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Books do not die: the price of information, human capital and the Black Death in the long fourteenth century

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Books do not die:
the price of information, human capital and the Black Death in the long fourteenth century

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Abstract: The overall price trend of late-medieval hand-written books was downwards, despite rising demand by a more literate population, causing upward pressure on prices. Gradually, higher writing speeds reduced late-medieval book prices. A lower price of information facilitated schooling and an increase in human capital. The plague's demographic shock (1348-1351) reduced used book prices to one half or two-thirds of their pre-plague levels, while production costs of new books then rose. Cheaper access to information (used books) in combination with other post-plague trend breaks gave human capital in the Latin West a boost, and laid a foundation for modern economic growth.

Keywords: hand-written books, human capital, economic growth, black death

JEL Codes: N33, E24, I130.

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Introduction

This study quantifies the development of the average price of written information between 1275 and 1450 in Europe. The price of information has been characterized as the average cost in grams of silver of one thousand characters of text, in order to make different prices of books comparable over time and space. Prices of manuscript books dominated access to written information in the late Middle Ages. Then, as now, written information was essential for education. Book prices thus influenced the possibilities for schooling and the level of medieval human capital. According to current economic thinking human capital is rated as one of the major elements contributing to economic growth (Glaeser et al., 2004). Baten and Van Zanden (2008) have shown that, in the early-modern period, a larger printed book production per capita increased economic performance. This study is the first to explore whether hand-written books in the late Middle Ages delivered a similar feat.

Medieval books required a considerable time to produce by a skilled scribe, making them a luxury article. Bozzolo and Ornato (1980, 25) demonstrated that in the late medieval period average used book prices decreased in the north of France. This study investigates whether this happened in the rest of the Latin West too. The influences on book prices of scribal wages, cost of writing materials and of writing speeds have never before been quantified. Their complex interplay has been examined by studying the impact of a large economic shock (Black Death) on medieval book prices collected from over one hundred medieval libraries found in wills and inventories from all over Europe. This paper is the first to present average prices of information in Europe per quarter-century, based on a new database containing nearly 1,500 prices of precisely dated and sized medieval books.

Medieval books had a long shelf life (in the order of centuries), and did not risk becoming obsolete soon. Books were valuable and got passed on between generations, this implies that most books that changed hands were used books. Therefore prices of used books dominated the price of information. To enable comparisons this value is standardised in the initial methodological section. The second section of this paper quantifies the main factors influencing production costs of new medieval books: wages of scribes, their writing speeds and costs of writing materials. In order to explore the influence of these processes on two different price classes of books I discerned the more luxurious liturgical and the cheaper non-liturgical books.[2] This section ends with the modelled production costs of new books in the late Middle Ages. Three main categories of users (monasteries, parishes and urban literates) determined the demand of books. The next section modelled this medieval demand as the average number of new books (per capita) that were needed per half century due to demographical and cultural developments. The fourth part presents the main results, and shows the development of the price of information in quarter-century periods between 1275 and 1450. In the last section the question is addressed why a lower price of information after the plague turned out to contribute to higher levels of human capital and how this helped the economy.

[2] As liturgical books I characterized: Bibles, psalters, brevaria, missals, pontificals, antiphonaria, evangelaria, graduals and ordinaria (N=346; the database does not contain any priced and sized hymnaria and martyrologia). Bibles characterised in the various medieval inventories as small (*parvum*) and those for personal use were not considered to be liturgical books (N=12). These and all other not mentioned categories of books have been included in the database as non-liturgical (77% of all 1,487 books). Generally speaking, medieval liturgical books contained less text and on average had a more luxurious execution than non-liturgical books, which is the main reason to discern these two categories. For the transfer of practical information the cheaper non-liturgical books were the more important.

1. Methodology

The demand shock by the Black Death allows an investigation of the interaction of books, their prices and the development of human capital. The first great pestilence in the second millennium led to a huge demographic loss. In a few years the grim reaper harvested circa one third of the inhabitants of Europe.[3] In the wake of the plague wages and prices of commodities generally rose, though wages rose somewhat more than prices. The post-plague patterns of demand changed from basic goods to those with higher income elasticity (Pamuk, 2007). This study concentrates on the fourteenth century and its aftermath, when the papal right of spoil supplied numerous exactly dated prices and descriptive titles of books. In 1348, as a consequence of the Black Death, five times more book inventories ended up in the papal spoils than in previous or later decades. Additional information on fourteenth-century books was based on wills and inventories after death. I gathered data concerning prices and titles from libraries containing three or more books between 1275 and 1450.[4] Strictly speaking they exceed the fourteenth century. Data collection on prices was stopped a few years before printing started in Europe because this revolutionary technique decreased the price of information by more than an order of magnitude. Basically the various medieval book prices were standardized by dividing their sizes (in numbers of characters) by their price in grams of silver. Scribal wages were found in various medieval contracts and in modern databases containing wages of medieval craftsmen, just as the cost of parchment and use of paper. More information on writing speeds in various scripts can be found in the online appendix. This study unravels their complex interplay.

Medieval books greatly differed in their execution and cost. Some were high-valued and magnificent books intended to show off the wealth of the patron who commissioned it. Other books were plainly written and only intended for personal use, often executed as simply as possible. Medieval wills or inventories generally made no mention of either execution or illumination of books, so the only information currently available is that of a date, price and title. Therefore a simple measure is needed that skirts the unsolvable issues of cost and execution. This led to a standardised measure that only characterizes the total number of characters in a text avoiding the actual content of written information or a book's unknown workmanship or luxury. The unit kchar (kilo-char) is introduced for one thousand characters of text and Mchar (mega-char) for one million characters. Prices will be expressed in grams of silver (g Ag) to make currencies comparable. The conversion into Florentine florins of prices expressed in Paris or Tours pounds (France), Portuguese pounds and Aragon florins (Spain) was done with Peter Spufford's *Handbook of Medieval Exchange* (1986). The quantity of silver in Florentine florins and English pounds came from the IISG website 'wages and prices', (see: http://www.iisg.nl/hpw/data.php). The actual prices and titles of manuscripts in the inventories in the papal spoils were found in Williman (1980) and in Jullien de Pommerol and Monfrin (2001), and for the papal library in Jullien de Pommerol and Monfrin (1991). Additional inventories were obtained from Cavanaugh (1980), Powicke (1931), Booton (2006), Leach (1896), Bell (1936), Derolez (1966), Derolez and Victor (1999), Derolez,

[3] S. Ryan Johansson (2003, 225) in the lemma: "Epidemics" of the *Oxford Encyclopaedia of Economic History*. Though the plague paid recurrent visits to the Latin West (and the Middle East) in the following centuries, its devastating shock effect on demography and society was less severe later on, as parts of the population then had managed to develop some resistance. Therefore such later bouts of the plague fall outside this analysis. Samuel Cohn (2002, 238) describes that "… mortalities declined rapidly after the first bout of plague in 1347-1351, and by the end of the century it had become largely a disease of children."

[4] The original assumption was that concentrating on whole libraries would lead to less statistical noise in the prices. Later on, after a first analysis, this turned out to be quite the opposite, and in the final analysis I just used the prices and titles of the individual manuscripts.

Victor and Klein (2001), Pellegrin (1949), Pansier (1922), Delisle (1978), Tuetey (1903), de Laborde (1851) and Fédou (1964).

The total number of characters in medieval texts (including the fully spelled abbreviations and blanc spaces) was approximated in three different ways. The results can be found in the excel sheet named 'text sizes', see http://www.cgeh.nl/global-historical-bibliometrics for the European book prices between 1275 and 1450. The first approximation was by a word count of Latin texts, whenever these were available in electronic form (black in database). In second instance printed texts were used when no electronic texts were available. The total numbers of characters in a few sentences were sampled and multiplied with the numbers of sentences per page and the numbers of pages to arrive at an estimate of text size (dark blue in database). The third and last source of sizes were the lists of peciae and hire prices of various medieval texts named in Thorndyke (1975, 112-117), Murano (2003) and Genest (1988), for which I used the relationship of 1 quaternus = 2 peciae = 32 columns. The calibration was done with texts by Thomas Aquinas found in Latin in electronic form on the site of the corpusthomisticum.org: *Summa Theologiae Prima Pars, (STPP), Summa Theologiae Prima Secundae, (STPS), Summa Theologiae Secunda Secundae, (STSS), Super Primo Sententiarum (SPS), De Spiritualibus Creaturis (DSC), Summa Contra Gentiles, (SCG), Questiones De Malo (QDM)*. For these works I regressed their sizes on the numbers of peciae of its exemplar (R^2 =0.99). Per pecia on average a size of 45.7 kchar was found, and a denier (d.) of hire on average leads to a text size of 75.0 kchar. With these two relationships I estimated the sizes of a few hundred texts of which I knew numbers of peciae or medieval hire prices (light blue in database).

The database contains information on 1,487 different hand-written books with their titles, sizes and precisely dated prices between 1275 and 1450. These books stem from 119 libraries: Belgium, 5; England, 35; France, 50; Germany, 1; Italy, 16; Portugal, 4; Spain, 6; and Sweden, 2.[5] The only prices and titles not included in the database were those of books in the inventories that were characterised as incomplete or defunct, those whose sizes or dates could not be established or whose prices could not be expressed in silver.

2. Production cost of medieval books

The production cost of a hand-written book largely depends on the average speed of writing, the wages of a medieval scribe, cost of parchment and the binding of a manuscript. In general binding cost least, for non-liturgical books this is some 4% of the total cost (Filippone, 2008). The bulk of the cost (not counting either illumination or binding) is hiring a scribe. This is some 60% to 80% of the total, and the rest is mainly that of writing material: usually parchment (Filippone, 2008). The basic assumption underlying this study is that the size of a text has a direct relationship with the time a scribe spends writing, and with the amount of writing support. This implies that a more or less linear relationship is expected between textual sizes and prices of books. Historically a number of contracts have been handed down in which costs were stipulated of copying a text. Generally speaking, the cost of a new book

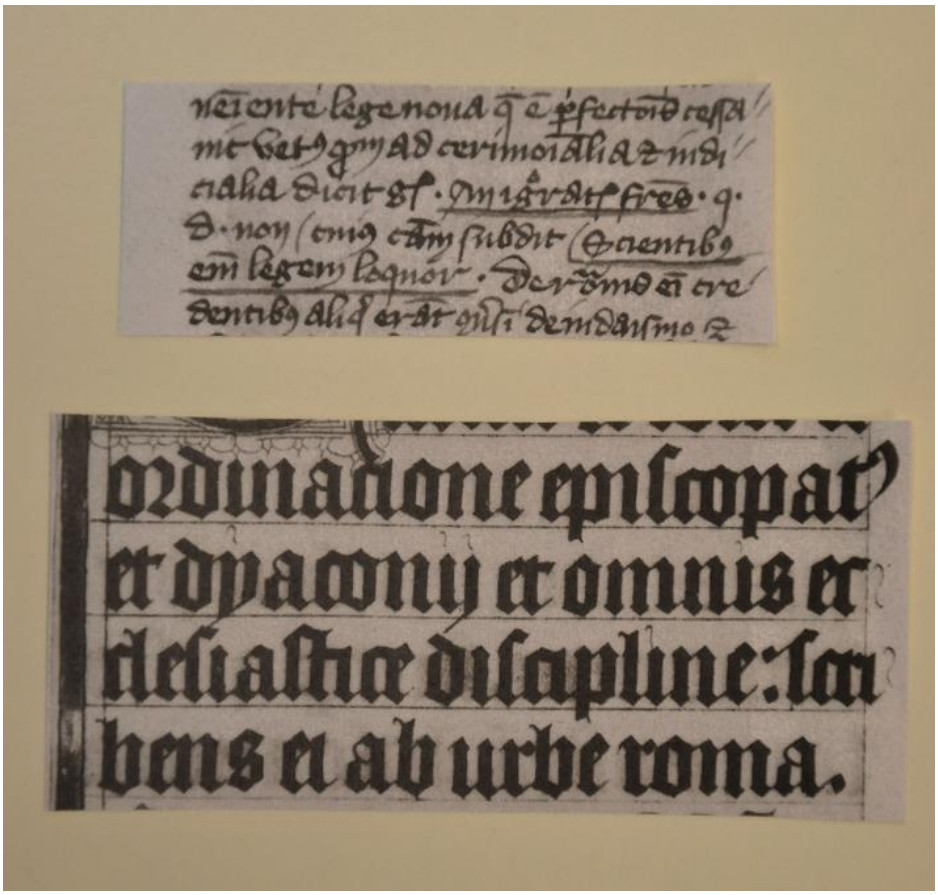
[5] The prices of books in the French royal library (1424) have been included too (N=20), though they may have been at the low end. When the French king desperately needed money during the Hundred Years' War he sold his library to the enemy at a bargain price (Bozzolo and Ornato, 1980, 21, note 10). Table 4 shows that average prices were considerably higher during this quarter century then in the later and previous periods, so the inclusion of this library did not bias our results.

caps the expected medieval price of a used book. If production costs of new books fall, prices of used books are expected to follow.

The bulk of the cost of copying a text is determined by two different elements: a scribe's writing speed and his daily wages. This study concentrates on writing speeds of secular professional scribes, free from spiritual obligations sometimes limiting the speed of monastic scribes. Unfortunately accurate and quantitative information on medieval writing speeds is rare. Virtually all reported speeds are expressed in terms of (non-size-defined) leaves (folios) or lines per day. I have recalculated these into a more standardised measure by dividing the collected size information of texts (in kchar) by the number of days a scribe spent writing.

Writing speeds
Figure 1 gives examples of the two main types of late-medieval scripts this paper discerns: speedier cursive scripts and a formal and slower *textualis formata,* generally used in liturgical books. Figure 1-a is a detail from a *Postillae* by Nicolaus de Lyre written in a gothic cursive in 1401 (Utrecht, UL, 255, f 12). A detail from a Bible written in *textualis formata* in 1473 (Utrecht, UL, 31^{v}, f 187v) can be found in Figure 1-b.

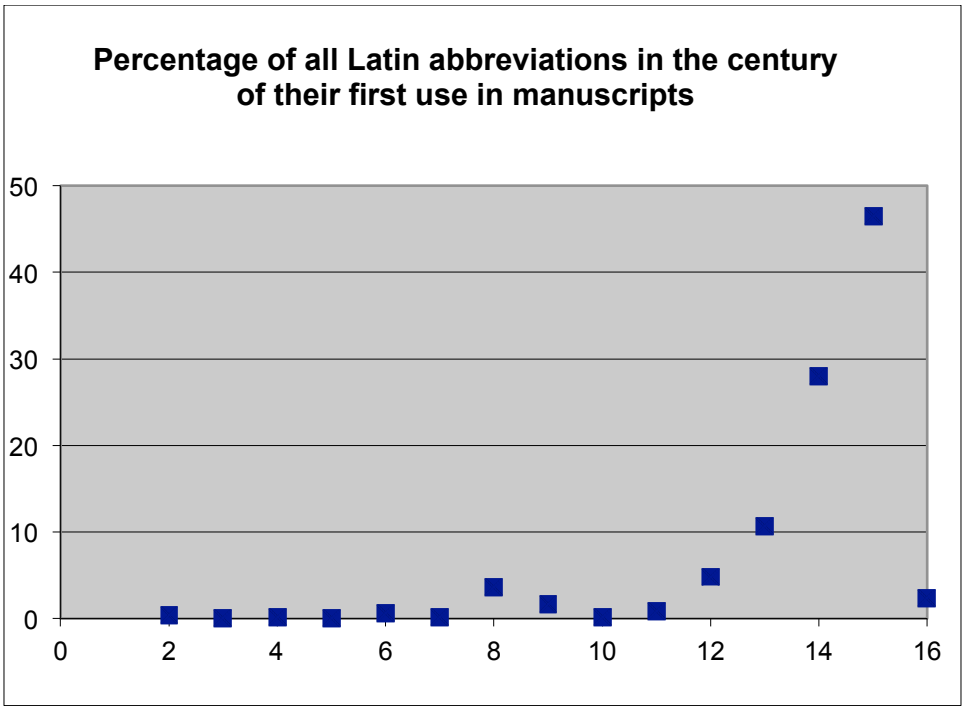
Figure 1. Fifteenth-century examples of cursive script (1-a) and *textualis formata* (1-b). Source: see text. (actual size)



The medieval texts used in this study to estimate their writing speeds at various dates are presented in the online appendix (see www.xxxx). The preliminary conclusion from these examples is that around 1300 professional scribes wrote nearly 12 kchar/day in cursive

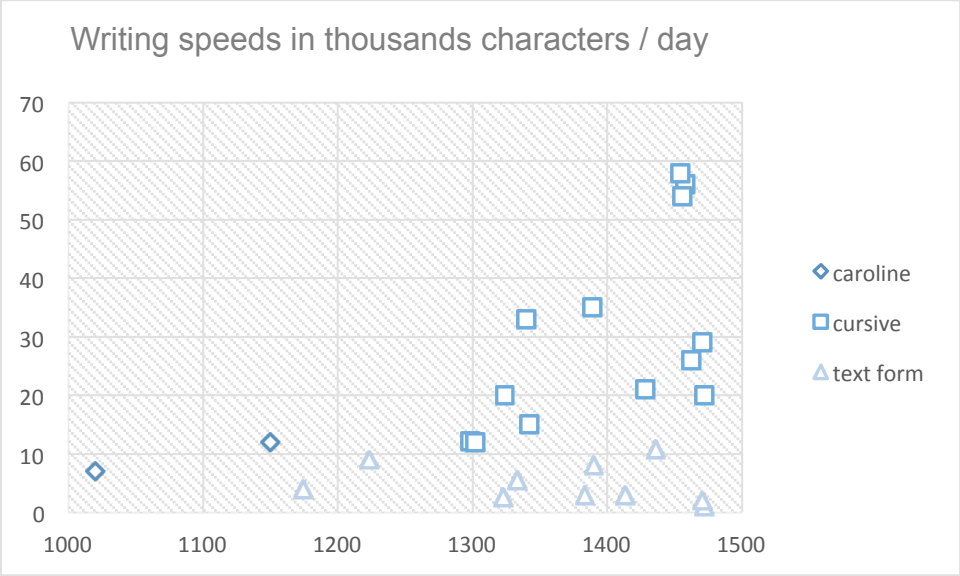
scripts, which at the end of the fourteenth century may have increased to 25 kchar/day, rising to some 40 kchar/day at the end of the next half-century. A writing speed of around 50-60 kchar/day should certainly be considered to be a rather exceptional higher limit. Individual differences between scribes were considerable. Later medieval scripts were less formal, mostly smaller, often more cursive and also frequently used common abbreviations. Those later scribes actually had to write far fewer letters to arrive at similar writing speeds in kchar/day. Table 1 contains the estimated writing speeds of non-liturgical books (often in cursive scripts) in the study period. Figure 2 explains visually why the writing specifically speeded up in the period studied. It shows the percentage of Latin abbreviations in the first century of their use, based on a random sample (N=501) of the 14,000 abbreviations contained in Cappelli (1990[6]).

Figure 2. The percentage of Latin abbreviations in the first century of their use, source: Cappelli (1990[6]).



As a rule cursive scripts were not used for liturgical books (neither was paper in the study period). Liturgical books were generally written in a more formal letter: *textualis formata,* which took considerably more time than cursive scripts. The writing speeds in this slower letter are also described in the online appendix. Based on this information I assumed an initial writing speed of around 3 kchar/day for the formal scripts used in luxury manuscripts or liturgical books. A missal from Salzburg (1436) and a breviary produced in France in this period, containing other scripts next to the slower *textualis formata* suggest that also for liturgical books speeds had accelerated somewhat at the end of the study period, possibly coming to 5 kchar/day in 1401-25 and 10 kchar/day in 1426-50. Figure 3 plots the found data on writing speeds.

Figure 3. Average writing speed of professional scribes in kchar/day in the caroline, cursive scripts and in the *textualis formata*. (Sources, see online Appendix: Writing speeds)



Hiring of a scribe

Actual data of hiring a scribe can be found in Shooner (1988, 31). He indicates that around 1300 a Paris scribe got paid 4 sol's per 4 folios, or 12d./folio. The price of hiring a scribe is close to 1d./kchar, and would have come to about 4.4 gAg/day or a cost of 0.36 gAg/kchar of text, assuming a ratio of 8 sols to the florin around 1300. In February 1341 master Gautier Lallemand received 9 gAg/day for copying 54 quires of large sexterns over slightly more than a year for the writing atelier of Pope Benedict XII (Pansier, 1922, 11). Lallemand's scribal wages come to 0.27 gAg/kchar. Because of his remarkable writing speed of 33 kchar/day he earned exceptionally well. Another papal scribe, Jean Jauffre, copied 24 similar quires and received a sum of 4.1 gAg/day, which is closer to the wages of a typical craftsman, coming to 0.29 gAg/kchar. His speed was a more modest 15 kchar/day. The accounts concerning the Litlyngton missal show that its scribe earned 4.5 gAg/day in 1382-1384, around the average wage of an English craftsman (see Table 1), while a scribe at Ely received 3.7 gAg/day in 1372 (Bell, 1936, 316).

Cost of writing support

Table 1 presents parchment prices in England from the IISG website on 'wages and prices'. The average price is 29.9 g silver/dozen in England for 1376-1400, which compares very well with French parchment prices presented by Bozzolo and Ornato (1980, 31) coming to 28.9 g silver/dozen. Paper prices are more difficult to find. The IISG website gives data on Spanish paper and on imported paper in England. There the first local paper mill only started to operate late in the fifteenth century. Bozzolo and Ornato (1980, 35) give a factor of four as price difference between the cost of paper and parchment for paper-producing France between 1350 and 1400. Competition and technological progress further decreased French paper prices between 1400-1450, increasing the difference between paper and parchment to a factor of eight. IISG data indicate that for imported paper in England this difference was only a factor two, because of transport costs. Before 1350 a similar difference is assumed on the Continent.

Table 1 also presents the fraction of new books actually written on paper. For this I analysed the composition of writing support and dates of copying of some 3,500 eleventh- to sixteenth-century manuscripts in *CMD* (*Catalogue des Manuscrits Datés*) from libraries in Italy, Austria, Belgium, France, Netherlands and Great Britain. Results can be found on the excel sheet named 'CMD'. The following *CMD*'s were consulted: CMD-I-1, CMD-I-2, CMD-A-1, CMD-B-1, CMD-B-2, CMD-F-2, CMD-F-3, CMD-NL-1, CMD-NL-2, CMD-GB-2, CMD-GB-3, CMD-GB-4 (sources see Buringh, 2011, 524).

Table 1. Writing speed, cost of parchment and wages of craftsmen, fraction of paper in new manuscripts, and difference in cost of parchment versus paper. (Sources respectively: online appendix, online appendix, IISG, IISG, *CMD*, *CMD*, Bozzolo&Ornato, IISG)

period:	Writing speed kchar / day li-turgical	Writing speed kchar / day non-lit.	Parch-ment g Ag / dozen	Wage craft g Ag / day	fraction paper new mss	fraction paper new mss	diffe-rence parchm / paper	diffe-rence parchm / paper
1276-1300	3	12	14.03	3.71	0.00	0.00	2	2
1301 - 25	3	12	15.43	4.16	0.04	0.00	2	2
1326 - 47	3	15	14.11	3.94	0.04	0.00	2	2
1352 - 75	3	19	34.79	4.67	0.20	0.00	4	2
1376-1400	3	25	29.85	4.87	0.39	0.05	4	2
1401 - 25	5	31	22.75	4.66	0.29	0.05	8	2
1426 - 50	10	40	26.11	4.56	0.42	0.21	8	2
area:	L. West	L. West	England	England	France	England	France	England

Cost estimates of new books

Appendix A explains the estimate of production costs of new medieval books, based on the values presented in Table 1. The results are presented in Table 2.

Table 2. Modelled new prices of medieval books in grams silver per thousand characters (gAg/kchar). Source: Appendix A

	liturgical books	**non-liturgical books**
1276-1300	1.595	0.361
1301 - 25	1,887	0.405
1326 - 47	1.616	0.305
1352 - 75	2.477	0.334
1376-1400	2.435	0.246
1401 - 25	1.231	0.187
1426 - 50	0.678	0.143

As a check the modelled values in Table 2 have been compared to surviving medieval production costs, not used for Figure 3. The production cost of *SQS* by Thomas Aquinas

(Liège, UL, 143 C) was 0.163 gAg/kchar in 1462 (Steinmann, 2013). It was written on parchment and the comparable modelled value is 0.170 gAg/kchar.[6] Production costs of parchment manuscripts written for Peterhouse (Cambridge) in the 1440s in a slower 'hybrida' (and not in cursive script) came to 0.266 gAg/kchar (Fillipone, 2008). Naturally this is somewhat higher than the modelled value 0.170 for cursive scripts. An additional check is comparing the modelled new price to the cost of copying a book by the previously mentioned master Lallemand (1341) in Avignon. This came to 0.340 gAg/kchar[7], which is near the above-modelled value of 0.305. These comparisons corroborate modelled production costs.

Per thousand characters the modelled price of new liturgical books is more than a factor four higher than that of (generally less luxurious) non-liturgical books. First of all, average writing speeds of liturgical books were considerably slower (a factor four to eight times) because their scripts were more formal. The quality of the parchment in liturgical books was generally higher, and in this period the use of slightly cheaper paper was confined to non-liturgical books, together explaining considerably lower prices of non-liturgical books.

Furthermore, Table 2 shows a clear post-plague break. New liturgical books increased more in price (+50%) then less luxurious non-liturgical books (+10%). Higher costs of parchment and higher wages of craftsmen are to blame for these post-plague price increases. Two reasons make this increase lower in non-liturgical books. Firstly, the general trend of average writing speeds of non-liturgical books had increased with 27% in this quarter century (while not changing in liturgical books), secondly approximately 20% of the new non-liturgical books then were written on paper. Some 37 ppt of the 40 ppt post-plague price difference between liturgical and non-liturgical books is caused by this rise in writing speed, the lower priced paper explains a minor 3 ppt. Average writing speeds of liturgical books then had not changed and these were solely written on parchment, causing higher post-plague prices (see Table 1). Before presenting the actual results of the prices of used medieval books in the Latin West (Section 4) I will first explore how the demand of new books was influenced by the plague.

3. Medieval demand of books

In a previous publication *Medieval Manuscript Production in the Latin West* I estimated the demand of manuscripts in the Latin West with a demographic model based on the use of books by monasteries, parishes and urban lay population. In this study the previously used assumptions, based on available historical data, have all been taken at face value and only the previous centenary time periods were split into two. Numerically the (now split) century-averages were the same as in the original calculations. For details on this model the reader is referred to Table 5.15 (Buringh, 2011, 295). In the first half of the fourteenth century after a couple of years of famine early in the century the population was assumed stagnant. In the model, in 1350 (after the Black Death), there is only 2/3 of the population left, and naturally demand diminishes. This abrupt loss of one third of all human life has been considerably larger than the average loss of manuscripts (1/8 per half-century), thereby sometimes leading to negative values, see Appendix B. Negative values in the modelling imply that there is a

[6] Table 2 includes a paper fraction of 0.42 in non-liturgical books in the time period, therefore we should look at the liturgical books (all written on parchment) with a writing speed of 10 kchar/day (1426-50); by dividing 0.678 by 4, one approaches the production cost of new non-liturgical books written on parchment in the period 1426-50 with a writing speed of 40 kchar/day.

[7] This value is calculated by multiplying the previously presented scribal costs of 0.27 gAg/kchar with 1.26, the factor that converts scribal costs of non-liturgical books into total production costs, see Appendix A.

relative oversupply of durable books. Only when population numbers have bounced back actual demand of new manuscripts turns positive again.

Table 3. Demand (in thousands) of new books in the Latin West and demand per capita modelled according to Appendix B.

new demand period	*clergy*	*Parish*	*urban*	Total	all books in circulation 000s	average population in period (in millions)	demand of books per cap. in half-century	Standardised: **average = 50** demand p.c.	fraction of books from 14th c. in circulation at end of peri
1251-1300	347	418	842	1,708	3,832	57.9	0.0295	**51**	0%
1301-1350	158	296	1,002	1,458	4,811	63.3	0.0230	**40**	30%
1351-1400	0	0	403	403	4,209	43.9	0.0092	**16**	40%
1401-1450	91	223	2,374	2,688	6,724	49.2	0.0546	**94**	22%

The eighth column of Table 3 contains the per capita demand of new books. In the ninth column this has been standardised (to a whole-period average of 50). In the second half of the thirteenth century demand in Europe was somewhat higher than in the half-century directly before the Black Death. Per capita demand of new books drops considerably in the half-century after the plague. The model estimates it to be 40% of its previous level. An oversupply of already existing books decreased demand. The model indicates a sharp increase in demand (to almost double the period average) in the beginning of the fifteenth century, mainly due to a then larger and considerably more literate urban population.

Table 3 indicates that only some 30% of books in circulation around 1350 were actually written in the fourteenth century. An anecdotic corroborating example is a fourteenth-century library containing 37 books (Bozzolo and Ornato, 1980, 115). The production dates of its manuscripts show that 27% $\pm$ 7% of its books were produced in the fourteenth century.

4. Prices of used medieval books

Table 4 shows the price development in the Latin West of nearly 1,500 used books per quarter century between 1276 and 1450. The four plague-years have been presented separately because the Black Death did not strike everywhere in the same year. One should not contribute too much weight to these exceptional plague-years. Though the actual prices per thousand characters of individual books jump about (see the considerable standard deviations in Table 4), the averages before and after the plague present an informative picture with some statistically significant differences ($p<0.05$). The table shows that after the Black Death values of used books, whether liturgical or non-liturgical, dropped significantly in price to between one half and two thirds of their pre-plague levels. A significant rise in used book prices can be observed around 1400, which is followed by a decrease in the second quarter of the fifteenth century.

Table 4. Average price of information in grams of silver per thousand characters text (gAg/kchar) in used books, modelled new prices, and used prices as percentages of the new prices of liturgical and non-liturgical books.
Source: used books: database, see http://www.cgeh.nl/global-historical-bibliometrics; new books: Table 2.

	liturgical books				**non-liturgical books**			
period:	g silver / kchar av.	stdev.	N=	new price	**%**	g silver / kchar av.	stdev.	N=	new price	**%**
1276-1300	0.574	± 0.446	18	1.595	36%	0.290	± 0.220	35	0.361	80%
1301 - 25	0.414	± 0.245	17	1,887	22%	0.194	± 0.248	58	0.405	48%
1326 - 47	0.607	± 0.546	59	1.616	38%	0.166	± 0.135	280	0.305	54%
1352 - 75	***0.408***	± 0.585	84	2.477	16%	***0.103***	± 0.098	343	0.334	31%
1376-1400	0.548	± 0.626	54	2.435	23%	0.082	± 0.081	103	0.246	33%
1401 - 25	***1.125***	± 1.166	43	1.231	91%	***0.177***	± 0.184	196	0.187	95%
1426 - 50	***0.331***	± 0.279	28	0.678	49%	0.069	± 0.063	50	0.143	48%
1348 - 51	0.414	± 0.349	43			***0.117***	± 0.298	76		

Only the values in bold face and italics are differing in a statistically significant way ($p < 0.05$) from those in the previous quarter-century.

Now I will perform some robustness checks on the results of Table 4. First of all, a check is in order to see if the found values around 1450 can be corroborated. An anchor point for this comparison is the average textual price of printed information in the 1460s, as this was the first decade of printing in Europe. Printing had to compete on a market then still dominated by hand-written books, and therefore its price level may be expected to be slightly lower. Prices of printed books in the 1460s have been divided by the numbers of characters in their texts, completely identical to the procedure followed with manuscript books. The average value of printed matter (N=9) is 0.168 ± 0.120 gAg/kchar in the 1460s and is in the range of prices of hand-written books around 1450.[8] It shows that printing presses could compete with the higher end of the market (liturgical books), and that non-liturgical books generally still were slightly cheaper in hand-written form in the 1460s. Soon printing experienced further technical progress, and increasing competition rapidly decreased prices of printed books in the following decades. Cuijpers (1988, 47) gives a ten times lower average value of 0.0168 gAg/kchar for printed matter in 1480, eventually dropping to 0.0112 gAg/kchar in 1540. Such low prices for information implicate that no sixteenth-century scribe could still make a living by competing with the printing press, even not if assuming a totally improbable writing speed of 100 kchar/day. Except for some niche markets hand-written books had lost out.

A second check is on the percentage of the price of used versus new books. In Table 4 overall average prices of used books as a percentage of new books are respectively 39% (liturgical)

[8] Cuijpers (1988, 35) gives four prices, a printed Bible in 1466 comes to 0.0849 gAg/kchar, an unbound *De Civitate Dei* and a different Bible are respectively 0.4022 and 0.1415 in 1467, and an *Epistolae* by Jerome fetches 0.2827 in 1468. Neddermeyer (1998, 837) also gives four prices, a *De Civitate Dei* is 0.1043 in 1470, a Bible in 1461 comes to 0.0849, a *STSS* by Thomas Aquinas in 1463 fetches 0.0521 and a *Catholicon* cost 0.1661 gAg/kchar in 1465. A *Summa Astesani* in 1470 of 0.1916 gAg/kchar completes the list of printed books (Rouse and Rouse, 2000, vol 2, 225).

and 56% (non-liturgical). This allows a different check of the values in Table 4. The fraction of liturgical books is 0.23 of the total, which leads to an overall percentage of 52% for the price of used books. This overall value matches nicely with a similar overall figure of 50% previously presented by Bozzolo and Ornato (1980, 43).

The above results have been found by converting local currencies into silver, by estimating sizes of texts mentioned in medieval inventories, and standardising the relative prices for every book by dividing its cost in silver by its text size in kchar. One could argue that values so obtained are the result of clever data manipulation. To counter this argument I calculated the, much too simple, pre- and post-plague overall averages of the actual non-standardised book prices in silver. Looking at all fourteenth-century prices before 1348 shows that an average medieval book then cost 803 g silver, while after the plague it cost 425 g silver (1352-1400). This is a decrease to 53% of its pre-plague price level. However crude, this finding reveals that the sizing of medieval manuscripts hasn't been numerically crucial. It shows that even if I had used a random number generator to size the various medieval books, the sheer magnitude of the database would have led to similar results. The various robustness checks implicate the found results can be trusted.

A preliminary remark concerning an explanation for post-plague prices is that nowhere in the book historical or codicological literature one finds that book production before or after the plague was considered fundamentally different in size, content or workmanship. In a study describing the conditions of production and diffusion of books between the thirteenth and fifteenth centuries the '*éminence grise*' of quantitative codicology Ezio Ornato (1997, 97ff) does not even mention the plague. *The Cambridge History of the Book in Britain, 1100-1400* refers to the Black Death twice, both times to indicate a date and not a phenomenon influencing books (Morgan and Thomson, 2008). Although the plague caused a large demographic shock with enormous and long-lasting social consequences, it most certainly was not a codicological watershed.

Prices mentioned in medieval wills and inventories are by their nature those of used books. Table 3 allows an interesting conclusion to be drawn. Because of their longevity (and value) hand-written books often got passed on after their owner had died. A typical medieval person may be expected to actually possess a book for a period of around a quarter-century of a book's on average four centuries 'life-time'.[9] Table 3 indicates that in the middle of the fourteenth century circa 30% of manuscripts in circulation had been copied in that same century; at its end this was some 40%. Such percentages implicate that not much more than around 5% to15% of all books in circulation were actually bought as new books. Therefore the bulk of medieval books in general circulation was second-hand, and thus used book prices are indicative for the medieval price of information.

The secular trend is downward in the late Middle Ages. Long-term average book prices of liturgical books (new and used) decreased with some 21% and 15% per half-century over the study period, while those of non-liturgical books (new and used) decreased with respectively 23% and 34%. These Europe-wide figures more or less confirm a long-term downward trend of the book-prices of 20% to 25% per half-century in the north of France, previously sketched by Bozzolo and Ornato (1980, 25).

[9] The durability of medieval books explains the modelled average loss rate of 1/8th per half century used in Appendix B. For loss rates see Buringh (2011, p.54-57, p.179-251).

The detailed picture of prices per quarter-century in Table 4 is even more interesting, and sometimes shows quite opposite trends. Contrary to prices of new books post-plague prices of used books dropped significantly to one half or two thirds of their pre-plague levels. An oversupply of used books after the plague because of a lack of demand probably caused this price fall. The more expensive liturgical books were 38% of their new price before the Black Death, while they decreased to respectively 16% and 23% of their new price in the two quarter-centuries afterwards. For cheaper non-liturgical books these figures are 54% pre-plague and respectively 31% and 33% afterwards. Table 3 shows that demand by monasteries and parishes was virtually zero due to the oversupply in the half-century after the plague, inducing even lower second-hand values for the higher priced liturgical segment.
The strong rise in demand in the beginning of the fifteenth century leads to an absolute increase in prices of used books, quite contrary to what then happened to new books. Liturgical and non-liturgical books doubled in price compared to those at the end of the fourteenth century. A considerable rise in demand (see Table 3) of mainly urban literates increased used book prices to 91% (liturgical) and 95% (non-liturgical) of their new price in the first 25-years of the fifteenth century. In the following quarter-century the second-hand price as a percentage of its new price is nearing its long-term average of 52% again, liturgical books then are 49% of the new price, and non-liturgical books come to 48%.
There is a considerable correlation between the demand per capita and the used book price as a percentage of its production cost, explaining the found price developments. For liturgical books the correlation coefficient is 0.85, and for non-liturgical books it is 0.67. However, due to the low number of observations (only seven quarter-centuries), solely the correlation of liturgical books is significant ($p<0.05$). Variations in estimated medieval demand explain respectively 72% (liturgical) and 44% (non-liturgical) of the variation in book prices. It shows that ups and downs in demand had a considerable influence on the prices of used books.

5. Why did a lower price of books turn out beneficial for the Latin West?

Gradually, falling prices of used books enabled access to information at less cost. After the plague this drop was maximal in texts of interest to specific segments of the skilled population. Though most medieval books were of a religious nature, there were scores of texts for non-clerical professionals, such as lawyers or doctors. Easier and cheaper access to such information will have contributed to human capital formation. Cheaper textbooks will enable more and also less wealthy persons to finish some form of education. The invention of printing has been credited with a reduction of the access cost of information, thereby becoming an important agent of change (Eisenstein, 1979). Dittmar (2011) showed that European cities with printing presses in the 1400s grew faster in the next century. Early-modern human capital formation, proxied as printed book production per capita, positively influenced economic performance (Baten and Van Zanden, 2008). The falling price of hand-written fourteenth-century books suggests this process may have started even before printing.

One of the immediate consequences of the plague was a deficiency in educated clerics and lay people who could participate in the administration. The Church found itself seriously short of manpower, resulting in a sharp rise in plural benefices. To cope with the lack of personnel the Church closed monasteries and parish churches and started mass ordination of young and often ill-educated and untrained clerics. The epoch after the Black Death witnessed a plethora of new foundations of colleges and universities all over Europe to refill the depleted ranks of clerics, to save students the risks of travel (which was considered dangerous), and finally because the deaths of the plague had produced a flood of pious bequests benefiting schooling (Herlihy, 1997, 69). Table 5 shows the absolute chances per year of the foundation of new

universities per million inhabitants in the Latin West. Skip the zeroes in this table, the absolute values of new university foundations are not of interest, it is the statistically significant difference in chances before and after the plague that matters. Table 5 also shows the chances per year of the foundation of a new reading/song school (primary) or a new grammar school (secondary) per million inhabitants in England, based on Orme (2006).

Table 5. The chance of a new foundation of a university (Latin West), primary and secondary school (England) per year and per million inhabitants.
(Sources: university foundations: Cantoni and Yuchtman (2014)[10], primary (reading/song) schools and secondary (grammar) schools: Orme (2006) and inhabitants: Appendix A and McEvedy and Jones, 1979).

Period	Universities Latin West	Primary schools England	Secondary schools England
1275 – 1300	0.0014	0.19	0.03
1301 – 1347	0.0013	0.14	0.16
1348 – 1400	0.0041	0.23	0.22
1401 – 1425	0.0044	0.24	0.21

Table 5 shows that the chance per capita of founding universities in Europe tripled after the plague. Furthermore, already existing universities grew in size after the plague. Cambridge acquired four new colleges (+100%) and Oxford two (+50%). This larger supply of higher education led to a surge in educated lay people and clerics in Europe in a few decades, more than making up for the losses caused by the plague. A few figures on the prevalence of medieval academics may corroborate this. Between 1301-1350 only 4% of all clerics in Cahors (N=2,053) had studied at a university (Ferrari, 2003, 22). This same source indicates that between 1326-1523 the fraction of university-trained clerics with benefices in Zürich rose to 36% (N=1,050), and in St Gall, Heilbronn and Anspach the fraction of clerics with university degrees after 1500 was approximately 50%. More university schooling has contributed to an increasing literate (and mainly urban) population, which in its turn explains a higher demand of books some decades after the plague. Table 5 also shows that possibilities for primary and secondary schooling increased in England after the plague. Due to the demographic shock there were more already-existing schools available for a then smaller number of pupils. Furthermore Table 5 shows that the per capita rate of foundations in England of new primary and secondary schools slightly increased after the plague, thereby even enlarging the average possibilities for schooling.

In 1370 in Bautzen (Germany) a pupil paid two groschen for a half-year of basic schooling while simple school books as 'ABC', '*pater noster*', '*credo*' or '*benedicite*' cost one groschen. This pupil's follow-up book: '*ars minor*' by Donatus cost ten groschen (Steinmann, 2013). Prices of books necessary for basic schooling then were a considerable fraction of the cost involved in human capital formation. At a medieval university it cost approximately six years of study to obtain a degree. The cost of living around 1380 in London was around 10d. per week (Bell, 1936, 317), and a student would therefore have spent some 3.3 kg silver on

[10] In contrast to Cantoni and Yuchtman I considered the university of Prague to have actually started in 1349, which also is in accordance with the 500th anniversary of this university that was celebrated in 1849.

board and lodging before acquiring an academic degree. Assuming this student was studying law, he certainly had to obtain his own copy of the '*Codex*', a standard medieval textbook. In the database the '*Codex*' is item # 384, and finding its price development is simple. This book cost 958 g silver before the Black Death (N = 6), making it a non-liturgical book with a more than average value. After the great pestilence its price had dropped to 239 g silver (N = 18), indicating a fall to 25% of its pre-plague level.[11] Assuming board and lodging not to have changed greatly before or after the plague, and assuming that this student went home with two personal textbooks similar to the '*Codex*' after having completed his study; before the plague this student would have had to pay an extra 58% on top of his investment in schooling.[12] After the Black Death this investment had only to be augmented with 14% to obtain both texts.

Post-plague monetary capital had become relatively more abundant in the Latin West. This contributed to lower interest rates all over Europe (Clark, 1988; Homer, 1977). Lower interest rates made capital goods relatively cheaper, despite increasing wages and prices of commodities after the Black Death. Langdon (2004, 225) showed that in the first half-century after the plague, in England the average rent of an important and ubiquitous medieval capital good as a grain water mill dropped to 51% of its pre-plague level. The plague fostered economic development in a direction that increased per capita labour productivity, the use of, and investment in, capital goods. Lower interest rates after the plague led to a fall in skill premium, see Van Zanden (2009). A decreasing skill premium is a sign of a rising level of human capital. The original wage data (underlying Table 1) show how in England this skill premium, on average 115% in the half-century before the Black Death, dropped to a value of only 49% afterwards. A lower price of information, more schooling and decreasing interest rates facilitated late medieval human capital formation.

That average levels of human capital probably increased after the Black Death, can be corroborated by a century-long growth of GDP per capita, independently occurring in England, Holland and Italy after the plague (Broadberry and Van Leeuwen, 2011). For the period 1352-1400 and compared to the previous half-century1301-48 these authors have in fact quantified modern economic growth (a growth in GDP_{pc}). I will concentrate on England because of longer data availability. The half-century growth of GDP_{pc} was 35% in England when comparing average GDP_{pc} in 1275-1348 to 1352-1400. In the next half century (1401-50) compared to the first half-century after the plague this growth of GDP_{pc} still was 7% in England. As a crude approximation I used a simple Cobb-Douglas production function to distribute the growth of GDP_{pc} in a half-century over capital (K) and labour (L):

$$GDP_{pc} = a * K_{pc}^{\alpha} * L_{pc}^{\beta} \qquad \text{(in which } \alpha + \beta = 1\text{)}$$

In the Cobb-Douglas production function the letter 'K' stands for the level of physical capital per capita, which incorporates the important medieval production factor land, while 'L' stands for the amount of human capital per person. The values of the coefficients α and β mostly are somewhere around 0.25 and 0.75 (I will explore a range of values to show that the actual coefficients do not really matter). The factor 'a' in the above expression is an area- and time-

[11] This price fall is considerably larger than that of typical non-liturgical books. An explanation for such an aberrant price development before and after the plague can be found in its marketability. A second-hand copy of a '*Codex*' would have not found a new home easily. The content of this book is only of value to a lawyer. Once a lawyer already had a copy of this text in his possession an additional copy of such a legal text would not be very useful to him, which can explain their relatively higher drop in prices when the market was temporarily oversupplied and there were less lawyers buying such textbooks.

[12] As food prices generally rose after the Black Death and prices of housing generally decreased then, (see IISG website 'wages and prices') this assumption does not seem totally out of the blue.

specific factor, which amongst other things is a proxy for the inverse of local transaction costs.[13] This makes the actual values of 'a' dependant on the levels of local institutions, as well as on an area's geographical characteristics enabling transport and trade. As I do not presume that institutions and geographical characteristics had greatly changed because of the plague, the value 'a' can here be considered to be a constant around 1350. During the plague one third of the population died, assuming the amount of physical capital itself not to be influenced by the Black Death then leads to a new value of at max 1.5K after the plague.[14] This allows solving the actual post-plague value of human capital or 'L', compared to its pre-plague level. It shows the value of 'L' has increased 30% in the first half-century after the plague for typical values 0.25 and 0.75 of the coefficients α and β in order to cause a growth of 35% in English GDP_{pc}. For different coefficients, e.g. 0.4 and 0.6 (α and β) this increase in human capital is still 26%, while for 0.1 and 0.9 it is 33%. Average levels of human capital will have risen after the plague for a wide range of coefficients. A rising level of human capital in this period is also what De Pleijt (forthcoming) finds for England. Though a formal econometric proof is lacking, the above calculations plausibly show that lower prices of access to information after the plague coincide with increasing levels of human capital, aiding a beginning of modern economic growth.

Conclusions

A previously reported long-term trend of gradually decreasing prices of late medieval books in the north of France can be found over the whole of the Latin West too. The secular trend of a decrease in prices of some 15% to 35% per half-century is caused by a considerable rise in average writing speeds, overpowering the influence of an also gradually rising medieval demand for hand-written books, which forced prices upwards. The resulting lower price of information contributed to a gradual rise in human capital.

After the Black Death prices of new books rose abruptly, as hiring a scribe and parchment had become more expensive. However, prices of used books dropped to one half or two thirds of their pre-plague levels. In the Middle Ages most books that passed hands were used books. The now lower price of used books made written information accessible to a larger public at lower cost. It enabled more people to invest in schooling, eventually leading to a higher demand of books a couple of decades after the plague, which drove prices upwards in the beginning of the 1400s. The ups and downs in medieval demand of books can explain a considerable part of the variation in the found book prices.

A temporary lower post-plague price of used books in combination with lower interest rates and growing opportunities for schooling gave a large boost to human capital in the Latin West. A lower skill premium is also a sign of such a larger human capital base. It is plausible that after the plague higher levels of human capital facilitated a beginning of modern economic growth.

[13] The Cobb-Douglas production function does not incorporate import and export, the factor 'a' to a certain extent compensates for this omission, which by the way was considerably smaller in the late medieval period than currently.

[14] This value may in fact have been lower than 1.5K because after the plague prices of housing dropped and less fertile lands went out of production, nevertheless a lower value of K produces even higher values of human capital.

Appendix A

This appendix explains the production cost estimates of medieval books in quarter-century periods in Table 2. Basically the price of a new book is determined by its size (in kchar), which indicates how many days a scribe was copying it (in kchar/day) for wages (in gAg/day) and the amount of parchment/paper (in gAg/dozen) on which it was written (see Table 1 and database). There are, however, additional costs that still have to be included, such as these for binding, ink, quills and rubrication. The assumption is that the development of the prices of parchment is a proxy for these additional costs. Joanne Filippone (2008) gives examples of the total costs of new hand-written books (thereby including such additional costs). For liturgical books her Tables 2 and 4 give examples from the fourth quarter of the fourteenth century. For liturgical books (N=3) the costs in addition to the scribal wages are a fraction 0.333 $\pm$ 0.058 of the total. The non-liturgical books (her Table 3) are from the fifteenth century, the additional part is 0.206 $\pm$ 0.025 (N=5) of their total cost. These two fractions differ. Its cost is larger for liturgical books, as such books generally were written on a better quality parchment and often had a more luxurious binding.

The database indicates that the average size of liturgical books is 1.42 Mchar in 1376-1400. With an average writing speed of 3 kchar/day and an average wage of 4.87 gAg/day this would come to a sum of 2.305 kg silver as scribal wages of a typical liturgical book in this period. The as yet unknown additional costs are 0.33 of the total cost, so the 2.305 kg silver has to be multiplied with 1.5 to find the total cost of a new liturgical book. The additional costs of 1.153 kg silver lead to a factor of 0.03861 [= 1.153 / 29.85] with which the parchment price at the time of "29.85" (see Table1) has to be multiplied to find the additional part. The scribal wage part follows from the sizes in the database. For the other periods actual parchment prices in combination with this factor (0.03861) let us estimate the additional part of a new liturgical book. Though we still have to take into account that writing speeds gradually increased over time by using more abbreviations and correct for an underestimate of parchment use by multiplying the result with the quotient of the actual writing speed of this example (3 kchar/day) and that in the time period in question. These successive numerical exercises allow us to arrive at production costs of typical liturgical books presented in Table 2. By dividing the result by the average size we standardise it to a price/kchar of text.

The average size of fifteenth-century non-liturgical books in the database is 4.25 Mchar, with an average writing speed of 35.5 kchar/day and a wage of 4.61 g silver, and would lead to a price of 0.559 kg silver for the scribal costs of a new non-liturgical book. This figure has to multiplied by 1.26 to find the additional costs, leading to a factor of 0.005935 to convert the average parchment price of "24.43" in the fifteenth century into the additional fraction in kg silver. Because non-liturgical books were also written on the somewhat cheaper paper we have to take this into account by multiplying by [1-fraction of paper/difference between parchment and paper] from Table 1. For the rest calculating the total price of new non-liturgical books is similar as for liturgical books.

Appendix B

The underlying assumptions in this model and a more detailed explanation of its values can be found in Table 5.15 (Buringh, 2011, 295). I have assumed that after the Black Death (here for reasons of model simplicity concentrated into the last day of the year 1350) the European population was reduced to 2/3 of what it was before the great pestilence.

Appendix B. Calculations with a demographic model.
For a numerical basis of the values reference is made to Table 5.15 (Buringh, 2011, 295).

				with negative values			without negative values		
			before BD	after BD			after BD		
	1250	1300	**1350**	**1350**	1400	1450	**1350**	1400	1450
total population in millions	52,5	63,3	63,3	42,2	45,4	53,0	42,2	45,4	53,0
percentage clergy	*2,0*	*2,0*	*2,0*	*2,0*	*2,0*	*2,0*	*2,0*	*2,0*	*2,0*
clergy * 1000	1050	1266	1266	844	908	1060	844	908	1060
mss per clergy	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
clergy mss * 1000	1050	1266	1266	844	908	1060		1108	969
Proxy mss replacement 1/8 (* 1000)		131	158	158	106	114		0	138
Proxy mss clergy new * 1000		216	0	-422	64	152		0	91
percentage parishes	*0,25*	*0,25*	*0,25*	*0,25*	*0,25*	*0,25*	*0,25*	*0,25*	*0,25*
parishes * 1000	131	158	158	106	114	133	106	114	133
mss per parish	*6*	*7*	*8*	*8*	*9*	*9*	*8*	*9*	*9*
parishes mss * 1000	788	1108	1266	844	1022	1193		1108	969
Proxy mss replacement 1/8 (* 1000)		98	138	158	106	128		0	138
Proxy mss parishes new * 1000		320	158	-264	178	171		0	223
percentage urban population	*15,0*	*18,0*	*20,0*	*20,0*	*22,0*	*22,5*	*20,0*	*22,0*	*22,5*
urban population * 1000	7875	11394	12660	8440	9988	11925	8440	9988	11925
percentage literate in urban population	*5*	*8*	*10*	*10*	*12*	*15*	*10*	*12*	*15*
lay urban literates * 1000	394	912	1266	844	1199	1789	844	1199	1789
mss per lay literate	*1,5*	*1,6*	*1,8*	*1,8*	*2,0*	*2,5*	*1,8*	*2,0*	*2,5*
lay urban mss * 1000	591	1458	2279	1519	2397	4472		1994	1745
Proxy mss replacement 1/8 (* 1000)		74	182	285	190	300		0	249
Proxy mss lay urban new * 1000		868	820	61	878	2075		403	2374

A first remark is that the exact numbers in this model should not be taken too literally. They give an indication of the general size of demand and can be used as a rough comparison of the different periods, but are certainly not set in stone.

A second remark is that this model only covers replacement demand and new manuscripts because of an increase in population. Commissions of new manuscripts made to order for wealthy patrons as a result of changes in preferences are not adequately modelled. Neither the oversupply of manuscript books after the plague nor the increased prices of hiring a scribe, illuminators or parchment were an impediment for the rich to restrict their commissions of new manuscripts. In the later medieval period, the production of books for lay buyers had

become a luxury segment of the market. Great (post-plague) lay patrons such as Charles v, king of France, and his brother Jean Duc de Berry were famous for their commissions of large numbers of luxury manuscripts. This example was widely followed by their retinue. Aside from lay patrons there were also clerical patrons. Modelling a value of zero with the clergy and the parishes in the half-century before 1400 is one that does not represent reality. The modelling resulted in a value of zero because strictly speaking the total numbers of monastics and clergy diminished so much that on average they could have filled their demand of books by using replacements that would have been available from earlier periods. That they did not do this and wanted to have new customized manuscripts does not make the modelling worthless; it just indicates that its results have to be interpreted with caution.

Online Appendix: Writing speeds

Accurate and quantitative information on medieval writing speeds is rare. Virtually all reported speeds are expressed in terms of (non-size-defined) leaves (folios) or lines per day. I have recalculated these figures into the more standardised measure (of thousands of characters per day) used in this study by dividing the collected size information of their texts (in kchar) by the number of days a scribe spent writing it. These writing speeds concern hand-written books written in the Carolingian caroline (which because of its time period is no part of this study but has been included here to give some indication of long-term developments of medieval writing speeds), in the former and slower *textualis formata* or *textura* and in the quicker gothic cursive. For medieval scripts size also matters, and smaller letters generally took less time to write.

Caroline
A number of very early writing speeds in a caroline or Carolingian minuscule, the letter of choice during the Carolingian and early post-Carolingian period, can be found in Gullick (1995, 46). Around 1020 various works by Augustine (Paris, BNdF, lat 12219) were written in 7 kchar/day in St Maur-des-Fossés, while in 1150 a Lanfranc was written in Worcester (London, BL, Roy 5 F xii) in a late caroline in 12 kchar/day.

Cursive
Examples of early professional writing speeds in cursive scripts can be deduced from basic data presented by Shooner (1988, 31-33), implying that around 1300 a copy of *SQS* by Thomas Aquinas (Paris, Bibl. Mazarine, 848) was completed in 12.2 kchar/day. A contemporary *STPS* by Thomas Aquinas, (Paris, BNdF, Lat 15344) was written with a speed of 12 kchar/day. This paper assumes scribes wrote 300 days/year, similar to the number of working days of medieval millers (Langdon, 2004, 242).[15] Bell (1936, 316) indicated that a *Vitae Patrum* was copied in 20 kchar/day in 1324. From Wattenbach (1958, 291) I calculated that a copy of the third decade by Livy was produced in 1389 in 35 kchar/day. A *Moralia in Job* was written in Italy in 1428 at an average speed of 21 kchar/day (Wattenbach, 1958, 292). Pansier (1922) found a contract (1458, Avignon) in which a scribe promised to copy the whole *Postillae* by Nicolaus de Lyre on 1,440 large folios in 16 months, implying a writing speed of 56 kchar/day. Pansier (1922, 89) gives two other French contracts in 1456 in which professional scribes agree to copy texts with similar writing speeds. Examples given by Overgaauw (1995) concern two Dutch professional scribes working in Italy in the fifteenth century. In 1470 one of these copied a second part of the *Summa theologica* by Alexander de Hales (Rome, Bibl. Angel., 537) in 29 kchar/day. In 1472 the other copied a *Historia tripartita* composed by Cassiodore in 20 kchar/day. De Hamel (1986, 229) describes the work of a scribe around 1480 who wrote "*l'arte lo ben morire*" in a total of 53 hours, implying a speed of some 18 kchar/day in a slower 'humanistic rotunda'. A different scribe presented by De Hamel (1986, 232) copied a number of works by Caesar in 1462 (London, BL, Add 16892), in 26 kchar/day.

Textualis formata
Gullick (1995, 46) indicates that a New Testament (Vienna, ÖNB, 1174) was written probably in Krems in 1174 with a speed of 4 kchar/day in a *textura*. A Bible in a small *textura* and completed in 1223 in Novarra (Tours, BM, 1) was written in a speed of 9 kchar/day (Gullick, 995, 46). For the more formal *textualis formata* Wattenbach (1958, 291) reported

[15] For his calculations of writing speeds in lines per day Gullick (1995, 46) assumes six days of writing for a medieval scribe, which comes to a similar 300 days per year.

that a gradual in Aldersbach was produced in 1323 at a speed of some 2.6 kchar/day. A *New Testament* was written in Austria in 1333 in 5.5 kchar/day (Wattenbach, 1958, 292). In 1383-84 the Litlyngton missal was written in 600 days in 3 kchar/day. Gullick (1995, 46) reports that a *Roman de la Rose* was written in a *textura* in Sully-sur-Loire in 1390 in 8 kchar/day. The scribe of the *Tres Riches Heures du Duc de Berry* in 1413 was only mentioned during one year in the duke's accounts. Assuming a size of 0.4 Mchar for its text and a writing period somewhere around 150 days, I come to writing speed of 3 kchar/day. In 1436 a missal was completed in Salzburg with an average speed of 10.7 kchar/day (Wattenbach, 1958, 292). A later (monastic) scribe took years to complete a multi-volume Bible (Utrecht, University Library, 31), written between 1464 and 1472 in around 1 kchar/day (CMD-NL-2, p.173). This last scribe also had his religious duties, but probably the main reason why this large Bible took so much time was the considerable size of its letters. Its '**d**' had a height of on average 10 mm. This is considerably larger than the average height of 6 mm of the same letter in the *Tres Riches Heures*. When looking at the square of the letter heights (a proxy of its surface area) a difference of a nearly factor three in writing speed can thus be readily accounted for.[16] The letter '**d**' in liturgical books produced in France (CMD-F-2, F-3 and NL-1) had an average letter height of 6 mm in 1326-50, which had decreased to 4 mm a century later, resulting in a roughly twofold increase in writing speed. Gullick (1995, 46) reports that a fraction of the *Moralia* (only 10 of the 35 books) was written in Weesp in 1470 in a *textura* in 1.6 kchar/day (Cambridge, Fitzwilliam Museum, McClean 271).

All these data have been plotted in Figure 3 and presented in Table 1 in: "Books do not die: the price of information, human capital and the Black Death in the long fourteenth century". Supporting indirect evidence of actual writing speeds in the Middle Ages can be found in the calculated average size of the pecia of 45.7 kchar. To allow students to copy a text at a medieval university an individual pecia was rented out for period of generally one week (Christ, 1938, 9), which assuming a six day writing week, would amount to an average writing speed of some 8 kchar/day. This gives us an average medieval writing speed that was considered doable in the period around 1300.

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