# New Media and Market Structure: Printing and Europe's Transformation After Gutenberg

Jeremiah Dittmar and Skipper Seabold[*]

Preliminary – Please Do Not Cite or Circulate

January 1, 2017

## Abstract

How did Gutenberg's printing technology impact European society? We study the role of book content in economic, religious, and institutional development at the city-level – and the role of competition in determining the amount and content of locally produced books in the 1500s. We focus on the diffusion of (1) business education content and (2) religious ideas during the Protestant Reformation. We construct data on output and industrial organization in printing for all European cities with printing presses 1454-1600. We document positive relationships between business education printing, individual achievement, and city growth, and between Protestant content and city-level institutional change. We then show that printer competition predicts content. We study the relationship between competition in printing, the diffusion of ideas, and economic outcomes directly and using the deaths of printers as a source of exogenous variation.

**Key words:** competition, firms, media, technology, institutions, religion, politics

# 1   Introduction

Starting in the late 1400s, Gutenberg's printing press technology transformed the diffusion of ideas in Europe. This paper studies how the diffusion of ideas in print shaped economic, institutional, and religious development – and the role of competition in printing in determining the amount and content of locally produced books in the 1500s. We focus on two major diffusion processes: the diffusion of knowledge about radical innovations in business practices, which changed economic activity; and the spread of the Protestant Reformation, which led to fundamental changes in beliefs and institutions.

Research on the origins of economic development in Europe highlights the importance of the opening of markets for ideas after 1500 (Mokyr 2016). Prior research studies the printing press as a technology that delivered a supply-side shock to the cost of storing and transmitting ideas (Eisenstein 1980; Dittmar 2011). Printing changed the transmission of ideas by introducing not only a new technology but also new forms of competition. Regulation was light: printing fell outside guild regulation and was one of the first industries in European history in which firms organized production (Brady 2009; Barbier 2006; Hirsch 1974).[1] Market structure and competition varied across cities and time.

We provide evidence that the *interaction* between technology and economic competition was fundamental for the diffusion of ideas that drove profound changes in European society in the post-Gutenberg era. We construct novel evidence from books to measure the diffusion of ideas; study how competition in printing shaped diffusion across cities and time; and document the causal effects of ideas on economic and institutional outcomes, using printer deaths as a source of exogenous variation. We focus on ideas that changed how Europeans (i) did business and (ii) thought about about religion and institutions.

Radical innovations in business practices appeared in Northern Italian cities by the 1300s, but diffusion was limited before printing (Miskimin 1975). The key innovations involved applied mathematics, accounting techniques, and cashless payments systems. With printing, a business education literature emerged that lowered the costs of knowledge for merchants (Jeannin 1996; Van der Wee 1967). The first printed mathematics texts were merchants' manuals that provided instruction on business applications for math; record-keeping, including double-entry accounting; and cashless payment technologies, including the bill of exchange. These ideas diffused in books and changed the way Europeans did business. European business shifted from an equilibrium of Roman numerals to the Arabic numbers we use today – in the 1500s (Meskens 2013).

---

[1]We provide further details on regulation below, including how regulation emerged in response to the Protestant Reformation, after the political and religious implications became apparent to ruling elites.

Printing also played a central role in religious and institutional change. Before the 1500s, the Catholic Church enjoyed an ideological monopoly and unparalleled social power. Starting in 1517, the Protestant Reformation was the first mass movement to make use of the new information technology and the first successful challenge to the Catholic monopoly. The Protestant Reformation introduced new forms of religious and institutional competition into European society. The Reformation emerged in and spread across the cities of German-speaking Europe and led to institutional changes at the city level that expanded public goods provision and established public education.

The diffusion of innovations in business practices and the introduction of competition in religion were arguably among the most important pivots in the development of Europe. Printing played a key role in both processes. No prior research has systematically studied the diffusion of these ideas in the media in quantitative terms, how competition in the printing industry shaped transmission, or the causal impact of these ideas on outcomes.[2]

This paper constructs new data on radical ideas in books and on industrial organisation, and studies how the diffusion of ideas shaped economic outcomes and how competition determined the amount and content of locally produced books.[3] We construct novel data on (1) the diffusion of the merchant manual literature across European cities and (2) the diffusion of religious content during the Protestant Reformation across cities in German-speaking Europe.[4] We document the positive relationship between the spread of merchant manuals, city growth, and individual achievement, and between the diffusion of Protestant ideas and institutional change at the local level. We show that variation in competition in printing at the city-level predicts the diffusion of ideas and economic outcomes. We study the implications of variation in competition due to entry and exit and use the timing of the deaths of active printers as a source of exogenous variation.

**Methodology and Results.** — First, we construct new data on output and industrial organization in printing. We gather evidence on all known books printed in Europe between 1454 and 1600: over 295,000 publications printed in 200+ cities. We measure content at the book-edition level, which can be considered a variety produced in a given city-year.[5] We hand-code individual merchant manual editions and classify religious

---

[2]For example, Dittmar (2011) studies the relationship between the *presence* of printing before 1500 (measured 1 or 0) and later city growth and Rubin (2014) studies the relationship between the *presence* of pre-1500 printing and a binary measure of religion – Protestant or Catholic – in the later 1500s. Baten and van Zanden (2008) document the relationship between books and macroeconomic growth at the country-century level. We discuss the non-quantitative literature on business practices below.

[3]In this paper we use the designation "books" as a short-hand. Significantly, our data on religious publications during the Protestant Reformation includes pamphlets.

[4]The Protestant Reformation emerged in Germany, which was characterized by a large number of printing cities and relative political decentralization, which mattered for supply as discussed below.

[5]The use of the editions as the measure of output is in part dictated by the available data. We have

publications as Protestant or Catholic based on the statistical distribution of authors' language, using methods for high-dimensional data (Taddy 2013b; Gentzkow and Shapiro 2010).[6] We construct data on industrial organization by identifying firms from inscriptions on historical books and biographical records. Finally, we assemble evidence on the timing of the deaths of printers, which we use as a source of exogenous variation.[7]

Second, we document the correlation between the diffusion of ideas in print and outcomes. We find that the local diffusion of business education content was strongly related to long-run city population growth between 1500 and 1600 across Europe. We find no robust relationship between other kinds of printing and city growth. We focus our analysis of printing in the Reformation on German-speaking cities and study local variation in printing and institutional change after Martin Luther circulated his famous theses in 1517.[8] We find that local exposure to Protestant media in the first years of the Reformation predicts city-level institutional change, which we measure by the adoption of municipal Reformation laws in the 1500s in German cities. Our analysis provides the first systematic, quantitive measure of the diffusion of the Protestant ideas in the media.

Third, we provide evidence on competition in printing and on the role of printer deaths as shocks. We show that most cities had small numbers of firms and that collusive arrangments were pervasive and fragile. We then provide evidence on the role of printer deaths as shocks which perturbed anti-competitive arrangements, lowered barriers to entry, and *increased* competition. We show that the deaths of active printers induced rapid entry by new producers and by producers who relocated from other cities. We also provide evidence on the transport costs that made within-city competition salient.

Fourth, we study the role of competition in determining the number and content of local books. We show that total output responded to variation in market structure in a city, that merchant manual output responded to competition in the merchant manual press, and that Protestant ideas in the media spread most in cities where printing was more competitive when Protestant ideas hit the market in 1517. We find that both variation in the number of firms active in a city and transitions between years with just one firm and years with multiple firms mattered for production – controlling for the

---

records on the size of print runs for only several hundred editions. See Appendix for details.

[6]Religious publications account for 35 percent of the total. Existing data do not record the ideology of books or authors, and a large share of religious output is by authors whose beliefs are not recorded.

[7]Evidence on printer deaths from book inscriptions is available for all city-years, but only covers firms that survive deaths. Evidence from biographical records covers *all* deaths, including in firms that exit and of already-retired printers (which we use as a placebo), but is only consistently available for German-speaking cities. We discuss the implications and how we use and interpret the data below.

[8]The emergence and diffusion of the Reformation in and across German cities reflected both printing and institutional factors. Printing in Germany was spread across a large number of cities and political authority was relatively decentralized across multiple jurisdictions (Pettegree 2015; Section 2 below).

economic environment in narrow city-specific time periods. Our identification strategy uses the fact that entries and exits were large, discrete changes in potential competition relative to more slowly evolving characteristics of local media markets.[9] We confirm our baseline findings with an instrumental variable (IV) strategy, using the timing of printer deaths as a source of exogenous variation in the number of firms competing in a city.[10] Our identification strategy examining religious printing studies how variation in competition *before* the Reformation explains religious output after Protestant ideas hit the market in late 1517. We find that *ex ante* competition positively predicts the diffusion of religious media during the Reformation and the effects are strongest for Protestant content. We confirm these findings using printer deaths just before the Reformation as a source of exogenous variation in the pre-Luther competitive environment.

Fifth, we document the impact of ideas in books on economic and institutional outcomes. We find that the diffusion of merchant manuals explains cross sectional variation in long-run city growth between 1500 and 1600, using the deaths of merchant manual printers as a source of exogenous variation.[11] Deaths of other types of printers have minimal impact on merchant manual output and no growth effects. We also show that shocks to merchant manual printing shifted individual-level achievement at the city-cohort level. We construct panel data from the *Deutsche Biographie*, the definitive "who's who" biographical dictionary of economic and cultural figures in German history (Hockerts 2008). We show that deaths of merchant manual printers drove variation in achievement in bourgeois occupations (but not in the church or nobility) in cohorts exposed to shocks in late adolescence and early adulthood, i.e. in critical years for advanced human capital formation. We similarly find that variations in the diffusion of Protestant content during the Reformation drove differences in the probability of institutional change, using printer deaths in the immediate pre-Reformation era as a source of exogenous variation.

**Putting Our Results in Context.** — Our paper relates to several literatures. Research on the origins of European economic development highlights the transformations in the market for ideas after 1500 (Mokyr 2016; 2011; David 2008). This research raises two central questions: What ideas drove economic and institutional change? And how can we document the diffusion of ideas? Our research contributes quantitative evidence from printing to study the diffusion of economic and religious ideas that transformed European society. We provide identification strategies that examine how variation in

---

[9]A related identification strategy is presented by Gentzkow et al. (2011), who study the role of newspaper entries and exits in shifting political activity in early 20th century US media markets.

[10]For merchant manuals, the deaths of more specialized printers of merchant manuals are what matter.

[11]This result holds in the complete sample, where observed deaths are selectively observed in firms that survive such shocks and in the subsample of German-speaking cities where we observe *all* printer deaths. The magnitudes are similar and the results highly significant in either case, but somewhat stronger when we examine the complete set of deaths.

competition in printing shifted the diffusion of ideas and outcomes. More broadly, the evidence from printing after Gutenberg provides a canonical setting in which to examine how the use of a break-through technology maps into output. We use this setting to study how the competitive environments in which technology is deployed may matter for its use, and in particular may shape the social implications of new media technology.

Our research also contributes to the literature on management practices and upper tail human capital. Previous research has studied the impact of management practices on firm-level outcomes in the post-WWII era (Bloom et al. 2013; Giorcelli 2015). Classic arguments in the social sciences going back to Sombart (1953) suggest that knowledge-based business practices had a profound impact on the historical development of European capitalism. We use data from printing to measure the diffusion of these ideas, uncover sources of quasi-experimental variation in supply, and provide the first evidence documenting the impact of business practice ideas on local growth, to the best of our knowledge. Our findings also relate to the literature on upper human capital, which has documented the role of scientific elites in economic development during the industrial revolution (Mokyr 2011; Squicciarini and Voigtländer 2015). Unlike previous research, our paper provides evidence on sources of quasi-experimental variation in high achievement human capital elites and studies the growth effects of knowledge that transformed business and commercial activity before the industrial revolution.[12]

Our paper also contributes to the literature on media, politics, and institutions. Prior research on the economics of the media has focused on settings where political competition is already established and supported by legal institutions (Gentzkow et al. 2011; 2014; DellaVigna and Kaplan 2007) and on the effects of propaganda by incumbent elites in non-democratic settings (Adena et al. 2015; Yanagizawa-Drott 2014). Prior research in political economy emphasizes the role of politically inclusive institutions as fundamental supports for economic inclusion (Acemoglu and Robinson 2012). In contrast, we provide evidence on the implications of economic competition in the media in a setting where political freedom and voice were otherwise severely restricted. During the Protestant Reformation, economic competition in printing promoted the diffusion of revolutionary ideas, opened new spaces for political and religious participation, and led to institutional change – in a setting with an entrenched elite administering an ideological monopoly.[13]

---

[12]Squicciarini and Voigtländer (2015) use the location of subscribers to the great encyclopedia in late 1700s France to measure local human capital elites, and study the relationship between scientific elites and industrial activity. In related research, Cantoni and Yuchtman (2014) study the impact of university foundation on the establishment of market-supporting institutions in medieval Germany.

[13]Prior research on the role of printing in the Reformation has studied the implications of access to printing technology but not competition (Rubin 2014). We provide evidence documenting the diffusion of ideas in the media and show that competition, rather than simply access to technology, was fundamental.

# 2   Historical Background

## 2.1   The Printing Industry

This section provides a condensed review of the historical organization of printing in Europe. The key facts are that: printing was for profit; regulation was light; fixed costs were substantial; competition was oligopolistic; anti-competitive behavior was common; within-city competition was salient; master printers had valuable knowledge; and printer deaths were shocks to local competition that lowered barriers to entry.

1. Printing was a for-profit enterprise from the outset. The first movable type printing press enterprise was established in Mainz, Germany around 1447 by Johannes Gutenberg and his business partners. Despite early attempts to maintain secrecy, the technology diffused to cities across Europe as it was adopted by firms (Dittmar 2011).

2. Printing diffused in an overwhelmingly unregulated, free market setting. Printing fell outside guild regulations (Barbier 2006; Nicholas 2003; Brady 1998). Füssel (2005; p. 59) observes that into the 16th century, the business was, "free to develop without regulation by governments, princely houses or the Church, nor is there any evidence that any restrictions were imposed by guilds." Entry was free and censorship was endogenous even during the Reformation (Hirsch 1974; Davis 1960; Creasman 2012). In some cities, restrictions were imposed on religious printing in response to the spread of Protestantism. For this reason, we study the implications of variation in competition *before* the Reformation for the diffusion of Protestant ideas after they hit the market in 1517.

3. Printing was characterized by fixed costs. The big firm-level fixed cost was the cost of moveable type. The process used to cast type was the key technological break-through in printing and remained semi-secret until 1540; the cost of a complete set of equipment in the mid-1500s was equivalent to 4 to 10 years of skilled wages (Dittmar 2011). In addition, paper was expensive, returns on print runs were realized only over time, and printing required a minimum efficient scale. As a result, printers typically required substantial wealth or financial backing. At the book level, the fixed costs included investments in cultivating and signing contracts with authors and in setting the type to print.[14]

4. The characteristic form of competition was oligopolistic and incumbents repeatedly

---

[14]As an example, in 1483 the Ripoli press in Rome incurred a fixed cost of 3 Florins for each 20 pages of type setting on Plato's *Dialogs*, used to print almost 1,000 individual book copies. In the 1480s a good scribe could charge 1 Florin to transcribe 20 pages of text (de la Mare 1985; p. 411). Evidence on firm-level capital is limited, however in the early 1500s the agreements establishing the largest Venetian printing syndicates stipulated total capital contributions equivalent to over 1,000 years of unskilled wages and over 100 years of income for a highly paid university professor in Northern Italy (Nuovo 2013).

entered into anti-competitive agreements. Close to 40% of cities with printing had one firm; almost 20% of cities had 2; just under 20% had 3 or 4; and just over 20% had 5 or more firms. This distribution was stable across the 1500s as printing spread to new cities. Both formal and informal anti-competitive agreements among firms were common (Pettegree 2011). Section 5 provides details on market structure, syndicates, and cartels.

5. High inter-city trade costs shaped competition. Print media was heavy and costly to transport overland, but also fragile and susceptible to water damage when transported by boat.[15] Books were traded across cities. But due to transport costs, local producers were partially sheltered from import competition, local production was important for local access to ideas, and within-city competition was salient (Febvre and Martin 1958; Nuovo 2013; Reske 2007). It was typical to take texts to be printed in cities with potential demand, rather than to export over even short distances (Edwards 1994).[16] We assemble unique data on purchases made in 40 cities and provide evidence on the price-distance gradient in the inter-city book trade, using data from the purchasing records of Christopher Columbus' son, who established the most ambitious library collection of the 1500s. We provide evidence on transport costs, prices, and reprinting in Appendix F.

6. Printing firms were family businesses to which master printers brought valuable and rare combinations of skills, knowledge, and contacts. Printers were capitalist entrepreneurs, "investors, organizers, and managers of their firms" (Brady 1998). Printers had to be multi-lingual, skilled mechanics, and flexible intellectuals (Eisenstein 1980).

7. The deaths of printers perturbed city industrial organization. Printing was characterized by repeated outbreaks of "cut-throat" competition and a "struggle to keep competition at bay" (Febvre and Martin 1958). Printer deaths unravelled anti-competitive agreements and entrance increased in city-years printers where died – even when their firms survived (Reske 2007). Parker (1996; p. 521) observes, "It is difficult to overestimate the disruption caused by the death of a master printer."

## 2.2 The Role of Business Books in Economic Development

A debate exists within historical research over the impact of the innovations in business practices observed in the 1500s. A significant body of evidence suggests that knowledge-based innovations in math, accounting, and contracting supported the expansion of trade and markets (Sombart 1953; Van der Wee 1967). But the adoption of best practice

---

[15]In a letter written in 1550, the Venetian printing magnate Benedetto Giunti observes: "we are entering a bad period to send books around both by sea and by land, because we are going into winter and they run the risk of getting wet" (Quoted in Richardson 1999; p. 37-38).

[16]This was the case for pamphlets published during the Reformation (Pettegree 2000; Edwards 1994).

innovations was not universal and occurred with lags, raising questions about whether these innovations had large effects within firms or more broadly (Yamey 1964).[17] The historical debate involves questions that arise wherever best management practices are not adopted by firms for which there are substantial net payoffs (e.g. Bloom et al. 2013).

Narrative evidence suggests that three dimensions of knowledge were particularly consequential: mathematical knowledge for business applications; knowledge about accounting and record-keeping techniques; and knowledge about the use of cashless payments (Davis 1960; Meuvret 1953; Mills 1994; Hoock 2008). Mathematical knowledge provided fundamental human capital for merchants (Jeannin 1996). Knowledge about accounting and record-keeping contributed to efficiency directly and by lowering transaction costs, as accounting ledgers began to be accepted as evidence in commercial courts (Van der Wee 1967). Innovations in cashless payments directly lowered transaction costs and supported innovation in contracting and capital markets.[18]

Printing provided a channel for diffusion. The first printed mathematics texts in Europe were *commercial arithmetics* that transmitted techniques used in business over the 1500s (Swetz 1987; Van der Wee 1993; Meskens 2013). The first guide to double-entry book-keeping was published in the 1490s and this technology spread in the 1500s. Mathematical notation became standardized and European business shifted from an equilibrium of Roman numerals to Arabic numerals – in the 1500s.[19] We observe this transition in publications in our data and in merchant practices. For example, the commercial arithmetic manual *Tot Profyte* (Antwerp, 1561) provides accounting examples in Roman and Arabic numerals. The records of Antwerp cloth merchant Frans de Pape switch from Roman to Arabic numerals in the 1560s.[20] More broadly, merchants' manuals provided instruction on business letter writing, contract design, and norms of conduct.

Printing changed how business practice ideas spread.[21] Person-to-person learning continued and hand-written manuscripts did not vanish (Meskens 1996). But printing amplified and substituted for the diffusion of knowledge that occurred face-to-face and via migration (Cipolla 1981). For example, the first Flemish treatise on book-keeping

---

[17]A classic debate centered on the claim that double-entry book-keeping by itself revolutionized business activity (Sombart 1953; Yamey 1975; 1964; 1949). This paper emphasis a *suite* of innovations.

[18]The bill of exchange enabled merchants to settle obligations across time and space without exchanging or transporting cash. The bill of exchange also enabled merchants to circumvent prohibitions on usury by structuring loans as foreign exchange contracts (Miskimin 1975) and supported additional innovations in endorsement, discounting, contracting, and market-based transfers of debt obligations.

[19]Arabic numerals were introduced to Europeans in the 1200s, but remained marginal in European economic and cultural life until the print media revolution in the 1500s (Meskens 2013; De Roover 1937).

[20]Similarly, in the records of the Antwerp Schoolmaster's Guild, Arabic numerals first appear in 1545, initiating a gradual transition from Arabic to Roman numbers completed by 1580. See Meskens (1996).

[21]The innovations developed in Northern Italy and were transmitted *within* business organizations in manuscript form (Van Egmond 1976; 1980) and via apprenticeships and schooling (Goldthwaite 1972).

was published in Antwerp in 1519 by Jan Ympyn Christoffels on his return from a decade in Venice, where he had been sent by his merchant father to learn business practices and accounting. While printing lowered access costs, merchants' manuals were distinguished by relatively high prices, authors' fees, and mark-ups over costs.[22]

## 2.3 The Role of Printing in the Protestant Reformation

A debate exists over the role of printing in the Reformation. Martin Luther circulated his theses criticizing church corruption in October 1517. Within months Luther's theses were printed in multiple German cities, provoking a public controversy. When the Catholic Church attacked Luther and other protesting clergy, the reformers responded by disseminating their ideas in print (Cameron 1991). The broad censensus in historical research is that printing played a central role in the diffusion of Protestant ideas (Edwards 1994; Brady 2009; Eisenstein 1980). But prior research does not systematically document the spread of Protestant printing in quantitative terms and invites us to ask whether religious content was determined on the supply- or demand-side (Whaley 2011).

Narrative evidence suggests that local competition mattered for the diffusion of religious ideas. During the Reformation, "religious and moral competition...often took place in compact geographical areas, even within individual cities...competition led to a greater variety in preferred salvation" (Roeck 1999; p. 279). The diffusion of Protestant ideas was depressed in cities with monopolies or anti-competitive combinations of printers: "Where a market was controlled, the free flow of innovative theological speculation was greatly inhibited" (Pettegree 2000; p. 114). Competition raised incentives for product differentiation and religion became a dimension for product differentiation (Reske 2007; Creasman 2012). In Basel, pre-Reformation printing had focused on scholarly Latin printing for university customers and the sudden appearance of Lutheran content, "created a clear opportunity for Adam Petri, who was able to corner the *local market* in evangelical works" (Pettegree 2015; p. 208 – emphasis added). Most printers would "cheerfully print for both sides" (Pettegree 2015; p. 217). In Strasbourg, all five major firms produced Protestant content – even the firm run by committed Catholic printer Johann Grüninger (Chrisman 1982). In cities with competitive markets, we observe printers publishing Luther's work and Papal denunciations of Luther in the same year.[23]

---

[22]For example, the accounts of the Antwerp printer Christopher Plantin from 1564/5 include information on an accounting manual by Pierre Savonne. The only more expensive book sold by Plantin was a richly illustrated anatomy text; the only book with a higher mark up over costs was a Hebrew bible; and the cost share of author's fees for Savonne were six times higher than for any other book (Voet 1969).

[23]Erfurt publisher Johan Knappe published works by Martin Luther and the Papal Bull condemning Luther. Johann Schott had a 'hit' with Luther's *Babylonian Captivity* in 1520, but a few weeks later was publishing the Papal Bull condemning Luther. We also observe printers willing to supply capital

The relationships between printers and city councils provide a particular reason to hypothesize that the difference between competition and monopoly may have been salient. City councils across Germany were initially opposed to reformist arguments (Cameron 1991; Dickens 1979; Sehling et al. 1909-2013) and were a source of work orders for printers (Febvre and Martin 1958). Municipal contracts could be threatened by the decision to print Protestant content (Reske 2007). If a monopolist printed Protestant material, the city council might encourage a new entrant. In cities with multiple firms, there was typically a single "city printer" (*ratsbuchdrucker*) with municipal work. Known city printers were not early advocates of the Reformation, consistent with the view that they did not want to endanger official work orders or antagonize city governments.[24]

Protestant ideas typically spread first in the media and then orally. The process followed a "strikingly common pattern" in Northern and Southern Germany (Brady 2009; p. 161). Print media impacted clergy and educated lay "opinion leaders," who then transmitted ideas orally to the public and developed popular movements (Edwards 1994).[25] In Augsburg, "A wave of religious pamphlets and, from 1520, the introduction of evangelical preaching, spread the new teaching" (Broadhead 1996; p. 581). In Northern cities, reading groups of the 1520s preceded activism and legal change in the 1530s (Schilling 1983). In Zürich, Reformation activism began when a printer and his workers engaged in civil disobedience by breaking the Lent fast with pastor Ulrich Zwingli as their witness. City authorities arrested the printers. Zwingli gave a sermon in their defense which was disseminated in pamphlet form, opening public debate.

The diffusion of Protestant ideas led to institutional institutional change at the city level. The Reformation era in which printing played a central role ran from 1518 to 1554. Starting in the 1520s, Protestant reformers worked with city councils to pass new laws that reformed religious services, established public education, and expanded public goods. This process generated institutional variation within territories (Hamm 1994). In 1555, the Peace of Augsburg formalized a legal settlement governing religion in the Holy Roman Empire – fixing institutions and establishing a geographic distribution of religion that would be maintained for several centuries (Brady 1998).[26]

---

across religious lines – to printers in nearby cities: Leipzig printer Valentin Schumann printed Luther's work but sold a set of type to a Catholic-minded press in Dresden, 120 kilometers away (Reske 2007).

[24]Evidence on books and pamphlets does not definitively identify city printers because municipal contracts involved forms and administrative ephemera. However, evidence on proclamations shows that typically one printer was the recipient of city work. In Mainz, all proclamations printed 1508-1517 were produced by Johann Schöffer. In Munich, all proclamations printed 1508-1517 were produced by Hans Schobser. In Strasbourg, starting in 1514 all city council publications were produced by Matthias Shürer.

[25]A number of significant lay reformers were city clerks. For example, Lazarus Spengler and Jörg Vogeli were clerks of Nürnberg and Konstanz, respectively, and published reformist works in the 1520s.

[26]The Peace of Augsburg set the rule *cuius regio, euis religio* (whose rule, his religion) with exceptions for cities where Protestants and Catholics were to share churches and magistracies (Brady 1998).

# 3  Data and Estimation Strategy

## 3.1  Data

**Publications** — We measure publications by the book or pamphlet edition, which can be thought of as a variety produced in a given city-year. We study over 299,000 editions printed in Europe between 1454 and 1600. The data are from the Universal Short Title Catalogue (USTC 2012), which is designed to catalogue all known books and pamphlets printed in Europe before 1600.[27] The USTC does not identify business education publications or classify religious publications by denomination or ideology.

**Business Education Publications** — We manually code data on business education publications from *Ars mercatoria: eine analytische Bibliographie: Handbücher und Traktate für den Gebrauch des Kaufmanns* (Hoock et al. 1991; Hoock and Jeannin 1993; Hoock et al. 2001), a three volume compendium designed to record all merchant manuals and business education texts printed in Europe through 1600. The Hoock and Jeannin data catalogue 1,151 merchants' manuals printed across Europe 1474-1600. We match individual publications in the Hoock and Jeannin data to the USTC using title, author, date, printer, and other information as described in the Appendix.[28]

**Classification of Religious Publications as Protestant or Catholic** — We classify religious publications as Protestant or Catholic based on the statistical distribution of authors' language, using multinomial inverse regression (MNIR) (Taddy 2013b; Gentzkow and Shapiro 2010). We first estimate how the distribution of language changes with religious affiliations of known 459 authors (225 Catholics and 234 Protestants). We then classify religion at the author level based on the 'distance' between authors' language and that of known Protestants and Catholics. We classify at the author-level to improve classification both in-sample and out of sample in held-out subsets of the data.[29] We restrict our classification of religious publications to printing in cities in German-speaking Europe, where the media played a key role in the diffusion of the Reformation, and to publications the USTC identifies as religious (35% of the total). We classify authors' output as Protestant if predicted Protestant is greater than or equal to 0.5 and Catholic

---

[27]The use of publication editions as the unit of analysis is in part dictated by the available data. We have records on the the number of copies printed for a small subset of publications. See Appendix A.

[28]We correct a limited number of errors and omissions in the Hoock and Jeannin data. See Appendix A.

[29]We defer a study of within-author variation to future research. Any sacrifice here is minimized by the fact that extremely few Protestant authors had any substantial publication record as Catholics. The within-author variation available to study is almost entirely within religion. To identify authors' religion we rely on Klaiber (1978), Mullett (2010), Carey and Lienhard (2000), and Wikipedia's list of Protestant Reformers. See www.wikipedia.org/wiki/List_of_Protestant_Reformers (downloaded 12/15/2012).

otherwise.[30] Our classification enables us to measure content in the majority of output which is by unknown authors, and in cities in which no publications by known religious authors appeared (see Appendix A.3). Our classification uses within-Latin and within-German shifts in the language used by Protestants and Catholics.[31]

Our classification procedure studies variation in language in long historical book titles that provide extensive information on content.[32] To understand the information in titles, we provide two examples of English-language books printed in 16th century Germany.[33] An example Protestant title is a book written by Martin Luther and printed in Wesel:

> The last wil and last Confeßion of martyn Luthers faith concerning the principal articles of religion which are in controversy, which he wil defend & maiteine until his death, agaynst the pope and the gates of hell.

An example Catholic title is a book written by John Old and printed in Emden:

> A Confeßion of the most auncient and true christen catholike olde belefe accordyng to the ordre of the .XII. Articles of our comon crede, set furthe in Englishe to the glory of almightye God, and to the confirmacion of Christes people in Christes catholike olde faith.

Table 1 presents the top German-language phrases differentiating Protestant and Catholic publications. Appendix B provides more detailed evidence on which single words and two and three-word phrases carry the most weight in identifying religion within German printing and within Latin printing, and additional examples of titles.

Table 1: Phrases Differentiating Protestant and Catholic Publications in German

| Protestant | | Catholic | |
|---|---|---|---|
| sermon von dem | sermon on the | sacrament des altars | sacrament of the altar |
| sermon von der | sermon for the | die sontags evangelia | the evangelical sunday |
| in der kirchen | in the church | biß auff ostern | from easter |
| ain sermon von | a sermon on | auf die fest | from the feast |
| die jungen christen | the young christians | unser lieben frawen | our dear women |

This table reports presents top three-word phrases (trigrams) that differentiate Protestant and Catholic authors. Appendix B provides examples of publications in which this language is observed. In the original, some words are capitalized which are rendered in lower case here.

---

[30] The distribution is bimodal. In robustness checks, we examine the continuous measure of predicted religion and find similar results as described in Appendix B.

[31] The Catholic-Protestant distinction is a powerful first model for religious ideas in the Reformation. In part this is because later divisions between Lutheran and Calvinist Protestants were only incipient in the first half of the 1500s. We discuss extensions and time-varying features of religious language below.

[32] Taddy (2013c) applies a similar research design to measure political sentiment in twitter "tweets." The *median* title in our data is longer than the *maximum* length for a "tweet."

[33] We provide examples of German titles with translations in the appendix.

Our classifier shows high performance on in- and out-of-sample classification. In-sample, we correctly predict the religion of an author 86% of the time.[34] We obtain simlar success rates out of sample when we estimate (train) over 80% of the data and predict (test) over the held-out 20%. These cross-validation exercises also show that the estimator is not overfitting. Figure 1 shows the performance of the classifier on held-out test data from a single draw and highlights how well we predict prominent authors Martin Luther and Johannes Eck. We provide detailed evidence on our classification and how it compares to strategies in the literature in Appendix B.

Figure 1: Out-of-sample classification of religious authors
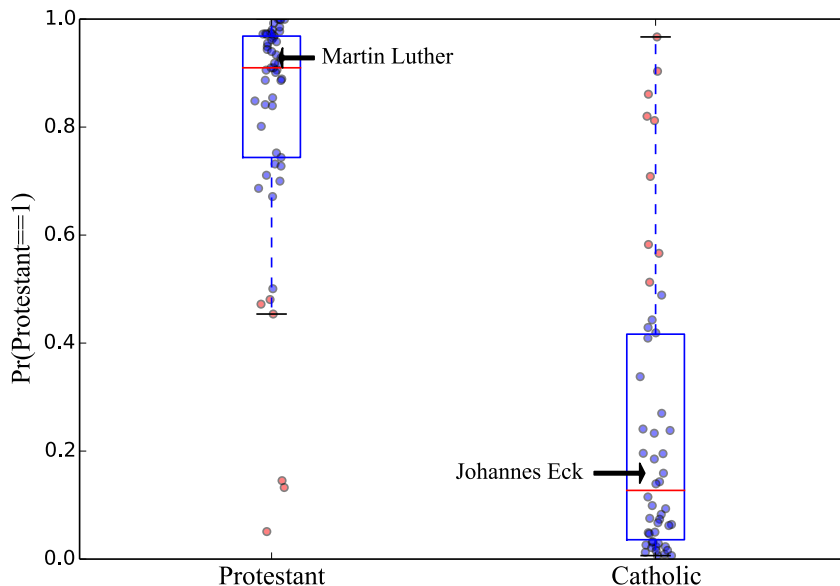


This graph presents the out-of-sample classification performance for a single draw from the data. The model is trained on 80% of the data and predicted on the held-out 20%. We present predictions for held-out Protestants (at left) and for held-out Catholics (at right).

**Printing Firms** — We construct data on the firms active across cities and time as follows. (1) We construct a *publications measure* by identifying firms active at the city-year level from inscriptions on historical publications that identify printers. We harmonize names and construct consistent firm identifiers. (2) We construct a *biographical measure* by hand-coding data on the city-years of operation for printers in the subset of 205 German-speaking cities using Reske (2007; 2015), *Die Buchdrucker des 16 und 17 Jahrhunderts im deutschen Sprachgebiet*, the authoritative biographical and business dictionary of historical printers in German-speaking Europe.[35] See Appendix A for details.

---

[34]This success rate compares favorably to results in similar prediction problems in the literature. For example, Gentzkow and Shapiro (2010) predict the party of US Congress members based on the text of their speeches, and obtain a correlation of 0.61 between true and predicted affiliation.

[35]Reske (2007; 2015) builds on the biographical catalog produced by Josef Benzing (1982), librarian at the Prussian State Library 1934-1945 and at University of Mainz 1946-1966. See Appendix A.

**Printer Deaths** — We construct data on the timing of printer deaths as follows. (1) We construct a *publications measure* in which we infer the year of death from printed inscriptions in books. These inscriptions record whether a publication is produced by the widow or heirs of a printer. We infer that the printer death occurred in the first year such an incription appears. By construction, the publication measure of deaths is observed for firms that survive deaths. (2) We construct a *biographical measure* from data on the years of death for German printers which we hand-code from Reske (2007; 2015). These data enable us to distinguish between deaths of active printers and deaths of printers who were retired or no longer active. We use these data to address questions concerning the selective observation of deaths in publications. See Appendix A for details.

**Economic Outcomes** — We use data from Bairoch et al. (1988) on the populations for urban agglomerations in 1500 and 1600. We construct data on the "who's who" of historical German Europe from the *Deutsche Biographie* (Bayerischen Akademie der Wissenschaften 2015), which provides the most comprehensive record of important individuals in German history to the best of our knowledge (Hockerts 2008). We classify the occupations of individuals in the *Deutsche Biographie* as either (i) bourgeois or (ii) Church or noble. Appendix A provides details on the data and occupational classification.

**Institutional Outcomes** — We measure institutional change with the passage of a Reformation law. Our principal source is, *Die evangelischen Kirchenordnungen des 16 Jahrhunderts* (Sehling et al. 1909-2013; 21 volumes), which collects the texts of all known Reformation laws passed in the 1500s in German cities. For a small number of German-speaking cities in Switzerland, Alsace, and Poland we rely on additional sources. See Appendix A for details.

## 3.2   Estimation Strategy

We study how competition in printing shaped the diffusion of ideas, and how ideas drove economic and institutional change. These relationships can be summarized schematically:

$$\text{Competition} \Rightarrow \text{Ideas in Publications} \Rightarrow \text{Outcomes}$$

We examine the relationships between competition and ideas, and between ideas and outcomes, with several different research designs. We study variation in panel data and in the cross-section, depending on the nature of the available data.

In Section 4, we motivate our analysis by documenting cross sectional correlations between the diffusion of ideas and city-level outcomes. Merchant manual printing was

correlated with city growth; Protestant printing was correlated with institutional change.

In Section 5, we characterize the nature of competition. We present evidence on market structure, the prevalence and fragility of anti-competitive arrangements, and the role of printer deaths as shocks that *increased* entrance and competition.

In Section 6, we study how variation in market structure that shaped competition explains production. We study variation in total and merchant manual output at the city-year level. We estimate models that examine how variation in competition predicts variation in output within city-decade. The intuition is that the timing of entries and exits within city-decades provides sharp variation in market structure relative to more slow-moving demand-side features of local media markets. We examine the implications of shifts from city-years with monopoly to city-years with multiple producers active and variation in the number of firms active. In contrast, we study religious printing during the Reformation in a cross-sectional design. We study how competition before Protestant ideas hit the market in 1517 predicts religious printing in the "post" period that runs from 1518 to the 1555 Peace of Augsburg. We estimate separate models for Protestant and Catholic publications. We study two proxy measures of competition. The first is whether at least two firms are active: we compare production with multiple firms and with monopoly. The second is the number of firms active: we compare production as the number of firms varies. We examine the implications of variation in the number of firms directly and using printer deaths as an IV for the number of firms.

Finally, in Section 7 we study the causal impact of ideas on city growth and institutional change, using the deaths of printers as a source of exogenous variation in number and content of publications in cross-sectional designs. For religious printing, we study variation induced by printer deaths just before the Reformation. For merchant printing, we use deaths of merchant printers over the course of the 1500s. For our study of merchant printing, we provide corroborating evidence from panel data on individual achievement at the city-cohort level. We show that shocks to merchant printing that hit city-cohorts in late adolescence positively impacted individual achievement, and specifically in bourgeois occupations but not in the Church or nobility.

# 4 The Role of Book Content in Economic and Institutional Change

In this section, we present evidence on the relationship between the content of books and pamphlets and economic and institutional outcomes. We document positive relationships

between the diffusion of business education content and city growth, and between the diffusion of Protestant content and institutional change at the local level during the Reformation. These results are suggestive correlations, not causal statements.

## 4.1 Business Education Content and City Growth

We study the relationship between the local production of merchants' manuals and city growth between 1500 and 1600 and document a large and highly significant positive correlation. In contrast, the correlation between total book publication and growth is relatively small, and conditional on business education there is effectively no relationship between the diffusion of books and growth. We examine city growth as a measure of economic dynamism in pre-industrial Europe motivated by the literature on historical growth (Acemoglu et al. 2005; DeLong and Shleifer). We disaggregate book production to document the relationship between urban dynamism and specific bodies of knowledge and ideas in print and restrict attention to 239 European cities with printing and with population recorded by Bairoch et al. (1988).

To study the relationship between the diffusion of content and growth, we estimate regressions of the form:

$$\ln(pop_{1600}/pop_{1500})_i = \alpha_0 + \alpha_1 publications_i + \gamma X_i + \epsilon_i \tag{1}$$

The outcome is log population growth and *publications* measures the number of publications produced between 1500 and 1600. We first look at merchants' manuals, then publications in general, and then a 'horse race' between merchants' manuals and publications in general. We measure publications in levels and in logarithms. The $X_i$ control for initial city population, port location, the presence of universities, navigable rivers, latitude, longitude, the interaction of latitude and longitude, and country fixed effects.

Table 2 shows that merchant manual production had a large, robust, and highly significant relationship with city growth, whereas books in general did not. These results highlight the importance of disaggregating the ideas in print and raise the question of whether the estimated parameters reflect unobservables that were the underlying determinants of city growth. The positive relationship between merchants' manuals and growth could capture the impact of knowledge in books or variations in underlying business environments and demand. We consider this question below, using printer deaths as a source of exogenous variation in supply.

16

Table 2: Merchant Manual Printing and City Growth

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Outcome: Log Population Growth 1500-1600 | | | | | |
| Merchant Manuals | 0.741** | | 0.852* | | | |
| | (0.315) | | (0.482) | | | |
| Publications | | 0.001** | -0.000 | | | |
| | | (0.001) | (0.001) | | | |
| Ln Merchant Manuals | | | | 0.171*** | | 0.159** |
| | | | | (0.059) | | (0.060) |
| Ln Publications | | | | | 0.051** | 0.010 |
| | | | | | (0.019) | (0.018) |
| Observations | 239 | 239 | 239 | 239 | 239 | 239 |
| $R^2$ | 0.28 | 0.27 | 0.28 | 0.33 | 0.29 | 0.33 |

This table reports estimates from regressions studying city population growth. The outcome is log population growth at the city level: $\ln(pop_{1600}/pop_{1500})$. "Publications" is the count of publications (varieties) observed 1500-1600 in units of 100. "Merchant Manuals" is the count of merchant manuals observed 1500-1600 in units of 100. All regressions control for log population in 1500, country fixed effects, city latitude and longitude, and indicators for: navigable rivers, ocean or sea ports, printing pre-1500, and the presence of universities established pre-1500. Standard errors in parentheses are clustered by country. Significance denoted: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

## 4.2 Protestant Content and Institutional Change

Narrative evidence indicates that the diffusion of ideas in print led to institutional change at the city level during the Protestant Reformation.[36] We examine whether local exposure to Protestant media positively predicts institutional change. We study city level institutional change because the legal institutions of the Reformation were first developed at the city level (Hamm 1994; Cameron 1991); cities provide rich variation in both printing and institutional change; and these institutions explain subsequent human capital and growth outcomes across cities (see Dittmar and Meisenzahl (2016) and Appendix E).

In Figure 2, we plot the relative intensity of Protestant ideas in cities that did and did not adopt city-level Reformation laws and the share of cities adopting Reformation institutions over time. We measure religion in the media as the mean of religious content (Protestant = 1, Catholic = 0). Prior to the Reformation, cities that did and did not adopt institutional change were producing similar religious media and there are no pre-trends. During the first years of the Reformation, Protestant content increased in all cities, but cities that pass laws produced more. From the 1520s, a gap opens and stabilizes. While large shifts in media content are observed in 1518, shortly after Martin Luther circulated his *hand-written* theses in late October 1517, institutional change

---

[36]For example, Ozment (1975; p. 49) observes that the Protestant books and pamphlets that we study, "express viewpoints that were later embodied...in church ordinances."

started in the 1520s. The share of cities with a Reformation law plateaus in the 1540s, when institutional change was arrested by the Schmalkaldic War 1546-7. Within the set of adopting cities, the Protestant share of religious content increases in years prior to institutional change and is stable afterwards, as we show in Appendix E.

Figure 2: Religious Ideas in the Media and City-Level Institutional Change
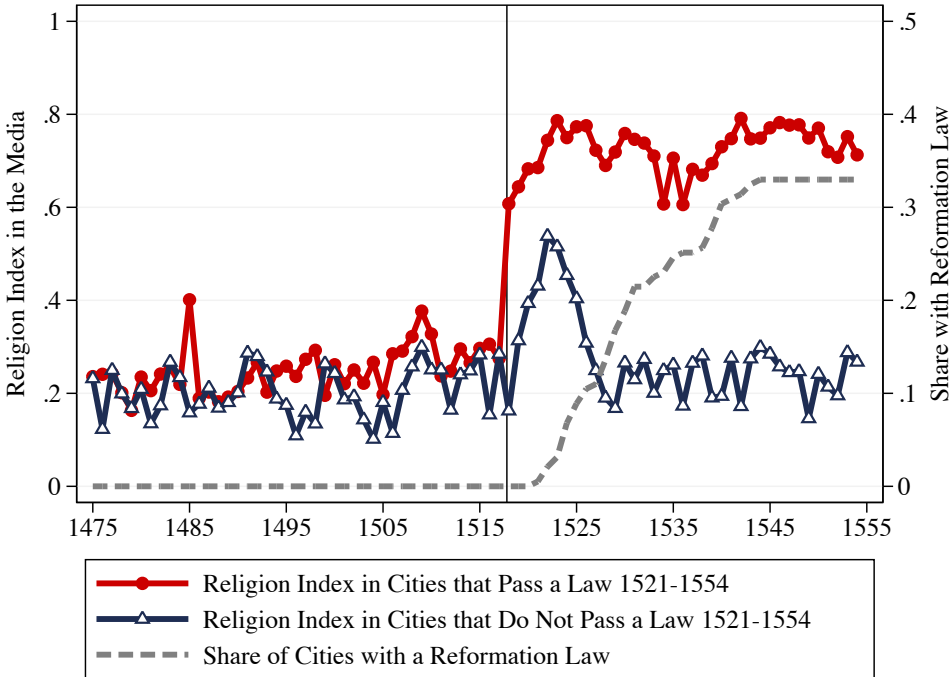


This graph presents the annual mean of the religion index for religious publications in cities that did and did not pass Reformation laws (Protestant = 1, Catholic = 0 on left axis). The graph also presents the share of cities having adopted institutional change measured by the passage of a city Reformation law (on right axis). The vertical line at October 1517 marks the first circulation of Martin Luther's theses.

We test whether local variation in Protestant media output in the early years of the Reformation predicts institutional change. Luther's ideas hit the media in 1518. Institutions began to change in 1521. The outcome we study is the passage of a Reformation law between 1521 and 1554, one year before the Peace of Augsburg. We use linear probability models to examine how local output of Protestant media between 1518 and 1521 shifted the probability of institutional change: Our baseline estimating equation is:

$$law_{i,1521-1554} = \alpha + \beta \ln protestant_{i,1518-1521} + \theta X_i + \epsilon_i \tag{2}$$

where $law_{i,1521-1554}$ is an indicator for cities with Reformation laws, $\ln protestant_{i,1518-1521}$ is the logarithm of Protestant publications plus one. The $X_i$ control for pre-Reformation city characteristics: the presence of formal market rights, city status as subject to ecclesiastical or prince-bishop rule, location on rivers, universities, and initial population. To control for the influence of local lords and regional factors that may have influenced

supply and demand, we study variation within states and within geographic grid cells.

Table 3 presents our results and documents a strong positive relationship between Protestant media and institutional change. Our estimates imply that a one standard deviation increase in Protestant content between 1518 and 1521 is associated with a 6% to 9% increase in the probability a city adopted the legal institutions of the Reformation (one standard deviation in 'ln Protestant' is 1.10). Our estimates are relatively stable across specifications, and hold within tight geographic regions. Institutional change was thus related variation in media content even across neighboring cities exposed to similar regional influences, including the preferences of territorial rulers.

Table 3: Protestant Media and Institutional Change at the City-Level

|                          | (1)       | (2)       | (3)       | (4)       |
|--------------------------|-----------|-----------|-----------|-----------|
|                          | Outcome: Reformation Law Passed 1521-1554 | | | |
| Ln Protestant 1518-1521  | 0.09***   | 0.06***   | 0.06      | 0.08**    |
|                          | (0.03)    | (0.02)    | (0.04)    | (0.04)    |
| Cluster Definition       | State     | State     | 210km     | 70km      |
| Cluster Fixed Effect     |           | Yes       | Yes       | Yes       |
| Observations             | 191       | 191       | 191       | 191       |
| Controls                 | Yes       | Yes       | Yes       | Yes       |

This table presents linear probability model estimates of the relationship between institutional change and Protestant publications. The outcome is a binary indicator for the passage of a law between 1521 and 1554. "Ln Protestant 1518-1521" is the logarithm of the count of Protestant publications plus one. All specifications control for: the number of Latin publications and the number of vernacular publications pre-1517; the share of titles on religious topics pre-1517; distance to Wittenberg measured in hundreds of kilometers; indicators for Hansa cities, ecclesiastical rule cities, prince bishroprics, cities on navigable rivers, and cities ever printing pre-1517. Population in 1500 is controlled for with fixed effects for bins: unknown (omitted), 1000-5000, 6000-1000, 11000-25000, 26000+. Standard errors are clustered on state or on geographic grid cells as indicated. The states are the historic principalities of the Holy Roman Empire. Following the Euratlas classification, free cities are assigned to the "Small States of the Holy Roman Empire" state category. The "210km" cluster designates 2 degree × 3 degree grid cells. The "70km" grid cell designates 70km grid cells. Significance at the 99%, 95%, and 90% levels denoted "***", "**", and "*", respectively.

While local variation in religious media predicted institutional change in tight geographic neighborhoods, books and pamphlets did travel and legal change reflected more than just the presence of Protestant content in local output (Dixon 1996). How and whether exposure to Protestant media translated into institutional change in part reflected variations in local demand.[37]

_____

[37]We study variation in institutional preferences in on-going research (Dittmar and Meisenzahl 2016).

# 5 The Structure of Printing Markets and the Effect of Printer Deaths

## 5.1 The Structure of Printing Markets

Media markets in Renaissance Europe were characterized by a small number of producers and pervasive anti-competitive collusion.[38]

Figure 5 documents the fact that most cities had few printing firms. Across the 1500s, approximately 40% of cities with printing had one firm and approximately 20% had two firms, three to four firms, and five or more. This distribution was very stable over time.

Table 4: The Number of Firms Active Across European Cities

| Year | Cities | Share of Cities with | | | |
|------|--------|--------|---------|--------------|----------|
|      |        | 1 Firm | 2 Firms | 3 or 4 Firms | 5+ Firms |
| 1500 | 83     | .42    | .19     | .14          | .24      |
| 1525 | 122    | .46    | .16     | .17          | .21      |
| 1550 | 150    | .43    | .21     | .15          | .20      |
| 1575 | 188    | .40    | .17     | .19          | .23      |

This table presents evidence on the number of firms active across European cities. Firms are identified from the inscriptions on historical books as described in the text.

Anti-competitive arrangements between incumbents were frequent. Formal and informal anti-competitive agreements were common (Pettegree 2011). Formal contracts limiting price and quantity competition or establishing consortia were typically set for a fixed duration of under 10 years (Parent 1974; p. 139). Anti-competitive arrangements are observed from the earliest years of printing. For example, in 1480 the two largest printers in Venice established a syndicate: Nicholas Jenson and Johannes de Colonia (18% and 15% of Venetian publications in the 1470s, respectively) formed the syndicate joining their operations and those of several additional lesser printers as "Johannes Colonia, Nicolas Jenson et Socii." However, both Jenson and Colonia died within one year of establishing the group, and the syndicate dissolved. In the 1500s, the Giunti family established a syndicate with "the most powerful names in Venetian publishing" (Nuovo 2013; p. 59).[39] Informal arrangements were also common. In Paris, "the industry developed a complex set of alliances between leading families, which effectively froze out

---

[38]More broadly, local market structure mattered because of the salience of within-city competition, as discussed above. Further evidence on the role of transport costs is presented in Appendix F.

[39]The total capital contributions in the business agreement came to 32,153 Ducats, equivalent to over 1,000 years of wages for an unskilled worker (Nuovo 2013; p. 53).

newcomers" (Pettegree 2015; p. 271). We observe formal and informal anti-competitive arrangements across European cities. Appendix C provides further discussion.

Anti-competitive agreements were fragile because there were incentives to defect, agreements terminated when a party died, and printer deaths initiated protracted and expensive legal processes involving both heirs and business counter-parties with claims on inventory and deliverables (Reske 2007; Maclean 2009; Nuovo 2013).

## 5.2 The Effect of Printer Deaths

The death of a printer was a big shock to the local competitive environment and lowered barriers to entry.

Printer deaths lowered barriers to entry by impairing the directly affected incumbent firm. Strong incumbents sought to dissuade entry (Maclean 2009). Printer deaths weakened incumbents firms. Printers managed workers, cultivated authors, and decided which books to market and how many copies to print – in an industry where the typical firm produced few books per year and one bad business decision could be disastrous (Pettegree 2011).[40] Master printers had skills that were hard to replace and frequently died young or without a substitute successor prepared to manage the firm. Firms that passed to widows and heirs faced difficulties maintaining previous levels of output because new managers typically did not have the human capital or business networks of their predecessors, and because widows faced constraints in managing workers and authors that related to gender norms (Driver 1998; Parker 1996; Broomhall 2002).

Printer deaths also lowered barriers to entry by unravelling anti-competitive strategies across firms. Deaths dissolved partnerships and cartel-like syndicates. For example, the multi-firm anti-competitive agreement set up by Venice's two leading printers in 1480 – Nicholas Jenson and Johannes de Colonia – lasted only one year due to the deaths of *both* leading partners. Similarly, the Giunti syndicate went into decline in the 1570s after the death of its leader – Luc'Antonio the Younger (Nuovo 2013). Deaths also triggered costly legal action among firms with interlocking business relationships. Due to the complicated nature of business relationships in printing, which involved obligations backed by inventories that could be liquidated only over time, deaths frequently initiated legal action over claims on firm assets. "If the associations or companies of publishers had to be terminated because of death or disharmony, the resultant legal actions seem often

---

[40]Employment across firms varied. Firms with a single printing press apparatus typically had one or two compositors setting the text and two pressmen – one inking the type and the other setting the paper and "pulling" the press. It was common in addition to employ apprentices, proof-readers, and family members of the master printer. See Richardson (1999) and Febvre and Martin (1958).

to have been highly complex and expensive" (Maclean 2009; p. 246). Legal actions often involved both heirs and business partners, layers of formal arbitration, and challenges in securing compliance with court orders (see Appendix C).

The deaths of active printers provided a shock to competition that positively shifted entry by new competitors. Entrants could either come from within a city or from other cities. Historians emphasize the intercity mobility of printers.[41] In our data, 8% of printers made permanent inter-city moves.[42] We observe the large within-city entrance response starting in the year of death, whereas the cross-city relocation response appears with a one-year lag (Appendix C). In addition, the impacts of deaths reflected firm heterogeneity. The deaths of specialized merchants' manual printers precipitated entry by new merchant manual printers, while deaths of other printers did not (Appendix C).

# 6    Printer Competition and the Book Market

This section studies the effect of printer competition on the book market. We study the relationships between overall competition and total city printing output, competition in the merchant press and merchant manual output, and competition just before the Reformation and the post-1517 production of religious media in German cities.

In our analysis of total output and merchant manual output, we study how variation in industrial organization explains differences in output within narrow city-specific time periods. Our research design uses the fact that entries and exits were discrete events relative to more slow-moving characteristics of media markets to study how shifts in local industrial organization drove variation in the number and content of publications. We first study how output rises in years with at least two producers, relative to years with monopoly in the same city-decade, to provide evidence on how transitions to potentially more competitive industrial organization impacted production. Because collusion was frequent, we emphasize that discrete transitions to "multiple firms" provide just one measure of competitive dynamics. Moreover, transitions between monopoly and non-monopoly focus our attention on variation in industrial structure across cities with a small number of firms. To consider the entire distribution, we also examine the output implications of variation in the number of firms both directly and using printer deaths as a source of exogenous variation, conditional on lagged industrial structure and output.

To analyze the diffusion of religious media during Protestant Reformation, we study

---

[41]Febvre and Martin (1958) and Clair (1976) describe printers as "nomadic" and "nomads."

[42]For this calculation, "permanent" moves are defined as moves where the year of the last book printed in city A is equal to or earlier than the year of the first book printed in city B. A limited number of editions were published in multiple cities simultaneously via partnerships and subcontracting.

how cross-sectional variation in market structure just *before* 1517 relates to the diffusion of Protestant and Catholic media after Protestant ideas hit the market in 1517. We examine the implications of the pre-1517 competitive environment because market structure became endogenous to the Reformation after 1517.[43] This enables us to study how initial competition predicts the diffusion of radical ideas originating from the small and previously unimportant town of Wittenberg, where Luther was based (Pettegree 2015). Competition prior to 1517 potentially reflected city characteristics that directly drove demand for religious innovation. We use the timing of printer deaths in the pre-Reformation period to isolate plausibly exogenous variation in industrial organization, and find similar effects of competition on religious output. We restrict our analysis of religious printing to German-speaking cities where the Reformation emerged and where printing played a central role in the diffusion of Protestant ideas.

## 6.1 Competition and Total Book Production

To study the implications of competition for total output we estimate regressions:

$$publications_{it} = \delta_{i,decade} + \beta_1(any\ printers)_{it} + \beta_2(multiple\ printers)_{it} + \epsilon_{it} \qquad (3)$$

$$publications_{it} = \delta_{i,decade} + \beta printers_{it} + \epsilon_{it} \qquad (4)$$

The outcome variable *publications* is the number of publications printed in a city-year. In equation (3), we model production with indicators for any printers ("*any printers*") and more than one firm ("*multiple printers*"). We present specifications that control for city and year fixed effects or with city-decade fixed effects ($\delta$), to study the implications of changes in industrial organization within narrow city-time-periods. Thus $\beta_2$ recovers the incremental variation explained by moving from monopoly to non-monopoly within a city or within a city-decade such as "Munich in the 1520s". In equation (4), *firms* measures the number of firms active. We estimate equation (4) with OLS and 2SLS, using the number of printer deaths in the past 2 or 10 years as the IV, conditional on lagged firms and lagged output. We restrict analysis to city-decades with some observed printing and study the unbalanced panel that broadly expands as printing was established in new cities.[44] We emphasize that the number of firms and the distinction between monopoly and non-monopoly are proxy measures of the competitive environment.

---

[43]We defer analysis of endogenous entry due to the Reformation to future research.

[44]There are years with zero publications occurring just before printing was established, or in a few cases after it left, or because the firm(s) in the city produced no output in that year. Our results are robust to using methods for count data or the log of books.

Table 5 presents our estimates and shows that were consistent positive effects associated with our measures of competition. Column 1 shows that output increased in years with multiple firms over the baseline for any printing. Column 2 shows that this positive effect is observed within city-decades: output increased by approximately 2.4 publications in years with multiple firms active. Columns 3 and 4 show that an extra firm was associated with 2.9 more publications within city-decade.

We find strong and slightly larger output effects when we study the implications of variation in the number of firms induced by printer deaths. We find that an extra firm was associated with 6.9 additional books when our instrument is the number of deaths in the last two years (Column 5) and 3.6 additional books when the IV is the number of deaths in the last ten years (Column 6). Our IV results control for lagged output and lagged firms before the IV period. The identifying assumption for the IV is that the *timing* of printer deaths was random, conditional on observables including the number of firms and production just before the IV period, and that deaths shifted output through their effects on induced entry.[45]

## 6.2 Competition in the Merchant Press and Merchant Manuals

To study the role of competition in the diffusion of business education content we estimate regressions studying the relationship between the number of merchant manuals printed and measures of market structure in merchant printing. We estimate regressions for equations (3) and (4), restricting attention to the number of firms active in merchant printing, defined as firms ever producing merchant manuals.[46]

Table 6 reports our findings and shows that competition in the merchant press explains output. Column 1 shows that output rose by 0.14 publications in years with multiple business education printers, relative to years with just one merchant printer. Column 2 shows that this effect holds when we study variation within city-decades. Columns 3 and 4 document the output effects of variation in the number of firms and show similar effects: an additional firm is associated with an increase of 0.08-0.11 merchant manuals. Finally columns, 5 and 6 show that our estimates are very similar when we examine variation in the number firms induced by the deaths of merchant manual printers.

Our results show changes in industrial organization in merchant printing drove sharp, highly significant output responses in this specialized content. The identifying assump-

---

[45]We find no significant effect of firm age on production, or of firm age induced by deaths in particular. We provide further discussion of this below.

[46]This measure captures underlying capacities for high valued added technical printing.

Table 5: Competition in Printing and Total City Output

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| *Panel A: OLS and IV Estimates* | | | | | | |
| | | | Outcome: Number of Publications | | | |
| | | OLS Estimates | | | IV Estimates | |
| Indicator: Any Printers | 0.67 | 1.98*** | | | | |
| | (0.61) | (0.12) | | | | |
| Indicator: 2+ Printers | 3.86*** | 2.37*** | | | | |
| | (1.36) | (0.18) | | | | |
| Number of Printers | | | 4.04*** | 2.90*** | 6.90* | 3.59** |
| | | | (0.12) | (0.50) | (3.74) | (1.46) |
| $R^2$ | 0.76 | 0.95 | 0.90 | 0.95 | | |
| F Statistic on IV | | | | | 9.27 | 11.99 |
| *Panel B: IV First Stage* | | | | | | |
| | | | | | Number of Printers | |
| Printer Deaths: Up to 2 Lags | | | | | 0.39*** | |
| | | | | | (0.13) | |
| Printer Deaths: Up to 10 Lags | | | | | | 0.97*** |
| | | | | | | (0.28) |
| $R^2$ | | | | | 0.99 | 0.96 |
| Observations | 19194 | 19194 | 19194 | 19194 | 19191 | 19191 |
| City and Year Fixed Effects | Yes | No | Yes | No | Yes | Yes |
| City-Decade Fixed Effects | No | Yes | No | Yes | No | No |
| Lagged Output & Printers | No | No | No | No | Yes | Yes |

This table presents regression estimates of the relationship between the structure of merchant printing and city-level output. The outcome in Panel A is the number of publications produced at the city-year level. "Indicator: Any Printers" and "Indicator: 2+ Printers" are 1/0 indicators for at least one and at least two printing firms, respectively. "Number of Printers" measures the number of printing firms active in a city-year. Columns 1 to 4 are estimated with OLS. Columns 5 and 6 are IV estimates. Panel B presents the first stage estimates for the IV estimates. "Printer Deaths: Up to 2 Lags" measures the number of printer deaths in the current and previous two years. Printer deaths over 10 lags is defined similarly. "Lagged Output & Printers" denotes the inclusion of lagged values as of the period before the IV realization. The analysis is restricted to city-decades with some printing activity (minimum of one publication and one firm). Standard errors in parentheses are clustered by city in specifications with city fixed effects and by city-decade in specifications with city-decade fixed effects. Statistical significance denoted $*$ $p < 0.1$, $**$ $p < 0.05$, $***$ $p < 0.01$. Three observations with no "within variation" are dropped from the IV estimates.

tion for our OLS designs is that changes in industrial organization are random within narrow city-specific intervals. The identifying assumption for our IV design is that the timing of the deaths of merchant manual printers is random, conditional on observables including lagged merchant manual output, and that these deaths shifted production through their impact on industrial organization as opposed to through other channels. Appendix C shows that merchant manual firms entered in city-years where merchant printers died, including in cases where the incumbent firms survived.

## 6.3  Competition and Religious Media During the Reformation

We study how religious printing during the Reformation era reflected variation in competition in printing in the immediate pre-Reformation period. We examine Protestant and Catholic publication outcomes over the period between Luther's initial intervention (1517) and the Peace of Augsburg (1555) in a cross-section of German cities. The outcomes we study are the number of publications produced and indicators which record whether the number of publications crossed different thresholds, which provide evidence on outcome effects across the distribution (Angrist 2001). We examine both cities with and without printing before the Reformation to study the extensive and intensive margins of printing. We present results that compare religious publishing during the Reformation in cities: without printing before the Reformation, with prior printing, and with multiple firms active *ex ante* – to differentiate between the effect of having printing and the effect of having a market structure with multiple firms. We then study the implications of variations in the number (count) of firms active, both directly and using printer deaths in the decade before the Reformation as an IV.[47]

Table 7 presents our findings examining how religious printing during the Reformation reflected the *ex ante* presence of printing and market structure. Panel A studies Protestant publication and Panel B studies Catholic printing. Columns 1 and 2 present OLS regressions where the outcome is the count of publications. We observe large positive effects of having two firms for Protestant output, on the order of 200 additional publications, but not for Catholic output. The Protestant effect is statistically significant when we study variation within narrow geographic neighborhoods defined by 210×210 kilometer grid cells (Column 2). This indicates that our results are not driven by factors shared by cities at the regional level, such as regionally varying preferences that shaped demand or regional variations in supply that could reflect the preferences of territorial lords.[48] In

---

[47]We use evidence on the years of printers' deaths from biographic records that cover *all* deaths, in both surviving and exiting firms. Appendix A provides information on each individual printer who exited a local market in our pre-Reformation period for reasons other than death.

[48]We use grid cells rather than territories because there are a large number of singleton territories

Table 6: Competition in Merchant Printing and Merchant Manual Output

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| *Panel A: OLS and IV Estimates* | | Outcome: Number of Merchant Publications | | | | |
| | | OLS Estimates | | | IV Estimates | |
| Indicator: Any Merchant Printers | 0.04*** | 0.04*** | | | | |
| | (0.01) | (0.01) | | | | |
| Indicator: 2+ Merchant Printers | 0.14*** | 0.14*** | | | | |
| | (0.03) | (0.03) | | | | |
| Number of Merchant Printers | | | 0.08*** | 0.11*** | 0.11** | 0.11*** |
| | | | (0.01) | (0.02) | (0.05) | (0.04) |
| $R^2$ | 0.19 | 0.19 | 0.25 | 0.35 | | |
| F Statistic on IV | | | | | 9.14 | 10.96 |
| *Panel B: IV First Stage* | | Outcome: Number of Merchant Printers | | | | |
| Merchant Printer Deaths: Current & 2 Lags | | | | | 1.02*** | |
| | | | | | (0.33) | |
| Merchant Printer Deaths: Current & 10 Lags | | | | | | 0.85*** |
| | | | | | | (0.24) |
| Year Fixed Effects | Yes | Yes | Yes | No | Yes | Yes |
| City Fixed Effects | Yes | Yes | Yes | No | No | No |
| City-Decade Fixed Effects | No | No | No | Yes | No | No |
| Lagged Output & Printers | No | No | No | No | Yes | Yes |
| Observations | 15177 | 15177 | 15177 | 15177 | 15173 | 15173 |

This table presents regression estimates of the relationship between the structure of merchant printing and merchant manual output. The outcome in Panel A is the number of merchant manuals published at the city-year level. "Indicator: Any Merchant Printers" and "Indicator: 2+ Merchant Printers" are indicators for at least one and at least two merchant printing firms, respectively. Merchant printers are defined as printers that ever produce merchant manuals. "Number of Merchant Printers" measures the number of merchant printing firms active in a city-year. Columns 1 to 6 are estimated with OLS. Columns 7 and 8 are estimated with 2SLS. In Column 7 the IV is merchant printer deaths in current and previous two years. In Column 8 the IV is merchant printer deaths in current and past ten years. IV estimates control for lagged merchant printing (one year before the IV period). Panel B presents the first stage estimates for the 2SLS analysis. Standard errors in parentheses are clustered by city in specifications with city fixed effects and by city-decade where city-decade fixed effects are introduced. Statistical significance denoted * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Four observations with no "within variation" are dropped from the IV estimates. Data are restricted to city-years with any printing.

27

Column 3, we model the count data with negative binomial regression and find cities with two or firms pre-Reformation produced 231% more Protestant media during Reformation than cities with one firm, conditional on observables. In contrast, the competition effect for Catholic content is both smaller (156%) and not statistically significant. In Columns 4 to 9 we study variation across the distribution and find that cities with multiple firms were more likely to cross output thresholds for Protestant publications. As we examine higher Protestant publication thresholds, the salience of having multiple firms grows in magnitude and statistical significance, whereas the salience of "any printing" declines and loses statistical signficance. For Catholic printing we find no appreciable effects of printing at low output thresholds and that a market structure with multiple firms only raised the probability of crossing the highest output thresholds. These findings suggest that economic competition had asymmetric effects on the diffusion of (i) revolutionary ideas and (ii) ideas supporting the incumbent religious monopoly.[49] We control for the *ex ante* number of Latin and vernacular publications, the share of pre-1517 output that was religious, and institutional features of cities: whether they were ecclesiastical cities, subject to feudal lords, ruled by prince-bishops, or had formal market rights.

A natural question is whether variation in competition *caused* differences in the diffusion of religious ideas or whether the sudden appearance of Protestant ideas activated unobserved differences in preferences, institutions, or human capital. Both processes were no doubt active. We use the deaths of printers active in the period 1508-1517 as an IV that provides plausibly exogenous variation in pre-Reformation competition – *conditional* on the lagged number of printers active and other observables. Printer deaths before the Reformation were shocks to competition that are free from forms of endogeneity that potentially could characterize entrance and city responses to deaths during the Reformation.[50] We measure printer deaths with the number of deaths occurring not more than one year after a printer's last business activity. This allows us to discriminate between the deaths of active printers (which matter for competition) and the deaths of retirees, which we use as a placebo in estimates reported in Appendix E. We provide additional discussion of evidence for the identifying assumptions below.

Table 8 studies the relationship between religious output during the Reformation and the number of firms active using OLS and 2SLS. Columns 1 to 4 present OLS results and show variation in the number of firms is a positive and statistically significant predictor

_____

with one city, limiting the within-territory variation available to study.

[49]We emphasize the difference between the effects for Protestant and Catholic printing. We acknowledge, however, that the Catholic effect is an imprecise zero and that we cannot consistently reject the possibility that the effect was the same for Protestant and Catholic.

[50]This distinguishes the methodological scope and aims of our study from research that studies incentives to ideological positioning for entrants (Gentzkow et al. 2014).

Table 7: Competition Before 1517 and Religious Printing During the Reformation

*Panel A: Protestant Publications 1518-1554*

|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
|  | Count Protestant | | | Binary: Protestant Count Crosses Threshold | | | | | |
|  | OLS | OLS | NB | 10+ | 10+ | 25+ | 25+ | 50+ | 50+ |
| Indicator: Any Printers Before | 17.27 | -1.33 | 2.98*** | 0.22* | 0.24** | 0.30** | 0.33*** | 0.16* | 0.16* |
|  | (36.25) | (59.18) | (0.70) | (0.12) | (0.11) | (0.11) | (0.11) | (0.08) | (0.09) |
| Indicator: 2+ Printers Before | 239.49 | 264.57*** | 2.31* | 0.20 | 0.26** | 0.23* | 0.25** | 0.32** | 0.34** |
|  | (198.77) | (75.11) | (1.07) | (0.14) | (0.12) | (0.13) | (0.11) | (0.13) | (0.12) |

*Panel B: Catholic Publications 1518-1554*

|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
|  | Count Catholic | | | Binary: Catholic Count Crosses Threshold | | | | | |
|  | OLS | OLS | NB | 10+ | 10+ | 25+ | 25+ | 50+ | 50+ |
| Indicator: Any Printers Before | -12.50 | -8.42 | 1.41* | 0.08 | 0.11 | 0.05 | 0.09 | -0.10* | -0.09 |
|  | (9.96) | (13.19) | (0.80) | (0.11) | (0.11) | (0.11) | (0.12) | (0.05) | (0.06) |
| Indicator: 2+ Printers Before | 4.04 | 2.90 | 1.56 | 0.03 | 0.06 | 0.02 | 0.02 | 0.30*** | 0.31*** |
|  | (30.39) | (16.75) | (1.35) | (0.13) | (0.11) | (0.10) | (0.09) | (0.09) | (0.08) |
| Observations | 191 | 191 | 191 | 191 | 191 | 191 | 191 | 191 | 191 |
| Geographic Fixed Effect | | Yes | | | | Yes | | | |

This table presents regression estimates of the relationship between the structure of city printing before the Reformation and the production of religious media during the Reformation. "Indicator: Any Printers Before" is an indicator for cities with any firms active 1508-1517. "Indicator: 2+ Printers Before" is an indicator for cities with multiple firms active 1508-1517. Panel A presents studies Protestant printing. Panel B studies Catholic printing. In columns (1) to (3) the outcome is the number of books classified as Protestant or Catholic. Outcomes are modelled using OLS in columns (1) and (2) and negative binomial regression in column (3). In columns (4) to (9) the outcome is an indicator for the number of publications crossing designated thresholds and regressions are OLS. All specifications control for: Latin Media pre-1517 and Vernacular Media pre-1517 measured in hundreds of titles; Religious Media pre-1517 measured as the share of titles on religious topics; distance to Wittenberg measured in hundreds of kilometers; indicators for Hansa cities, ecclesiastical rule cities, prince bishroprics, cities on navigable rivers, and cities ever printing pre-1517. Population in 1500 is controlled for with fixed effects for bins: unknown (omitted), 1000-5000, 6000-1000, 11000-25000, 26000+. Specifications with geographic fixed effects include fixed effects for 210×210 kilometer grid cells. Standard errors are clustered on historic territories (principalities) of the Holy Roman Empire (see Appendix A). Statistical significance denoted * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: OLS and IV Analysis of Competition and Religious Printing

|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
|  | OLS | | | | IV | | | |
| *Panel A: Protestant Publications 1518-1554* | | | | | | | | |
|  | Outcome: Count or Binary | | | | Outcome: Count or Binary | | | |
|  | Count | 10+ | 25+ | 50+ | Count | 10+ | 25+ | 50+ |
| Number of Printers Pre-Reformation | 34.93* | 0.06** | 0.08** | 0.08** | 133.74** | 0.13* | 0.14** | 0.18*** |
|  | (19.08) | (0.02) | (0.03) | (0.03) | (60.42) | (0.07) | (0.07) | (0.06) |
| Observations | 191 | 191 | 191 | 191 | 191 | 191 | 191 | 191 |
| *Panel B: Catholic Publications 1518-1554* | | | | | | | | |
|  | OLS | | | | IV | | | |
|  | Outcome: Count or Binary | | | | Outcome: Count or Binary | | | |
|  | Count | 10+ | 25+ | 50+ | Count | 10+ | 25+ | 50+ |
| Number of Printers Pre-Reformation | 16.58 | -0.00 | 0.01 | 0.04 | 56.42** | 0.22** | 0.24*** | 0.05 |
|  | (11.43) | (0.04) | (0.03) | (0.03) | (27.86) | (0.10) | (0.07) | (0.04) |
| Observations | 191 | 191 | 191 | 191 | 191 | 191 | 191 | 191 |
| *Panel C: First Stage for IV* | | | | | | | | |
|  | | | | | Outcome: Firms Pre-Reformation | | | |
| Printer Deaths 1508-1517 | | | | | 0.99*** | 0.99*** | 0.99*** | 0.99*** |
|  | | | | | (0.14) | (0.14) | (0.14) | (0.14) |
| F Statistic on IV | | | | | 52.50 | 52.50 | 52.50 | 52.50 |
| Observations | | | | | 191 | 191 | 191 | 191 |

This table presents regression estimates of the relationship between the structure of city printing before the Reformation and the production of religious media during the Reformation. "Number of Printers Pre-Reformation" is the count of firms active 1508-1517. Panel A presents studies Protestant printing. Panel B studies Catholic printing. In columns (1) and (2) the outcome is the number of books classified as Protestant or Catholic. In columns (3), (4), and (5) the outcome is an indicator for the number of publications crossing designated thresholds. Panel C presents first-stage estimates for the IV. The outcome is the number of firms pre-Reformation. The IV is the number of printer deaths 1508-1517. All specifications control for: Latin Media pre-1517 and Vernacular Media pre-1517 measured in hundreds of titles; Religious Media pre-1517 measured as the share of titles on religious topics; distance to Wittenberg measured in hundreds of kilometers; indicators for Hansa cities, ecclesiastical rule cities, prince bishroprics, cities on navigable rivers, and cities ever printing pre-1517. Population in 1500 is controlled for with fixed effects for bins: unknown (omitted), 1000-5000, 6000-1000, 11000-25000, 26000+. IV estimates additionally control for the lagged number of firms active (firms active 1498-1507). Standard errors are clustered on historic territories (principalities) of the Holy Roman Empire (see Appendix A). Statistical significance denoted * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

of Protestant but not Catholic printing. Columns 5 to 8 present IV estimates that document positive and statistically significant relationships between the number of firms in a city before the Reformation and Protestant content that are consistently larger than the OLS estimates. The IV estimates indicate that an extra firm raises the probability of Protestant publications crossing output thresholds by 13-18%, where the OLS estimates range between 6% and 8%. The IV estimates for Catholic publications are also positive and with one exception statistically significant (Panel B, Columns 5 to 7), whereas the OLS estimates for Catholic publications are close to zero and statistically insignificant.

There are several possible explanations for the fact that the IV estimates are larger than the OLS estimates. First, the IV may address proxy measurement error implicit in the OLS estimates. Second, it may be that variation industrial organization due to shocks was more consequential than variation arising from other sources, including endogenous factors. Historical evidence that printer deaths destabilized anti-competitive arrangements points in this direction. Supporting the view that printer deaths had their impact via competitive channels, we find that deaths did *not* drive variation in publications through their impact on the age composition of firms (Appendix E). However, it remains the case that the IV recovers a local average treatment effect.

# 7   The Effect of Ideas on Economic Development and Institutional Change

In this section, we study the relationship between ideas in print and economic outcomes using printer deaths as a source of plausibly exogenous variation in supply. We first study the relationship between the diffusion of business education publications and long-run city growth in a cross-sectional design. We present corroborating panel data evidence on shocks to merchant printing and individual achievement at the city-by-cohort-by-sector level. We then study the relationship between the spread of Protestant ideas in the media and city-level institutional change across cities in German-speaking Europe.

## 7.1   Merchant Printing, City Growth, and Individual Achievement

This section first presents IV estimates of the relationship between business education content and long-run city population growth in the cross-section. The cross-sectional design and the fact that merchant manual printing diffused gradually raise the question

of whether shocks to merchant printing drove or responded to economic development. To test whether shocks to merchant printing drove or responded to economic development, we examine the relationship between the timing of shocks to business education printing and individual achievement in panel data at the city-decade level.

**City Growth** – We study the relationship between business education content and city growth using the deaths of active printers who were producers of merchant manuals as a source of exogenous variation in supply. We examine two measures of business education content: (1) the number of manuals published 1500-1600 and (2) the log of the number of manuals printer plus one ($\ln[manuals + 1]$). In all specifications, the controls $X$ include city population in 1500, pre-1500 printing, port location, the presence of historic universities, navigable rivers, latitude, longitude, and country fixed effects. We control for whether a given city produced any business education content. To focus on variation in exposure to shocks and output across *ex ante* highly comparable cities, we place cities in matching groups (cells) based the similarity of their printing industries along three key dimensions over the period 1454-1499, before any deaths are observed for business education printers. All cities in a matching group (1) belong to the same initial output quantile, (2) were above (below) average producers of scientific books, and (3) were above (below) average educational books, as classified in the USTC.[51]

We consider a first stage model examining variations in business education content:

$$manuals_i = \alpha_0 + \alpha_1 deaths_i + \alpha_x X_i + \epsilon_i \tag{5}$$

The first stage results isolate plausibly exogenous variation in supply we use to estimate the relationship between growth and the merchant manual publications in a model:

$$\ln(POP_{1600}/POP_{1500}) = \beta_0 + \beta_1 manuals_i + \beta_x X_i + \nu_i \tag{6}$$

We focus on the IV estimates in this section and report first stage estimates in Appendix D. The first identifying assumption is that the deaths of merchant printers were random across cities conditional on observables, including the composition of printing output as of 1500. The second identifying assumption is that the deaths of merchant printers impacted long-run growth only through their effects on the supply of business education publications. We discuss these assumptions below and in Appendix D.

Table 9 presents IV estimates of the relationship between growth and merchant manual publications. Panel A examines the complete set of cities and uses the measure

---

[51]For details on the define matching groups and within-group variation in the exposure to printer deaths see Appendix D.

of printer deaths from publications data. Columns 1-5 show that when printer deaths are used as an IV for supply we estimate that an additional merchants' manual was associated with an increase in population growth of 0.7%-2.5%. Columns 6-10 present estimates examining variations in growth induced by variations in the log of business education publications. The estimated elasticities of growth with respect to this media output fall between 0.1 and 0.2 and are highly significant. To interpret these magnitudes, consider that the mean city experienced 30% population growth 1500-1600.

To interpret our results, several further observations are important. First, our results using merchant printer deaths as a source of variation in merchant publications are robust to controlling for other printer deaths (Table 9, Columns 4, 5, 9, and 10). This shows that our effects are *not* explained by a generalized economic boom that drew more printers and mechanically led to more printer deaths of all types being observed. Second, our findings are not driven by the potentially selective observation of deaths in "good cities" when we measure deaths using book inscriptions.[52] To show this we restrict attention to the subset of German cities where we can measure printer deaths using both book inscriptions and biographical records from Reske (2007; 2015). Panel B shows our results for German cities using the baseline measure of deaths observed in book inscriptions as the IV. Panel C shows our results for German cities using the measure of deaths from biographical data. In both cases the results are broadly similar in magnitude to the baseline results for all of Europe. The results using evidence on deaths from biographical records as the IV are slightly larger in magnitude and somewhat more precisely estimated than the results using evidence from book inscriptions. Third, we find minimal growth effects due to variation in non-merchant printing induced by the deaths of non-merchant printers. We report these results in Appendix D. Fourth, it is possible that local economic growth in the 1500s could have differentially induced entry by merchant manual printers and thus mechanically led to *relatively* more such deaths being observed in dynamic cities. To test whether local development preceeded or followed shocks in printing in higher frequency data, we study individual-level achievement at the city-cohort level.

**Individual Achievement** – To provide more precise evidence on the timing of the effects of printer deaths, and to test whether shocks to the business education press shifted individual-level achievement, we study how the achievement at the city-cohort-sector level responded to the deaths of merchant manual printers.

We measure individual achievement by the number of people from a given city-cohort observed in the *Deutsche Biographie*. We define cohorts as individuals born in the same

---

[52]To be clear, deaths in inscriptions are observed in firms that survive. The natural question is whether firms survive to have inscriptions recording deaths in a positively selected subset of cities.

Table 9: IV Estimates of the Growth Impact of Merchant Manuals

|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| *Panel A: Baseline All Cities – IV from Book Inscriptions* | | | | | | | | | | |
| | | | | Outcome: Ln Growth 1500-1600 | | | | | | |
| Merchant Manuals | 0.01*** | 0.02** | 0.02** | 0.01** | 0.02** | | | | | |
| | (0.00) | (0.01) | (0.01) | (0.01) | (0.01) | | | | | |
| Ln Merchant Manuals | | | | | | 0.11*** | 0.20*** | 0.18*** | 0.14** | 0.18** |
| | | | | | | (0.02) | (0.06) | (0.06) | (0.06) | (0.07) |
| F Stastistic on IV | 7.73 | 22.60 | 21.49 | 11.82 | 12.95 | 18.65 | 115.25 | 90.44 | 28.03 | 31.21 |
| Observations | 239 | 239 | 239 | 239 | 239 | 239 | 239 | 239 | 239 | 239 |
| *Panel B: German Cities – IV from Book Inscriptions* | | | | | | | | | | |
| | | | | Outcome: Ln Growth 1500-1600 | | | | | | |
| Merchant Manuals | 0.02*** | 0.02* | 0.02* | 0.02** | 0.02** | | | | | |
| | (0.00) | (0.01) | (0.01) | (0.00) | (0.01) | | | | | |
| Ln Merchant Manuals | | | | | | 0.13 | 0.13 | 0.12 | 0.22*** | 0.23 |
| | | | | | | (0.08) | (0.08) | (0.07) | (0.04) | (0.14) |
| F Stastistic on IV | 10.65 | 9.65 | 19.61 | 12.35 | 18.52 | 29.68 | 29.68 | 82.22 | 17.99 | 22.04 |
| Observations | 65 | 65 | 65 | 65 | 65 | 65 | 65 | 65 | 65 | 65 |
| *Panel C: German Cities – IV from Biographical Data* | | | | | | | | | | |
| | | | | Outcome: Ln Growth 1500-1600 | | | | | | |
| Merchant Manuals | 0.02** | 0.02** | 0.02** | 0.03* | 0.03 | | | | | |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.02) | | | | | |
| Ln Merchant Manuals | | | | | | 0.18*** | 0.18*** | 0.18*** | 0.26** | 0.23 |
| | | | | | | (0.06) | (0.06) | (0.07) | (0.11) | (0.14) |
| F Statistic on IV | 9.35 | 12.78 | 13.95 | 11.46 | 8.70 | 39.02 | 39.02 | 40.11 | 24.79 | 22.04 |
| Observations | 65 | 65 | 65 | 65 | 65 | 65 | 65 | 65 | 65 | 65 |
| Death Other Printers | | | Yes | Yes | Yes | | | Yes | Yes | Yes |
| Ever Manuals | | | | Yes | Yes | | | | Yes | Yes |
| Match Group Fixed Effects | | | | | Yes | | | | | Yes |

This table presents instrumental variable estimates of the relationship city growth and merchant manual supply. Panel A presents first stage regressions documenting the city-level relationship between the supply of merchants' manuals and printer deaths. The dependent variable in columns 1-5 is the number of manuals produced 1500-1600. The dependent variable in columns 6-10 is the log of manuals ($\ln[manuals + 1]$). "Deaths Any" is an indicator for any printer deaths 1500-1600. "Death Merchant" is an indicator for deaths of printers whose firms ever produced merchants' manuals. "Death Non-Merchant" is an indicator for deaths of printers whose firms did not. "Ever Manuals" is an indicator for cities that ever produced business education content. Control group fixed effects are as discussed in the text. Panel B presents 2SLS estimates of the impact of merchant manual supply on growth. The dependent variable is: $ln(POP_{1600}/POP_{1500})$. All regressions control for population in 1500, pre-1500 printing, port location, the presence of historic universities, navigable rivers, latitude, longitude, and country fixed effects. Standard errors clustered at the country level. Statistical significance denoted $* \ p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$.

city-decade. We examine the 65 German-speaking cities with printing (above) and cohorts born between the 1450s and the 1580s, hence individuals turning 30 by the first decade of the 1610s. To study sectoral allocation, we distinguish between achievement in (i) bourgeois occupations and (ii) the nobility or the church (religious occupations).[53]

We first estimate reduced-form regressions:

$$people_{it} = \alpha_i + \delta_t + \sum_{\tau=-3}^{3} (\beta_\tau death_{i,\tau}) + \epsilon_{it}$$

The outcome $people_{it}$ is either the number of people born in a city-decade or an indicator for any people born in a city-decade observed in the *Deutsche Biographie*. The parameters of interest are the $\beta_\tau$, which capture how individual achiecement responded to the timing of shocks to the business education press, measured by the death of a merchant printer ($death_{i,\tau}$) at the city-decade level. Cities and decades are indexed $i$ and $t$. The timing of shocks is indexed relative to individuals' decade of birth: $\tau = 0$ corresponds decade of birth, $\tau = 1$ the decade in which individuals turned 10, and $\tau = 2$ the decade in which individuals turned 20, and so on. The $\alpha_i$ and $\delta_t$ are city and decade fixed effects.

Table 10 shows that shocks to merchant printing that occur that hit cohorts in late adolescence and early adulthood are significant predictors of achievement in bourgeois occupations.[54] Shocks to merchant printing do not predict achievement in religious careers or in the nobility. Shocks occuring before the late adolescence, early adulthood period are not significant predictors of achievement. The relationship we observe between individual achievement at the city-cohort level and shocks in the merchant press is not driven by outlier cities. We present robustness exercise results in Appendix Table D8.

We then estimate IV regressions and find that variation in merchant manuals driven by shocks predicts bourgeois achievement. Table 11 shows that an additional merchant manual was associated with an additional 0.4 to 0.8 high achievement bourgeois individuals in a city-cohort, relative to a mean of 0.4. Our estimates are imprecise controlling only for city and decade fixed effects (column 1), but become more precise when we control for lagged deaths of merchant printers (column 2) and lagged deaths of non-merchant printers (column 3). The estimates rise in magnitude when we control for lagged publications (column 5) and lagged merchant manual publications (column 6). We find a weak positive relationship between achievement among churchmen and nobles and variation in merchant manual publication induced by printer deaths (column 7).

---

[53]Motivated by evidence on the application of business-related knowledge in the public sector, and on spillovers across occupations, we classify all non-noble and non-religious occupations as 'bourgeois'.

[54]On average the shocks occur at age 20. Because we 'bin' individuals by decade, some individuals in a cohort experience the same shock in their teens and other in their twenties.

Table 10: Merchant Printer Deaths and Achievement Across Cohorts

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | Outcome: Count by City-Decade | | | | Outcome: Binary by City-Decade | | | |
| | Bourgeois Occupations | | Noble or Church Occupations | | Bourgeois Occupations | | Noble or Church Occupations | |
| Merchant Death in Decade Individuals Turn 30 | 0.02 | 0.08 | 0.08 | 0.09 | -0.05 | -0.08 | -0.01 | -0.02 |
| | (0.15) | (0.20) | (0.20) | (0.22) | (0.11) | (0.10) | (0.11) | (0.11) |
| Merchant Death in Decade Individuals Turn 20 | 0.74** | 0.76** | 0.25 | 0.27 | 0.25* | 0.23* | -0.03 | -0.03 |
| | (0.32) | (0.33) | (0.33) | (0.35) | (0.13) | (0.12) | (0.10) | (0.11) |
| Merchant Death in Decade Individuals Turn 10 | 0.03 | 0.06 | -0.04 | -0.03 | 0.03 | 0.04 | -0.11 | -0.12 |
| | (0.20) | (0.21) | (0.19) | (0.22) | (0.10) | (0.11) | (0.08) | (0.09) |
| Merchant Death in Decade Individuals Born | 1.28 | 1.28 | -0.19 | -0.21 | 0.13 | 0.12 | -0.12 | -0.14 |
| | (0.99) | (0.99) | (0.14) | (0.15) | (0.13) | (0.12) | (0.11) | (0.11) |
| Merchant Death in Decade Individuals Age − 10 | 0.15 | 0.15 | 0.17 | 0.16 | 0.17 | 0.16 | 0.06 | 0.04 |
| | (0.43) | (0.44) | (0.25) | (0.25) | (0.17) | (0.16) | (0.14) | (0.13) |
| Merchant Death in Decade Individuals Age − 20 | 1.17 | 1.16 | -0.08 | -0.09 | 0.13 | 0.10 | -0.02 | -0.03 |
| | (1.14) | (1.17) | (0.05) | (0.06) | (0.16) | (0.15) | (0.05) | (0.08) |
| Merchant Death in Decade Individuals Age − 30 | 0.17 | 0.17 | 0.19 | 0.17 | 0.22 | 0.19 | -0.05 | -0.09 |
| | (0.49) | (0.47) | (0.25) | (0.26) | (0.16) | (0.17) | (0.05) | (0.07) |
| Observations | 910 | 910 | 910 | 910 | 910 | 910 | 910 | 910 |
| City & Decade Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Leads & Lags of Non-Merchant Printer Death | | Yes | | Yes | | Yes | | Yes |
| Mean of Outcome | .40 | .40 | .09 | .09 | .17 | .17 | .07 | .07 |
| P-value: Decades Before Turn 20 | .49 | .51 | .08 | .20 | .24 | .40 | .23 | .15 |
| Cities | 65 | 65 | 65 | 65 | 65 | 65 | 65 | 65 |

This table reports regression estimates of the relationship between the individual achievement outcomes and the deaths of printers who produced merchant manuals. Achievement outcomes are measured at the city-cohort-sector level by the number (presence) of people born in a given city-decade with occupations classified as 'bourgeois' or 'noble or church' who are recorded in the *Deutsche Biographie*. Occupations are classified as bourgeois if they were neither in the nobility nor religious occupations. In columns 1-4, the outcome is the number of people. In columns 5-8, the outcome is a binary indicator for any high achievement people. In columns 1 and 2, the outcome is the number of people who had bourgeois careers. In columns 3 and 4, the outcome is the number of people who either were in the nobility or had religious careers. The independent variables are indicators that capture the timing of the first city-decade with the death of a merchant manual printer. "Merchant Death in Decade Individuals Turn 30" is an indicator for a death of a printer of merchant manuals in the decade individuals in a given city turned 30 years old. "Merchant Death in Decade Individuals Turn 20" is an indicator for death of a merchant manual printer in the decade individuals turned 20. Other variables are defined similarly. We examine data on people born from the 1450s through the 1580s, hence turning 30 by or before the first 1610s. The sample comprises 65 German-speaking cities with population data examined in analysis of city growth. All specifications include city and decade fixed effects. Even columns additionally control for leads and lags of non-merchant printer deaths. Standard errors clustered by city. Statistical significance denoted * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 11: Merchant Manual Publication and Individual Achievement Across Cohorts

|  | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| *Panel A: IV Estimates* | | | | | | |
|  | Outcome: High Achievement Individuals by City-Decade Cohort | | | | | |
|  | Bourgeois Careers | Bourgeois Careers | Bourgeois Careers | Bourgeois Careers | Bourgeois Careers | Church or Nobility |
| Merchant Manuals Published Decade Cohort Turns 20 | 0.40 | 0.44** | 0.46** | 0.53* | 0.83* | 0.10 |
|  | (0.31) | (0.22) | (0.23) | (0.31) | (0.44) | (0.21) |
| Observations | 910 | 910 | 910 | 910 | 910 | 910 |
| F Statistic on IV | 6.63 | 11.03 | 11.37 | 11.22 | 8.87 | 8.87 |
| Mean Outcome | .40 | .40 | .40 | .40 | .40 | .09 |
| Cities | 65 | 65 | 65 | 65 | 65 | 65 |
| *Panel B: First Stage Estimates* | | | | | | |
|  | Outcome: Merchant Manuals Published in City-Decade | | | | | |
| Merchant Printer Death in City-Decade | 1.40** | 1.67*** | 1.62*** | 1.40*** | 1.05*** | 1.05*** |
|  | (0.54) | (0.50) | (0.48) | (0.42) | (0.35) | (0.35) |
| Observations | 910 | 910 | 910 | 910 | 910 | 910 |
| *Controls Across Specifications* | | | | | | |
| City and Decade Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Lags of Merchant Printer Death |  | Yes | Yes | Yes | Yes | Yes |
| Lags of Non-Merchant Printer Death |  |  | Yes | Yes | Yes | Yes |
| Lags of Total Publications |  |  |  | Yes | Yes | Yes |
| Lags of Merchant Manual Publications |  |  |  |  | Yes | Yes |

This table reports IV regression estimates of the relationship between the individual-level achievement outcomes and local merchant manual publishing. High achievement outcomes are measured by people born in a given city-decade cohort and recorded in the *Deutsche Biographie*. Panel A presents IV estimates. In columns 1-5, the outcome is the number of people who had bourgeois occupations. Individuals occupations are classified as bourgeois if they were not in the nobility and were not religious (i.e. were outside the Church, were not not rabbis, etc.). In column 6, , the outcome is people who were either nobles or had religious careers. The independent variable is the number of merchant manuals published in the decade a city-cohort turned 20 (cohorts are defined as individuals born in the same city-decade). Panel B presents first stage estimates where the outcome is the number of merchant manuals published in the city-decade when a cohort turns 20 years old. "Merchant Death in Decade Cohort Turns 20" is an indicator for the first death of a merchant manual printer in the decade individuals turned 20. All specifications include city and decade fixed effects. All lagged controls include five decadal lags. "Lags of Merchant Printer Deaths" indicates five lags of merchant printer deaths. "Lags of Non-Merchant Printer Deaths" indicates five lags of non-merchant deaths in the decade a cohort turns 20. "Lags of Total Publications" indicates five lags of the number of total publications on all subjects. "Lags of Merchant Manual Publications" indicates five lags of merchant manual publications. The analysis examines data on people born from the 1450s through the 1580s, hence turning 30 by or before the 1610s. Standard errors clustered by city. Statistical significance denoted $* p < 0.1$, $** p < 0.05$, $*** p < 0.01$.

## 7.2 Protestant Ideas and City-Level Institutional Change

We study the relationship between media content and city-level institutional change using printer deaths as a source of exogenous variation in content. We examine the implications of printer deaths that occurred on the years immediately preceeding the Reformation, conditional number of firms active in a city in the early 1500s, the composition of pre-Reformation print media, the institutional status of cities, the presence of universities, and locational characteristics.

We focus on Protestant publishing over the critical first years of the Reformation between 1518 and 1521, the years laws institutional change began. We focus on these years because historical evidence suggests that printing in this era was critical in shifting views (Chrisman 1982; Brady 2009) and to examine the relationship between printing and subsequent institutional change *before* institutional change could itself determine publication patterns. By restricting our analysis to publishing through 1521, we also focus attention on the period before new restrictions on religious printing were introduced.[55]

We estimate a first stage regression:

$$\ln(protestant_i) = \alpha + \beta death_i + \gamma X_i + u_i \qquad (7)$$

Here $\ln(protestant_i)$ is the log of the number of Protestant books printed between 1517 and 1521, the year of the first city law, plus one. The IV ($death_i$) is an indicator for printer deaths in the ten years before the Reformation (1508-1517). The $X_i$ control for: vernacular and Latin publications, and the share of religious publications, pre-Reformation; for status as a Hansa city, ecclesiastical rule, prince-bishoprics; distance to Wittenberg, universities, and locations on navigable water. In the second stage, examine institutional outcomes – whether a city adopted a Reformation law between 1521 and the 1555 Peace of Augsburg.

Table 12 presents our estimates. We find that a printer death in the years preceding the Reformation was associated with an increase in Protestant content of approximately 0.81 log points, controlling for city population and approximately 0.55 log points controlling for city characteristics and geographic grid cell fixed effects (see Panel A). Introducing

---

[55]For example, Nürnberg's city council first pressed local printers not to publish Lutheran tracts in the 1521 – before adopting the Reformation in the face of popular pressure. Similarly, Lutheran publishing flourished in Leipzig in the first years of the Reformation, before the local Duke imposed restrictions on Protestant publishing that remained in place for several years until his death. Thus, while censorship in German cities was broadly endogenous (Creasman 2012) and punishments for publishing controversial materials were light compared to those in the Low Countries and France (Pettegree 2015), we focus here on the institutional implications of publications produced in an initial period when printing in Germany was particularly open.

Table 12: Protestant Content and Institutional Change IV Estimates

|  | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *Panel A: IV Estimates* | | | | |
| | Outcome: Reformation Law Passed 1521-1554 | | | |
| Ln Protestant 1517-1521 | 0.28*** | 0.22*** | 0.34** | 0.17 |
| | (0.10) | (0.08) | (0.17) | (0.11) |
| Firms 1498-1507 | -0.05 | -0.04 | -0.01 | 0.00 |
| | (0.04) | (0.05) | (0.04) | (0.04) |
| Observations | 191 | 191 | 191 | 191 |
| F Statistic on IV | 17.07 | 14.13 | 4.46 | 2.59 |
| *Panel B: First Stage* | | | | |
| | Outcome: Ln Protestant Publications 1517-1521 | | | |
| Printer Deaths 1508-1517 | 0.80*** | 0.81*** | 0.55** | 0.57 |
| | (0.19) | (0.21) | (0.26) | (0.35) |
| Firms 1498-1507 | 0.41*** | 0.42*** | 0.13 | 0.14* |
| | (0.06) | (0.07) | (0.09) | (0.08) |
| Observations | 191 | 191 | 191 | 191 |
| $R^2$ | 0.58 | 0.58 | 0.66 | 0.68 |
| Population in 1500 | | Yes | Yes | Yes |
| Controls | | | Yes | Yes |
| Grid Cell FE | | | | 210KM |

This table presents IV regression estimates examining the institutional change outcome. In Panel A, the outcome is a binary indicator for the passage of a law between 1521 and 1554. The endogenous independent variable is the number of log of the number of Protestant publications produced 1517-1521 plus one. The IV is the number of printer deaths 1508-1517. Panel B presents the first stage Estimates. Population in 1500 is controlled for with fixed effects for bins: unknown (omitted), 1000-5000, 6000-1000, 11000-25000, 26000+. Controls are: Latin Media pre-1517 and Vernacular Media pre-1517 measured in hundreds of titles; Religious Media pre-1517 measured as the share of titles on religious topics; distance to Wittenberg measured in hundreds of kilometers; indicators for Hansa cities, ecclesiastical rule cities, prince bishroprics, cities on navigable rivers, and cities ever printing pre-1517. Standard errors are clustered on territories (principalities) of the Holy Roman Empire or on geographic grid cells where grid cell fixed effects are introduced. The "210km" cluster designates 2 degree × 3 degree grid cells. Significance at the 99%, 95%, and 90% levels denoted "***", "**", and "*", respectively.

grid cell fixed effects does not change our first stage point estimate but substantialy increases the standard errors. We find in the second stage that variations in Protestant content induced by pre-Reformation printer deaths shifted the probability of institutional change. While our estimates are median unbiased, when we introduce controls the first stage F-statistic falls to 4.46 (column 3). Our first stage precisions declines further and the second stage ceases to be statistically significant when we introduce geographic grid cell fixed effects. This reflects the fact that local variation in exposure to shocks was limited, and that variation in both printing and in institutional change was driven by multiple factors.[56] While our findings are thus not without qualification, they strongly

---

[56]For example, Dittmar and Meisenzahl (2016) examine shocks that shifted demand for institutional-

point towards the role of shocks to competition in media markets as a source of variation in content that had a causal impact on outcomes, consistent with narrative evidence.[57]

# 8  Conclusion

Research on the origins of European economic development highlights the importance of transformations in the market for ideas after 1500 (Mokyr 2016). Prior scholarship has assembled rich narrative evidence to characterize the emergence of open markets for ideas and the dynamics of knowledge in Europe. Our research contributes quantitative evidence on the role of the printing industry and studies two of the most important diffusion processes in European history. We document the role of printing in the diffusion of knowledge about innovative business practices. These business practices directly transformed the economy by changing how European capitalists conducted affairs. We also document the role of printing in the diffusion of religious ideas that challenged ideological monopoly of the Catholic Church. These ideas introduced competition in religion and drove fundamental institutional change – in world characterized by an incumbent elite administering an ideological monopoly.

Printing was the key "ideas" industry of early modern Europe, and provides rich evidence in which to study the implications of competition in the media. The printing industry was one of the first industries where production was organized by firms. Printing firms operated in lightly regulated markets. Industrial organization varied across cities and time and reflected the interplay between competition and collusion. Collusive arrangements among producers were both frequent and fragile. Our research indicates that industrial organization mattered for fundamental changes in the market for ideas. The impact of Gutenberg's revolutionary technology on markets for ideas – and thus on European economic development more broadly – was shaped by variations in the nature and extent of competition at the local level.

---

ization of Protestantism and were orthogonal to supply-side shocks due to printer deaths.

[57]In Appendix E we show that printer deaths did not shift Protestant printing via any effects on the age distribution of firms, consistent with the view that the effects ran through a more classically competition-based channel.

# References

Daron Acemoglu and James Robinson. *Why Nations Fail: The Origins of Power, Prosperity, and Poverty.* New York, 2012.

Daron Acemoglu, Simon Johnson, and James Robinson. The rise of europe: Atlantic trade, institutional change, and economic growth. *American Economic Review*, 95(3):546–579, June 2005.

Maja Adena, Ruben Enikopolov, Maria Petrova, Veronica Santarosa, and Ekaterina Zhuravskaya. Radio and the rise of the nazis in germany. *Quarterly Journal of Economics*, pages 1885–1939, 2015.

Joshua D Angrist. Estimation of limited dependent variable models with dummy endogenous regressors. *Journal of business & economic statistics*, 19(1), 2001.

Paul Bairoch, Jean Batou, and Pierre Chèvre. *Population des villes européennes de 800 à 1850.* Droz, Genève, 1988.

Frédéric Barbier. *L'Europe de Gutenberg: le livre et l'invention de la modernité occidentale, XIIIe-XVIe siècle.* Belin, Paris, 2006.

Jorg Baten and Jan Luiten van Zanden. Book production and the onset of modern economic growth. *Journal of Economic Growth*, 13(3):217–235, 2008.

Bayerischen Akademie der Wissenschaften. Deutsche biographie, 2015.

Josef Benzing. *Die Buchdrucker Des 16. Und 17. Jahrhunderts Im Deutschen Sprachgebiet.* Otto Harrasowitz, Wiesbaden, 1982.

Nicholas Bloom, Benn Eifert, Aprajit Mahajan, David McKenzie, and John Roberts. Does management matter? evidence from india. *The Quarterly Journal of Economics*, 128(1): 1–51, 2013.

Thomas A. Brady. *Communities, Politics, and Reformation in Early Modern Europe.* Brill, 1998.

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

Philip Broadhead. Guildsmen, religious reform and the search for the common good: the role of the guilds in the early reformation in augsburg. *The Historical Journal*, 39:577–597, 9 1996.

S. Broomhall. *Women and the book trade in sixteenth-century France.* Ashgate, Farnham, 2002.

Euan Cameron. *The European Reformation.* Clarendon Press, Oxford, 1991.

Davide Cantoni. The economic effects of the protestant reformation: testing the weber hypothesis in the german lands. *Journal of the European Economic Association*, 2014.

Davide Cantoni and Noam Yuchtman. Medieval universities, legal institutions, and the commercial revolution. *The Quarterly Journal of Economics*, pages 823–887, 2014.

P.W. Carey and J.T. Lienhard. *Biographical Dictionary of Christian Theologians.* Greenwood Press, 2000.

J.D. Casado. *Diccionario de impresores españoles: siglos XV-XVII.* Arco/Libros, Madrid, 1996.

Miriam U. Chrisman. *Lay Culture, Learned Culture: Books and Social Change in Strasbourg, 1480-1599.* Yale University Press, 1982.

Carlo M. Cipolla. *Before the Industrial Revolution: European Society and Economy, 1000-1700.* Methuen, London, 1981.

Colin Clair. *A history of European printing.* Academic Press, Cambridge, 1976.

Allyson Creasman. *Censorship and Civic Order in Reformation Germany, 1517–1648: 'Printed Poison & Evil Talk'.* Ashgate, Farnham, 2012.

Paul David. The historical origins of'open science': an essay on patronage, reputation and common agency contracting in the scientific revolution. *Capitalism and Society*, 3(2), 2008.

Natalie Zemon Davis. Sixteenth-century french arithmetics on the business life. *Journal of the History of Ideas*, 21(1):18–48, 1960.

Biblioteca de Huelva. Catálogo general opac. [http://213.97.164.119/ABSYS/abwebp.cgi/X5103/ID15223/G0](http://213.97.164.119/ABSYS/abwebp.cgi/X5103/ID15223/G0), 2012.

Albinia de la Mare. New research on humanistic scribes in florence. In Albinia Garzelli, editor, *Miniatura Fiorentina del Rinascimento 1440-1525.* Giunta Regionale Toscana, 1985.

Raymond De Roover. Aux origines d'une technique intellectuelle: La formation et l'expansion de la comptabilit  partie double. *Annales d'histoire économique et sociale*, 9(44):171–193, 1937.

Stefano DellaVigna and Ethan D. Kaplan. The fox news effect: Media bias and voting. *The Quarterly Journal of Economics*, 122(3):1187–1234, 2007.

J. Bradford DeLong and Andrei Shleifer. Princes and merchants: European city growth before the industrial revolution. *Journal of Law and Economics.*

A.G. Dickens. Intellectual and social forces in the german reformation. In W. Mommsen, editor, *Stadtbürgertum und Adel in der Reformation.* Ernst Klett, Stuttgart, 1979.

Jeremiah Dittmar. Information technology and economic change: the impact of the printing press. *The Quarterly Journal of Economics*, 126(3):1133–1172, 2011.

Jeremiah Dittmar. New media, competition, and growth: European cities after gutenberg. 2015. URL [www.jeremiahdittmar.com/research](www.jeremiahdittmar.com/research).

Jeremiah Dittmar and Ralf Meisenzahl. State capacity and public goods: Institutional change, human capital, and growth in early modern germany. Technical report, CEP Paper, 2016. URL [http://www.jeremiahdittmar.com/research](http://www.jeremiahdittmar.com/research).

C. Scott Dixon. The german reformation and the territorial society. *German History*, 14: 123–140, 1996.

Cristina Dondi. The venetian booktrade: a methodological approach to and first results of book-based historical research. In B. Wagner and M. Reed, editors, *Early Printed Books as Material Objects.* De Gruyter, Berlin, 2010.

Martha Driver. Women printers and the page, 1477–1541. *Gutenberg Jahrbuch*, 1998.

Mark U. Edwards. Catholic controversial literature, 1518-1555: Some statistics. *Archiv für Reformationsgeschichte*, 79, 1988.

Mark U. Edwards. *Printing, Propaganda, and Martin Luther.* University of California Press, Berkeley, 1994.

Elizabeth L. Eisenstein. *The Printing Press as an Agent of Change.* Cambridge University Press, Cambridge, 1980.

Lucien Febvre and Henri-Jean Martin. *L'Apparition du livre.* Albin Michel, Paris, 1958.

John Flood. The book in reformation germany. In J.F. Gilmont, editor, *The Reformation and the book*. Ashgate, Farnham, 1998.

Stephan Füssel. *Gutenberg and the Impact of Printing*. Ashgate, Farnham, 2005.

Matthew Gentzkow and Jesse Shapiro. What drives media slant? evidence from u.s. daily newspapers. *Econometrica*, 78(1):35–71, 2010.

Matthew Gentzkow, Jesse Shapiro, and Michael Sinkinson. The effect of newspaper entry and exit on electoral politics. *American Economic Review*, 101(7):2980–3018, 2011.

Matthew Gentzkow, Jesse Shapiro, and Michael Sinkinson. Competition and ideological diversity: Historical evidence from us newspapers. *American Economic Review*, 104(10):3073–3114, 2014.

Michela Giorcelli. The long-term effects of management and technology transfer: Evidence from the us productivity program. Stanford University Working Paper, 2015. URL http://web.stanford.edu/~michelag/giorcelli_jmp.pdf.

Richard A. Goldthwaite. Schools and teachers of commercial arithmetic in renaissance florence. *Journal of European Economic History*, 1972.

J. Gruys and C. de Wolf. *Thesaurus 1472-1800, Nederlandse Boekdrukkers en Boekverkopers*. Hes & De Graaf, Nieuwkoop, 1989.

Berndt Hamm. The urban reformation in the holy roman empire. In T.A. Brady, H.A. Oberman, and J.D. Tracy, editors, *Visions, Programs and Outcomes*. Brill, Leiden, 1994.

Rudolf Hirsch. *Printing, selling and reading, 1450-1550*. Harrassowitz, Wiesbaden, 1974.

Hans Günter Hockerts. Vom nationalen denkmal zum biographischen portal. die geschichte von adb un ndb 1858-2008. In L. Gall and Bayerische Akademie der Wissenschaften. Historische Kommission, editors, *"Für deutsche Geschichts- und Quellenforschung": 150 Jahre Historische Kommission bei der Bayerischen Akademie der Wissenschaften*. Oldenbourg, 2008.

Jochen Hoock. Professional ethics and commercial rationality at the beginning of the modern era. In M. Jacob and C. Secretan, editors, *The Self-Perception of Early Modern Capitalists*. Palgrave MacMillan, New York, 2008.

Jochen Hoock and Pierre Jeannin. *Ars Mercatoria: Handbücher und Traktate für den Gebrauch des Kaufmanns, 1470-1820*. Schöningh, Paderborn, 1993.

Jochen Hoock, Pierre Jeannin, and Wolfgang Kaiser. *Ars Mercatoria: eine analytische Bibliographie*. Schöningh, Paderborn, 1991.

Jochen Hoock, Pierre Jeannin, and Wolfgang Kaiser. *Ars mercatoria: eine analytische Bibliographie: Handbücher und Traktate für den Gebrauch des Kaufmanns, 1470-1820*. Schöningh, Paderborn, 2001.

Pierre Jeannin. *Marchands d'Europe: Practiques et Savoirs à l'époque moderne*. CNRS, Paris, 1996.

Wilbirgis Klaiber. Katholische kontroverstheologen und reformer des 16 jahrhunderts. *Reformationsgeschichtliche Studien und Texte*, 136(116), 1978.

Ian Maclean. *Learning and the Market Place : Essays in the History of the Early Modern Book*. Brill, Leiden, 2009.

T.M. Martínez, J.M.R. Asencio, and K. Wagner. *Catálogo concordado de la biblioteca de Hernando Colón*. Number v. 1. Fundación Mapfré América, 1993.

Ad Meskens. Mathematics education in late sixteenth-century antwerp. *Annals of Science*, 53 (2):137–155, 1996.

Ad Meskens. *Practical mathematics in a commercial metropolis: Mathematical life in late 16th century Antwerp.* Springer, Dordrecht, 2013.

Jean Meuvret. Manuels et traités a l'usage des négociants aux premières époques de l'age moderne. *Etudes d'histoire moderne et contemporaine*, 5:5–29, 1953.

Geofrey T. Mills. Early accounting in northern italy: The role of commercial development and the printing press in the expansion of double-entry from genoa, florence and venice. *The Accounting Historians Journal*, 21(1):pp. 81–96, 1994.

H.A. Miskimin. *The Economy of Early Renaissance Europe, 1300-1460.* Cambridge University Press, Cambridge, 1975.

Joel Mokyr. *The Enlightened Economy: Britain and the Industrial Revolution, 1700-1850.* Penguin Books Limited, London, 2011.

Joel Mokyr. *A Culture of Growth: The Origins of the Modern Economy.* Princeton University Press, Princeton, 2016.

Burt Monroe, Michael Colaresi, and Kevin Quinn. Fightin' words: Lexical feature selection and evaluation for identifying the content of political conflict. *Political Analysis*, 16(4):372–403, 2008.

Jean Müller. *Dictionnaire abrégé des imprimeurs/éditeurs français du seizième siècle.* Verlag Librairie Heitz, Baden-Baden, 1970.

Michael Mullett. *Historical Dictionary of the Reformation and Counter-Reformation.* Scarecrow Press, 2010.

David Nicholas. *Urban Europe, 1100-1700.* Palgrave Macmillan, 2003.

Angela Nuovo. *The Book Trade in the Italian Renaissance.* Brill, Leiden, 2013.

Steven Ozment. *The Reformation in the Cities: The Appeal of Protestantism to Sixteenth Century Germany and Switzerland.* Yale University Press, New Haven, 1975.

Annie Parent. *Les Métiers du Livre à Paris au XVIe siècle.* Droz, Genève, 1974.

Deborah Parker. Women in the book trade in italy, 1475-1620. *Renaissance Quarterly*, 49(3): pp. 509–541, 1996.

Andrew Pettegree. *The Reformation World.* Routledge, London, 2000.

Andrew Pettegree. *The Book in the Renaissance.* Yale University Press, New Haven, 2011.

Andrew Pettegree. *Brand Luther: 1517, Printing, and the Making of the Reformation.* Penguin, New York, 2015.

Christoph Reske. *Die Buchdrucker des 16. und 17. Jahrhunderts im deutschen Sprachgebiet: auf der Grundlage des gleichnamigen Werkes von Josef Benzing.* Harrassowitz, Wiesbaden, 2007.

Christoph Reske. *Die Buchdrucker des 16. und 17. Jahrhunderts im deutschen Sprachgebiet.* Harrassowitz, Wiesbaden, 2015.

Brian Richardson. *Printing, Writers and Readers in Renaissance Italy.* Cambridge University Press, Cambridge, 1999.

Bernd Roeck. Health care and poverty relief in counter-reformation catholic germany. In O.P. Grell, A. Cunningham, and J. Arrizabalaga, editors, *Health Care and Poor Relief in*

*Counter-Reformation Europe*. Routledge, 1999.

Jared Rubin. Printing and protestants: an empirical test of the role of printing in the reformation. *Review of Economics and Statistics*, 96(2):270–286, 2014.

Gerard Salton and Michael McGill. Introduction to modern information retrieval. 1986.

Heinz Schilling. The reformation in the hanseatic cities. *The Sixteenth Century Journal*, 14(4): pp. 443–456, 1983.

Emil Sehling, Institut für Evangelisches Kirchenrecht, and Lutheran Church. *Die Evangelischen Kirchenordnungen des XVI. Jahrhunderts*. O. R. Reisland, 1909-2013.

Werner Sombart. Medieval and modern commercial enterprise. In Frederic Lane, editor, *Enterprise and secular change: readings in economic history*. Allen & Irwin, London, 1953.

Mara Squicciarini and Nico Voigtländer. Human capital and industrialization: Evidence from the age of enlightenment. *Quarterly Journal of Economics*, 130(4):1825–1883, 2015.

Frank Swetz. *Capitalism and Arithmetic: The New Math of the 15th Century*. Open Court, Chicago, 1987.

Matt Taddy. The gamma lasso. arXiv preprint arXiv:1308.5623, 2013a.

Matt Taddy. Multinomial inverse regression for text analysis. *Journal of the American Statistical Association*, 108(503):755–770, 2013b.

Matt Taddy. Measuring political sentiment on twitter: Factor optimal design for multinomial inverse regression, 2013c.

USTC. Universal short title catalogue, 2012. URL http://arts.st-andrews.ac.uk/~ustc/index.php#.

Herman Van der Wee. Anvers et les innovations de la technique financière aux xvie et xviie siècles. *Annales. Histoire, Sciences Sociales*, 22(5):1067–1089, 1967.

Herman Van der Wee. *The Low Countries in the Modern World*. Variorum, Aldershot, 1993.

Warren Van Egmond. *The Commercial Revolution and the Beginning of Western Mathematics in Renaissance Florence, 1300-1500*. University Microfilms, 1976.

Warren Van Egmond. *Practical Mathematics in the Italian Renaissance: A Catalog of Italian Abbacus Manuscripts and Printed Books to 1600*. Giunti Barbèra, Firenze, 1980.

L. Voet. *The Golden Compasses: The History of the House of Plantin-Moretus*. Routledge & Kegan Paul, 1969.

Joachim Whaley. *Germany and the Holy Roman Empire: Volume I: Maximilian I to the Peace of Westphalia, 1493-1648*. Oxford University Press, Oxford, 2011.

Basil S. Yamey. Scientific bookkeeping and the rise of capitalism. *Economic History Review*, 1: 99–113, 1949.

Basil S. Yamey. Accounting and the rise of capitalism: Further notes on a theme by sombart. *Journal of Accounting Research*, 2(2):117–136, 1964.

Basil S. Yamey. Notes on double-entry bookkeeping and economic progress. *Journal of European Economic History*, 4(3):717, 1975.

David Yanagizawa-Drott. Propaganda and conflict: Evidence from the rwandan genocide. *The Quarterly Journal of Economics*, 129(4):1947–1994, 2014.