Becker and Wößmann on a broader set of German lands and finds little evidence of the effect of Protestantism on human capital accumulation. However, Becker and Wößmann's data includes rural areas (using complete census data), unlike Cantoni. Indeed, Becker and Wößmann

This paper is far from the first to connect the printing press to the Reformation.[4] This argument is centuries old, with arguments in support of (Dickens 1968; Eisenstein 1979; Edwards 1994; Gilmont 1998) and against (Febvre and Martin 1958; Scribner 1989) the causal linkage connecting the press and the Reformation. For example, in their classic book *The Coming of the Book: The Impact of Printing* – which extols the *positive* historical significance of the printing press – Febvre and Martin (1958, p. 288) claim that "it is not part of our intention to revive the ridiculous thesis that the Reformation was the child of the printing press". But is this thesis so ridiculous? It is clear that the pamphlets, broadsheets, and papal caricatures made possible by the press contributed significantly to the success of the Reformation. Indeed, the Reformation was the first major historical movement in the post-Gutenberg era facilitated by the press (Eisenstein 1979; Spitz 1985). Moreover, the Church was unable to suppress the Reformers at it had previous "heretics" such as John Wycliffe, Jan Hus, the Albigensians, and the Waldensians. These individuals had similar grievances with Church corruption as did Luther, Zwingli, and Calvin, but lived in a period before the Gutenberg and his press.[5]

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do not find a clear connection between Protestantism and development when looking only at cities. Blum and Dudley (2001) present a pro-Weber argument, but suggest that Protestant economic networks, not a "work ethic" are the root cause. Arruñada (2010) argues that Protestants did not have a unique work ethic, but instead had a "social ethic" which favored market transactions. Barro and McCleary (2003) and Grier (1997) tackle a similar question, analyzing the connection between Protestantism (amongst other religions) to economic outcomes using cross-country studies. Likewise, Guiso et al. (2003) find a positive correlation between Christian religions and attitudes conducive towards economic growth.

[4] Cantoni (2011) asks a similar question to the one posed in this paper. He finds that, amongst other things, there was a strong spatial pattern to the spread of Protestantism. This result is consistent with the one found in this paper. I also show that there was a spatial component to the spread of the Reformation independent of the effect of the press. Cantoni's work and the present paper also relate to Barro and McCleary's (2005) work seeking the determinants of state religion. These papers suggest historical roots underlying Barro and McCleary's findings in the case of European Protestantism, although Barro and McCleary are not concerned with denominational differences.

[5] Another factor differentiating the attempt of previous reformers with Luther, Zwingli, and Calvin was the Ottoman threat on Eastern and Central Europe in the 16th century, which encouraged the pope and Emperor Charles V to make various concessions to the reformers. This thesis is most recently laid out econometrically by Iyigun (2008). Iyigun's thesis is complementary to the one proposed in this paper, as both help explain the timing of the Reformation, though the present argument also helps explain the spatial pattern of the Reformation. Ekelund, Hébert and Tollison (2002, 2008) also present a complementary hypothesis which views the Church as a discriminating monopolist that encouraged entry by "rival firms". They have difficulty explaining the timing of the Reformation

A key problem with past theses connecting the printing press to the Reformation is that the linkage may be spurious. Even if we accept that the press facilitated the Reformers' ability to spread the seeds of dissent, it is certainly possible that cities which were more likely to accept the Reformation were also more likely to accept printing from an early period for reasons correlated with both the press and Protestantism, such as higher pre-printing press literacy rates, larger population, or local independence from centralized rule.[6] If this were the case, then the Reformation may have been accepted in these cities even if the press were never invented.

It is nearly impossible to disentangle these events without careful data collection and analysis. To this end, I collect city-level data on conversion to Protestantism, the presence of a printing press, the number of books produced in a city by decade, and a host of control variables including population, the presence of a university, and many others. I first focus on the de facto Holy Roman Empire (including modern day Germany, Belgium, Austria, Czech Republic, and parts of France and Poland), as there was significant heterogeneity of Protestant adoption in the Empire, and, after all, it was the birthplace of both the printing press and the Reformation. A probit analysis suggests that that cities which adopted the press early (prior to 1500) were on average 19.6 percentage points more likely to become Protestant by 1600, even after controlling for a host of city-level characteristics associated with the acceptance of the Reformation.

To address the omitted variable issues previously mentioned – such as pre-printing literacy rates correlating with the acceptance of both the press and Reformation – I instrument for the printing press with a city's distance to Mainz, the birthplace of printing. This instrument is also used by Dittmar (2011), and is similar to the "distance from Wittenberg" instrument

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(and the failure of previous reformers), but the micro-mechanisms they suggest underscore an important aspect of the Reformers' motivations.

[6] Putnam (1993), Guiso, Sapienza, and Zingales (2008), and Jacob (2010) contend that the independence of certain cities in Northern Italy and the Holy Roman Empire led to greater social capital and hence better subsequent economic outcomes.

employed by Becker and Wößmann (2008, 2009, 2010) and Cantoni (2010). It is a useful instrument because printing spread in a relatively concentric circular pattern outward from Mainz; yet a city's distance from Mainz should have no *direct* effect on the adoption of the Reformation. I find that distance from Mainz is strongly correlated with many of the proxies that I create for a city's access to printed works (while satisfying exclusion restrictions), and a two-stage analysis indicates that the impact of the press has an even stronger effect of adoption of the Reformation than in simple probit estimations. For example, the analysis suggests that towns within 10 miles of a press were 57.4 percentage points more likely to accept the Reformation by 1600. This indicates that the omitted variables negatively biased the effect of the press on the Reformation. This could have occurred if more literate towns were less likely to adopt the Reformation (perhaps due to the influence of the Church) but more likely to have a press. The results are similar when print intensity (proxied by the number of books printed in a city) is employed instead of the presence of a printing press. The results largely remain robust, although the marginal effects are smaller, when data across Europe is employed. Likewise, using data from the 1816 Prussian census, I find that the early spread of the press predicts a substantial portion of Protestant share nearly *three centuries* after the onset of the Reformation.

This paper contributes a much needed empirical analysis to the debate on the link between the printing press and the Reformation. Though it by no means suggests that the Reformation was a mono-causal event, it sheds light on a causal linkage which in turn focuses our attention on broader arguments connecting the events of 1450-1550 to economic development. Most importantly, if Dittmar (2011) is correct and the press had an independent effect on economic development, then Weber's (and Becker and Wößmann's) linkage between Protestantism and economic development may be spurious, reflecting instead developments

associated with the diffusion of print media. Likewise, if Weber (1905) and Becker and Wößmann (2008, 2009, 2010) are correct that Protestantism had an independent effect on development, then the role of the press may be reduced – or, at the very least, the effect of the press on subsequent development would only be indirect through its role in facilitating the Reformation. Of course, both the printing press and Protestantism may have had independent effects on economic development, and it is not the purpose of this analysis to differentiate between these two hypotheses. What this analysis does suggest, however, is that any investigation of the long-run economic effects of the printing press (or, more generally, information technologies) and the Reformation (or, more generally, social and political upheaval) cannot ignore the relationship between the two.

2. Historical Background

2.1. Early Printing

The printing press was invented circa 1450 by Johann Gutenberg in Mainz.[7] Within the fifty years following the invention, the press diffused to many of the major cities in Western Europe. Although the press met some resistance in some areas at different times, such as in post-Reformation France, 60 of the 100 largest European cities had a press by the end of the fifteenth century (Dittmar 2011). By 1500, nearly eight million books had been printed – most of which were religious in nature and printed in Latin – perhaps more than the scribes had produced in the previous millennium (Eisenstein 1979).[8] The early centers of printing in the Holy Roman Empire

[7] I am only concerned here with the invention of the press in Europe. Printing was known in the East for centuries prior to Gutenberg, but was not introduced to Europe until the 1450s.

[8] Johns (1998) argues that scribal culture persisted for well over a century after the spread of the press. This should not detract from the primary argument made in this paper – the *rapidity* of reproduction allowed by the press versus the scribes is the important source of connection between the press and the Reformation.

were Cologne, Augsburg, Strasbourg, Leipzig, and Nuremberg, though numerous other print shops were scattered throughout the Empire.

The first print workshops were established by Gutenberg and his assistants. They held a printing monopoly for about a decade, before the bible was printed in Strasbourg in 1459 (Febvre and Martin 1958). Printing remained almost exclusively German in its first few decades, and by the 1470s printing was controlled by a small group of "printer-scholars", educated laymen who ran the printing presses and played a significant role in editing. These printer-scholars were often former priests or university professors who lived nomadic lives and moved to places where demand for books was the highest: first to the major commercial centers and then to the university towns (Eisenstein 1979). Most university towns eventually became printing centers, as the guaranteed market they provided attracted printers and encouraged them to settle. Printing expanded rapidly in the 1470s, particularly in Germany and Italy, and by 1480 the press was in nearly universal use throughout Western Europe (Febvre and Martin 1958).

Although the press ultimately undermined the power of the Church (through the mechanism proposed in this paper), the Church would have had a difficult time suppressing printing had it wanted to. By the mid-fifteenth century, the primary intellectual centers were the universities, many (but far from all) of which were outside the control of the Church. Indeed, the Church was one of the biggest early customers of printing, using presses to print ordinances, works of popular piety, bulls, indulgences, and propaganda for its anti-Turkish crusade (Febvre and Martin 1958; Eisenstein 1979). Secular leaders also used the press for propaganda purposes; for example, Emperor Maximilian employed the press prior to the Reformation in order to mobilize support for his policies (Edwards 1994). A significant source of demand came from war-ravaged churches, who desired printed liturgical books (Febvre and Martin 1958).

Numerous monasteries welcomed printers to their quarters and printers found a large market for religious works in small Italian cities. Indeed, the large and lucrative market for printed materials provided by the Church was one of the most important factors contributing to the relatively rapid diffusion of the press (Eistenstein 1979).

The price of books fell dramatically after the spread of the press. On top of the large outward supply shift following the diffusion of the press, technological changes in the paper production process and the use of ink based on oil decreased the price of books around 85 percent (Spitz 1985; Buringh and van Zanden 2009). Humanist and legal texts became much more popular in the pre-Reformation period due to these changes. In subsequent centuries, the decreased price of books also led to dramatic increases in literacy, particularly in Great Britain, the Netherlands, Germany, and Sweden (Buringh and van Zanden 2009).

2.2.The Spread of Protestantism

On October 31, 1517, Martin Luther nailed his Ninety-five Theses to the door of the All Saints Church at Wittenberg, sparking what would become the Protestant Reformation. Luther's concerns were primarily related to Church abuses, which had become increasingly prominent in the century prior to the Reformation – these include indulgences, relic cults, clerical privileges, clerical concubinage, simony and a broad host of other perceived abuses emanating from the Church hierarchy and papacy.[9] Although Luther's complaints were initially focused on reforming the Church from within, his complaints were quickly echoed by lay and clerical interests alike throughout northern Europe, indicating that anti-papal sentiments were deeply rooted well before the Reformation.

[9] There were other complaints put forward by the Reformers, many of which were theological in nature. Many had to do with salvation and the corruption of the Church's means to salvation.

Luther initially circulated his theses privately, but printed editions quickly emerged in Leipzig, Magdeburg, Nuremberg, and Basel. Political concerns discouraged the Church from initially suppressing Luther – Pope Leo X hoped to prevent Charles V from rising to Holy Roman Emperor, and to do so the pope needed the support of Friedrich III of Saxony (who oversaw Wittenberg and supported Luther) (Cameron 1991). After Charles V (1519-1555) was elected, the case against Luther was reopened, and Friedrich abducted Luther so that he could escape a death sentence. In 1520, a papal bull was announced excommunicating Luther and calling for the burning of all of his books. In 1521, an edict of the imperial representative assembly (Reichstag) at Worms banned his works throughout the Empire. Despite these impediments, Luther's literary output was immense – he wrote 30 publications which sold over 300,000 copies between 1517 and 1520 – and spread quickly throughout the Empire via printed copies (Spitz 1985).

The Reformation initially spread in what was a highly fragmented Holy Roman Empire. The Reichstag consisted of three archbishop electors (Mainz, Trier, Cologne), four lay electors (Brandenburg, Saxony, Palatinate, Bohemia), 120 prelates, 30 lay princes, and 65 imperial cities, and power was much more decentralized than in the monarchies of Western Europe (Spitz 1985; Cameron 1991). This entailed a loosely federal structure, with princes and electors having significant power within their domains but under the ultimate rule of the emperor, while the free and imperial cities were subordinate only to the emperor. The cities relied on the emperor for protection, but expected him to be largely removed from daily economic happenings (Ozment 1975).

Luther's message initially spread in the free cities of central Germany. Cities such as Nuremberg accepted the Reformation, with powerful friends of Luther appointing preachers

sympathetic to reform ideas (Cameron 1991). A contemporary movement emerged in the Swiss confederation, where Huldrych Zwingli (1484-1531) espoused many similar principles to Luther and preached to Zürich congregations in the vernacular (although Zwingli was by no means a direct disciple of Luther and the two disagreed on many points of doctrine). A hybrid Luther-Zwingli message caught on in the 1520s in many of the free cities of southern Germany such as Strasbourg and Constance (Cameron 1991).

The Reformation usually took hold in a city through the efforts of a small cadre of learned, literate priests and scholars who took it upon themselves to spread Luther or Zwingli's message. Many of these reformers were quite fervent, aggressively questioning congregations about the nature of worship and the practices of the Church hierarchy and the pope (Blickle 1984). It was through the efforts of these reformers that the movement spread so quickly; most had positions in the established Church and could address the masses directly from the pulpit. These preachers were particularly effective in Saxony and Central Germany in the 1520s, where they were successful in spreading the Reformation to towns such as Nuremberg, Reutlingen, Altenburg, Eisenach, and Zwickau. In the late 1520s and 1530s, reforming preachers helped convert larger towns such as Strasbourg and Lübeck, with numerous other Baltic cities following suit. Many major south German cities, such as Augsburg, converted in a similar manner in the 1530s. In many cities, these reformers were welcomed by the city fathers or princes in order to justify the strength of their position vis-à-vis the Church (Cameron 1991).[10] This was not the case in all cities however, as the Reformation was rejected or suppressed in a number of German cities such as Cologne, Würzburg, Bamberg, and Freiburg.

[10] Ekelund, Hébert and Tollison (2002) suggest, in a similar manner, that civil authorities sought an alternative provider of legal services and a less costly path to salvation through the Reformation, as the Church (a monopolist) was overcharging. Their analysis highlights yet another necessary pre-condition of the Reformation, complementing the one proposed in this paper.

Perhaps more importantly, the message of the Reformation spread from city to city through broadsheets and pamphlets, most of which were written by the lead reformers (especially Luther). Although most people were illiterate in this period, the pamphlets were written in such a manner such that they would be read aloud in public meeting places. Oral communication was still prevalent in this period and was the primary way that the printed word spread. The Reformers certainly knew this; for example, Luther's pamphlet in response to a papal bull of condemnation was addressed to "all who read or hear this little book" (Scribner 1989). Likewise, broadsheets were drawn in a manner that was easy to understand for the general population while graphically introducing complex issues in a simplified manner (Robinson-Hammerstein 1989).[11] Cameron (1991, p. 227) makes this connection clear:

> Luther's *Ninety-Five Theses* were published by his correspondents, in separate editions in at least four cities within a few months … Up to 1530 Germany was flooded with perhaps 4,000 titles of small, short-run pamphlets for mass distribution in a rapid turnover of editions, based in printing centers … However, *printing* a pamphlet was only part of the communication process … Even in the most sophisticated of towns 'literacy' may not have exceeded 30 per cent, while 5 and 10 per cent may have been nearer the norm. Most, therefore, would neither have read pamphlets from start to finish, nor indeed bought their own copies. To have a mass effect they were almost certainly read aloud in inns, workshops, or market-places, or even posted up on walls in public places … In the Lutheran movement especially, much use was made of pictorial pamphlets and flysheets, which served to remind readers of the message they had heard from the pulpit, rather than to convert and instruct believers by themselves.

Much ink has been spilled by historians claiming that the Reformation was an "urban event".[12] Indeed, 50 of the 65 imperial cities either permanently or periodically accepted the Reformation (Ozment 1975). The close proximity of urbanites to each other, greater levels of

[11] Broadsheets were well established by the 1480s and had previously been used to spread news about major events and to promote propaganda in favor of the Emperor (Robinson-Hammerstein 1989).

[12] On the other hand, the Reformation coincided (and was perhaps facilitated by) a series of uprisings amongst the peasant masses between 1524 and 1526. These inter-connected revolts, broadly known as the Peasants' War, occurred throughout most of Germany, except for Bavaria. Luther rejected the Peasant's grievances but urged the lords to come to a peaceful solution (Spitz 1985).

wealth and literary awareness, and relative political sophistication have been given as reasons why the Reformation took off in many of the free cities of the Holy Roman Empire. Ozment (1975) suggests that such cities permitted a much greater degree of Protestant infiltration than the closed, autocratic regimes of the princes. In many of the cities that accepted the Reformation, such as Strasbourg and Ulm, the city council took charge of installing the Reformation by bringing in preachers sympathetic to the reform ideas. In the northern Hanseatic cities, it was largely the middling bourgeoisie – who were wealthy but had little political power within the cities – that pushed for the Reformation as a means of confronting the established powers. Some of the members of these council sought economic gains, such as confiscation of Church property, while others undoubtedly felt the pressures for change arising from preachers and the masses (Blickle 1984). In most cases, the Reformation was supported by some literate class with a modicum of power, but far enough removed from the princes or Emperor to not fear direct retribution (Cameron 1991). Once the Reformation was accepted by a town, it generally followed that the old privileges and status of the priesthood and hierarchy were removed, followed by the confiscation or destruction of the Church's material wealth.[13]

This pattern was much different from the one followed in the territories of the princes, where fear of imperial retribution delayed the introduction of the Reformation until the late-1520s, if at all (Cameron 1991). In 1530, many of the Protestant cities and princes signed the Augsburg Confession, despite condemnation from the Reichstag, which contained 22 articles stating the Lutheran message. The houses of Saxony, Hesse, Braunschweig-Lüneburg, Anhalt, and Mansfield all delayed acceptance until the late 1520s, but by 1530-1531 formed an alliance

[13] The acceptance of the Reformation by no means happened in each town for the same reason. Cameron (1991) lists three primary reasons which are not mutually exclusive: political/material reasons, those based on the Reformation's alleged appropriateness to a class, order, or constitution, and psychological/spiritual reasons. It is not the purpose of this paper to discern between these three.

of Protestant electorates known as the Schmalkaldic League. By 1535, many of the important Protestant independent cities joined the League, which provided mutual defense against Catholic invasion. They were joined by Denmark, which quickly accepted the Reformation in the 1520s under the imperial edicts of kings Frederick I (1523-1533) and Christian III (1533-1559). The defense provided by the League permitted a truce for over a decade, in part due to the Ottoman threat on Vienna.[14] Eventually, the League was crushed by the Emperor in the Schmalkaldic War (1547), and most disputes were put to rest at the Augsburg Reichstag of 1555, which permitted sovereign princes or lords of the Holy Roman Empire to determine the faith of their subjects.[15]

Protestant ideas eventually spread throughout much of Europe. In France, Calvinist churches rapidly spread in the west and south in the 1550s. These Protestants, known as the Huguenots, were violently suppressed until a series of peace edicts were agreed upon in the 1570s-1590s (Cameron 1991). Similar movements occurred in the Low Countries, where Calvinist ideas spread through the 1540s-1560s. The Spanish Habsburgs reacted quite harshly to Protestants, burning nearly 2,000 between 1523 and 1555. Protestantism was deeply enmeshed with the broader revolt against Spanish rule and was especially popular in the northern half (Netherlands), where William of Orange co-opted the new religion. Political motives were also readily apparent in England, where Henry VIII dealt significant blows to the established church, which consolidated as the state-sponsored Anglican Church under Elizabeth I (1558-1603).

2.3.The Causal Mechanism: Connecting Printing and Protestantism

> *"[The printing press is] God's highest and ultimate gift of grace by which He would have His Gospel carried forward." – Martin Luther* (quoted in Spitz 1985)

[14] For a recent economic analysis of the link between the Ottoman threat and the spread of the Reformation, see Iyigun (2008).

[15] An important point with respect to the argument put forth in this paper is that while the Augsburg Reichstag bound a territory to the religion of the ruler's choice, this choice was generally a function of events in the previous three decades, which may have been affected by the presence or absence of printing.

Is it a coincidence that two of the most important events in the Western world of the last millennium – the spread of the printing press and the Protestant Reformation – sprouted 250 miles apart in the Holy Roman Empire, with the Reformation commencing soon after the press became entrenched throughout Europe? Is it a coincidence that the Reformers employed the "first propaganda campaign conducted through the medium of the press" (Febrve and Martin, p. 288)?[16] The hypothesis tested in this paper is that the printing press significantly facilitated the spread of the Reformation in the 16th century. This paper is far from the first one to make this connection, but it is the first one to statistically test the *extent* of the role played by the press.

There are four primary reasons that the printing press facilitated the spread of the Reformation. First, papal caricatures and broadsheets disseminated by the Reformers played an enormous role in their propaganda efforts amongst the illiterate masses. These broadsheets were easy to understand and designed to catch the attention of the reader, often including direct insults to the Church and the papacy.[17] Robinson-Hammerstein (1989, p. 12) describes how the Reformers used broadsheets to reach the masses as follows:

> Even if the people confronting the broadsheet were unable to read, they could still have received the message, since it was customary and indeed made good business sense for a pedlar to recite the title in order to attract the attention of prospective buyers. However, to forestall all ambiguities and conjectures, a fuller text was also provided, designed to assist further in decoding and communicating a message which was considered by its originators as of vital interest to the spectators. Again, the unlettered were more than likely to find literate bystanders willing to read out and talk about the text, thus initiating a process of intensified communication.

Second, the press allowed for the spread of pamphlets to literate preachers and other religious-minded individuals who brought the Reformation into cities and villages. Even in the

[16] Edwards (1994, p. 1) begins his book on Luther and the printing press by noting that "The Reformation saw the first major, self-conscious attempt to use the recently invented printing press to shape and channel a mass movement."

[17] The effect of printed religious drawings was significant prior to the Reformation as well and likely provided motivation for its use as propaganda by the reformers (Ozment 1975).

cities, it was unlikely that the literacy rate was greater than 30 percent – for this reason, the Reformation word must have primarily been spread orally (Edwards 1994). Indeed, it was mainly literate preachers who brought the message of the Reformation to the masses. The small pamphlets, which were generally around eight pages, provided an inexpensive, concealable, and easily transportable means for would-be reformers to spread the ideas promulgated by the lead reformers (Edwards 1994). The oral transmission of ideas was still the most common information transmission technology for many decades (if not centuries) after the spread of the press, and was employed with great skill by the reformers (Spitz 1985).

Third, the press allowed for rapid dissemination of pamphlets that were verbalized by the literate portion of the population (secular and lay) at taverns and other meeting places. These pamphlets complemented the work of the reforming priests, allowing the masses to hear the message of the Reformation from multiple sources. Luther argued that printing was a special sign of God's grace not just because it allowed the mass production of biblical texts, sermons, and the like, but also because it permitted the spread of these ideas through pamphlets and broadsheets (Robinson-Hammerstein 1989). Fourth, the press allowed for information dissemination through posters. Before most big Reformation events, posters were placed to advertise, ensuring a large audience and giving the event a sense of importance (Febvre and Martin 1958).[18]

[18] Another possible role that the press played in the Reformation was, according to Eisenstein (1979), its transformation of concerns faced by individuals to those more broad in nature. She suggests (p. 132) that "while communal solidarity was diminished, vicarious participation in more distant events was also enhanced; and even while local ties loosened, links to larger collective units were being forged. Printed materials encouraged silent adherence to causes whose advocates could not be found in any one parish and who addressed an invisible public from afar."

The connection between the printing press and the Reformation is strengthened by considering the attempts made at reforming the Church prior to the spread of the press.[19] Attempts were made within the Church to strip power from the pope and reduce the pomp associated with the Church hierarchy, pushing instead for power to be transferred to Church Councils. Jean Gerson (1362-1429) was the leading proponent of this "reform from within" and was an important influence on Luther's writings (Dolan 1965). Such reform was unsuccessfully attempted in varying degrees at the Councils of Lyons (1274), Vienne (1311-12), Constance (1414-18), Pavia-Siena (1423-24), and Basel (1431-39).[20] In fact, much of the support for the anti-papist agenda at Basel originated from the free cities of Switzerland and southern Germany that were eventually so important to the initial spread of the Reformation (Cameron 1991). Even on the eve of the Reformation there was considerable pressure to reform the Church from within, but attempts made at Fifth Lateran Council (1512-1517) were unsuccessful.

Perhaps the most serious challenge to the Church came from the Prague preacher Jan Hus (c. 1372-1415), who led the anti-Church movement which would bear his name in the early 15th century. Hus challenged the rights of sinful Churchmen to keep their positions and wealth, a position which caused him to be burned to death as a heretic in 1415. The Hussite movement which followed established rival churches throughout Bohemia based on the denial of the Roman hierarchy, but their influence never expanded beyond Bohemia (Cameron 1991). Other heresies abounded in the century prior to the Reformation. In 15th-century England, the Lollard movement spread the ideas of John Wyclif (d. 1384). Wyclif was an ardent supporter of the rights of lay rulers over the papacy and had significant influence over poorer parish priests, but

[19] Dickens (1968) and Eisenstein (1979) also note the failure of pre-press heresies very well may have been due to the lack of access to the press.
[20] For more on the debate between papism and conciliarism, and especially the role played by Gerson, see Dolan (1965, ch. 4).

the Lollard movement he spawned was ultimately suppressed. A similar fate awaited the Waldensians in France, who rejected Church dogma and were brutally suppressed. Dickens (1968, p. 51) makes the contrast between these movements and the Reformation quite clear: "Unlike the Wycliffite and Waldensian heresies, Lutheranism was from the first the child of the printed book."

While this paper does not claim that the elements of the Reformation pervaded Europe for centuries and must have been merely awaiting the printing press to spread the message, it is striking that all of the attempts at reform prior to the invention and diffusion of the printing press were rather easily suppressed by the Church.[21] Indeed, the argument being presented in this paper does not necessarily contradict the idea that the Reformation was an outgrowth of a perfect storm of events that came together in the early 16th century, with the printing press being one of many necessary conditions. The data that I collect do not allow for a test of whether the press was a necessary or a sufficient condition for the Reformation to spread. What it does allow, however, is a statistical test of the role that the printing press played in the spread of the Reformation in the factual world where the printing press was invented and diffused prior to the Reformation. In particular, I explore the question: "How much more likely was a city to adopt the Reformation if it had (or was very close to) a printing press?" If it turns out that print cities were much more likely to adopt the Reformation (and indeed, I show that they were), then it suggests an important linkage between the spread of printing and the success of the Reformation.

3. Analysis

3.1. Data

[21] Rubin (2011) provides an economic explanation for such an outcome, suggesting that highly centralized authorities, such as the pre-Reformation Church, are easily able to suppress 'shocks' when the shocks are not spread to a large portion of the population, but are more susceptible to massive changes when shocks are widespread.

The primary relationship of concern is the one between the printing press and the spread of Protestantism. To this end, I have gathered city-level data which includes whether a city was Protestant in 1530, 1560, and 1600, whether a city had a printing press by 1500, how many books were printed in the city by 1500, and numerous control variables. The universe of observations is the cities found in Bairoch et al. (1988), who collected population data for every European city that reached 5,000 inhabitants at some point by 1800. Details of all variables are available in Appendix III.

Protestantism spread quickly throughout the German parts of the Holy Roman Empire. Many of the cities in these areas adopted Protestantism by 1560, though numerous Catholic enclaves remained. Protestant ideas were popular in Bohemia (Czech Republic) though it remained nominally Catholic – in some cases by compulsion. Protestant ideas eventually spread to the Low Countries – the Netherlands adopted Protestantism by 1600 and Protestantism was popular, though suppressed by the Spanish, in Belgium.

The first part of the analysis focuses on the acceptance of Protestantism in the Holy Roman Empire. The econometric reason for this is that there is no (or little) variation in religion (Protestant or Catholic) in Spain, Italy, Portugal, England, Ireland, or Scandinavia. It is also economically and historically interesting to confine the analysis to the Holy Roman Empire, as it was the birthplace of both printing and the Reformation. While I do include cities in other Western European countries in an analysis in Section 3.4 (without country fixed effects), the lack of variation in these countries could provide misleading results.

I consider each city as part of the Holy Roman Empire (HRE) if it were de facto subject to the Emperor and the empire's institutions throughout the 16th century.[22] This includes cities in

[22] I thank Davide Cantoni for pointing out to me the nuances of the differences between the de facto and de jure Holy Roman Empire. For more, see Cantoni (2010).

present day Germany, Austria, Czech Republic, Belgium, Luxembourg, eastern France, and western Poland. This excludes Switzerland, which de facto broke away from the Empire in 1499, the Netherlands, which revolted and broke away from the HRE in the 1570s, and northern Italy (e.g., the Duchies of Savoy and Milan), which was not de facto subject to the Emperor. Cities in the HRE with populations of at least 10,000 are listed in Table 1, along with their religious affiliation in 1600 and whether the city had a printing press by 1500.

[INSERT Table 1 HERE]

It is immediately noticeable from Table 1 that a majority of the larger cities of the Holy Roman Empire had printing presses. Printing spread outward from Mainz soon after its invention in 1450, and printers generally moved to large population centers, where demand for printed works was greatest. This stylized fact allows for identification of the effect of printing on the acceptance of Protestantism: if large cities were likely to adopt printing, it is likely that the biggest impact of printing on the emergence of Protestantism was in smaller cities, where printing adoption was more "random". This is suggested by Figure 1, where it appears that a greater portion of small Protestant cities had presses than small Catholic cities, especially in cities further away from Wittenberg (labeled "W" on the map). This can also be seen in Table 2, which breaks down all cities with at least 10,000 inhabitants by press and printing adoption.

[INSERT Figure 1 HERE]

[INSERT Table 2 HERE]

These tables and figures help motivate the analysis. At first glance, it is not clear that printing had an effect on the adoption of Protestantism: a greater percentage of non-press towns adopted Protestantism (55.1%) than did press towns (53.7%). However, this pattern is reversed when the sample is broken up into small and large towns – suggesting that it is possible that

printing had a positive impact on the likelihood of accepting Protestantism controlling for city size. More generally, it suggests that a regression analysis which controls for city-specific features may shed significant light on the causal connection between printing and the Reformation.

Such an econometric analysis should control for numerous features which related to the decision of a city to accept Protestantism. To this end, controls are included for whether the city housed a university by 1450, whether the city housed a bishop or archbishop by 1517 (proxying for depth of Church influence), whether the city was a member of the Hanseatic League (and thus had better access to information flows and greater wealth), whether the city was on water (ocean, sea, large lake, or river connected to another city; this also controls for information flows), whether the city was an independent city in 1517 (which indicates that it was large and economically important), and the latitude, longitude, and interaction between the two (to control for north/south or east/west biases). I use the presence of a university as of 1450 instead of 1517 because it is possible that the presence of a press (which was invented in 1450) could have attracted scholars and thus encouraged the building of a university. I employ other controls as of 1517, the year that Luther posted his 95 Theses, despite testing the spread of Protestantism as late as 1600, because any post-1517 universities, bishoprics, or changes in population may be endogenous to Protestantism, and reverse-causality would result.[23]

I also control for the distance to Wittenberg, which is shown by Becker and Wößmann (2008, 2009, 2010) to be correlated with the spread of Protestantism. This can clearly be seen in

[23] Dittmar (2011) suggests that cities that adopted printing early grew faster in subsequent centuries, and Becker and Wößmann (2008, 2009, 2010) suggest that cities and counties which adopted Protestantism had better subsequent economic outcomes due to greater levels of human capital. Data on printing presses is readily available and reliable prior to 1500 but not 1517 (Clair 1976; Febvre and Martin 1976).

Figure 1.[24] Moreover, Dittmar (2011) shows that the spread of printing is related to distance from Mainz – hence not controlling for distance to Wittenberg may falsely indicate that printing (and not proximity to Wittenberg) had an effect on acceptance of Protestantism. A city's distance to Wittenberg, in combination with the city's geographic coordinates, should serve to control for the spatial component of the Reformation. It is possible, however, that Reformation-specific spatial correlations not picked up by the distance to Wittenberg and geographic coordinates variables were present. I address this possibility in Appendix II, where I create a Protestant "potential" variable, which is based on the urban potential variables in de Vries (1984) and Bosker, Buringh, and van Zanden (2010).[25]

Summary statistics of all variables for cities in the Holy Roman Empire are listed in Table 3. The correlation matrix for all variables is presented in Table 4.[26]

[INSERT Table 3 HERE]

[INSERT Table 4 HERE]

3.2.Printing Presses and Protestantism in the Holy Roman Empire: 1530-1600

3.2.1. Probit Analysis

The correlation matrix displayed in the previous section suggests that there is little correlation between cities that had a press and those that became Protestant. However, Figure 1 and Table 2 indicate that the correlation may be positive after controlling for city size. The link between the

[24] Likewise, Spitz (1985, p. 190) suggests that "perhaps because of its greatest distance from Wittenberg and Zurich, the progress of reform was slow and inconsistent, as compared with progress in the north and northeast [of Germany] as well as the southwest."

[25] The results including the Protestant potential variable are broadly similar to those reported in the body of the paper. I relegate these results to an appendix, however, because there are possible endogeneity issues associated with this variable which may bias the results. I discuss these endogeneity issues in the appendix.

[26] Note that the log(distance to cities) variables are actually log(1 + variable), which should not dramatically effect results, since the "distance to city" variable are large numbers. The variables are transformed in this manner so that the cities in question (Mainz and Wittenberg) remain part of the analysis, as log(0) is undefined.

press and Protestantism can therefore be tested by analyzing the following reduced form equation:

(1) $$Protestant\ in\ Year\ t = \alpha_1 + \beta_1 Press + X_t\gamma_1 + \varepsilon_1$$

where t = {1530, 1560, 1600}, Press is a proxy for a city's accessibility to printed works and X_t is a vector of control variables in year t, including log of population in 1500, dummies for whether the city was a member of the Hanseatic league, an independent city by 1517, had a university by 1450, a bishop by 1517, access to water, distance to Wittenberg, and its geographic coordinates.

I test three simple probit regressions for each year in which I have data: 1530, 1560, and 1600.[27] The average marginal effects of all major variables are reported in Table 5. The first three columns report only the simple correlation between Protestantism and the presence of printing. As is suggested by the summary statistics, there appears to be little correlation between the two when all controls are omitted. Columns 4 through 6 include control variables (city population and the independent city dummy) which proxy for city size and economic importance. As expected, the independent city dummy enters positively and significantly – in the spirit of Ozment's (1975) claim that the Reformation was an urban event – but the average marginal effect of the press remains insignificant (though, tellingly, the magnitude of the average marginal effect point estimate increases substantially). Columns 7-9 include the university dummy and columns 10-12 include the bishop dummy, which proxies for Catholic influence. Both enter with a negative sign (as is expected for the bishop dummy), but neither are significant, and the press variable remains largely insignificant. With the addition of variables

[27] Results are robust to using an OLS, linear probability model specification. These results are available upon request. The average marginal effects of probit regressions are reported because the linear probability model provides many results that are outside a 0-1 bound. The probit coefficients for all regressions are available upon request.

controlling for information flows (Hanseatic dummy and water dummy) in columns 13-15 and geography (distance to Wittenberg and coordinates) in columns 16-18, the press coefficient becomes highly significant. All of these controls, where significant, enter with the expected sign. Especially striking is the large negative coefficient on the distance to Wittenberg variable – a finding which supports that validity of Becker and Wößmann's (2008, 2009, 2010) "distance to Wittenberg" instrument. The R^2 of the final set of regressions is substantially larger, as well, indicating the importance of including geographic controls. More importantly, after controlling for geography, the coefficient on the press is highly significant. Cities with presses by 1500 were on average 11.4 percentage points more likely to adopt the Reformation in 1530, 23.1 percentage points more likely to adopt the Reformation in 1560, and 19.6 percentage points more likely to adopt the Reformation in 1600.

[INSERT Table 5 HERE]

The results reported in Table 5 employ a dummy for whether a city had a printing press as a proxy for accessibility to printed works. Yet, it is not immediately clear that this is the best proxy for a city's accessibility to printed works. Is actually having a press in a town important, or is being *near* a press town sufficient? Edwards (1994) notes that high transport costs and lack of copyright in this period meant that printed works were not often shipped from a printing center to other locations – instead, works more frequently spread through reprinting. Hence, cities that were too far away from print towns were unlikely to have access to inexpensive printed works, but cities close to print towns may have. To address this concern, I include proxies which account for a press within 10 or 20 miles of a city; given transportation costs of the period, it is unlikely that printed works frequently traveled much further.[28] These proxies better underscore

[28] Results are robust, though weaker, to proxies that account for a press being within 25 or 50 miles of a city. These results are available upon request.

the causal mechanism proposed in this paper – after all, it is *access* to printed works which matters if the argument made in this paper is correct. I report results using these proxies for the entirety of the paper; indeed, it is quite possible that these results are more informative than those which include only a dummy for whether a press was located in the city. In all, I create five proxies for the availability of printed works in a city: a dummy for whether a city had a press by 1500, two dummies for whether there was a press within 10 or 20 miles of the city, and two variables indicating the total number of cities with presses within 10 or 20 miles.

The results for regressions employing each of these proxies are reported in Table 6 (minus the printing press dummy results, which are reported in Table 5).[29] The results are broadly similar to those reported in Table 5, though the significance of the press in the 1530 specifications diminishes. Columns 1-6 indicate that being near more cities with presses increased the probability that a city would become Protestant by 1560 or 1600 by 8.3-12.2 percentage points, while columns 7-12 indicate that merely being within 10 or 20 miles of a printing city increased the probability that a city would become Protestant by 1560 or 1600 by 10.7-18.4 percentage points.[30] In all, these results provide strong evidence that towns with inexpensive access to printed works were more likely to adopt the Reformation.

[INSERT Table 6 HERE]

The control variables in Table 5 and Table 6 largely have the expected sign. It is not clear *a priori*, however, which sign the University coefficient should take. Although this coefficient is rarely significant, it is always negative.[31] This is not a completely surprising result – while some

[29] These results are robust to different definitions of the Holy Roman Empire. Appendix Table A 1 and Table A 2 replicate Table 5 and Table 6 using data from the German-speaking parts of the Empire (as in Cantoni [2010, 2011]), dropping Belgium and Bohemia, and data from the de jure HRE (including the Netherlands, Switzerland, and parts of northern Italy).

[30] This does not include the result reported in column 6.8, which is not statistically significant.

[31] The university coefficient is much more frequently negative and significant when other definitions of the HRE are employed or when Protestant potential is controlled for. See Appendices I and II.

universities helped facilitate the spread of Reformation ideas (e.g. Wittenberg, Erfurt, Zwickau), others were openly hostile (e.g. Rostock, Cologne, Leuven) (Cameron 1991). Indeed, despite the Church losing its monopoly on university curricula at some major universities such as Paris, entrenched Church power and ideology were associated with many institutions of higher education at the time of the Reformation.[32] Likewise, Cantoni (2011), citing Walter Ziegler, notes that university employees had an interest in keeping the status quo, since they were further advanced in the state bureaucracy, which required training in formal law. The attitude of universities towards the reformers thus indicates the possibility that an omitted variable – pre-printing press literacy – could negatively bias the coefficient on the press variable. Since universities were centers of learning and literacy – Buringh and van Zanden (2009) show that the presence of a university is positively correlated with the per capita production of manuscript books – printers were attracted to university towns (Eisenstein 1979). If towns with higher exogenous (pre-press) literacy were more likely to attract presses but less likely to convert to Protestantism (a possibility indicated by the negative coefficient on the University dummy), then the coefficient on the press dummy is negatively biased and the effect of the press on the Reformation is *greater* than indicated by this regression.[33] I tackle this possibility in the following section by instrumenting for the press.[34]

3.2.2. Testing for Endogeneity: Distance to Mainz as an Instrument

[32] On the other hand, Spitz (1985) notes that universities were a source of criticism of the Church and can be viewed as the "mother of the Reformation". This view is difficult to reconcile with the evidence presented in this paper.
[33] Cantoni and Yuchtman (2010) argue that the Papal Schism of the 14th century encouraged the building of universities in the German lands. They use the Schism as a "natural experiment" to argue that universities contributed positively to economic growth.
[34] Another potential problem with the results reported in this section is that the dates in which press data were collected, 1450-1500, are arbitrary. To alleviate such a concern, I create variables like the five printing proxies noted above for whether a city had a press by 1480 and 1490. These results are reported in Appendix Table A 3. These results broadly confirm the idea that early adopters of the press were more likely to accept the Reformation, all else being equal.

Since the printing press was not randomly assigned to cities, omitted variable bias may be affecting the interpretation of the regression results reported in the previous section. One such unobserved factor, pre-printing press literacy, is related to the adoption of printing and possibly related to the acceptance of the Reformation. Cities that were more literate prior to the advent of printing were almost certainly more likely to adopt printing, and it is possible that such cities were less (or more) likely to adopt the Reformation. Since the printing press proxies may be correlated with omitted variables that are themselves correlated with conversion to Protestantism, some source of exogenous variation in printing is needed to obtain causal results. I address this problem in this section, where the city's distance to Mainz (the birthplace of printing) is employed as an instrument for the printing proxies.

Distance to Mainz provides an ideal instrument for the adoption of printing because it was an important determinant of adoption while, theoretically, it should have had no independent impact on the acceptance of Protestantism. Dittmar (2011), who uses distance to Mainz as an instrument for printing (to test the effects of early print adoption on subsequent city growth), notes in great detail that early printers were either apprentices or business partners of Gutenberg in Mainz. Due to the proprietary nature of the technology, significant barriers to entry existed, and printing technology hence spread *outward* from Mainz in a series of concentric circles. The largest barrier to entry was the acquisition of metal type, as the process used to cast movable metal type required a specific combination of alloys that remained a secret amongst a small group of printers (Dittmar 2011).[35]

All else being equal, cities that were closer to Mainz were more likely to adopt printing, though the same can also be said for larger cities and university cities, where demand was greater

[35] Dittmar (2011) also notes that the locations of paper mills, which had been established for centuries prior to the press, were not a determinant of the diffusion of printing.

(though the latter two would not qualify as instruments, as they were independently related to the acceptance of Protestantism). This is suggested by Figure 2, which shows the percentage of cities that adopted printing, broken down by distance from Mainz. It is clear that cities closer to Mainz were more likely to adopt printing.

[INSERT Figure 2 HERE]

After controlling for a host city characteristics, there are still some unobserved variables such as pre-press literacy, idiosyncrasies amongst powerful printers, and printer networks which affected where printing spread. While these characteristics provide some of the variation needed to obtain causal results (to the extent that the variation is random), there may be concern that the variation is not truly exogenous. In order for distance to Mainz to provide a source of exogenous variation, it must be correlated to the Protestant variables *only* through its correlation to the press. In other words, distance to Mainz works as an instrument only if it is unrelated to the pre-existing (prior to 1450) economic, educational, and religious determinants of whether a city adopted the Reformation. The results reported in Table 7 suggest that although Mainz was not an unimportant town (it housed an archbishop who was an elector on the Reichstag), it was not an economic, educational, or religious center prior to the invention of the press.[36] These estimations, which control for all other covariates in X_t, show that distance to Mainz does not predict pre-printing economic status (measured by the independent city and Hanseatic dummies), educational status (measured by the university dummy), or religious status (measured by the bishop dummy). This entails that distance to Mainz provides a plausible source of exogenous variation which can be exploited in an instrumental variables analysis.

[INSERT Table 7 HERE]

[36] To save space, I do not report the coefficients on the control variables. These results are available upon request for all regressions reported in this paper.

Another way in which the distance to Mainz instrument may be problematic is that it could be picking up a spatial component related to the spread of printing that would arise by analyzing the distance to *any* city. This would be the case if printing did not spread outward from Mainz but instead spread along some other spatial pattern. I test the robustness of this instrument vis-à-vis other distance variables by running "first stage" probit regressions (with all controls in X_t), but employing distance to other important cities as an instrument. As can be seen in Table 8, distance to Mainz is highly significant (particularly in regressions using proxies within 10 or 20 miles of a city) but this is not the case with any of the other distance variables.

[INSERT Table 8 HERE]

Table 8 suggests that the distance to Mainz instrument works better for printing proxies that account for the number of presses near a city. Yet, it could simply be the case that cities are clustered closer together near Mainz, and thus the fact that cities further away from Mainz have less presses in their vicinity is an artifact of the way that cities are clustered instead of the manner that printing spread. I check that this is not the case by analyzing the "first stage" regression, replacing the press proxy with a variable indicating the number of cities within either 10 or 20 miles of the city. The results are reported in Table 9. The coefficients on the distance to Mainz variable are not significant and it is thus highly unlikely that the instrument is invalid due to the way that cities are clustered.

[INSERT Table 9 HERE]

With these concerns regarding the instrument alleviated, I analyze the following system of equations, where X_t includes all of the independent variables included in the regressions in the previous section (equation (1)):

(2) $$Protestant\ in\ Year\ t = \alpha_2 + \beta_2 Press + X_t\gamma_2 + \varepsilon_2$$

(3) $$Press = \alpha_3 + \beta_3 Distance\ to\ Mainz + X_t\gamma_3 + \varepsilon_3.$$

Following Angrist (2001), I estimate equation (2) using a probit estimation and equation (3) using an OLS estimation.[37] The marginal effects of the instrument in the first stage and the press proxy in the second stage are reported in Table 10. I also report the weak instrument F-statistic derived from estimating this system of equations using 2SLS.[38] The average marginal effects of the various printing proxies are highly significant in all specifications. Caution should be taken in interpreting the coefficients in the "printing dummy" and the "press within 20 miles dummy" estimations, as the distance to Mainz instrument is weak in these specifications. The instrument is quite strong for the "number of presses within 20 miles" variable and is just under the Stock and Yogo (2002) strong instrument threshold for the "presses within 20 miles" and the "press within 10 miles dummy" variables.

[INSERT Table 10 HERE]

The magnitude of these results is enormous and confirms the possibility of a negative bias on the press proxy. The most easily interpretable, and arguably the most important, of these results are those employing the "press within 10 miles" dummy. They suggest that the mere presence of a printing press prior to 1500 within 10 miles of a town increased the probability that it would become Protestant in the 16th century between 55.7 and 57.4 percentage points, ceteris paribus. The effect is even greater if a town were located within 10 miles of *two* press towns (including itself).[39] Columns 6-8 indicate that such towns were 81.0-83.0 (40.5*2 and 41.5*2) percentage points more likely to become Protestant. Indeed, of the seven cities located within 10

[37] The OLS estimation is more properly called a linear probability model when the printing proxy is dichotomous. The estimation method that I employ has the major benefit of being straight-forward and transparent, as it can be completed by using Stata's ivprobit command. Results are robust to 2SLS and bivariate probit estimation. Those results are available upon request.
[38] All other test statistics are available upon request.
[39] No town in the sample was within 10 miles of more than two press towns.

miles of two press towns (Aalst, Brussels, Esslingen, Mainz, Reutlingen, Stuttgart, and Tübingen), five were Protestant by 1600.

3.3.Printing Intensity and Protestantism in the Holy Roman Empire

The printing proxies employed in the previous section shed light on the role that the presence of printing played in a city's acceptance or rejection of the Reformation. It is possible, however, that a more important determinant of the spread of the Reformation was print *intensity*, not simply the existence of a printing press.

I address this possibility by collecting publication data cataloged by the Incunabula Short Title Catalog (ISTC 2008).[40] These data were drawn from a massive project spearheaded by the British Library to catalog all incunabula (books published between 1450 and 1500) still in existence. While these data permit a further testing of the hypothesis, it should be noted up front that major selection issues may exist. Namely, it is possible that there were different survival rates of books published in different cities. If books produced in Protestant cities were more likely to survive, the results would be biased in favor of the hypothesis proposed in this paper. The most likely cause of bias is that some areas faced greater destruction during the Thirty Years War and thus manuscripts were less likely to have survived from these areas.[41] The greatest destruction, in terms of casualties, occurred in southwest and northeast Germany, both of which were predominantly Protestant. This means, therefore, that any bias would likely be *against* finding more books in Protestant areas, meaning that the effect of the press may be understated.[42] Regardless, the results presented in this section should be viewed merely as *support* for the

[40] Data on books in German which were collected as part of the ISTC project as of 1962 is also available (British Library 1962). Estimating the regressions with these data gives broadly similar results. These results are available upon request.

[41] I thank Jeremiah Dittmar for this insight.

[42] The ISTC project began over 100 years ago, and many of the incunabula were catalogued before the damage inflicted on much of Germany by World War II bombings.

results reported in the previous section; they are not meant to be taken as the primary results reported in this paper.

The top printing centers of the HRE, in terms of the number of books printed between 1450 and 1500 that have been cataloged by the ISTC, are listed in Table 11. It is clear that most of the printing centers of Germany were Protestant by 1560, with Cologne as the primary exception. There is general continuity in the top print centers, with Cologne, Strasbourg, Augsburg, and Nuremberg in the top seven in each decade in question.

[INSERT Table 11 HERE]

I first re-estimate equation (1) using a probit specification and measures of print intensity as the printing proxy. Three measures of print intensity are employed: the number of books printed in a city, the number of books printed within 10 miles of a city, and the number of books printed within 20 miles of a city. The average marginal effects of each of these specifications are reported in Table 12.

[INSERT Table 12 HERE]

These results are broadly similar to those reported in the previous section. The signs and significance of all of the control variables are the same, and the average marginal effects of all of the print intensity proxies are positive and significant in each specification. Moreover, the magnitude of the marginal effects of the print intensity proxies is far from trivial. They indicate, for example, that increasing the amount of books produced within 10 miles of a city by 10 percent increases the average probability that a city will become Protestant in the 16th century by 3.5-3.9 percentage points.[43] Likewise, a city one standard deviation (1.813) above the mean log

[43] This is close to the precise interpretation of the results. Since all logged values are log(1 + # of books), and the number of books in most cities where books were produced is large, this interpretation is very close to precise, but is not exact.

number of books printed within 10 miles is 0.063 percentage points (1.813*0.035) more likely than the mean book-producing city to be Protestant in 1600.

The same omitted variable problems noted in the previous section affect the probit results reported in Table 12. I again employ a city's distance to Mainz as an instrument for print intensity. The validity of this instrument is suggested by Table 13, which shows that the weighted distance to Mainz of the top print centers slowly increased over the latter half of the 15th century. Many of the printing centers were relatively close to Mainz (closer than 150 miles), with Augsburg and Leipzig being the biggest exceptions.

[INSERT Table 13 HERE]

Table 14 reports the results of a two stage analysis of the system of equations (2) and (3), where equation (2) is estimated with a probit regression and equation (3) with an OLS regression. The marginal effects of the print intensity proxy in the second stage of all the specifications are positive and highly significant. This again indicates that the probit results have a severe negative bias. Extreme caution should be taken in the interpretation of these results, however, as the distance to Mainz is a weak instrument (F-stat less than 4) for all three print intensity proxies. I am thus hesitant to interpret the magnitude of the coefficients as causal – though their large degree of statistical significance is striking. Regardless, this helps provide *additional* support to the hypothesis tested more formally in Section 3.2 that access to printed materials was a causal determinant underlying the spread of the Reformation.

[INSERT Table 14 HERE]

3.4.Printing Presses and Protestantism throughout Europe: 1530-1600

In this section I test the robustness of these results by analyzing the relationship between printing presses and Protestantism throughout Europe. In addition to the cities considered in Section 3.2, I

also include data from Spain, Portugal, France, Italy, England, Ireland, Scotland, Denmark, Norway, and Sweden. These countries are not analyzed in Section 3.2 because there is little or zero variation with respect to adoption of Protestantism at any point in any of these countries. Thus, the regressions reported in Section 3.2 give ostensibly the same results as cross-Europe regressions with country fixed-effects (if the Holy Roman Empire is considered one country). For this reason, I do not include country fixed effects in these regressions. This reduces the causal power provided by these regressions, but they are merely intended to exhibit the robustness of the previous findings.[44]

The map in Figure 3 suggests that the patterns found in the Holy Roman Empire are consistent with those found across Europe. Most importantly, while a great deal of Catholic cities adopted the press by 1500, most of these cities were large (over 20,000). However, a large portion of the Protestant cities with presses were small. Since larger cities were more likely to have a press, all else being equal, this indicates that the presence of a press may be positively correlated with acceptance of Protestantism after controlling for city size (and other features controlled for in previous regressions). The summary statistics for these data are reported in Table 15.

[INSERT Figure 3 HERE]

[INSERT Table 15 HERE]

I first re-estimate the probit results reported in Table 5 and Table 6 using printing presence data and in Table 12 using print intensity data. The previously reported results suggested that, in the Holy Roman Empire, the presence of press in or near a city increased the probability of a city becoming Protestant in the 16th century, though the results are weakest in the

[44] Cantoni (2011) notes a similar problem with using cross-Europe data in analyzing the determinants of the Reformation, and he only employs data for the Holy Roman Empire.

1530 specification. The cross-Europe marginal effects, which are reported in Table 16 and Table 17, provide similar results in terms of statistical significance, although the marginal effects are smaller in the Europe sample. The primary difference between the Europe and HRE results is that the presence of press in or near a city does not have a statistically significant effect on the probability of a city becoming Protestant by 1560 in the Europe sample. This is likely due to the conversion of England (a country with only 4 presses prior to 1500) to Protestantism under Henry VIII and Elizabeth I. The coefficient is positive and significant in all 1600 specifications, however, likely reflecting the fact that the Netherlands (an area with numerous presses) became Protestant in the intervening period.

[INSERT Table 16 HERE]

[INSERT Table 17 HERE]

The university dummy is negative, though not always significant, in all of the regressions, again indicating that these results may suffer from omitted variable bias by not including a measure of (unobserved) pre-press literacy. To overcome this problem, I again turn to the "distance to Mainz" instrument, which should work well as an instrument in the Europe sample for the same reason that it worked for some of the proxies in the HRE sample. The results reported in Table 18 suggests that distance to Mainz may be a much better instrument in the cross-Europe sample, as it is strongly and negatively correlated with all eight of the printing proxies.

[INSERT Table 18 HERE]

As noted in the previous section, the distance to Mainz instrument could be problematic for the proxies which account for the number of presses or the presence of a press within 10 or 20 miles of a city if cities are clustered closer to each other near Mainz. In this case, the distance

to Mainz instrument could work through the clustering patterns of cities, not through the exogenous spatial patterns related to the spread of printing. I address this concern (in the same manner as in the previous section) by replacing the first stage dependent variable with a variable which counts the number of cities within 10 or 20 miles of the city in question. The results are reported in Table 19 and contrast substantially to those found in the HRE sample. It is clear that, all else being equal, cities further from Mainz were less clustered across Europe, and therefore the instrument may be invalid for printing proxies that consider the number or presence of a press within 10 or 20 miles. Hence, for the rest of the analysis I only employ the printing proxies that account for printing within a city, namely the press by 1500 dummy and the log of books printed in a city.

[INSERT Table 19 HERE]

Another concern highlighted in the previous section is that the instrument could be picking up some spatial patterns that would be present if the distance from *any* major city were considered. For the instrument to work there has to be something special about Mainz. To this end, Table 20 reports the first stage results using the distance to four other major cities in place of Mainz. Although the results for the other cities are not as weak as in the HRE sample (Table 8), the distance to Mainz is the only consistently strong instrument. The only result which suggests a problem for the distance to Mainz instrument is that the distance to Rome appears to be a strong instrument for the log of books printed in a city. The distance to Rome is a much weaker instrument for the presence of a press, however. Though this dampens the power of the conclusions derived using the distance to Mainz instrument, the F-statistics reported in Table 20, in tandem with the validity of the instrument in the HRE sample, suggest that it is worth proceeding with this instrument.

[INSERT Table 20 HERE]

With this caveat regarding the instrument in mind, I estimate the system of equations (2) and (3) for the entire Europe sample. As in the previous sections, equation (2) is analyzed using a probit estimation and equation (3) is analyzed using OLS estimation. The average marginal effects of the distance to Mainz instrument (in the first stage) and the printing proxy (in the second stage) are reported in Table 21. The magnitude of the coefficients in the 1530 and 1600 regressions is much greater than in the probit regressions, suggesting that negative bias was present in the probit estimation. These results indicate that European cities which adopted printing prior to 1500 were 58.3 percentage points more likely to be Protestant in 1530 and 37.4 percentage points more likely to be Protestant by 1600, all else being equal. Moreover, a 10% increase in the number of books published in a city increased its probability of becoming Protestant by 14.2 percentage points in 1530 and 7.6 percentage points in 1600.[45]

[INSERT Table 21 HERE]

One result which stands out in Table 21 is that the coefficient on both printing proxies is insignificant in the 1560 regressions. The most likely explanation for this is that Henry VIII and Elizabeth I imposed Anglicanism on England by 1560, while England was also a late adopter of printing (it had only four presses by 1500). Meanwhile, the Protestant revolt in the Netherlands (an early adopter of printing) had yet to come to fruition, and it is coded as Catholic in 1560. The fact that the result is positive and significant in 1600 – despite the only major religious change between 1560 and 1600 being the conversion of the Netherlands to Protestantism – strengthens

[45] The results on the log of books (a print intensity proxy) support the pattern found by Buringh and van Zanden (2009) that the countries that became the centers of book production (on a per capita basis) after the spread of the press were not coincidentally Protestant. These countries include Switzerland, Netherlands, Great Britain, and Sweden.

the validity of the connection between the spread of printing and the acceptance of the Reformation.

3.5. Persistent effects of the press: the case of Prussia

Finally, I test whether the early adoption of printing affected the *persistence* of Protestantism. Cantoni (2010), for example, shows that adoption of the Reformation in the 16th and 17th centuries had long-persisting effects. He shows that territories adopting the Reformation were highly Protestant in the mid-19th century and territories spurning the Reformation were highly Catholic in the mid-19th century.[46] This indicates that the press may have played a major role in which cities were Protestant centuries *after* the Reformation.

To test this connection, I gathered data from the 1816 Prussian census (Mützell 1825). The census includes the number of Protestants and Catholics in each Prussian city and county. Unfortunately, only 43 cities from the HRE sample match with the Prussian census. There are two reasons for the limited number of matches. First, Prussia only covered the northern half of Germany and western and northern Poland, so the many cities of southern Germany (including Mainz) are not included. The other problem is that some cities in my data set are included as part of counties in the Prussian census. I only report results where the city name in the Prussian census matches the city name in my data set. The paucity of data reduces the causal power of the reported results, but it at least permits an initial foray into the question of persistence.

I begin by estimating equation (1) with OLS. Instead of employing a dichotomous dependent variable (whether or not the city was Protestant in a given year), I use Protestant share in 1816, which is a continuous variable. All control variables are employed as of 1517 (except for the university dummy, which is as of 1450). Though variables in 1517 may be weak

[46] This concern is also why Becker and Wößmann (2008, 2009, 2010) instrument for the adoption of Protestantism despite the fact that they are concerned with economic outcomes in the 19th century.

predictors of Protestantism in 1816, the results reported by Dittmar (2011) and Becker and Wößmann (2009) suggest that the controls variables as of 1816 may be endogenous to the adoption of printing or the Reformation. That is, if the spread of printing or Protestantism had positive economic effects on a city, this would be reflected in the 1816 controls. Hence, pre-Reformation controls are employed. The OLS results are reported in Table 22.

[INSERT Table 22 HERE]

These results suggest a limited role for the press in the persistence of Protestantism. None of the coefficients on the printing proxies are significant. Indeed, only the geographical controls enter significantly, suggesting (in the spirit of Becker and Wößmann [2008, 2009, 2010]) that early spatial patterns emanating from Wittenberg played an important role in the spread and persistence of the Reformation. Yet, once again it is possible that omitted variable bias is obscuring the true impact of the press. I address this possibility by again employing a city's distance to Mainz as an instrument. Table 23 reports the first stage results for each of the five printing proxies. It is clear that the distance to Mainz only works as an instrument for two of the proxies: the number of presses within 10 miles and the press within 10 miles dummy. In fact, in this limited sample these two variables are exactly the same – none of the 43 cities in the Prussian sample is located within 10 miles of more than one press. Hence, I only test for endogeneity in the "press within 10 miles" specification, as an instrumental variables approach would provide highly misleading results in all other specifications.

[INSERT Table 23 HERE]

Table 24 reports the 2SLS results using distance to Mainz as an instrument for the press within 10 miles dummy. The second-stage coefficient on the press dummy is large and highly significant. It suggests that cities located within 10 miles of a press in 1500 had an average of

69.1 percentage points more Protestants in 1816. Though this result is striking, it should be interpreted with extreme caution, since only 43 observations are available and the results only apply to areas which eventually came under Prussian control (which itself may be endogenous). Given this caveat, however, these results provide suggestive evidence that the press played a persisting role in religious choice.

[INSERT Table 24 HERE]

4. Conclusion

The connection between the printing press and the spread of the Protestant Reformation has long been debated. Despite the fact that the Reformers employed the printing press effectively to spread anti-papal propaganda, there is no counter-factual history to determine whether the Reformation would have been a success in the absence of the press. The biggest difficulty that previous studies faced is one of spurious correlation – it is quite possible that the city-level characteristics that encouraged adoption of the printing press *also* encouraged acceptance of the Reformation.

In this paper, I address this issue through an econometric analysis. Probit and instrumental variables regressions suggest that cities which adopted printing early were much more likely to accept the Reformation. The connection is quite strong in the Holy Roman Empire, which was the birthplace of both printing and the Reformation. I find that cities with a press or located within 10 miles of a press were 55.7 percentage points more likely to adopt Protestantism by 1530, 56.2 percentage points more likely to adopt Protestantism by 1560, and 57.4 percentage points more likely to adopt Protestantism by 1600. These results are broadly

robust to a cross-Europe sample, although the marginal effects are smaller and the effect disappears in the 1560 sample (only to re-appear in the 1600 sample).

These results have broader implications for economic history. For one, by connecting the printing press to an event which undermined the power of religious authorities in Europe, it has implications for what the *lack* of printing meant in the contemporary Ottoman Empire. It is well known that the Ottomans highly regulated the press despite being aware of its invention and economic potential. A more complete analysis of the impact of printing and its role in the interplay between political and religious authorities, therefore, should be comparative in nature, as the Ottoman anti-printing policy provides a "control experiment" for understanding the economic, political, and religious trajectory of a society where the introduction of the press was delayed for nearly three centuries.[47] Moreover, a number of recent studies have suggested that the printing press (Baten and Van Zanden 2008; Buringh and Van Zanden 2009; Dittmar 2011) or the Reformation (Becker and Wößmann 2008, 2009, 2010; Boppart et al. 2010) have played a significant role in the subsequent economic development of Europe and "the West". The present study suggests that any linkages between the press or the Reformation and economic growth must be taken with extreme caution. It is possible that the true economic effects of the Reformation arose because cities that accepted the Reformation were in a better position to succeed due to earlier acceptance of the press. Conversely, it is possible that cities which adopted the printing press were successful in subsequent centuries because they were more likely to become Protestant and thus had some unique "work ethic" or incentive to acquire human capital. Though it is not the point of this paper to discern between these possibilities, it provides strong

[47] For a contrast of the regulations imposed by European political authorities and the Ottomans, see Coşgel, Miceli, and Rubin (2011).

evidence that the historical connection between the printing press and the Reformation needs to be considered in any such investigations.

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Appendix I: Extra Tables – Robustness Checks

Table A 1: Average Marginal Effects, Printing Press Proxies, German-speaking parts of HRE

	(A1.1) Prot in 1530	(A1.2) Prot in 1560	(A1.3) Prot in 1600	(A1.4) Prot in 1530	(A1.5) Prot in 1560	(A1.6) Prot in 1600	(A1.7) Prot in 1530	(A1.8) Prot in 1560	(A1.9) Prot in 1600	(A1.10) Prot in 1530	(A1.11) Prot in 1560	(A1.12) Prot in 1600	(A1.13) Prot in 1530	(A1.14) Prot in 1560	(A1.15) Prot in 1600
Printing Press by 1500	0.181**	0.314***	0.291***												
	(0.090)	(0.055)	(0.054)												
Presses w/in 10 miles				0.066	0.135***	0.164***									
				(0.079)	(0.051)	(0.051)									
Presses w/in 20 miles							0.032	0.188***	0.217***						
							(0.050)	(0.038)	(0.044)						
Press 10 miles dummy										0.062	0.115*	0.156**			
										(0.100)	(0.066)	(0.067)			
Press 20 miles dummy													0.052	0.232***	0.272***
													(0.083)	(0.068)	(0.064)
Log Population in 1500	0.041	-0.067	-0.043	0.060	-0.028	-0.016	0.068	-0.027	-0.009	0.061	-0.015	-0.005	0.069	-0.012	0.004
	(0.052)	(0.052)	(0.049)	(0.051)	(0.052)	(0.052)	(0.051)	(0.044)	(0.042)	(0.050)	(0.051)	(0.053)	(0.051)	(0.050)	(0.048)
Independent City	0.226**	0.292***	0.308***	0.215**	0.244***	0.283***	0.203*	0.213***	0.257***	0.211**	0.227***	0.260***	0.199*	0.175***	0.187***
	(0.107)	(0.068)	(0.063)	(0.106)	(0.069)	(0.063)	(0.107)	(0.062)	(0.063)	(0.107)	(0.070)	(0.065)	(0.110)	(0.064)	(0.056)
University	-0.304*	-0.187**	-0.218**	-0.235	-0.097	-0.133	-0.228	-0.099	-0.146**	-0.238	-0.110	-0.151	-0.234	-0.136	-0.166**
	(0.167)	(0.093)	(0.094)	(0.162)	(0.093)	(0.089)	(0.162)	(0.063)	(0.060)	(0.167)	(0.100)	(0.094)	(0.159)	(0.085)	(0.068)
Bishop	-0.290***	-0.301***	-0.345***	-0.229**	-0.213***	-0.277***	-0.220**	-0.202***	-0.258***	-0.227**	-0.209***	-0.273***	-0.221**	-0.224***	-0.283***
	(0.102)	(0.058)	(0.054)	(0.096)	(0.066)	(0.055)	(0.098)	(0.050)	(0.037)	(0.100)	(0.069)	(0.060)	(0.102)	(0.064)	(0.048)
Hanseatic	-0.095	-0.008	0.016	-0.112	-0.076	-0.034	-0.101	-0.016	0.028	-0.113	-0.086	-0.048	-0.103	-0.049	-0.005
	(0.078)	(0.087)	(0.082)	(0.081)	(0.085)	(0.083)	(0.079)	(0.059)	(0.050)	(0.082)	(0.087)	(0.085)	(0.081)	(0.076)	(0.063)
Water	0.198***	0.171***	0.188***	0.188***	0.138***	0.161***	0.191***	0.174***	0.206***	0.190***	0.139***	0.160***	0.196***	0.186***	0.219***
	(0.067)	(0.047)	(0.045)	(0.068)	(0.051)	(0.047)	(0.068)	(0.039)	(0.033)	(0.068)	(0.051)	(0.047)	(0.068)	(0.050)	(0.043)
Log Distance to Wittenberg	-0.247***	-0.086	-0.116	-0.236***	-0.091	-0.095	-0.236***	0.050	0.047	-0.235***	-0.112	-0.108	-0.235***	0.049	0.069
	(0.080)	(0.218)	(0.185)	(0.077)	(0.205)	(0.217)	(0.076)	(0.119)	(0.112)	(0.078)	(0.196)	(0.208)	(0.076)	(0.126)	(0.057)
N/S Coordinate	0.165*	-0.095	-0.052	0.147*	-0.124	-0.079	0.147*	-0.123	-0.052	0.142*	-0.126	-0.085	0.142*	-0.185**	-0.151**
	(0.091)	(0.093)	(0.071)	(0.086)	(0.104)	(0.102)	(0.085)	(0.105)	(0.099)	(0.084)	(0.098)	(0.096)	(0.084)	(0.089)	(0.070)
E/W Coordinate	0.625	-1.042	-0.779	0.558	-1.136	-0.890	0.566	-1.297**	-0.934	0.540	-1.112	-0.905	0.548	-1.633***	-1.456***
	(0.447)	(0.707)	(0.536)	(0.408)	(0.745)	(0.751)	(0.402)	(0.635)	(0.597)	(0.402)	(0.695)	(0.708)	(0.403)	(0.590)	(0.413)
Coordinate Interaction	-0.013	0.022	0.016	-0.012	0.024	0.019	-0.012	0.028**	0.020	-0.011	0.023	0.019	-0.011	0.034***	0.031***
	(0.009)	(0.015)	(0.011)	(0.008)	(0.016)	(0.016)	(0.008)	(0.013)	(0.012)	(0.008)	(0.015)	(0.015)	(0.008)	(0.012)	(0.009)
Observations	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139
No. of Clusters	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
pseudo R-squared	0.185	0.563	0.569	0.172	0.520	0.556	0.170	0.640	0.704	0.170	0.499	0.531	0.169	0.547	0.610

Robust standard errors clustered by territory in parentheses; Probit model, average marginal effects reported; all log values are log (1 + variable) except for log of population

*** p<0.01, ** p<0.05, * p<0.1

Table A 2: Average Marginal Effects, Printing Press Proxies, de jure HRE

	(A2.1) Prot in 1530	(A2.2) Prot in 1560	(A2.3) Prot in 1600	(A2.4) Prot in 1530	(A2.5) Prot in 1560	(A2.6) Prot in 1600	(A2.7) Prot in 1530	(A2.8) Prot in 1560	(A2.9) Prot in 1600	(A2.10) Prot in 1530	(A2.11) Prot in 1560	(A2.12) Prot in 1600	(A2.13) Prot in 1530	(A2.14) Prot in 1560	(A2.15) Prot in 1600
Printing Press by 1500	0.067	0.133***	0.184***												
	(0.049)	(0.046)	(0.053)												
Presses w/in 10 miles				0.013	0.061*	0.120***									
				(0.041)	(0.033)	(0.036)									
Presses w/in 20 miles							-0.014	0.037*	0.071***						
							(0.024)	(0.019)	(0.022)						
Press 10 miles dummy										0.013	0.061	0.121**			
										(0.052)	(0.045)	(0.052)			
Press 20 miles dummy													-0.007	0.098*	0.158***
													(0.051)	(0.053)	(0.057)
Log Population in 1500	-0.029	-0.055*	-0.067**	-0.018	-0.038	-0.051	-0.013	-0.034	-0.045	-0.018	-0.037	-0.049	-0.015	-0.037	-0.046
	(0.026)	(0.031)	(0.032)	(0.025)	(0.032)	(0.032)	(0.024)	(0.033)	(0.030)	(0.024)	(0.032)	(0.032)	(0.024)	(0.032)	(0.031)
Independent City	0.190***	0.189***	0.265***	0.188***	0.179***	0.256***	0.188***	0.180***	0.247***	0.188***	0.177***	0.254***	0.188***	0.164***	0.228***
	(0.057)	(0.047)	(0.065)	(0.058)	(0.049)	(0.065)	(0.058)	(0.049)	(0.062)	(0.058)	(0.049)	(0.066)	(0.058)	(0.049)	(0.066)
University	-0.153	-0.171**	-0.273**	-0.127	-0.146*	-0.236**	-0.118	-0.137	-0.210**	-0.128	-0.148*	-0.246**	-0.120	-0.159*	-0.247**
	(0.114)	(0.087)	(0.110)	(0.113)	(0.088)	(0.108)	(0.110)	(0.089)	(0.101)	(0.115)	(0.089)	(0.110)	(0.111)	(0.092)	(0.109)
Bishop	-0.101	-0.100*	-0.215***	-0.083	-0.077	-0.190**	-0.079	-0.061	-0.151**	-0.083	-0.075	-0.190**	-0.080	-0.070	-0.175**
	(0.066)	(0.059)	(0.075)	(0.065)	(0.057)	(0.074)	(0.068)	(0.057)	(0.071)	(0.066)	(0.058)	(0.074)	(0.067)	(0.057)	(0.072)
Hanseatic	0.014	0.008	-0.063	0.006	-0.020	-0.087	0.001	-0.018	-0.071	0.005	-0.024	-0.096	0.005	-0.010	-0.073
	(0.053)	(0.058)	(0.071)	(0.054)	(0.063)	(0.074)	(0.054)	(0.066)	(0.070)	(0.054)	(0.063)	(0.076)	(0.054)	(0.064)	(0.072)
Water	0.071	0.102***	0.245***	0.071	0.098**	0.245***	0.074	0.094**	0.235***	0.071	0.098***	0.244***	0.072	0.106***	0.254***
	(0.047)	(0.038)	(0.044)	(0.047)	(0.038)	(0.044)	(0.048)	(0.039)	(0.044)	(0.048)	(0.038)	(0.044)	(0.047)	(0.040)	(0.044)
Log Distance to Wittenberg	-0.167***	-0.337***	-0.319***	-0.166***	-0.337***	-0.317***	-0.167***	-0.346***	-0.314***	-0.166***	-0.339***	-0.322***	-0.167***	-0.351***	-0.320***
	(0.050)	(0.080)	(0.082)	(0.050)	(0.086)	(0.080)	(0.050)	(0.095)	(0.085)	(0.050)	(0.087)	(0.083)	(0.050)	(0.090)	(0.086)
N/S Coordinate	-0.043	-0.171***	-0.027	-0.044	-0.182***	-0.037	-0.044	-0.189***	-0.037	-0.044	-0.180***	-0.034	-0.044	-0.182***	-0.029
	(0.037)	(0.043)	(0.058)	(0.037)	(0.044)	(0.058)	(0.037)	(0.042)	(0.055)	(0.037)	(0.044)	(0.059)	(0.037)	(0.041)	(0.059)
E/W Coordinate	-0.147	-0.984***	-0.515*	-0.148	-1.042***	-0.554*	-0.144	-1.094***	-0.554**	-0.147	-1.026***	-0.541*	-0.145	-1.050***	-0.528*
	(0.187)	(0.256)	(0.288)	(0.186)	(0.258)	(0.289)	(0.184)	(0.248)	(0.280)	(0.186)	(0.255)	(0.293)	(0.185)	(0.247)	(0.297)
Coordinate Interaction	0.003	0.020***	0.010*	0.003	0.021***	0.011*	0.003	0.022***	0.011**	0.003	0.021***	0.011*	0.003	0.021***	0.011*
	(0.004)	(0.005)	(0.006)	(0.004)	(0.005)	(0.006)	(0.004)	(0.005)	(0.006)	(0.004)	(0.005)	(0.006)	(0.004)	(0.005)	(0.006)
Observations	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
No. of Clusters	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
pseudo R-squared	0.213	0.576	0.433	0.208	0.565	0.433	0.209	0.569	0.449	0.208	0.561	0.423	0.208	0.569	0.436

Robust standard errors clustered by territory in parentheses; Probit model, average marginal effects reported; all log values are log (1 + variable) except for log of population

*** p<0.01, ** p<0.05, * p<0.1

Table A 3: Average Marginal Effects, Printing introduced at various times

	(A3.1) Prot in 1530	(A3.2) Prot in 1560	(A3.3) Prot in 1600
Printing Press by 1480	0.246***	0.102*	0.107*
	(0.079)	(0.060)	(0.058)
Presses w/in 10 miles by 1480	0.038	0.205**	0.218***
	(0.178)	(0.083)	(0.072)
Presses w/in 20 miles by 1480	-0.011	0.091**	0.100***
	(0.059)	(0.038)	(0.035)
Press 10 miles by 1480 dummy	0.038	0.205**	0.218***
	(0.178)	(0.083)	(0.072)
Press 20 miles by 1480 dummy	-0.037	0.147**	0.167***
	(0.080)	(0.059)	(0.054)
Printing Press by 1490	0.168**	0.122**	0.142***
	(0.075)	(0.058)	(0.055)
Presses w/in 10 miles by 1490	-0.063	0.062	0.137*
	(0.139)	(0.093)	(0.077)
Presses w/in 20 miles by 1490	-0.002	0.065**	0.076***
	(0.043)	(0.029)	(0.027)
Press 10 miles by 1490 dummy	-0.063	0.062	0.137*
	(0.139)	(0.093)	(0.077)
Press 20 miles by 1490 dummy	0.005	0.151***	0.198***
	(0.081)	(0.054)	(0.043)
City-Specific Controls	Yes	Yes	Yes
Geographical Controls	Yes	Yes	Yes

Each estimate is a coefficient from a different regression
Robust standard errors clustered by territory in parentheses; Probit model, average marginal effects reported; City Specific and Geographic control variables are same as in previous regressions; a constant term is included
*** p<0.01, ** p<0.05, * p<0.1

Appendix II: Protestant Potential and Reverse Causality

It is possible that cities were more likely to become Protestant if nearby cities were Protestant, with this effect depending on the size of the nearby cities. Most of this spatial correlation is picked up in the primary analysis through the geographical coordinates and the distance to Wittenberg variable. However, there may also be some Reformation-specific pattern that these variables do not pick up. This Appendix suggests a variable that addresses this problem.

To address this concern, I create a Protestant and Catholic "urban potential" variable, which is based on the urban potential variables in de Vries (1984) and Bosker, Buringh, and van Zanden (2010). I first measure the lagged, distance-weighted sum of all other Protestant or Catholic cities as follows:

(4) $$Pot_{Prot,i,t} = \sum_{j \neq i} \left(\frac{pop_j}{D_{ij}} I_{Prot,j,t-1} \right)$$

(5) $$Pot_{Cath,i,t} = \sum_{j \neq i} \left(\frac{pop_j}{D_{ij}} I_{Cath,j,t-1} \right)$$

where pop_j is city j's population, D_{ij} is the distance between city i and j, and $I_{Prot,j,t-1}$ and $I_{Cath,j,t-1}$ are indicators equaling one if city j is Protestant or Catholic in period t – 1, where $t \in \{1530, 1560, 1600\}$. Using lagged values helps circumvent issues of reverse causality which may arise from contemporaneous conversion to Protestantism. I construct a "Protestant potential" variable for each city by dividing its Protestant urban potential by its overall urban potential, or:

(6) $$Protestant\ Potential_{i,t} = \frac{Pot_{Prot,i,t}}{Pot_{Prot,i,t} + Pot_{Cath,i,t}} * 100$$

There is one major problem with using this variable in a regressions analysis. This is, namely, that it aggregates the left-hand side of the other cities into a variable used on the right-hand side. This entails that the Protestant potential variable may suffer from reverse causality. If

Protestant potential is a salient factor in a city becoming Protestant, then cities near city i could become Protestant in part due to city i being Protestant. This would especially be true for large cities that are near many other cities. In this case, the left-hand side is implicitly included in the right-hand side, and the regression is mis-specified. I address this concern below.

First, however, I re-estimate the equation (1) including the Protestant potential variable as a control.[50] I do not estimate the 1530 specification, since the Protestant potential variable is lagged and is only applicable to the 1560 and 1600 specifications. Table A 4 and Table A 5 report the results from the HRE sample. The coefficients on the press proxies change little from those reported in the body of the paper (Table 5, Table 6, and Table 12). Moreover, the average marginal effect of the Protestant potential variable is large and highly significant. Though these regressions may suffer from reverse causality, these results provide evidence that there was a substantial spatial pattern in the spread of the Reformation.[51]

Next, I address the possibility that the Protestant potential variable may suffer from reverse causality. If Protestant potential is a salient factor in a city becoming Protestant, then cities near city i could become Protestant in part due to city i being Protestant. This would especially be true for large cities that are near many other cities. Such cities would have a heavy influence on the Protestant potential of many nearby cities, which could in turn effect the Protestant potential of city i.

To address this issue, I determine the "maximum effect" that each city could have on its own Protestant or Catholic urban potential. I then omit observations that do not have a negligible

[50] The results of the two-stage regressions are similar to those reported in the body of the paper, but *only* when the sample excludes the smallest cities (those with populations of 1,000 or 2,000). This is not surprising – many of the smaller cities did not have presses and were heavily influenced by what the religious choice of nearby cities. In other words, the "Protestant potential" of a city had an overwhelming influence on the decision of small cities to convert, but the press played an important role in the decision of medium and large cities.

[51] A similar result related to the spatial patterns of the Reformation is found in Cantoni (2011).

effect on their own "potential". If, for example, city j is Protestant, I first determine what proportion of each non-j city's Protestant urban potential is made up by city j. I then determine the proportion that each non-j city plays in j's Protestant potential. The "maximum effect" that a city has on its own Protestant potential is the sum of the product of each of these two proportions. I denote this result the "maximum effect" because it is the effect if Protestant potential is the *only* variable affecting whether a city becomes Protestant. For example, if city j contributes 10% of city k's Protestant potential (meaning that city j is large, the two cities are close, or both), then city j would be assumed to affect 10% of city k's probability of becoming Protestant. If city k in turn contributes 20% of city j's Protestant potential, then city j being Protestant determines 2% of its own Protestant potential just through city k. The maximum effect is determined by summing the total effect for all non-j cities.

The purpose of this exercise is to determine how many cities have a negligible effect on their Protestant or Catholic potential. If a city's religion determines a sufficiently small portion of its own potential, then the potential variable is ostensibly exogenous, much as prices are to price-taking firms in competitive environments. In fact, most cities contribute well less than 5% to their own Protestant or Catholic potential under the "maximum effect" case. To ensure that the few cities that do have a substantial effect are not driving the results, I re-estimate the regressions, but do not include cities that have a maximum effect on their own Protestant or Catholic urban potential of at least 5%. The results for the HRE sample are reported in Table A 6. These results are broadly consistent with those reported in the paper.

Table A 4: Average Marginal Effects, Protestantism in HRE, including Protestant potential control

	(A4.1) Prot in 1560	(A4.2) Prot in 1600	(A4.3) Prot in 1560	(A4.4) Prot in 1600	(A4.5) Prot in 1560	(A4.6) Prot in 1600	(A4.7) Prot in 1560	(A4.8) Prot in 1600	(A4.9) Prot in 1560	(A4.10) Prot in 1600
Printing Press by 1500	0.190***	0.134***								
	(0.047)	(0.043)								
Presses w/in 10 miles			0.075**	0.082**						
			(0.037)	(0.038)						
Presses w/in 20 miles					0.061***	0.064***				
					(0.021)	(0.019)				
Press 10 miles dummy							0.070	0.080*		
							(0.049)	(0.047)		
Press 20 miles dummy									0.125**	0.150***
									(0.051)	(0.058)
Log Population in 1500	-0.025	-0.025	0.006	-0.011	0.007	-0.012	0.010	-0.008	0.008	-0.009
	(0.031)	(0.026)	(0.033)	(0.028)	(0.033)	(0.025)	(0.032)	(0.029)	(0.033)	(0.029)
Independent City	0.172***	0.198***	0.124*	0.176***	0.123**	0.173***	0.116*	0.166***	0.102*	0.153***
	(0.060)	(0.048)	(0.064)	(0.049)	(0.060)	(0.049)	(0.064)	(0.049)	(0.061)	(0.050)
University	-0.183***	-0.126**	-0.151**	-0.101**	-0.133**	-0.080*	-0.161**	-0.109**	-0.166**	-0.118**
	(0.063)	(0.052)	(0.068)	(0.050)	(0.065)	(0.048)	(0.070)	(0.052)	(0.068)	(0.048)
Bishop	-0.203***	-0.184***	-0.156**	-0.160***	-0.141**	-0.135***	-0.154**	-0.156***	-0.152**	-0.153***
	(0.063)	(0.052)	(0.063)	(0.049)	(0.059)	(0.046)	(0.063)	(0.049)	(0.059)	(0.046)
Hanseatic	-0.067	-0.071	-0.091	-0.086*	-0.067	-0.062	-0.098	-0.093*	-0.081	-0.077
	(0.059)	(0.049)	(0.060)	(0.048)	(0.061)	(0.049)	(0.061)	(0.050)	(0.060)	(0.048)
Water	0.106***	0.101***	0.097**	0.096**	0.099**	0.094**	0.093**	0.094**	0.106**	0.113***
	(0.041)	(0.038)	(0.043)	(0.039)	(0.045)	(0.040)	(0.043)	(0.038)	(0.045)	(0.040)
Log Distance to Wittenberg	0.002	0.063**	-0.004	0.059**	-0.010	0.048**	0.004	0.063***	0.008	0.060***
	(0.065)	(0.025)	(0.057)	(0.024)	(0.055)	(0.022)	(0.055)	(0.023)	(0.052)	(0.020)
N/S Coordinate	-0.075	-0.050	-0.071	-0.050	-0.071	-0.040	-0.072	-0.053	-0.069	-0.043
	(0.048)	(0.049)	(0.049)	(0.049)	(0.051)	(0.050)	(0.049)	(0.049)	(0.051)	(0.047)
E/W Coordinate	-0.886***	-0.711**	-0.767***	-0.657**	-0.756***	-0.584**	-0.773***	-0.667**	-0.787***	-0.666**
	(0.287)	(0.289)	(0.285)	(0.283)	(0.290)	(0.278)	(0.285)	(0.285)	(0.298)	(0.261)
Coordinate Interaction	0.018***	0.014**	0.015***	0.013**	0.015***	0.012**	0.016***	0.013**	0.016***	0.013***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)	(0.005)
Protestant Potential$_{t-1}$	0.030***	0.021***	0.031***	0.021***	0.028***	0.019***	0.033***	0.022***	0.032***	0.022***
	(0.006)	(0.002)	(0.006)	(0.002)	(0.005)	(0.002)	(0.006)	(0.002)	(0.006)	(0.002)
Observations	187	187	187	187	187	187	187	187	187	187
No. of Clusters	90	90	90	90	90	90	90	90	90	90
pseudo R-squared	0.674	0.720	0.652	0.718	0.669	0.737	0.647	0.713	0.663	0.743

Robust standard errors clustered by territory in parentheses; Probit model, average marginal effects reported; all log values are log (1 + variable) except for log of population

*** p<0.01, ** p<0.05, * p<0.1

Table A 5: Average Marginal Effects, Protestantism in HRE, including Protestant potential control, print intensity proxies

	(A5.1) Prot in 1560	(A5.2) Prot in 1600	(A5.3) Prot in 1560	(A5.4) Prot in 1600	(A5.5) Prot in 1560	(A5.6) Prot in 1600
Log Books	0.033***	0.029***				
	(0.011)	(0.010)				
Log Books w/in 10 miles			0.028***	0.025***		
			(0.011)	(0.009)		
Log Books w/in 20 miles					0.024**	0.020**
					(0.010)	(0.009)
Log Population in 1500	-0.009	-0.024	-0.002	-0.019	0.005	-0.011
	(0.035)	(0.028)	(0.035)	(0.028)	(0.034)	(0.026)
Independent City	0.125*	0.172***	0.119*	0.167***	0.103*	0.147***
	(0.065)	(0.051)	(0.064)	(0.050)	(0.062)	(0.052)
University	-0.163**	-0.106**	-0.157**	-0.100**	-0.151**	-0.095**
	(0.064)	(0.049)	(0.065)	(0.048)	(0.065)	(0.048)
Bishop	-0.181***	-0.170***	-0.170***	-0.163***	-0.156**	-0.145***
	(0.065)	(0.054)	(0.065)	(0.053)	(0.063)	(0.050)
Hanseatic	-0.087	-0.087*	-0.093	-0.093*	-0.075	-0.078
	(0.060)	(0.050)	(0.061)	(0.050)	(0.063)	(0.052)
Water	0.091**	0.083**	0.089**	0.083**	0.110**	0.097**
	(0.041)	(0.038)	(0.042)	(0.038)	(0.045)	(0.042)
Log Distance to Wittenberg	0.001	0.064***	0.005	0.065***	-0.018	0.053**
	(0.059)	(0.023)	(0.057)	(0.023)	(0.063)	(0.023)
N/S Coordinate	-0.076	-0.051	-0.080*	-0.054	-0.072	-0.037
	(0.047)	(0.048)	(0.047)	(0.048)	(0.049)	(0.049)
E/W Coordinate	-0.827***	-0.689**	-0.833***	-0.696**	-0.769***	-0.581**
	(0.274)	(0.287)	(0.273)	(0.288)	(0.281)	(0.281)
Coordinate Interaction	0.017***	0.014**	0.017***	0.014**	0.016***	0.012**
	(0.005)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)
Protestant Potential$_{t-1}$	0.029***	0.020***	0.030***	0.020***	0.027***	0.019***
	(0.006)	(0.002)	(0.006)	(0.002)	(0.006)	(0.002)
Observations	187	187	187	187	187	187
No. of Clusters	90	90	90	90	90	90
pseudo R-squared	0.664	0.723	0.660	0.721	0.664	0.722

Robust standard errors clustered by territory in parentheses; Probit model, average marginal effects reported; all log values are log (1 + variable) except for log of population
*** p<0.01, ** p<0.05, * p<0.1

Table A 6: Average Marginal Effects, without "Endogenous" Protestant Potential, HRE

	(A6.1) Prot in 1560	(A6.2) Prot in 1600
Printing Press by 1500	0.180***	0.138***
	(0.048)	(0.042)
Observations	176	185
Presses w/in 10 miles	0.073**	0.083**
	(0.036)	(0.037)
Observations	176	185
Presses w/in 20 miles	0.055***	0.066***
	(0.020)	(0.020)
Observations	176	185
Press 10 miles dummy	0.066	0.081*
	(0.048)	(0.047)
Observations	176	185
Press 20 miles dummy	0.119**	0.151***
	(0.048)	(0.057)
Observations	176	185
Log Books	0.028**	0.026***
	(0.012)	(0.010)
Observations	176	185
Log Books w/in 10 miles	0.022*	0.023**
	(0.012)	(0.009)
Observations	176	185
Log Books w/in 20 miles	0.019**	0.019**
	(0.010)	(0.009)
Observations	176	185

Each estimate is a coefficient from a different regression from a probit estimation average marginal effects reported
Robust standard errors clustered by territory in parentheses
City Specific, Geographic control variables, and constant included as in previous regressions
*** p<0.01, ** p<0.05, * p<0.1

Appendix III: Data Sources

Dependent Variable: Protestant Dummies

The dependent variable is a dummy equaling one if a city is Protestant in the year in question (1530, 1560, or 1600). In some cases, delineation by religion is obvious – all Spanish, Portuguese, and Italian were always Catholic, while and Danish and Swedish cities are Protestant throughout the period, British and Norwegian cities are Protestant after 1530, and Dutch cities are Protestant after 1560. Although Protestantism made some inroads into present-day Austria, Belgium, and Czech Republic (Bohemia), it ended up being suppressed and all cities are considered Catholic. The cities with the most difficult religions to determine are located in northern and eastern France, western Poland, Germany, and Switzerland. Most of France and Poland remained Catholic, but there were parts of each country (under current boundaries) which were part of the Holy Roman Empire at the beginning of the 16th century. Examples in France include Haguenau, Strasbourg, Metz, and Douai, while examples in Poland include Breslau (Wroclaw) and Stettin (Szczecin). Any French or Polish city not in the Holy Roman Empire (HRE) is considered Catholic. The religion of cities in the Polish and French parts of the HRE is determined in the same manner as the religion of German and Swiss cities. The method for determining whether a city was in the Holy Roman Empire is explained below (in the "Independent Variables" section).

For German and Swiss cities (and Polish and French cities in the HRE), there is significant religious variation over time and place. The first step in determining which cities were Protestant and when they became Protestant was to search historical atlases which marked the spread of Protestantism prior to the Thirty Years War (Ward et al. 1912; O'Brien 2002). There is some variation in these maps, particularly near the Catholic-Protestant boundaries, but most cities quite obviously became Protestant or remained Catholic in a given period. For example, northern Germany was mostly Protestant by 1560, with the cities near the Jutland peninsula becoming Protestant prior to 1530. The Swiss cities were also relatively easy to delineate, as most of the cantons explicitly accepted (e.g., Zürich, St. Gallen, and eventually Geneva) or rejected (e.g., Fribourg) Protestantism (of the Zwingli and Calvin variety). The German, French, and Polish border cities were more difficult to determine, as in some instances cities were not fully Protestant or Catholic. In these cases, especially where the historical atlases disagreed, the Catholic Encyclopedia was consulted (http://www.newadvent.org/cathen/). The Encyclopedia has an entry for every remotely large city (10,000 or greater) and in almost every case discusses the city's history around the Reformation period. A city was considered Protestant if it accepted the Augsburg Confession, Catholics were forced to flee, or the Encyclopedia explicitly states the Protestantism was accepted.

Independent Variables

Printing Press: Cities with printing presses prior to 1500 are found in Febvre and Martin (1958) and Clair (1976). There is some disagreement between these two sources (Febrve and Martin list 15 press cities not included in Clair, and Clair lists 12 press cities not included in Febvre and Martin). The "Printing Press" dummy takes a value of 1 if either of these sources lists a printing press being present in the city in 1500. Population data (see below) does not exist for a number

of the cities with presses, as many of the presses arose near monasteries (such as Cluny). These presses are omitted from the analysis.

For book data at the city level, all data was found at the website for the *Incunabula Short Title Catalogue* (http://www.bl.uk/catalogues/istc/). This catalog has been pieced together over the last century by the British library and "records nearly every item printed from movable type before 1501, but not material printed entirely from woodblocks or engraved plates. 29,777 editions are listed as at January 8th 2008" (ISTC 2008). These records include year of place of publication, both of which were recorded in the data. The search engine on the website has some bugs, so each record was double-checked to ensure that the count of books published in each city was correct.

Population: Population data is from Bairoch et al. (1988), who collected population data on every European city that reached 5,000 inhabitants at some point by 1800. As noted in De Long and Shleifer (1993), these data are broadly consistent with those found in Chandler and Fox (1974) and de Vries (1984), but are much more complete. I collected data for every city in which Bairoch et al. have population data for 1500. I did not collect data for Eastern Europe, and thus Hungary, Romania, Bulgaria, Russia (and former Soviet republics), Greece, Albania, and the former Yugoslavian republics are not included. My method has the unfortunate consequence of omitting a few cities (but no large cities) for which population data exists before 1500 but not in 1500. One way to overcome this could have been by taking the average pre-1500 and post-1500 populations. This is highly problematic, however, as Dittmar (2011) suggests that cities with printing presses showed greater growth rates by the 16th century (and the data would thus be skewed). I have thus left these cities out of the analysis.

City Coordinates and Distance: City coordinates are acquired from Bairoch et al. (1988) and double-checked using the website http://www.itouchmap.com/latlong.html, a site which uses Google Maps to pinpoint the exact latitude and longitude of any point (searchable in Google) on the globe.[52] The distance variables (e.g. distance from Wittenberg, distance from Mainz) were calculated "as the crow flies", using city coordinates and the distance formula (and translating degrees into miles).

Bishop and University: The erection and promotion date to Diocese or Archdiocese (where bishops and archbishops preside, respectively) of all cities in the Catholic sphere of influence is available at http://catholic-hierarchy.org/. The date recorded in the data is the first one in which a city housed a Diocese or Archdiocese. The dummy variable "Bishop" takes a value of 1 if the city housed a Diocese or Archdiocese prior to (and including) 1517, when Luther published the 95 Theses. The University dummy also takes a value of 1 if the city housed a university prior to (and including) 1450. University data is acquired from Darby and Fullard (1957-1979). 15 universities from Darby and Fullard (including 9 in Germany) are located in cities where population data in 1500 did not exist, and these universities are excluded from the data.

[52] For example, this site pointed to different coordinates for Oldenburg, Germany than in Bairoch et al. It is likely that Bairoch et al confuse two places with similar names. I am grateful to Jeremiah Dittmar for pointing this out to me.

Independent City and Hanseatic League: Jacob (2010) provides beginning and end dates for the independence of cities in the Holy Roman Empire. The Independent City dummy variable takes a value of 1 if the city was independent in 1517. Jacob (2010) also provides data on whether cities in the Holy Roman Empire were part of the Hanseatic League. Various internet searches (by city) confirmed whether or not cities in present day Poland were members of the Hanseatic League (Polish Hanseatic members are Kolobrzeg (Colberg), Opole, Slupsk, and Stettin (Szczecin)).

Water: A city is considered to be on water if it borders a sea, ocean, large lake, or a river which flows to another city. These metrics were chosen because the important aspect of being near water relative to the question posed in this paper was the access to information it provided. All data points were collected by searching Google Maps and determining each city's access to water. Cities which border the Atlantic, a sea, a large lake, or a major river were easy to determine, as were those far away from any water. The only ambiguity arose for cities with access to minor rivers or far-off tributaries of major rivers. The metric employed in this dataset is that any city with a river running through it that also connected to another city was counted as having access to water.

Protestant share in 1816: These data are extracted from the 1816 Prussian census (Mützell 1825). The census includes the number of Protestants and Catholics in each Prussian city and county. I include cities that match cities existing in 1500. This invariably misses some cities, since the Prussian census was conducted at the county level.

TABLES

Table 1: Cities in the Holy Roman Empire (population ≥ 10,000)

Cities (with population ≥ 10,000) with Printing Presses by 1500		
City	Population (in 1500)	P/C (by 1600)
Prague	70,000	C
Ghent	55,000	C
Cologne	45,000	C
Nuremberg	38,000	P
Bruges	35,000	C
Brussels	33,000	C
Augsburg	30,000	P
Valenciennes	30,000	C
Antwerp	30,000	C
Breslau	25,000	P
Lübeck	25,000	P
Regensburg	22,000	P
Strasbourg	20,000	P
Vienna	20,000	C
Erfurt	19,000	P
Magdeburg	18,000	P
Leuven	17,000	C
Ulm	16,000	P
Hamburg	15,000	P
Metz	15,000	C
Brno	15,000	C
Speyer	13,000	P
Munich	13,000	C
Pilsen	12,000	C
Olmütz	12,000	C
Lüneburg	11,000	P
Rostock	10,000	P
Münster	10,000	C
Leipzig	10,000	P
Kuttenberg	10,000	C

Cities (with population ≥ 10,000) without Printing Presses by 1500		
City	Population (in 1500)	P/C (by 1600)
Tournai	35,000	C
Lille	26,000	C
Mechelen	25,000	C
Liège	20,000	C
Brunswick	18,000	P
Bremen	18,000	P
Aachen	18,000	C
Schwaz	17,000	C
Mons (Bergen)	15,000	C
Goslar	12,000	P
Frankfurt (Am Main)	12,000	P
Hondschoote	12,000	C
Stralsund	11,000	P
Görlitz	11,000	P
Frankfurt (An der Oder)	11,000	P
Saint-Omer	11,000	C
Arras	11,000	C
Soest	10,000	P
Osnabrück	10,000	C
Hildesheim	10,000	P
Douai	10,000	C
Ypres	10,000	C

Table 2: Catholic and Protestant Cities in the de facto Holy Roman Empire

	Cites With Press by 1500		Cites With No Press by 1500		Total
	N	%	N	%	
Total Catholic:	25	46.3%	61	44.9%	86
Total Protestant:	29	53.7%	75	55.1%	104
Total Catholic, pop ≥ 10,000	16	53.3%	13	59.1%	29
Total Protestant, pop ≥ 10,000	14	46.7%	9	40.9%	23
Total Catholic, pop < 10,000	9	37.5%	48	42.1%	57
Total Protestant, pop < 10,000	15	62.5%	66	57.9%	81

Table 3: Summary Statistics, HRE

Variable	Obs.	Mean	Std Dev	Min	Max
			Protestant and Printing Variables		
Protestant in 1530	187	0.235	0.425	0	1
Protestant in 1560	187	0.545	0.499	0	1
Protestant in 1600	187	0.556	0.498	0	1
Printing Press in 1500	187	0.294	0.457	0	1
Number of presses within 10 miles	187	0.417	0.565	0	2
Number of presses within 20 miles	187	0.824	1.009	0	5
Press within 10 miles dummy	187	0.380	0.487	0	1
Press within 20 miles dummy	187	0.545	0.499	0	1
Log(books printed in city)	187	1.005	1.891	0	7.306
Log(books printed within 10 miles of city)	187	1.170	1.955	0	7.306
Log(books printed within 20 miles of city)	187	1.897	2.402	0	7.306
			Control Variables		
Log (population in 1500, in thousands)	187	1.668	0.938	0	4.248
University in 1450	187	0.053	0.226	0	1
Bishop in 1517	187	0.166	0.373	0	1
Hanseatic	187	0.209	0.407	0	1
Independent City	187	0.193	0.395	0	1
Water	187	0.674	0.470	0	1
City Coordinate N/S	187	50.37	1.70	45.34	54.28
City Coordinate E/W	187	9.04	3.85	2.15	17.55
Log (distance to Wittenberg, in miles)	187	5.310	0.822	0	6.303
Log (distance to Mainz, in miles)	187	5.209	0.645	0	6.269

**All log values are log (1 + variable) except for log of population

Table 4: Correlation Matrix, all variables except city coordinates

	Prot in 1530	Prot in 1560	Prot in 1600	Press in 1500	Presses 10 mi.	Presses 20 mi.
Prot in 1560	0.506					
Prot in 1600	0.496	0.957				
Press in 1500	0.002	0.024	-0.014			
Presses 10 mi.	-0.008	0.009	0.012	0.813		
Presses 20 mi.	-0.041	0.021	0.025	0.533	0.714	
Press 10 mi. dummy	-0.018	-0.016	-0.011	0.825	0.945	0.597
Press 20 mi. dummy	-0.025	0.029	0.049	0.589	0.675	0.747
Books	0.107	0.048	0.028	0.826	0.666	0.468
Books 10 mi.	0.075	0.018	0.002	0.776	0.757	0.577
Books 20 mi.	0.068	0.053	0.041	0.561	0.563	0.759
Population	-0.054	-0.104	-0.117	0.499	0.380	0.172
University	-0.076	-0.069	-0.075	0.368	0.246	0.136
Bishop	-0.044	-0.055	-0.065	0.407	0.257	0.064
Hanseatic	0.026	0.231	0.247	0.015	0.017	-0.172
Independent City	0.145	0.146	0.191	0.161	0.144	0.126
Water	0.144	0.144	0.136	0.099	0.049	-0.009
Dist to Wittenberg	-0.371	-0.585	-0.580	0.074	0.083	0.159
Dist to Mainz	-0.166	-0.120	-0.139	-0.089	-0.243	-0.246

	Press 10 mi. dummy	Press 20 mi. dummy	Books	Books 10 mi.	Books 20 mi.	Population
Press 20 mi. dummy	0.714					
Books	0.681	0.487				
Books 10 mi.	0.767	0.548	0.941			
Books 20 mi.	0.526	0.723	0.677	0.732		
Population	0.419	0.245	0.510	0.484	0.275	
University	0.304	0.217	0.389	0.356	0.236	0.276
Bishop	0.303	0.205	0.373	0.324	0.185	0.385
Hanseatic	0.059	-0.087	0.003	0.013	-0.106	0.192
Independent City	0.149	0.201	0.244	0.213	0.242	0.283
Water	0.074	0.006	0.134	0.122	-0.019	0.130
Dist to Wittenberg	0.057	0.087	0.073	0.089	0.111	0.162
Dist to Mainz	-0.160	-0.182	-0.181	-0.177	-0.215	0.040

	University	Bishop	Hanseatic	Indep City	Water	Dist to Witt
Bishop	0.214					
Hanseatic	0.053	0.196				
Independent City	0.005	0.293	0.016			
Water	0.064	0.218	-0.064	0.050		
Dist to Wittenberg	-0.019	0.013	-0.199	0.153	-0.085	
Dist to Mainz	-0.061	-0.137	0.099	-0.308	-0.006	-0.094

Table 5: Average Marginal Effects, Protestantism in HRE

	(5.1)	(5.2)	(5.3)	(5.4)	(5.5)	(5.6)	(5.7)	(5.8)	(5.9)	(5.10)	(5.11)	(5.12)	(5.13)	(5.14)	(5.15)	(5.16)	(5.17)	(5.18)
	Basic Correlation			City Size			University			Catholic Influence			Information Flows			Geography		
	Prot in 1530	Prot in 1560	Prot in 1600	Prot in 1530	Prot in 1560	Prot in 1600	Prot in 1530	Prot in 1560	Prot in 1600	Prot in 1530	Prot in 1560	Prot in 1600	Prot in 1530	Prot in 1560	Prot in 1600	Prot in 1530	Prot in 1560	Prot in 1600
Printing Press by 1500	0.002	0.026	-0.015	0.030	0.105	0.057	0.048	0.126	0.074	0.069	0.156*	0.108	0.091	0.227***	0.179**	0.114*	0.231***	0.196***
	(0.081)	(0.087)	(0.080)	(0.076)	(0.089)	(0.086)	(0.079)	(0.093)	(0.089)	(0.074)	(0.093)	(0.087)	(0.072)	(0.082)	(0.075)	(0.066)	(0.057)	(0.058)
Log Population in 1500				-0.058	-0.108**	-0.111**	-0.053	-0.104**	-0.108**	-0.046	-0.096*	-0.098*	-0.066*	-0.136***	-0.138***	-0.027	-0.078**	-0.086***
				(0.041)	(0.049)	(0.049)	(0.042)	(0.049)	(0.049)	(0.043)	(0.052)	(0.053)	(0.039)	(0.046)	(0.045)	(0.029)	(0.033)	(0.034)
Independent City				0.177**	0.240*	0.310**	0.170**	0.235*	0.306**	0.184**	0.264**	0.341***	0.201***	0.288**	0.368***	0.292***	0.290***	0.334***
				(0.079)	(0.125)	(0.125)	(0.077)	(0.126)	(0.125)	(0.079)	(0.127)	(0.126)	(0.077)	(0.116)	(0.112)	(0.071)	(0.053)	(0.049)
University							-0.144	-0.131	-0.100	-0.141	-0.123	-0.092	-0.138	-0.161	-0.138	-0.160	-0.166*	-0.140
							(0.168)	(0.170)	(0.171)	(0.163)	(0.161)	(0.162)	(0.167)	(0.146)	(0.149)	(0.135)	(0.090)	(0.092)
Bishop										-0.092	-0.130	-0.145	-0.159*	-0.280***	-0.299***	-0.166**	-0.217***	-0.219***
										(0.096)	(0.113)	(0.114)	(0.094)	(0.100)	(0.097)	(0.083)	(0.064)	(0.059)
Hanseatic													0.107	0.400***	0.422***	-0.041	-0.008	0.011
													(0.071)	(0.103)	(0.105)	(0.062)	(0.058)	(0.054)
Water													0.171***	0.219***	0.209***	0.119**	0.160***	0.154***
													(0.065)	(0.064)	(0.063)	(0.052)	(0.036)	(0.035)
Log Distance to Wittenberg																-0.182***	-0.331***	-0.302***
																(0.055)	(0.062)	(0.061)
N/S Coordinate																0.090	-0.094**	-0.069
																(0.069)	(0.047)	(0.043)
E/W Coordinate																0.309	-0.809***	-0.680***
																(0.304)	(0.269)	(0.241)
Coordinate Interaction																-0.006	0.016***	0.014***
																(0.006)	(0.005)	(0.005)
Observations	187	187	187	187	187	187	187	187	187	187	187	187	187	187	187	187	187	187
No. of Clusters	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
pseudo R-squared	0.000	0.000	0.000	0.029	0.038	0.053	0.033	0.040	0.055	0.037	0.046	0.061	0.073	0.150	0.177	0.233	0.603	0.624

Robust standard errors clustered by territory in parentheses; probit model, average marginal effects reported; a constant term is included
All log values are log (1 + variable) except for log of population
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Average Marginal Effects, Protestantism in HRE, other printing proxies

	(6.1) Prot in 1530	(6.2) Prot in 1560	(6.3) Prot in 1600	(6.4) Prot in 1530	(6.5) Prot in 1560	(6.6) Prot in 1600	(6.7) Prot in 1530	(6.8) Prot in 1560	(6.9) Prot in 1600	(6.10) Prot in 1530	(6.11) Prot in 1560	(6.12) Prot in 1600
Presses w/in 10 miles	0.051	0.103**	0.122***									
	(0.060)	(0.046)	(0.045)									
Presses w/in 20 miles				0.012	0.083***	0.091***						
				(0.035)	(0.026)	(0.025)						
Press 10 miles dummy							0.040	0.084	0.107*			
							(0.072)	(0.058)	(0.058)			
Press 20 miles dummy										0.014	0.153**	0.184***
										(0.060)	(0.061)	(0.066)
Log Population in 1500	-0.014	-0.044	-0.067*	-0.006	-0.040	-0.069**	-0.012	-0.038	-0.060*	-0.005	-0.040	-0.065*
	(0.028)	(0.036)	(0.035)	(0.027)	(0.036)	(0.033)	(0.027)	(0.035)	(0.034)	(0.026)	(0.036)	(0.036)
Independent City	0.284***	0.250***	0.316***	0.278***	0.240***	0.310***	0.282***	0.241***	0.299***	0.277***	0.215***	0.271***
	(0.070)	(0.056)	(0.050)	(0.071)	(0.054)	(0.051)	(0.071)	(0.056)	(0.051)	(0.072)	(0.057)	(0.055)
University	-0.126	-0.116	-0.097	-0.116	-0.106	-0.072	-0.125	-0.121	-0.106	-0.116	-0.138	-0.118
	(0.131)	(0.090)	(0.087)	(0.129)	(0.081)	(0.076)	(0.135)	(0.093)	(0.089)	(0.130)	(0.090)	(0.085)
Bishop	-0.137*	-0.167***	-0.189***	-0.126	-0.144**	-0.149***	-0.132	-0.160**	-0.178***	-0.125	-0.155**	-0.167***
	(0.079)	(0.064)	(0.056)	(0.083)	(0.060)	(0.052)	(0.082)	(0.066)	(0.059)	(0.084)	(0.062)	(0.056)
Hanseatic	-0.051	-0.041	-0.011	-0.046	-0.010	0.019	-0.051	-0.046	-0.017	-0.048	-0.021	0.009
	(0.064)	(0.062)	(0.055)	(0.063)	(0.062)	(0.054)	(0.065)	(0.064)	(0.057)	(0.064)	(0.062)	(0.055)
Water	0.117**	0.151***	0.151***	0.119**	0.159***	0.158***	0.118**	0.146***	0.144***	0.120**	0.167***	0.169***
	(0.052)	(0.040)	(0.037)	(0.053)	(0.037)	(0.034)	(0.052)	(0.039)	(0.036)	(0.052)	(0.038)	(0.036)
Log Distance to Wittenberg	-0.179***	-0.328***	-0.295***	-0.180***	-0.326***	-0.296***	-0.179***	-0.334***	-0.301***	-0.180***	-0.341***	-0.311***
	(0.056)	(0.065)	(0.058)	(0.055)	(0.070)	(0.067)	(0.056)	(0.071)	(0.064)	(0.055)	(0.073)	(0.068)
N/S Coordinate	0.085	-0.104**	-0.074*	0.080	-0.113**	-0.076*	0.081	-0.107**	-0.079*	0.078	-0.110**	-0.081*
	(0.069)	(0.046)	(0.042)	(0.067)	(0.046)	(0.045)	(0.068)	(0.046)	(0.041)	(0.067)	(0.046)	(0.043)
E/W Coordinate	0.299	-0.788***	-0.665***	0.291	-0.841***	-0.673***	0.286	-0.787***	-0.666***	0.283	-0.828***	-0.712***
	(0.296)	(0.241)	(0.224)	(0.287)	(0.246)	(0.233)	(0.292)	(0.234)	(0.213)	(0.288)	(0.240)	(0.227)
Coordinate Interaction	-0.006	0.016***	0.013***	-0.006	0.017***	0.014***	-0.006	0.016***	0.013***	-0.005	0.017***	0.014***
	(0.006)	(0.005)	(0.004)	(0.006)	(0.005)	(0.005)	(0.006)	(0.005)	(0.004)	(0.006)	(0.005)	(0.004)
Observations	187	187	187	187	187	187	187	187	187	187	187	187
No. of Clusters	90	90	90	90	90	90	90	90	90	90	90	90
pseudo R-squared	0.227	0.580	0.624	0.223	0.608	0.656	0.224	0.567	0.607	0.223	0.588	0.638

Robust standard errors clustered by territory in parentheses; probit model, average marginal effects reported; a constant term is included
All log values are log (1 + variable) except for log of population
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Exogeneity of Distance to Mainz Instrument

	(7.1) Independent City	(7.2) Hanseatic	(7.3) University	(7.4) Bishop
Log Distance to Mainz	-0.163	-0.016	-0.040	-0.064
	(0.102)	(0.048)	(0.040)	(0.058)
Observations	187	187	187	187
No. of Clusters	90	90	90	90
pseudo R-squared	0.294	0.429	0.117	0.274

OLS regression; robust standard errors clustered by territory in parentheses
City specific, geographic control variables, and constant included as in previous regressions; all controls employed in each regression except for the dependent variable in question
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Validity of Various Distance Instruments - Average Marginal Effects

	(8.1) Printing Press by 1500	(8.2) Presses w/in 10 miles	(8.3) Presses w/in 20 miles	(8.4) Press 10 miles dummy	(8.5) Press 20 miles dummy
Log Distance to Mainz	-0.062*	-0.237***	-0.338***	-0.127***	-0.096*
	(0.036)	(0.053)	(0.120)	(0.044)	(0.053)
F-stat	2.98	19.71	8.00	8.16	3.31
Log Distance to Vienna	0.106**	0.087	0.213	0.060	0.028
	(0.049)	(0.061)	(0.136)	(0.047)	(0.052)
F-stat	4.72	2.03	2.45	1.64	0.28
Log Distance to Rome	-0.198	-0.226	-1.008	0.041	0.187
	(0.561)	(0.795)	(1.598)	(0.625)	(0.798)
F-stat	0.12	0.08	0.40	0.00	0.05
Log Distance to Paris	0.429**	0.326	0.178	0.275	0.044
	(0.187)	(0.252)	(0.669)	(0.201)	(0.326)
F-stat	5.29	1.66	0.07	1.88	0.02
Log Distance to Genoa	-0.535	-0.709	-1.709	-0.414	-0.397
	(0.347)	(0.539)	(1.127)	(0.402)	(0.547)
F-stat	2.38	1.73	2.30	1.06	0.53

Each estimate is a coefficient from a different OLS regression from the first stage of ivprobit
Robust standard errors clustered by territory in parentheses
City specific, geographic control variables, and constant included as in previous regressions
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Distance to Mainz and City Clustering

	(9.1) Cities w/in 10 miles	(9.2) Cities w/in 10 miles
Log Distance to Mainz	-0.039	0.341
	(0.081)	(0.313)
Observations	187	187
No. of Clusters	90	90
R-squared	0.223	0.390

Robust standard errors clustered by territory in parentheses;
OLS estimation; city specific, geographic control variables, and constant included as in previous regressions
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Average Marginal Effects, two stage regression with distance to Mainz instrument

	(10.1) First Stage	(10.2)	(10.3) Second Stage	(10.4)
	Press Proxy	Prot in 1530	Prot in 1560	Prot in 1600
Log Distance to Mainz	-0.062*			
	(0.036)			
Press by 1500		0.760***	0.802***	0.801***
		(0.056)	(0.042)	(0.040)
Weak Instrument F-Stat	2.981			
Log Distance to Mainz	-0.237***			
	(0.053)			
Presses w/in 10 miles		0.415***	0.405***	0.412***
		(0.071)	(0.102)	(0.108)
Weak Instrument F-Stat	19.706			
Log Distance to Mainz	-0.338***			
	(0.120)			
Presses w/in 20 miles		0.249***	0.254***	0.260***
		(0.043)	(0.049)	(0.051)
Weak Instrument F-Stat	7.996			
Log Distance to Mainz	-0.127***			
	(0.044)			
Press 10 miles dummy		0.557***	0.562***	0.574***
		(0.066)	(0.085)	(0.084)
Weak Instrument F-Stat	8.158			
Log Distance to Mainz	-0.096*			
	(0.053)			
Press 20 miles dummy		0.542***	0.556***	0.564***
		(0.024)	(0.019)	(0.016)
Weak Instrument F-Stat	3.307			

Robust standard errors clustered by territory in parentheses; ivprobit estimation, average marginal effects reported; city specific, geographic control variables, and constant included as in previous regressions

*** p<0.01, ** p<0.05, * p<0.1

Table 11: Top 10 Cities by Book Production (in HRE), by decade

1460-1469			1470-1479		
City	Books	P/C (1560)	City	Books	P/C (1560)
Mainz	47	P	Cologne	412	C
Cologne	44	C	Augsburg	298	P
Strasbourg	17	P	Strasbourg	250	P
Bamberg	9	C	Nuremberg	165	P
Augsburg	6	P	Leuven	78	C
Eltvil	3	P	Ulm	73	P
Nuremberg	1	P	Mainz	64	P
			Speyer	46	P
			Lübeck	42	P
			Bruges	32	C
1480-1489			1490-1500		
City	Books	P/C (1560)	City	Books	P/C (1560)
Cologne	441	C	Leipzig	1040	P
Augsburg	405	P	Cologne	591	C
Strasbourg	364	P	Nuremberg	492	P
Nuremberg	359	P	Augsburg	486	P
Leipzig	284	P	Strasbourg	484	P
Antwerp	188	C	Antwerp	235	C
Leuven	154	C	Ulm	163	P
Ulm	144	P	Speyer	144	P
Speyer	126	P	Mainz	126	P
Lübeck	126	P	Lübeck	110	P

Table 12: Average Marginal Effects, Protestantism in HRE, book data

	(12.1) Prot in 1530	(12.2) Prot in 1560	(12.3) Prot in 1600	(12.4) Prot in 1530	(12.5) Prot in 1560	(12.6) Prot in 1600	(12.7) Prot in 1530	(12.8) Prot in 1560	(12.9) Prot in 1600
Log Books	0.053***	0.046***	0.045***						
	(0.016)	(0.011)	(0.011)						
Log Books w/in 10 miles				0.039**	0.036***	0.035***			
				(0.016)	(0.011)	(0.011)			
Log Books w/in 20 miles							0.025**	0.037***	0.035***
							(0.010)	(0.010)	(0.010)
Log Population in 1500	-0.051*	-0.059	-0.080**	-0.040	-0.050	-0.072**	-0.017	-0.042	-0.065**
	(0.030)	(0.037)	(0.035)	(0.028)	(0.037)	(0.033)	(0.026)	(0.035)	(0.030)
Independent City	0.275***	0.246***	0.300***	0.282***	0.242***	0.296***	0.268***	0.204***	0.262***
	(0.069)	(0.055)	(0.053)	(0.070)	(0.055)	(0.052)	(0.073)	(0.055)	(0.055)
University	-0.273	-0.159*	-0.135	-0.214	-0.136	-0.111	-0.169	-0.147*	-0.115
	(0.175)	(0.091)	(0.089)	(0.158)	(0.090)	(0.088)	(0.137)	(0.088)	(0.084)
Bishop	-0.216***	-0.208***	-0.214***	-0.178**	-0.186***	-0.194***	-0.155*	-0.170***	-0.173***
	(0.074)	(0.063)	(0.056)	(0.073)	(0.064)	(0.057)	(0.083)	(0.063)	(0.057)
Hanseatic	-0.012	-0.035	-0.013	-0.035	-0.044	-0.021	-0.038	-0.014	0.004
	(0.058)	(0.061)	(0.055)	(0.058)	(0.062)	(0.056)	(0.061)	(0.061)	(0.055)
Water	0.105**	0.138***	0.132***	0.106**	0.137***	0.131***	0.127**	0.172***	0.164***
	(0.050)	(0.035)	(0.033)	(0.050)	(0.036)	(0.034)	(0.052)	(0.036)	(0.035)
Log Distance to Wittenberg	-0.170***	-0.302***	-0.270***	-0.169***	-0.311***	-0.278***	-0.166***	-0.314***	-0.284***
	(0.051)	(0.066)	(0.063)	(0.053)	(0.069)	(0.065)	(0.054)	(0.073)	(0.070)
N/S Coordinate	0.097	-0.107**	-0.080**	0.091	-0.114**	-0.086**	0.104	-0.113**	-0.079*
	(0.069)	(0.044)	(0.039)	(0.069)	(0.044)	(0.039)	(0.068)	(0.045)	(0.041)
E/W Coordinate	0.329	-0.847***	-0.721***	0.306	-0.864***	-0.731***	0.368	-0.858***	-0.700***
	(0.297)	(0.246)	(0.220)	(0.295)	(0.240)	(0.214)	(0.289)	(0.241)	(0.220)
Coordinate Interaction	-0.006	0.017***	0.015***	-0.006	0.017***	0.015***	-0.007	0.017***	0.014***
	(0.006)	(0.005)	(0.004)	(0.006)	(0.005)	(0.004)	(0.006)	(0.005)	(0.004)
Observations	187	187	187	187	187	187	187	187	187
No. of Clusters	90	90	90	90	90	90	90	90	90
pseudo R-squared	0.264	0.595	0.626	0.249	0.586	0.620	0.241	0.609	0.640

Robust standard errors clustered by territory in parentheses; probit model, average marginal effects reported; a constant term is included
All log values are log (1 + variable) except for log of population
*** p<0.01, ** p<0.05, * p<0.1

Table 13: Distance from Mainz – Top 10 Cities by Book Production

1460-1469		1470-1479	
City	Distance	City	Distance
Mainz	0	Cologne	90
Cologne	90	Augsburg	172
Strasbourg	102	Strasbourg	102
Bamberg	129	Nuremberg	143
Augsburg	172	Leuven	185
Eltvil	7	Ulm	140
Nuremberg	143	Mainz	0
		Speyer	49
		Lübeck	291
		Bruges	260
Average	92	Average	143
Weighted Avg (by Books)	68	Weighted Avg (by Books)	129
1480-1489		1490-1500	
City	Distance	City	Distance
Cologne	90	Leipzig	219
Augsburg	172	Cologne	90
Strasbourg	102	Nuremberg	143
Nuremberg	143	Augsburg	172
Leipzig	219	Strasbourg	102
Antwerp	206	Antwerp	206
Leuven	185	Ulm	140
Ulm	140	Speyer	49
Speyer	49	Mainz	0
Lübeck	291	Lübeck	291
Average	160	Average	141
Weighted Avg (by Books)	149	Weighted Avg (by Books)	155

Table 14: Average Marginal Effects, two stage regression with distance to Mainz instrument

	(14.1)	(14.2)	(14.3)	(14.4)	(14.5)	(14.6)	(14.7)	(14.8)	(14.9)	(14.10)	(14.11)	(14.12)
	Log Books	Prot in 1530	Prot in 1560	Prot in 1600	Log Books 10 miles	Prot in 1530	Prot in 1560	Prot in 1600	Log Books 20 miles	Prot in 1530	Prot in 1560	Prot in 1600
Log Distance to Mainz	-0.450*				-0.458**				-0.496*			
	(0.228)				(0.230)				(0.282)			
Press Proxy		0.184***	0.178***	0.179***		0.166***	0.160***	0.162***		0.122***	0.122***	0.123***
		(0.026)	(0.036)	(0.036)		(0.022)	(0.030)	(0.030)		(0.009)	(0.013)	(0.013)
Observations	187	187	187	187	187	187	187	187	187	187	187	187
No. Clusters	90	90	90	90	90	90	90	90	90	90	90	90
Log Likelihood		-405.502	-384.231	-379.782		-422.231	-400.518	-395.743		-480.195	-455.698	-451.188
Weak Instrument F-Stat	3.897				3.959				3.085			

Robust standard errors clustered by territory in parentheses; 2SLS estimation; city specific, geographic control variables, and constant included as in previous regressions
*** p<0.01, ** p<0.05, * p<0.1

Table 15: Summary Statistics, Europe

Variable	Obs.	Mean	Std Dev	Min	Max
			Protestant and Printing Variables		
Protestant in 1530	610	0.118	0.323	0	1
Protestant in 1560	610	0.308	0.462	0	1
Protestant in 1600	610	0.366	0.482	0	1
Printing Press in 1500	610	0.275	0.447	0	1
Number of presses within 10 miles	610	0.364	0.563	0	2
Number of presses within 20 miles	610	0.723	1.040	0	6
Press within 10 miles dummy	610	0.321	0.467	0	1
Press within 20 miles dummy	610	0.452	0.498	0	1
Log(books printed in city)	610	0.863	1.734	0	8.157
Log(books printed within 10 miles of city)	610	0.988	1.828	0	8.157
Log(books printed within 20 miles of city)	610	1.499	2.166	0	8.185
			Control Variables		
Log (population in 1500, in thousands)	610	1.814	0.944	0	5.416
University in 1450	610	0.080	0.272	0	1
Bishop in 1517	610	0.325	0.469	0	1
Hanseatic	610	0.066	0.248	0	1
Independent City	610	0.557	0.497	0	1
Water	610	0.677	0.468	0	1
City Coordinate N/S	610	47.184	5.638	35.54	63.25
City Coordinate E/W	610	5.808	7.367	-9.08	22.15
Log (distance to Wittenberg, in miles)	610	6.153	0.805	0	7.270
Log (distance to Mainz, in miles)	610	5.959	0.745	0	7.088

**All log values are log (1 + variable) except for log of population

Table 16: Average Marginal Effects, Printing Press Proxies, Europe

	(16.1) Prot in 1530	(16.2) Prot in 1560	(16.3) Prot in 1600	(16.4) Prot in 1530	(16.5) Prot in 1560	(16.6) Prot in 1600	(16.7) Prot in 1530	(16.8) Prot in 1560	(16.9) Prot in 1600	(16.10) Prot in 1530	(16.11) Prot in 1560	(16.12) Prot in 1600	(16.13) Prot in 1530	(16.14) Prot in 1560	(16.15) Prot in 1600
Printing Press by 1500	0.058**	0.090**	0.093***												
	(0.025)	(0.036)	(0.032)												
Presses w/in 10 miles				0.028	0.032	0.070***									
				(0.020)	(0.028)	(0.023)									
Presses w/in 20 miles							0.010	0.011	0.044***						
							(0.011)	(0.018)	(0.016)						
Press 10 miles dummy										0.033	0.029	0.065**			
										(0.026)	(0.034)	(0.032)			
Press 20 miles dummy													0.033	0.030	0.079**
													(0.026)	(0.035)	(0.037)
Log Population in 1500	-0.027**	-0.081***	-0.055***	-0.022*	-0.071***	-0.051***	-0.018	-0.067***	-0.048***	-0.022*	-0.069***	-0.048***	-0.020	-0.069***	-0.048***
	(0.013)	(0.016)	(0.017)	(0.012)	(0.016)	(0.016)	(0.012)	(0.015)	(0.015)	(0.013)	(0.017)	(0.016)	(0.012)	(0.016)	(0.015)
Independent City	0.073**	0.234***	0.118**	0.073**	0.234***	0.123**	0.074**	0.237***	0.140***	0.072**	0.232***	0.120**	0.073**	0.235***	0.127**
	(0.032)	(0.050)	(0.058)	(0.032)	(0.050)	(0.057)	(0.032)	(0.047)	(0.053)	(0.032)	(0.050)	(0.058)	(0.031)	(0.049)	(0.057)
University	-0.092	-0.045	-0.085*	-0.075	-0.022	-0.070	-0.068	-0.015	-0.057	-0.078	-0.023	-0.073	-0.076	-0.021	-0.071
	(0.062)	(0.048)	(0.046)	(0.060)	(0.046)	(0.043)	(0.060)	(0.044)	(0.040)	(0.061)	(0.047)	(0.044)	(0.060)	(0.046)	(0.045)
Bishop	-0.060*	-0.084**	-0.116***	-0.048	-0.069*	-0.107***	-0.042	-0.063*	-0.091***	-0.049	-0.069*	-0.107***	-0.046	-0.066*	-0.101***
	(0.032)	(0.037)	(0.031)	(0.030)	(0.039)	(0.031)	(0.031)	(0.038)	(0.031)	(0.030)	(0.038)	(0.031)	(0.031)	(0.038)	(0.031)
Hanseatic	-0.004	0.067	-0.007	-0.010	0.056	-0.012	-0.009	0.058	0.006	-0.011	0.053	-0.018	-0.008	0.057	-0.005
	(0.029)	(0.055)	(0.056)	(0.029)	(0.056)	(0.058)	(0.029)	(0.055)	(0.054)	(0.029)	(0.056)	(0.058)	(0.029)	(0.057)	(0.057)
Water	0.041**	0.072***	0.124***	0.042**	0.077***	0.125***	0.043**	0.077***	0.123***	0.042**	0.077***	0.125***	0.043**	0.078***	0.128***
	(0.020)	(0.027)	(0.029)	(0.020)	(0.028)	(0.030)	(0.020)	(0.027)	(0.030)	(0.020)	(0.027)	(0.030)	(0.020)	(0.028)	(0.030)
Log Distance to Wittenberg	-0.082***	-0.279***	-0.290***	-0.082***	-0.282***	-0.286***	-0.082***	-0.284***	-0.285***	-0.081***	-0.282***	-0.290***	-0.080***	-0.281***	-0.285***
	(0.024)	(0.035)	(0.047)	(0.024)	(0.035)	(0.046)	(0.024)	(0.035)	(0.046)	(0.024)	(0.035)	(0.048)	(0.024)	(0.035)	(0.047)
N/S Coordinate	0.002	0.028***	0.035***	0.002	0.026***	0.034***	0.002	0.026***	0.033***	0.002	0.026***	0.034***	0.002	0.027***	0.035***
	(0.003)	(0.006)	(0.007)	(0.003)	(0.006)	(0.006)	(0.003)	(0.006)	(0.006)	(0.003)	(0.006)	(0.007)	(0.003)	(0.006)	(0.007)
E/W Coordinate	-0.036**	0.007	-0.026	-0.037**	0.005	-0.026	-0.038***	0.003	-0.026	-0.037**	0.004	-0.026	-0.038**	0.004	-0.026
	(0.015)	(0.030)	(0.037)	(0.015)	(0.029)	(0.036)	(0.015)	(0.029)	(0.036)	(0.015)	(0.029)	(0.037)	(0.015)	(0.029)	(0.038)
Coordinate Interaction	0.001***	-0.000	0.000	0.001***	-0.000	0.000	0.001***	-0.000	0.000	0.001***	-0.000	0.000	0.001***	-0.000	0.000
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Observations	610	610	610	610	610	610	610	610	610	610	610	610	610	610	610
No. of Clusters	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176
R-squared	0.425	0.567	0.601	0.419	0.560	0.602	0.417	0.559	0.609	0.419	0.559	0.597	0.420	0.559	0.601

Robust standard errors clustered by territory in parentheses; probit model, average marginal effects reported; a constant term is included

All log values are log (1 + variable) except for log of population

*** p<0.01, ** p<0.05, * p<0.1

Table 17: Average Marginal Effects, Printing Intensity Proxies, Europe

	(17.1) Prot in 1530	(17.2) Prot in 1560	(17.3) Prot in 1600	(17.4) Prot in 1530	(17.5) Prot in 1560	(17.6) Prot in 1600	(17.7) Prot in 1530	(17.8) Prot in 1560	(17.9) Prot in 1600
Log Books	0.029***	0.029***	0.033***						
	(0.007)	(0.009)	(0.008)						
Log Books w/in 10 miles				0.021***	0.018**	0.028***			
				(0.006)	(0.009)	(0.008)			
Log Books w/in 20 miles							0.014***	0.012	0.022***
							(0.005)	(0.008)	(0.008)
Log Population in 1500	-0.040***	-0.086***	-0.062***	-0.034***	-0.077***	-0.057***	-0.025**	-0.073***	-0.052***
	(0.012)	(0.016)	(0.016)	(0.012)	(0.016)	(0.015)	(0.012)	(0.016)	(0.014)
Independent City	0.073**	0.233***	0.117**	0.077**	0.237***	0.124**	0.074**	0.239***	0.129**
	(0.030)	(0.050)	(0.057)	(0.031)	(0.050)	(0.056)	(0.030)	(0.050)	(0.056)
University	-0.147*	-0.045	-0.090**	-0.117	-0.030	-0.079*	-0.093	-0.023	-0.068*
	(0.084)	(0.046)	(0.042)	(0.074)	(0.045)	(0.041)	(0.066)	(0.044)	(0.041)
Bishop	-0.086***	-0.087**	-0.120***	-0.070**	-0.078**	-0.116***	-0.057*	-0.068*	-0.100***
	(0.031)	(0.036)	(0.031)	(0.029)	(0.038)	(0.032)	(0.031)	(0.038)	(0.031)
Hanseatic	0.016	0.066	-0.006	0.005	0.061	-0.007	0.002	0.066	0.005
	(0.028)	(0.055)	(0.055)	(0.028)	(0.056)	(0.055)	(0.028)	(0.055)	(0.052)
Water	0.035*	0.068**	0.118***	0.036*	0.071***	0.117***	0.044**	0.077***	0.126***
	(0.019)	(0.027)	(0.029)	(0.020)	(0.027)	(0.029)	(0.020)	(0.028)	(0.030)
Log Distance to Wittenberg	-0.076***	-0.271***	-0.279***	-0.079***	-0.277***	-0.278***	-0.078***	-0.279***	-0.278***
	(0.022)	(0.033)	(0.044)	(0.023)	(0.034)	(0.044)	(0.024)	(0.034)	(0.044)
N/S Coordinate	0.001	0.026***	0.033***	0.001	0.026***	0.032***	0.001	0.026***	0.033***
	(0.003)	(0.005)	(0.006)	(0.003)	(0.005)	(0.006)	(0.003)	(0.006)	(0.006)
E/W Coordinate	-0.036***	0.003	-0.030	-0.038***	0.004	-0.028	-0.041***	0.002	-0.030
	(0.014)	(0.028)	(0.035)	(0.014)	(0.028)	(0.034)	(0.015)	(0.029)	(0.036)
Coordinate Interaction	0.001***	-0.000	0.000	0.001***	-0.000	0.000	0.001***	-0.000	0.000
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Observations	610	610	610	610	610	610	610	610	610
No. of Clusters	176	176	176	176	176	176	176	176	176
R-squared	0.457	0.573	0.610	0.443	0.565	0.609	0.436	0.563	0.610

Robust standard errors clustered by territory in parentheses; probit model, average marginal effects reported; a constant term is included
All log values are log (1 + variable) except for log of population
*** p<0.01, ** p<0.05, * p<0.1

Table 18: Validity of distance to Mainz instrument for different printing proxies, Europe sample

Independent Variables	(18.1) Log Dist to Mainz
Printing Press by 1500	-0.113***
	(0.030)
F-stat	14.19
Presses w/in 10 miles	-0.214***
	(0.040)
F-stat	28.99
Presses w/in 20 miles	-0.447***
	(0.088)
F-stat	25.57
Press 10 miles dummy	-0.160***
	(0.034)
F-stat	22.72
Press 20 miles dummy	-0.228***
	(0.049)
F-stat	21.84
Log Books	-0.545***
	(0.134)
F-stat	16.67
Log Books w/in 10 miles	-0.588***
	(0.134)
F-stat	19.19
Log Books w/in 20 miles	-0.982***
	(0.202)
F-stat	23.74

Each estimate is a coefficient from a different OLS regression from the first stage of ivprobit; robust standard errors clustered by territory in parentheses;city specific, geographic control variables, and constant included as in previous regressions
*** p<0.01, ** p<0.05, * p<0.1

Table 19: Distance to Mainz and City Clustering, Europe sample

	(19.1) Cities w/in 10 miles	(19.2) Cities w/in 20 miles
Log Distance to Mainz	-0.097***	-0.323**
	(0.037)	(0.153)
Observations	610	610
No. of Clusters	176	176
R-squared	0.084	0.264

Robust standard errors clustered by territory in parentheses; OLS estimation; city specific, geographic control variables, and constant included as in previous regressions
*** p<0.01, ** p<0.05, * p<0.1

Table 20: Validity of Various Distance Instruments - Average Marginal Effects, Europe sample

	(20.1) Press by 1500	(20.2) Log Books
Log Distance to Mainz	-0.113***	-0.545***
	(0.030)	(0.134)
F-stat	14.19	16.67
Log Distance to Vienna	-0.104*	-0.347*
	(0.061)	(0.190)
F-stat	2.89	3.35
Log Distance to Rome	-0.071*	-0.438***
	(0.042)	(0.136)
F-stat	2.87	10.42
Log Distance to Paris	-0.066*	-0.176*
	(0.037)	(0.104)
F-stat	3.26	2.86
Log Distance to Genoa	-0.100**	-0.326*
	(0.044)	(0.178)
F-stat	5.12	3.36

Each estimate is a coefficient from a different OLS regression from the first stage of ivprobit; robust standard errors clustered by territory in parentheses
City specific, geographic control variables, and constant included as in previous regressions
*** p<0.01, ** p<0.05, * p<0.1

Table 21: Average Marginal Effects, two stage regression with distance to Mainz instrument, Europe sample

	(21.1) Press by 1500	(21.2) Prot in 1530	(21.3) Prot in 1560	(21.4) Prot in 1600
Log Distance to Mainz	-0.113***			
	(0.030)			
Printing Press by 1500		0.583***	0.185	0.374**
		(0.074)	(0.213)	(0.167)
Observations	610	610	610	610
No. Clusters	176	176	176	176
Log Likelihood		-352.420	-400.824	-396.299
Weak Instrument F-Stat	14.19			

	(21.5) Log Books	(21.6) Prot in 1530	(21.7) Prot in 1560	(21.8) Prot in 1600
Log Distance to Mainz	-0.545***			
	(0.134)			
Log Books		0.142***	0.030	0.076*
		(0.026)	(0.042)	(0.040)
Observations	610	610	610	610
No. Clusters	176	176	176	176
Log Likelihood		-1143.967	-1194.689	-1189.123
Weak Instrument F-Stat	16.67			

Robust standard errors clustered by territory in parentheses; ivprobit estimation, average marginal effects reported; city specific, geographic control variables, and constant included as in previous regressions
*** p<0.01, ** p<0.05, * p<0.1

Table 22: OLS, Persistence of Protestantism to 1816

	(22.1)	(22.2)	(22.3)	(22.4)	(22.5)
	Dependent Variable = Protestant Share in 1816				
Printing Press by 1500	-0.009				
	(0.137)				
Presses w/in 10 miles		0.071			
		(0.118)			
Presses w/in 20 miles			0.076		
			(0.116)		
Press 10 miles dummy				0.071	
				(0.118)	
Press 20 miles dummy					0.066
					(0.118)
Log Population in 1500	-0.061	-0.070	-0.072	-0.070	-0.072
	(0.066)	(0.062)	(0.063)	(0.062)	(0.063)
Independent City	0.104	0.104	0.108	0.104	0.105
	(0.177)	(0.172)	(0.171)	(0.172)	(0.172)
University	-0.319	-0.342	-0.311	-0.342	-0.318
	(0.248)	(0.241)	(0.235)	(0.241)	(0.237)
Bishop	0.016	-0.007	-0.023	-0.007	-0.010
	(0.179)	(0.168)	(0.181)	(0.168)	(0.172)
Hanseatic	0.076	0.071	0.070	0.071	0.075
	(0.112)	(0.115)	(0.117)	(0.115)	(0.113)
Water	-0.177	-0.186	-0.184	-0.186	-0.182
	(0.119)	(0.124)	(0.125)	(0.124)	(0.124)
Log Distance to Wittenberg	-0.146**	-0.143**	-0.139**	-0.143**	-0.142**
	(0.065)	(0.064)	(0.068)	(0.064)	(0.066)
N/S Coordinate	-0.303	-0.312	-0.283	-0.312	-0.291
	(0.208)	(0.214)	(0.211)	(0.214)	(0.208)
E/W Coordinate	-1.582*	-1.639*	-1.540	-1.639*	-1.560*
	(0.911)	(0.928)	(0.907)	(0.928)	(0.902)
Coordinate Interaction	0.032*	0.033*	0.031*	0.033*	0.031*
	(0.018)	(0.018)	(0.018)	(0.018)	(0.017)
Observations	43	43	43	43	43
No. of Clusters	28	28	28	28	28
R-squared	0.474	0.480	0.482	0.480	0.479

Robust standard errors clustered by territory in parentheses; OLS model; a constant term is included; all log values are log (1 + variable) except for log of population
*** p<0.01, ** p<0.05, * p<0.1

Table 23: Validity of distance to Mainz instrument for different printing proxies

	(23.1) Printing Press by 1500	(23.2) Presses w/in 10 miles	(23.3) Presses w/in 20 miles	(23.4) Press 10 miles dummy	(23.5) Press 20 miles dummy
Log Distance to Mainz	0.034	-0.372***	-0.104	-0.372***	-0.091
	(0.051)	(0.130)	(0.155)	(0.130)	(0.157)
F-stat	0.45	8.15	0.46	8.15	0.33
Observations	43	43	43	43	43
No. of Clusters	28	28	28	28	28
R-squared	0.600	0.356	0.353	0.356	0.349

Each estimate is a coefficient from a different OLS regression; robust standard errors clustered by territory in parentheses
City specific, geographic control variables, and constant included as in previous regressions
*** p<0.01, ** p<0.05, * p<0.1

Table 24: 2SLS, two stage regression with distance to Mainz instrument, Protestant persistence

	(24.1) Press by 1500	(24.2) Prot Share in 1816
Log Distance to Mainz	-0.372***	
	(0.130)	
Press 10 miles dummy		0.691**
		(0.333)
Observations	43	43
No. Clusters	28	28
Log Likelihood		-18.684
Weak Instrument F-Stat	8.15	

Robust standard errors clustered by territory in parentheses; 2SLS estimation; city specific, geographic control variables, and constant included as in previous regressions
*** p<0.01, ** p<0.05, * p<0.1

FIGURES

Figure 1: Protestantism and Printing in the de facto Holy Roman Empire
(cities with population ≥ 5,000 in 1500)

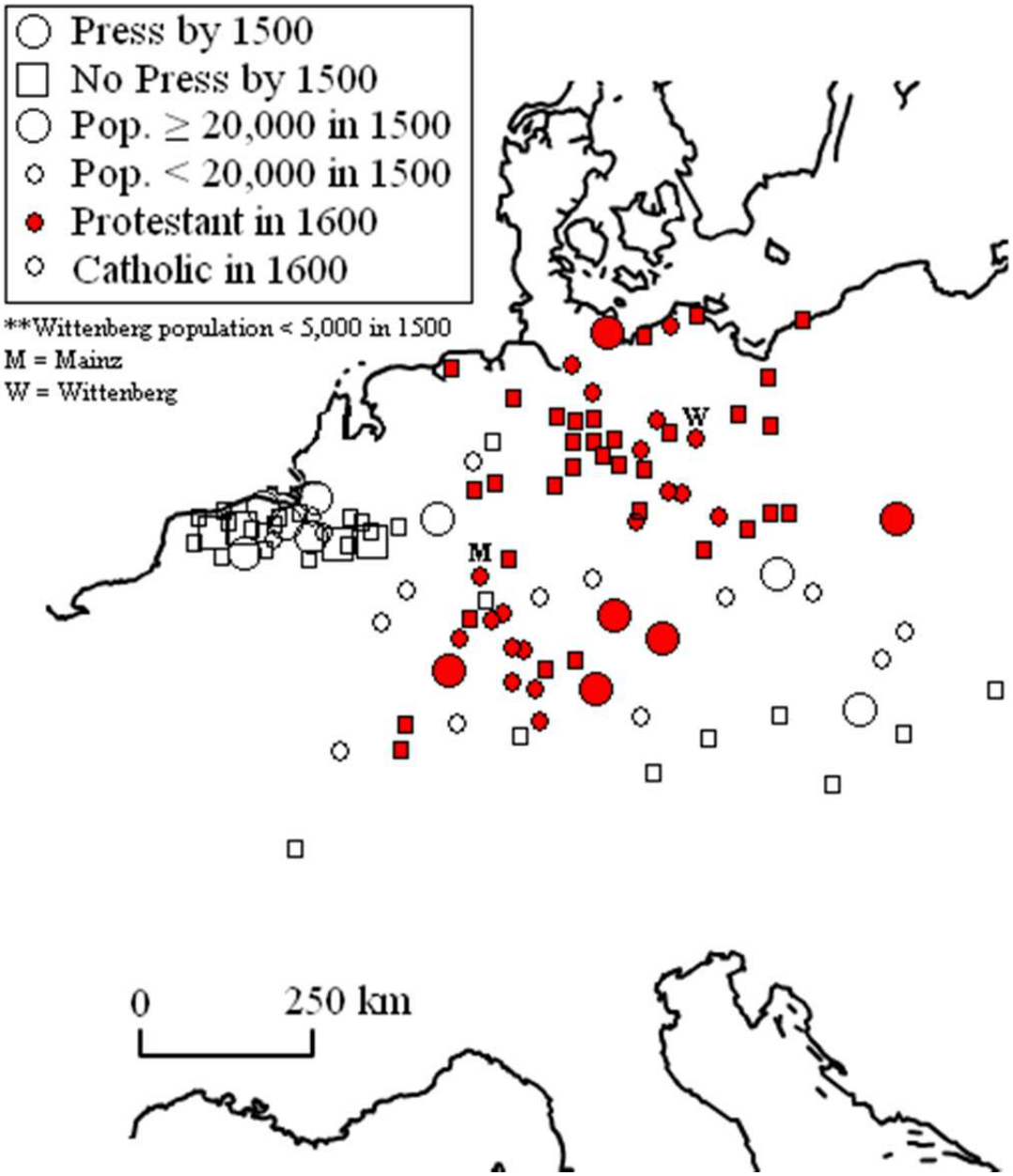

Figure 2: Distance to Mainz, Population, and Adoption of Printing before 1500

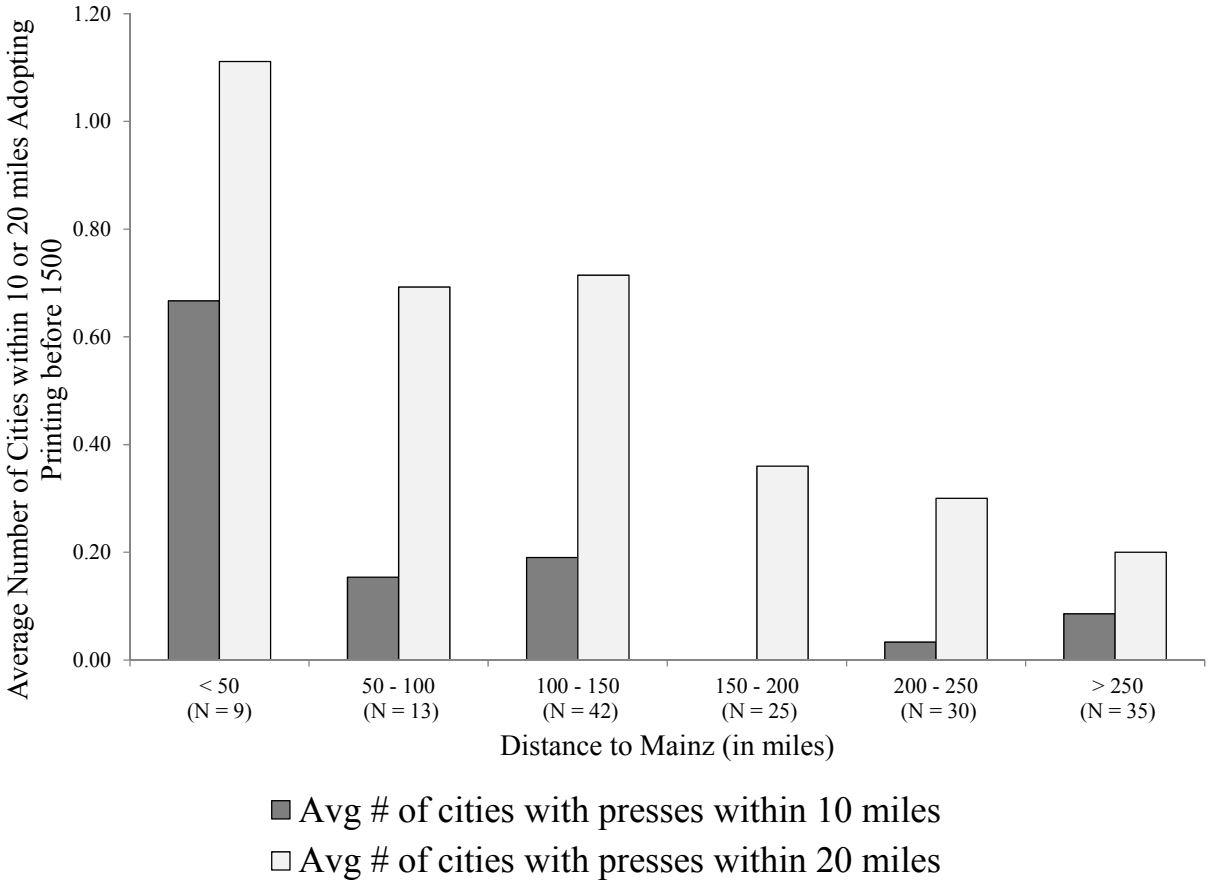

Figure 3: Protestantism and Printing in Western Europe (cities with population ≥ 5,000 in 1500) – Press Cities Only