Appendix I

Method for the estimation of manuscript (ms) production in Latin West 501-1500

A sample of surviving manuscripts from the Latin West

We used a subset of 17,352 manuscripts (mss) as a sample of currently remaining mss produced in eleven areas, together encompassing the Latin West (Table I-1). This sample covers the period from 501 to 1500 and was drawn from a global database containing descriptors of 29,871 mss copied in 19 centuries prior to the twentieth. The results of the global database covering two-dozen areas of the earth are published separately (Buringh, 2009). The original global database was constructed from a library that contained over 2,100 books, publications and volumes of journals on mss anywhere in the world. The procedure followed to construct the database and the mathematical operations applied afterwards will be described meticulously in this appendix.

We will use the subscripts ($_i$) and ($_k$) to identify respectively the ten centuries and eleven areas of the subset Latin West. For the global database and its subset we employ capital letter N, while capital letter M signifies the set of currently still surviving numbers of mss and W indicates the set of mss originally produced in medieval times. A capital letter *S* stands for the maximal numeric part of a specific set of mss in a library, which all have the same alphanumeric shelf mark. While for the same library lower case *s* represents the total number of mss in the database that all have the same alphanumeric shelf mark. The letters L_i and F_k respectively stand for the loss rates of mss from century (*i*) in percent per century and for the dimensionless spatial calibration factors per area (*k*).

Table I-1. Geographical distribution of mss over areas (*k*) from the subset Latin West in the database ($N_{i,k}$) in absolute numbers per century (*i*)

	Century (i)									
Area (k)	*6th*	*7th*	*8th*	*9th*	*10th*	*11th*	*12th*	*13th*	*14th*	*15th*
CentrE						3	12	26	61	98
Boh						6	6	14	103	143
Brit	1	14	64	34	60	122	281	343	250	432
Fran	18	29	162	277	68	235	597	760	790	2,154
Belg		2	15	15	11	59	173	236	197	1,367
Neth		1	2	1	1	6	17	10	60	1,008
Germ			52	152	166	176	343	274	280	632
Switz		1	17	56	27	16	20	16	25	54
Austr			19	24		10	77	38	38	109
Italy	82	40	50	57	61	152	216	283	925	1,928
Iberia	4	7	9	19	61	50	81	83	113	165
Latin West	105	94	390	635	455	835	1,823	2,083	2,842	8,090

blanc spaces indicate that there were no mss in the database for that period

Source: database Buringh 2009

Construction of the database

The following four selection criteria, that should each be met one by one, determined inclusion of any ms into the global database:

- First of all, the ms in question should be handwritten, furthermore it is regarded as a codicological entity (the intended end product of a writers scribal activities, Mostert, 1989), which means that its size could range from a surviving fragment to a wholly intact ms as well as any fraction of a ms in between;

- Secondly, mss copied on papyrus, wood, wax tablets, parchment, vellum, leather, paper, leaves or plant material, cloth or silk can all be found in the global database, however writing on other materials as stone, slate, clay (*ostraca*) and tiles or writing embroidered or woven into cloth were not included in the database;
- Thirdly, the availability of a picture of the ms in one or more of the publications in the library was a criterion for inclusion, this however does not necessarily imply that only illustrated mss were included, merely that a specimen of the writing or illustration had been considered to be so important by the original author of the publication found in the library that it warranted its reproduction;
- Finally, there should be a (sometimes brief) description of the place and date of origin and an indication of the contents of the ms in question and some location of the place where it is kept or has last been and of its shelf mark to help with retrieval of the ms and to have a unique and universally usable identification code.

As a result of these four inclusion criteria we may expect temporal and spatial skewness to arise in the global database as a consequence of unavoidable publication and selection biases. Nevertheless, numerically such skewness can be overcome by specific correction and standardization steps, as we will demonstrate later. Other codicological data that, if known, were included in the database were the author, title and illuminator and the total number of references in the library to that specific ms. Mss that are currently lost or destroyed but that nevertheless satisfy all four inclusion criteria have been incorporated into the database. It should be stressed that as such the contents of a ms was not one of the criteria for inclusion.

For the Latin West eleven areas of ms production have been discerned. These will be described with their borders around 1990. The area called “CentrE”, short for Central Europe, lumps the relatively few mss from Hungary, Slovakia, Poland, Denmark, Sweden, Finland,

Norway and Iceland into one large geographical container. “Boh” or Bohemia may be identified with the Czech republic, while the British Isles and Ireland have been considered as a single area. France is seen as one entity and the heading “Belg” combines the mss originally copied in Belgium and Luxembourg. The Netherlands, Germany, Switzerland, Austria and Italy are all separate areas, while “Iberia” comprises the whole of the Iberian Peninsula including Spain and Portugal and the part-time Moorish territories. When the location of production of a ms was presented in a publication as jointly in Northern France/Belgium as happened for quite a number of Psalters or Books of Hours or jointly in France and Germany for Carolingian mss, the origins of these mss were distributed by chance over one of the areas, with a 1:1 for Northern France and Belgium and 2:1 for France and Germany by taking into account the proportion of firmly localized mss for these areas and periods.

A uniform procedure has been followed to prevent any ambiguities in dating. According to regular costume century *B* starts with the year (*B-1*)01 and ends with the year *B*00 and is called the B^{th} century. Any ms with a firm date of copying has of course been given that date and those dated to a certain century have been given the date of the middle of the century, so a ms from the fourteenth century gets dated as 1350. For those mss that have been dated to some mixed century as twelfth/thirteenth, chance has been used to assign it to either the twelfth (date:1200) or the thirteenth (date:1201), a similar approach has been taken for mss that were dated to around a century, as circa1200, which also leads to an equal chance of ending in either the twelfth or thirteenth. The use of chance to consign mss to a certain century was applied to some 8% of the subset.

Palimpsests have of course been included twice in the database with their appropriate places and dates, in accordance with the concept of a codicological entity. For more complex mss

(convolutes or albums) that have been produced over more than a century the date of the picture in the original publication has been decisive. When more than one picture over more than one century was available for such a ms, each century has been seen as a separate entry, though it was quite seldom that something like this happened (one of the better known exceptions in the global database is the St Petersburg Muraqqa).

It may be without mention that Byzantine mss produced in Southern Italy (currently 43 mss in the database) have been included under the heading of Italy, similarly as a single Armenian ms in the database that was produced in Italy, as the area of production was the decisive criterion for its localization. Also Jewish mss have not been seen as a separate entity but have been included under their various areas of production.

Validation of the database

The global dataset has been validated against the available quantitative distributions of mss. For the earlier part (outside the current period of 501-1500) the distribution of roll and codex in Egypt in the first to fifth century in the database has been contrasted with an overview presented by Mazal (1999, 134). This comparison led to an explained variance of 99%. A point estimate of books in the inventory of an Egyptian church property in the seventh and eighth centuries (Hoogendijk and Van Minnen, 1991, 54) also compared favorably with a similar subset from the database. A comparison of a later date than the period currently under observation of Dutch *Alba amicorum* of the sixteenth-eighteenth centuries in Dutch libraries (Thomassen, 1990, 11) produced an explained variance of 88%.

For the current period (501-1500) and subset (Latin West) specific validations have been performed too. Latin Gospel Books from fifth-eighth century presented by McGurk (1961) and a similar subset from the database led to an explained variance of 86% (data not shown). A number of ninth century monastic catalogues (Becker, 1885) and an appropriate subset of

the database led to an explained variance of 87% (data not shown). The comparison of Latin bestiaries from the eleventh to fifteenth century (Baxter, 1998, 147-8) and the database produced an explained variance of 98% (data not shown). The whole European corpus of *manuscrits datés* (*CMD*) is extensive and quite pivotal for mss from the Latin West and therefore this comparison has been included here (Table I-2). A comparison of the database and the distribution of mss in *CMD* led to an explained variance of 95%. The *CMD* also allows validations for the 5th and 16th centuries; these are reported elsewhere (Buringh, 2009).

Table I-2. Historical distribution of mss in Latin script from *CMD* and from the subset Latin West in the database.

Century (i)	*CMD*	Latin West Database (N_i)
6th	**2**	**105**
7th	**5** ½	**94**
8th	**28** ½	**390**
9th	**160**	**635**
1 0th	**90**	**455**
11th	**236**	**835**
12th	**567**	**1,823**
13th	**877**	**2,083**
14th	**2,032**	**2,842**
15th	**10,520**	**8,090**

Source: CMD and database, for more information see Buringh (2009)

The relatively high explained variance for the various validations indicate that the found (relative) distributions of mss in the database compare well with what we can find in the relevant literature, and we may conclude that with these comparisons also those specific subsets have been validated. Because the global database is so extensive in its coverage we cannot compare it directly with any known dataset, and therefore we can only compare certain subsets of the database with appropriate standards for these subsets. With an argument of induction we may conclude that if some arbitrary subset of the database compares well with its appropriate standard we can also conclude that the other not checked parts would have compared well with standards had they been available. Therefore we may presume that the whole database has been validated and not just the subsets that we scrutinized above.

Spatial calibration per area

We can expect a certain spatial skewness in the database caused by publication and selection biases, which may either over or under represent mss from a certain area. However, we can compensate for both biases together by counting per area in the subset how many local mss from that area the local libraries in that area contain and how many local mss the shelf marks of these local mss represent and standardize the distributions with a spatial calibration factor. Ruggles and Brodie (1947) reported on statistical methods used by Allied intelligence during the Second World War to estimate enemy war production on the basis of serial numbers of captured materiel, and quite similar to the methods of Ruggles and Brodie we have used library shelf marks to estimate total numbers of mss in a library. The total numbers of mss with the same (alphanumeric) shelf mark have been estimated as: $S*(1+1/s)$. An estimate on the basis of the above approach concerning the total numbers of global mss, which instead of the current subset uses the whole database together with a more extensive treatment of the results, can be found in Buringh (2009).

For eleven areas Table I-3 presents the total number of local mss ($N_k^{shelfmarklocal}$) in local libraries and the number of local mss in the subset of the Latin West (N_k^{local}) together with the average number of local mss that each one of these specifically local mss in the database represents. Per area the average number of local mss per local ms has been divided by the overall average number of local mss for one local ms from the total subset of the Latin West to arrive at the dimensionless spatial calibration factor (F_k^{area}) in the last column of Table I-3.

Table I-3. The values of F_k^{area} and the local numbers of mss (N_k^{local}) and total numbers ($N_k^{shelfmarklocal}$) based on the shelfmarks of *k* areas.

Area (*k*)	N_k^{local}	$N_k^{shelfmarklocal}$	av. numbers/ local ms	F_k^{area}
Central Europe	136	57,428	422	5.767
Bohemia	121	4,216	35	0.476
British Isles	1,127	59,848	53	0.725
France	2,059	125,518	61	0.833
Belgium	687	31,599	46	0.628
Netherlands	648	12,140	19	0.256
Germany	1,013	90,690	90	1.223
Switzerland	149	3,227	22	0.296
Austria	230	20,541	89	1.220
Italy	1,514	122,865	81	1.108
Iberia	185	48,102	260	3.551
Latin West	7,869	576,174	73	1.000

Source: database Buringh (2009)

When this spatial calibration factor F_k^{area} (in Table I-3) is 1.000 there is no under or over representation in the subset of the database. For areas with a spatial calibration factor over 1.000 the numbers of mss in the subset are lower than average, and should be multiplied by this factor to compensate for the under representation, something similar applies to a spatial calibration factor under unity that signifies a relative over representation in the subset. Next, in order to find the spatial calibration for every area from the subset in Table I-1 the numbers of mss ($N_{i,k}$) are multiplied by the area specific spatial calibration factor (F_k^{area}) and the resulting spatially corrected distribution ($N_{i,k}^{spatial.\ cor}$) is presented in Table I-4.

Table I-4. Spatially corrected distribution of mss ($N_{i,k}^{spatial.\ cor}$) from Latin West

	Century (i)										
Area (k)	6^{th}	7^{th}	8^{th}	9^{th}	10^{th}	11^{th}	12^{th}	13^{th}	14^{th}	15^{th}	F_k^{area}
CentrE	0.0	0.0	0.0	0.0	0.0	17.3	69.2	149.9	351.8	565.2	5.767
Boh	0.0	0.0	0.0	0.0	0.0	2.9	2.9	6.7	49.0	68.1	0.476
Brit	0.7	10.2	46.4	24.7	43.5	88.5	203.7	248.7	181.3	313.2	0.725
Fran	15.0	24.2	134.9	230.7	56.6	195.8	497.3	633.1	658.1	1794.3	0.833
Belg	0.0	1.3	9.4	9.4	6.9	37.1	108.6	148.2	123.7	858.5	0.628
Neth	0.0	0.3	0.5	0.3	0.3	1.5	4.4	2.6	15.4	258.0	0.256
Germ	0.0	0.0	63.6	185.9	203.0	215.2	419.5	335.1	342.4	772.9	1.223
Switz	0.0	0.3	5.0	16.6	8.0	4.7	5.9	4.7	7.4	16.0	0.296
Austr	0.0	0.0	23.2	29.3	0.0	12.2	93.9	46.4	46.4	133.0	1.220
Italy	90.9	44.3	55.4	63.2	67.6	168.4	239.3	313.6	1024.9	2136.2	1.108

Iberia	14.2	24.9	32.0	67.5	216.6	177.6	287.6	294.7	401.3	585.9	3.551
Latin West	120.8	105.3	370.4	627.4	602.5	921.1	1932.4	2183.6	3201.6	7501.3	

The spatially corrected distribution of mss ($N_{i,k}^{spatial.\ cor}$) from the Latin West from Table I-4 will form the basis for the next step a correction of the temporal skewness of the database.

From relative to more absolute numbers

After the validation and spatial calibration we still need to come from a relative distribution of a subset of the database to one that is more absolute. We have used the distribution over time of surviving manuscript and printed books from medieval libraries of Great Britain presented by Ker (1964[2]) to achieve this. Ker has shown for 5,337 mss that once were in British libraries how they are distributed in an absolute way over the period sixth to fifteenth century. By looking what proportion of the subset of the database coincides with that of Ker ($N_i^{ker\ n\ dbase}$) we can determine the correction factor (per century) with which we have to multiply the specific fractions of the subset ($N_i^{spatial.\ cor}$) to arrive at a distribution ($M_i^{no\text{-}scale}$) that is less relative but not absolute as it has not yet been scaled. The results are presented in the first six columns of Table I-5.

Despite the fact that we have constructed a less relative distribution of the subset over the period sixth-fifteenth ($M_i^{no\text{-}scale}$) we are not yet done, as Ker (1964[2]) had to leave out of his book quite a number of medieval mss (a multiple of what he could describe) that did no longer contain any sign of medieval ownership, for instance on a fly leaf, with which he could document an attribution of their origin to one of the medieval libraries in Great Britain. Fortunately there are a number of peg's for the Latin West (three in this case) to quantify the

missing fractions and arrive at the desired absolute numbers. They are from different centuries and therefore may be used for extrapolations to other centuries.

Table I-5. Un-scaled distribution ($M_i^{no\text{-}scale}$) of mss in the Latin West and the scaled distribution ($M_i^{Lat\text{-}West}$) for the period 501-1500 based on Ker and the database.

Century (i)	Ker (1964[2])	$N_i^{ker\ n\ dbase}$	Correction factor (*i*): column2/3	$N_i^{spatal.\ cor}$	$M_i^{no\text{-}scale}$	*Scaling factor (i)*	$M_i^{Lat\text{-}West}$
6th	1	1	1.00	120.8	120.8	2.0	242
7th	6	5	1.20	105.3	126.4	2.0	253
8th	28	15	1.87	370.4	691.4	2.0	1,383
9th	37	15	2.47	627.4	1,547.6	5.5	8.512
10th	86	34	2.53	602.5	1,524.0	5.0	7,620
11th	250	65	3.85	921.1	3,542.7	4.5	15,942
12th	1,452	146	9.95	1,932.4	19,218,1	4.0	76,872
13th	1,514	88	17.20	2,183.6	37,567.8	3.5	131,487
14th	1,144	60	19.07	3,201.6	61,043.8	3.0	183,132
15th	819	51	16.06	7,501.3	120,462.1	2.5	301,155

For the period prior to the ninth century there is a collection of (fragments) of mss that has been covered extensively in the series *Codices Latini Antiquores* by Lowe. *CLA* had described in its latest count in 1971 some 1,811 mss. Since then Bischoff and Brown (1985) have described another 54 new items and Brown had some dozen more in 1991 (Mayo and Sharma, 1992) so a nice round number would be some 1,900 mss from this period. For the 939 mss (from the sixth to the eighth) in Table I-5 ($M_i^{no\text{-}scale}$) we now can assume that they coincide

with some 1,900 still surviving mss and therefore have to use a *scaling factor* of 2.0 to correct for the missed mss and arrive at an absolute distribution in the Latin West.

We fortunately also have a standard for the ninth century because of the work of Bischoff (1998), Birgit Ebersperger (1999) and Bischoff and Ebersperger (2004) implicating that currently some 8,200 continental mss from this century survive. When we also take into account the numbers of surviving Visigoth mss (Millares Carlo, 1983[3], vol1, 323-342) and the numbers of insular mss based on Anglo-Saxon mss by Gneuss (2001) the estimated the numbers of surviving ninth-century mss amount to 8,500 for the Latin West. For the relative number of 1,548 mss from the Latin West in the ninth century (Table I-5) this second peg of 8,500 leads to a *scaling factor* of 5.5 to correct for the missed mss of the absolute distribution.

There is a third peg for the thirteenth century. This may be found in the 50 remaining Latin bestiaries that Baxter (1998, 147) reports that have been produced in the British Isles. He also reported a relationship between numbers of bestiaries and other mss on medieval booklists and finds 1 bestiary for some 375 other mss. The multiplication of the 50 remaining bestiaries with the 375 other mss on medieval booklists would have lead to a value, based on the booklists, of 18,750 remaining mss in total. When this total number is divided by the previously presented value of 5,337 for the identified number of surviving mss found by Ker we arrive at a *scaling factor* of 3.5 for the thirteenth century to correct for the mss that were missed.

For the centuries between the ninth and thirteenth, the *scaling factor (i)* is found by linear interpolation between the above presented values of respectively 5.5 and 3.5, while for the two centuries after the thirteenth the *scaling factor* based on a straight line is extrapolated for

the fourteenth and fifteenth centuries. This approach produces century specific *scaling factors* in Table I-5 (7^{th} column). The results of the so calculated absolute numbers of the currently remaining mss ($M_i^{Lat\text{-}West}$) from the Latin West are presented in the last column in Table I-5.

Note that by this procedure with independent pegs presenting more or less "golden standards" we have made the relative results (of the subset) of the database largely independent of the size of the database, for a different size of the database the values of the various scaling factors just would have been different from those presented above while nevertheless the final results would probably have remained quite similar numerically.

Correction of losses

When the absolute numbers of surviving mss are corrected for the losses that have occurred in the period between the original copying of the ms and the present we may arrive at the numbers produced in medieval times. The data presented by Ker (1964[2]) also is pivotal for the quantification of losses of medieval mss. Ker's data allows the calculation of loss rates in percent per century of medieval mss from a number of libraries in Great Britain for the twelfth-sixteenth centuries, these data and the ensuing loss rates are presented in Annex L (Buringh,2009). Quite similarly for non-UK libraries loss rates of mss have been calculated in Annex N (Buringh, 2009) based on a host of other references.

We will briefly describe the method to quantify the loss rates (L_i) of medieval mss. For the calculation of the loss rates of mss in a certain medieval library we need the original numbers of mss (*b*) and the presently remaining numbers (*c*). We also need two dates (expressed in units of centuries), a date (*B*), in the past, when the content of the original library was counted or when the medieval press or shelf marks were originally attributed to the mss in the library

and a date (*C*) at which the current numbers were established of mss surviving from that specific library.

Apart from those rather extraordinary situations where there were specific data on the original numbers of medieval mss, generally the original numbers (*b*) have been estimated from the medieval press marks or shelf marks similarly to the method used for estimating the numbers of remaining mss for a certain shelf mark in a library with the formula: *S*(1+1/s)*, which has been elaborated above in the section on spatial calibration. The loss rate (L_i) in percentage per century can then be calculated as:

$L_i = - (1 - e^{(\ln(c/b)/(C-B))})*100\%$.

From the data produced by Ker (1964[2]) a geometric mean loss rate of mss in UK-libraries has been determined at -22%, -28%, -39% and -40% per century for the twelfth to fifteenth centuries respectively (more details can be found in Buringh, 2009). No UK-loss rates could be calculated before the twelfth century because of a lack of data. Therefore for these earlier centuries a similar loss rate has been assumed as was found for the twelfth century. Not only the loss rates but also the processes (though not the dates) of medieval and post-medieval ms losses in the Latin West in general were quite comparable to those in the UK. Nevertheless for the numerical values of the loss rates in Latin West we will use those established from the data of Ker (1964[2]), as this was the most extensive dataset available.

However, we still have to complement the above-established values of the loss rates of UK-medieval libraries with those of the institutions of which no mss at all have managed to survive. For mathematical purposes we have to assume some hypothetically remaining number of mss that is higher than 0 and less than 0.45 (we have taken 0.4) in order to be able to calculate a loss rate for such completely disappeared medieval libraries. If such a

hypothetical fourteenth-century library would have contained four mss to start with, we can calculate a loss rate of –32% per century, with 40 mss its loss rate would been –54% and for a library with originally 400 mss its loss rate would have been –69% per century assuming of course that at present no mss are left. In a low estimate a typical medieval library would have contained some 40 to 60 mss, indicating that, as expected, completely disappeared fourteenth-century libraries would probably have had a higher loss rate than those that have survived (the –39% found above). The proportion of completely disappeared libraries may be estimated from those listed by Ker (1964[2]) and from the maps by Jedin et al., (1970). Ker lists mss from 530 monastic and clerical libraries while 679 monasteries and 68 dioceses were counted for the British Isles (including Ireland), this points to a missing proportion in Ker's listing of some 29% of the institutions. Of course we still have to account for the fact that Irish monasteries and dioceses are included in the counted numbers while Ker limits himself to the UK. Therefore as a final estimate of the proportion of missing institutions a percentage of 20% is taken. For the size of these libraries with no surviving mss a conservative estimate of some 40 mss is taken and the "missed" loss rates can than be calculated. The geometrically corrected 14th century loss rate becomes -42%, and can be simply calculated as: *39^0.8*54^0.2*. For the whole period the of the twelfth to the fifteenth century the loss rates corrected for missed libraries have been estimated as respectively: -25%, -31%, -42% and -43%. For the loss rates in the period before the twelfth the value of –25% of the twelfth will be taken, as no other information is available. However, dates derived from palimpsests generally confirm a value of a medieval loss rate of some -25% per century (data not shown).

With the found loss rates (L_i) the factors ($Surv_i$) can be calculated that compensate for losses over time. With a loss rate of –25% per century we can calculate that in the 20th century the numbers of surviving sixth-century mss have to be multiplied by a survival factor ($Surv_i$) of

56.1 (calculated as: *1/(0.75^14*) see Table I-6) to find the numbers that were originally produced in the Latin West in the sixth century. For the other centuries the survival factors are calculated similarly. Only for the fourteenth century the so calculated survival factor (26.3) seems to be an outlier when compared to the others (see Table I-6), therefore the above calculated fourteenth century survival factor has been rejected and has been replaced by a value of 15.0, which is the average survival factor for the adjacent thirteenth and fifteenth centuries *(13.4+16.6)/2*, as there are no compelling historical reasons to assume that on average fourteenth-century British mss would have had a very different fate from those of the thirteenth or fifteenth centuries.

Table I-6. The values of $Surv^{(*)}_i$ and the numbers of still existing medieval mss fifth to fifteenth centuries ($M_i^{Lat\text{-}West}$), based on Ker and the subset Latin West of the database and the estimated numbers produced in the Latin West during 501-1500 ($W_i^{Lat\text{-}West}$).

Century (i)	*power* ΔC	$Loss_i$	$1/Loss_i\text{^}\Delta C$ $Surv^*_I$	$M_i^{Lat\text{-}West}$	$Surv_i$	$W_i^{Lat\text{-}West}$
6th	14	0.75	56.1	242	56.1	13,554
7th	13	0.75	42.1	253	42.1	10,640
8th	12	0.75	31.6	1,383	31.6	43,697
9th	11	0.75	23.7	8,512	23.7	201,728
10th	10	0.75	17.8	7,620	17.8	135,633
11th	9	0.75	13.3	15,942	13.3	212,030
12th	8	0.75	10.0	76,872	10.0	768,725
13th	7	0.69	13.4	131,487	13.4	1,761,932

14th	6	0.58	26.3	183,132	15.0	2,746,973
15th	5	0.57	16.6	301,155	16.6	4,999,175
Total number	5th-15th				R^2=0.94	10,894,087

Independent data of Mynors et al., (1991) can corroborate our interpretation of the 14th-century survival factor in Table I-6 as being an outlier. Based on an extensive medieval booklist, the "*Registrum Anglie de libris doctorum et auctorum veterum*" from circa 1310, containing a description of 6,193 individual titles housed in over 90 libraries of which currently 400 are surviving we arrive at a survival factor of approximately 15 for fourteenth-century British mss.

Production rates of medieval mss

Finally, when the century totals ($W_i^{Lat\text{-}West}$) from Table I-6 are multiplied with the fraction composed by the spatially corrected numbers per area and century ($N_{i,k}^{spatial.\ cor}$) divided by the century totals ($N_i^{spatial.\ cor}$), which can be found in Table I-4, the absolute ms production ($W_{i,k}^{Lat\text{-}West}$) in that area ($k$) and century ($i$) has been estimated (see Table I-7).

Table I-7. Spatial distribution per area (k) of mss written in century (i) in the Latin West ($W_{i,k}^{Lat\text{-}West}$) in absolute numbers per century

	Century (i)									
Area (k)	*6th*	*7th*	*8th*	*9th*	*10th*	*11th*	*12th*	*13th*	*14th*	*15th*
CentrE	0	0	0	0	0	3,983	27,530	120,987	301,833	376,650

Boh	0	0	0	0	0	657	1,136	5,377	42,066	45,363
Brit	81	1,026	5,474	7,926	9,793	20,360	81,044	200,654	155,513	208,729
Fran	1,682	2,441	15,920	74,190	12,752	45,061	197,831	510,828	564,624	1,195,783
Belg	0	127	1,111	3,029	1,555	8,529	43,219	119,588	106,148	572,124
Neth	0	26	60	82	58	354	1,731	2,066	13,179	171,974
Germ	0	0	7,503	59,771	45,703	49,548	166,876	270,392	293,814	515,116
Switz	0	30	594	5,330	1,799	1,090	2,355	3,821	6,349	10,652
Austr	0	0	2,735	9,414	0	2,808	37,370	37,408	39,777	88,623
Italy	10,194	4,478	6,536	20,307	15,215	38,768	95,207	253,013	879,364	1,423,668
Iberia	1,594	2,512	3,770	21,693	48,763	40,871	114,422	237,818	344,284	390,478
Latin West	13,552	10,639	43,702	201,742	135,637	212,030	768,721	1,761,951	2,746,951	4,999,161

Note that the number of significant digits of the values in the various tables certainly will not be more than one or two, nevertheless in order to minimize a propagation of errors all digits have been presented in the Tables I-1 to I-7. A more formal treatment of uncertainties can be found in Section 5.3 in Buringh (2009)

Appendix II

Estimates of book production 1454-1800

We estimate the number of titles or editions that appeared in Western Europe between 1454 and 1800, multiplied by rather crude (and probably relatively low) estimates of the average size of print runs. The definition of title and of edition (and re-edition) is derived from the OECD, which collects this kind of data for the present.[1] A title is 'a printed publication which forms a separate whole, whether issued in one or several volumes. Different language versions of the same title published in a particular country should be considered as individual titles'; this includes first editions and re-editions, the latter being a 'publication distinguished from previous editions by changes made in the contents (revised edition) or layout (new edition) and which requires a new ISBN'. Titles may be books (which have by definition more than 49 pages), or pamphlets (i.e. smaller publications). The first printing of Gutenberg's bible is one title, new editions of the bible will again be counted, but e reprint of exactly the same manuscript would not be included.

The most important sources for counting new titles are library catalogues and national and international datasets which are based on these catalogues and present inventories of editions published in different countries and/or languages (the 'short title catalogues'), most of which are available on-line. The most important sources and steps in the estimation process were:

- the *Incunabula Short Title Catalogue*, a near-complete inventory of books printed in Europe between 1454 and 1500, which is probably the best source for the whole 500-

[1] OECD definitions: the OECD collects information on: Number of titles of non-periodic printed publications (books and pamphlets) published in a particular country and made available to the public. Unless otherwise stated, statistics on titles refer to both first editions and re-editions of books and pamphlets; Title: Term used to designate a printed publication, which forms a separate whole, whether issued in one or several volumes. Different language versions of the same title published in a particular country should be considered as individual titles; First edition: First publication of an original or translated manuscript. Re-edition: Publication distinguished from previous editions by changes made in the contents (revised edition) or layout (new edition) and which requires a new ISBN; see http://www.uis.unesco.org/ev.php?ID=5058_201&ID2=DO_TOPIC

1800 period as it is based on the work of many people specialized in the history of these first printed books, and catalogues of these books are very detailed and complete; it is relatively easy to draw from the underlying dataset figures of editions published in the different cities in different years, and derive from this estimates of national book production in this period;

- for the Netherlands (*Short Title Catalogue, Netherlands*) and the English speaking world (*English Short Title Catalogue*, covering Great Britain and Ireland as well as Canada and The United States) comparable catalogues for the period until 1800 have also been set up, which contain information on (in theory) all books published in the Netherlands and published in English;[2] similar, but less complete information is available for Belgium.[3]
- for estimating new titles between 1500 and 1800 in the rest of Europe the next most important source is the *Hand-Press Book File*, a catalogue of book published between 1454 and 1830, which is however not nearly as complete as some of the national short title catalogues. For a few countries – Sweden and Switzerland in particular – this catalogues appears to be (near) complete.[4] For other countries the degree to which this source underestimates new titles can be estimated by comparing with the – much more

[2] The only problem with the Netherlands Short Title Catalogue is that the coverage of the catalogue for eighteenth century the Netherlands is much smaller than for the period before 1700, as important library catalogues have not been included yet for the post-1700 period (see a description of this at http://www.kb.nl/kb/resources/frameset_kb.html?/kb/stcn/stcn-en.html). As a result there is a break in the series in 1700. We also know the number of publishers in the Netherlands in the seventeenth and eighteenth centuries, a series which is more complete and does not show the same break in 1700 (again available online at http://www.kb.nl/kb/resources/frameset_kb.html?/kb/stcn/stcn-en.html). The correction made for the break in 1700 is that it is assumed that book production per publisher was the same in 1700/09 as in 1690/99; the series for 1700-1800 from the Short Title Catalogue has been increased applying this correction factor.

[3] For Belgium there is the Short Title Catalogue Vlaanderen (available at http://www.stcv.be/ned/frame.html) for the seventeenth century (but not covering the French speaking part of the country, but the main printing centres were in Flanders), for 1540-1600 Cockx-Indestege et.al. *Belgica Typographica* (volume IV contains an index by year, which makes it possible to estimate book production annually) and for the other periods the estimates from the Incunabula Short Title Catalogue and the Hand-Press Book catalogue. A number of estimates had to be made to make these different data consistent (figures for the eighteenth century appear to be too low still, however).

[4] For Sweden we could compare with the estimates published by Jarrick, *Back*, p. 90; the figures from the Hand Press Book file are slightly higher than those by Jarrick, which probably points to the fact that the database has been improved between 1999, when his book was published, and 2004

complete - *Incunabula Short Title Catalogue*. This results, for the period 1454-1500, in an estimate of the degree to which the former dataset underestimates book production - this ratio varies from 27.5% (France) to 48.4% (Italy). In order to estimate total book output per country the number of books according to the Hand-Press Book File have been corrected by this ratio, which gives a systematic series of book production from 1455 to 1800. The problem with this procedure is that it assumes that the degree of underestimation of the Hand Press Book file is constant in time, which may not be the case (for example, there appears to be a discontinuity in the number of Spanish titles included in the file as the number suddenly drops from 742 in 1700 to 175 in 1701 and 133 in 1702). So we checked the results of this procedure on a country-by-country basis, using the available literature on book production in those countries.[5]

- The same method for estimating new titles can be applied to Germany and Poland (or Russia), but the resulting estimates are much lower than the number of new titles that are mentioned in the catalogues of the Leipziger and Frankfurter Buchmesse from the same years (a series which begins in 1565);[6] so the Hand Press Book file and the additional corrections made in these cases seriously underestimate the output of new titles; for these countries we have therefore relied on the figures of the book fairs, although these are also lower bound estimates (not all books were presented there);[7]

[5] . For France, for example, this results in a series that is broadly consistent with the different graphs of book production published in Martin and Chartier (eds.) *Histoire de l'édition française*, I, pp. 166, 443-6, and II, pp. 95-99 and E. Leroy Ladurie, 'Une Histoire Sérielle du Livre' pp 3-24; for Italy the estimates used here have been made consistent with the estimates of 16th century book production published by Santoro, *Storia*, pp. 106-107; similarly, the estimates for Spain have been made consistent with the 18th century estimates made by Jean-Marc Buigues, 'Evolución', pp. 309-312;

[6] Schwetschke, *Codex*

[7] A discussion about the representative ness of these book fairs in Laeven 1992; these fairs were of great importance for the book trade in Central Europe (a lot of the book production in 'Poland' occurred in 'German' cities, by German publishers), but also many books from France, the Low Countries and Italy were presented here.

- Finally, for six countries – Norway, Denmark, Portugal, Hungary, Austria and the Czech Republic – we were unable to estimate book production directly, as the numbers in the Hand Press Book file and the catalogues of the book fairs were very small; in order to get total estimates for Western Europe which are comparable which those for manuscript production before 1500, we estimated, on the basis of the share of these six countries in the Hand Press Book file the total volume of the printing industry – but this share was extremely small (it increased from 0.18% in 1454-1500 to 1.54% during the 18th century). [8]

For a number of reasons our figures should be interpreted as lower-bound estimates: we do not correct for the (many?) books of which all traces have been lost, nor for the fact that at the book fairs only part of the production was presented. Series publications are not included either. The estimates of print runs are also conservative: we follow the literature that average sizes of editions between the 1450s and 1500 probably increased from 100 to 500 (the print run of the Gutenberg bible was 200); there is ample evidence that this increase continued after 500, but at a slower pace. We tentatively estimate that it went up to 1,000 in 1800, again a quite conservative estimate (print runs of mass produced books, such as bibles, prayer books and primary school books increased to more than hundred thousand in some cases).

Another problem to be addressed is the importance of international trade in books. Because the printing industry was characterized by economies of scale and externalities, production was often concentrated in large cities (for example, Venice in the fifteenth century, Antwerp in the sixteenth century and Amsterdam thereafter). Censorship and government policies to

[8] Additionally, and only for comparative purposes, estimates were also made of book production in Russia, which was quite small, in particular before ca 1700; these estimates were based on the book fairs for the period before 1716 and on the Hand Press book file for the later period; for the slow development of printing in Russia see Marker 1982.

keep book prices at a high level created additional incentives for international trade.[9] The number of books that were being presented at the annual book fairs of Frankfurt and Leipzig can be used as a proxy of the share of the output that was traded internationally, in particular for the non-German world. In Germany (and probably also in Switzerland and Austria) almost all books were presented there; it may be assumed that when a Dutch or Italian publisher went to the trouble of going to these fairs and presented his books there, he expected to export at least part of his production. So for non-German countries these data offer a proxy for the level of exports. These corrections affect levels of production and consumption in the small countries quite a bit (for example, we estimate that about a quarter of Belgian's output was exported in the sixteenth century, and about 10% of Dutch output in the seventeenth century), but do not have a big impact on the consumption in the big countries (except for Great Britain which may have imported as much as 30% of its consumption between 1450 and 1550). We will therefore use both, production and consumption in our estimates below.

Table II-1: Estimates of the import and export shares of books (1454/99-1750-99)

	1454-99	1500-49	1550-99	1600-49	1650-99	1700-49	1750-99
Brit	1.38	0.48	0.16	0.07	0.03	0.00	0.00
Fran	0.25	0.02	0.03	0.02	0.00	0.01	0.01
Belg[a]	0.00	-0.21	-0.22	-0.28	-0.03	0.11	0.26
Neth	0.00	0.00	0.00	-0.08	-0.07	-0.02	-0.05
Germ	-0.11	0.01	0.03	0.03	0.01	0.00	0.01
Switz[a]	0.00	-0.29	-0.21	-0.70	-0.42	-0.20	-0.41

[9] Switzerland was, for example, during the sixteenth century the most important center of Reformation publishing (apart from Southern Germany itself), and in the eighteenth century became popular again as a means of escaping the French legislation against 'rebellious' literature (for example, Voltaire's Candide was clandestinely printed in Geneva in 1759). The Low Countries played a similar role for book consumption in England (sixteenth and seventeenth centuries) and France (seventeenth and eighteenth centuries).

Italy[a]	-0.14	-0.05	-0.02	-0.03	0.00	0.00	0.00

[a]For Italy and Belgium (and Switzerland) we have assumed that 50% of the print runs of these books were sold abroad; for the Netherlands such an estimate appears to be too low, and we have assumed that this share was 100%;[10] before 1700 exports from Belgium and the Netherlands mainly went to the British Isles, after 1700 also France and Germany each received a third of these exports; Italian and Swiss exports were mainly destined to France and Germany (50% each).[11]

Finally, the estimates of production and consumption were turned into estimates of the stocks of books available in the different countries at the end of each period. We started from the loss rates estimated by Buringh (see above) for the fifteenth century; because printed books were cheaper than manuscripts, loss rates were probably higher throughout the early modern period. The maximum loss rate for manuscripts was estimated at 43%; for printed books we estimate it to be as high as 60%, or 1 % per annum, and we assume that this did not change during the 1454-1800 period. Because of the very rapid growth of book production, and the relatively high loss rates, the development of stocks is dominated by the growth of production, and, as Table 7 shows, regressions on these two independent variables do not show very big differences (for this reason we focus on the development of production and consumption in this paper, and pay relatively little attention to the very similar development of stocks).

[10] The assumption is that, if print runs of exported books were the same as print runs of all books, the whole print run would be exported in the Dutch case; but average print runs f export books were probably relatively large, a factor which cannot be taken into account here

[11] For the fifteenth century we used the estimates of book exports and imports by Buringh (2006), and for the years between 1500 and 1565 we intrapolated the two patterns found.

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