Explorations in Economic History 94 (2024) 101614

Contents lists available at ScienceDirect

Explorations in Economic History

journal homepage: www.elsevier.com/locate/eeh

Research paper

Print culture and economic constraints: A quantitative analysis of book prices in eighteenth-century Britain

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ARTICLE INFO

Dataset link: https://github.com/COMHIS/article_2024_print_culture_and_economic_constraints

Keywords:
Book prices
Book history
Eighteenth century
History of inequality
Luxury
Predictive inference
Bayesian statistics

ABSTRACT

Who could afford books in the late early-modern period? We explore how prices related to the demand for books in eighteenth-century Britain by analysing extensive bibliographic and socio-economic data based on Bayesian statistics and machine learning. Our results quantify in financial terms the difficulty of buying print products faced by most British households in the eighteenth century, and how this related to the varying levels of supply across price segments. We found no evidence of the well known claim that legislation would have led to lower prices. The inadequate supply and high cost of books make it likely that only higher-income households bought them regularly from the primary market.

1. Introduction

The movable-type printing press was arguably the most important invention in early-modern Europe, as it allowed for the mass diffusion of texts with significant scientific, cultural, and economic consequences (Dittmar, 2011; Eisenstein, 1983). It also made the prices of printed books and pamphlets objects of interest that have attracted the attention of book historians, social theorists, economists, and psychologists (Clark, 2007; Dittmar and Seabold, 2021; Dittmar, 2019; Habermas, 2003; Pinker, 2011; Raven, 2009; Sher, 2006). What unites much of the interest in (retail) prices is how they limited the democratising effect of the printing press on the production and dissemination of information. High prices of non-necessities such as print products could have significantly decreased their demand among those with less money available. We use the term price constraint to describe the possibly demand-limiting effect that prices had on the size and variety of the supply produced with the printing press.[1] Despite the multi-disciplinary interest in the prices of early modern print products, comprehensive analyses of questions such as price constraint remain rare. One explanation for this is that the pricing of books and pamphlets falls at a challenging intersection between different academic fields (economic and book history) and relevant methods (statistics, economics, and bibliography) (Proot, 2019, p. 90).

The function of the retail price of a book as a constraint was especially relevant in eighteenth-century Britain. Although literacy was heavily correlated with location, socio-economic status and gender (Cressy, 1993, pp. 314–318), roughly half of the English adult population in the middle of the century had acquired the skill, based on the ability to give their signature at their moment of marriage (Stephens, 1990, pp. 553–556). Anecdotal literary evidence of reading, whether one counts books, pamphlets, or

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[1] On occasions we use the term print culture, which, although having other connotations and usage in book history and cultural history could be understood here as equivalent to the supply of books produced.

https://doi.org/10.1016/j.eeh.2024.101614
Received 27 April 2023; Received in revised form 9 July 2024; Accepted 11 July 2024
Available online 15 July 2024
0014-4983/

periodicals, is very heavily skewed towards social classes from the upper-middle echelons and upwards, but there are also examples of labourers, servants and (especially) people of the lower-middling sort who read.[2] Historical evidence makes it plausible that a significant proportion of eighteenth-century demand for books either remained latent or was met through the second-hand book market and other more affordable means because of the high prices.[3] The sections of the book market that likely reached large audiences like seventeenth-century chapbooks (Spufford, 1981, pp. 83–101) or the millions of copies of the *Cheap Repository Tracts* in the late eighteenth century (Stoker, 2013, p. 100) were also affordable. It seems evident that prices modified how and which segments of the book market eighteenth-century Britons could access but in a way that does not reduce to a clear dichotomy between those that could purchase them and those that could not. Still, we are lacking a rigorous quantitative overview of how the prices would have limited the demand for books.

Our aim in this article is to analyse how price constraints related to books and pamphlets developed and varied in eighteenth-century Britain, and how they affected the capability of people to participate in print culture. This question comprises three core elements. First, our interest is in the price constraint itself: how severely could prices have limited the demand for books on different levels of income? Second, we wish to find out how the price constraint varied among different segments of the book market, that is to say whether the limits on demand that prices set were especially severe (or lax) in some places, periods or genres. In particular, we wonder whether there is evidence indicating that the argued late-eighteenth-century drop in book prices could be connected to falling monopolies, as some scholars have suggested. Finally, we investigate the extent to which the overall supply of books and the demand for them varied by price on the primary market of eighteenth-century Britain, and whether high prices led to lower supply, as we would expect.

Our quantitative approach to these questions also falls into three segments. First, we model how much income different households would have had for purchasing books. Second, using a Bayesian regression model on a large data set of prices we analyse how price variation related to the temporal, spatial, physical and other characteristics of print products. In particular, we test whether the change in copyright legislation in 1774 was associated with price shifts in potentially sensitive sections of the book market, as some scholars have argued. Third, we utilise the predictions of a machine-learning model to obtain a price estimate for most books and pamphlets of the period[4] thereby enabling us to analyse the supply of books in different price segments. We use information about the socio-economic composition of early-modern Britain to contextualise our results. All these elements are rare in historical scholarship concerning books[5], and to our knowledge they have not been previously combined in a similar manner.

Our results indicate that the arguably revolutionising impact of the printing press on the affordability and hence the supply of and demand for books had stagnated in eighteenth-century Britain. Prices, which were high compared to the money most households had available for non-necessities, did not fall significantly, and correspondingly, supply was consistently sufficiently low to imply that regular demand from a small and wealthy section of the population could have generated it. Although there was an increase in the number of editions per household across the price range, it was not big enough to imply changes in the composition of the book-buying public. This highlights the important role of the re-sale market, subscription libraries, periodicals, the "blue library" and other less costly ways of participating in eighteenth-century print culture.

Closely-related results from the price constraint model enabled us to make interpretable statements about the relative economic limitations on book purchasing in eighteenth-century Britain. Even given the uncertainties, it is evident that the spending opportunities were significantly more unequal than the already skewed income distribution of the period showed: the less affluent families lived close to subsistence level, which would have significantly limited their potential to purchase print products. Throughout the century, worker families would have needed almost a week's income available for non-necessities to purchase a moderately expensive title, and books could be several orders of magnitude more expensive than that. Even lower-middle-class families would have needed at least three days worth of income available for non-necessities to buy a moderately expensive edition without adjusting other spending. We considered this to be a plausible explanation of the fact that the production quantities of the more expensive books would have supplied only a small minority of households (e.g., owners of large property) making frequent purchases.

However, prices were not equal among the various publications. Religion as a genre was cheaper and more abundant than literature, and items printed in London were more expensive than those produced in Ireland or Scotland. Publication time and

[2] For evidence, we refer to the Reading Experience Database (RED) (http://www.open.ac.uk/Arts/reading/UK/search.php) and the records for which the socio-economic class of the reader and the type (e.g., book or periodical) of material read is known. We include the counts of our queries in the data published alongside this article for transparency, but we urge the reader not to draw too heavy conclusions from them, as RED is not intended for statistical analysis. Literary evidence on reading is very probably heavily biassed towards those whose reading experiences were more likely to have survived in a recorded format. The database is heavily inflated by individuals' diaries, for example, marking multiple instances of the same individual reading the same work, and much of the data is not tagged by socio-economic or format-related metadata.

[3] Probate inventories and other sources from North-western Europe and North America demonstrate that printed items, clocks and teaware were not particularly uncommon among the less prosperous (de Vries, 2008; Sear and Sneath, 2020, pp. 151–154, 284). Nevertheless, ownership of books also correlated with wealth (Weatherill, 1993; Shammas, 1990, pp. 223, 306–313), and social groups below the upper-middle class are virtually absent in the summary statistics of owners of personal libraries (Montoya, 2021; Towsey, 2010, pp. 913, 27). Despite the large resale market (Elliott, 2010, pp. 359–360), numerous subscription libraries (Allan, 2008, p. 34), reading at coffee houses and other strategies employed to decrease the cost of reading or to avoid it completely, the evidence points towards rather than against the interpretation that the reading public included those whose consumption was affected by price. Resales involved buying large quantities of books that had not sold at all for the original retail price, and then selling them on much more cheaply (Altick, 1957, pp. 58–59). Subscription libraries as voluntary associations set rules to resolve arguments about what titles to purchase (Allan, 2008, p. 84), and more affordable access to expensive titles was one of the functions they provided for subscribers (Towsey, 2010, pp. 56–57).

[4] The survival of eighteenth-century books and pamphlets is discussed in the appendix.

[5] We are not aware of any other publications that use statistical models to predict prices in order to analyse the price segmentation of an early-modern book market.

physical properties also affected the price.[6] It is noteworthy that all these attributes could have increased or decreased the price such that it would have taken varying percentages from a household's daily budget available for non-necessities. It is also plausible that there was a significant difference in the size of the readership for smaller print products (pamphlets) as opposed to book-length items in the first-hand book market. However, we found no evidence of the argued price revolution related to a legislative change at the end of the century, even when we limited its potential impact to be more specific than in previous studies. Overall, our analysis paints a relatively conservative picture of the relationship between price and the print culture in that literature and science, which are major categories in the historiography of the century, were sold in more expensive editions than religion.

We argue that the approach we introduce enables us to make claims about eighteenth-century prices and their effect on consumers that are more concrete, extensive and quantitatively systematic than those made in previous studies.[7] Beginning from the nineteenth century, there have been attempts to chart how book prices varied between different item types and over time, and how prices compared to wages and other (often more necessary) commodities (Altick, 1957; Chapman, 1965; Knight, 1854; Plant, 1965; Sutherland, 1948; Tompkins, 1932). There have been a few previous studies applying either large data sets or formal statistical methods to analyse eighteenth-century book prices. Raven (2009, 2007) collected a large number of prices from eighteenth-century review journals and derived a price index. Duhaime (2019) used the 30,000 records with prices in the English Short Title Catalogue (ESTC) to analyse the development of eighteenth-century prices using visualisations and univariate regressions.[8] Fielding and Rogers (2017b) considered the relationship of book prices and copyright payments to various factors and applied formal statistical and mathematical models in their analysis, but they had a relatively small data set of fewer than 500 observations. Some long-running price indexes of economic historians also cover the eighteenth century, such as those of Clark (2010). To our knowledge, we are the first to offer a data-driven overview covering the entirety of surviving bibliographic evidence by means of an evaluated method for predicting prices and contextualising them with socio-economic information about household numbers, income distributions and price constraints.

More recent[9] research on book prices in the eighteenth-century Anglosphere has also reflected on the unequal effect of price on demand (Martin, 2000; Stiverson and Stiverson, 1983). To our knowledge, Robert Hume's attempt to convert book prices into plausible ranges of equivalent sums of modern-day money is the most comprehensive take on the topic (Hume, 2014). The problem with these previous approaches is that they leave the true implications of price rather abstract, which takes away much of the validity from any potential conclusions. For example, neither the wages of workers nor the prices of individual commodities, which are often used as comparison points, shed light on the money that was available for luxury consumption in an economy in which many households lived close to the subsistence level. Converting book prices to present-day money is more intuitive, but even that does not reveal what kind of income would have enabled the household to have that much money at their disposal. We introduce a data-driven model (price constraint) that enables us to investigate how much money a typical eighteenth-century household with a given income level would have had available for non-necessities such as books, thereby facilitating a more systematic, interpretable and realistic assessment of the demand-inhibiting potential of book prices than previous approaches have produced.

We expand on previous efforts to analyse price variation, especially regarding the effect of the ruling of the House of Lords on Donaldson vs. Becket (DB) in 1774. This reaffirmed an earlier statute that set the copyright of books at 28 years maximum, whereas leading publishers had argued that it was perpetual. Perpetual copyright arguably allowed owners to keep the prices of popular titles high without fear of competition. Some scholars describe the change as revolutionary (Plant, 1965; Clair, 2005; Ross, 1996; Altick, 1957; Feather, 1994). However, others found no or contradictory evidence of major changes in pricing after 1774 (Elliott, 2010; Fielding and Rogers, 2017b), or emphasised that arrangements between prominent members of the book trade remained in place despite changes in legislation (Sher, 1998; Raven, 2012). What unites previous substantial quantitative analyses is that they do not uncover evidence of a general late-eighteenth-century decrease in price. We add depth to the analysis of price variation in previous studies, which either used less refined analytical methods such as visualisations, indexes or univariate regression (Raven, 2009; Duhaime, 2019), or much smaller data sets (Fielding and Rogers, 2017b). We combine a large data set with Bayesian multivariate analysis, which enables us to conduct a systematic study of the possibility that prices fell in specific sections (e.g., among the works of copyright-owning publishers or reprints) of the book market.

Despite the value of these findings, we must emphasise that the relationship between prices and demand is by no means straightforward in the early-modern context. In addition to price, factors such as utility and the consumer preferences of different socio-economic groups affected demand. Some publications including almanacs and the Bible were probably considered necessities, which was reflected in higher demand and production quantities. Our analysis implies (see the appendix) that outliers of very high production quantities were more common among cheap publications. Some works required more education, skills, or prior

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[6] In the three paragraphs below, we elaborate on what we contribute in relation to other analyses that have considered the relationship of price to other characteristics of books, some of which have made similar observations.

[7] In addition to research on eighteenth-century prices, we know of one manuscript with many similar elements. Dittmar (2012) analyses the welfare impact of printed books in Britain prior to 1701 in an unpublished and incomplete draft, which includes analyses and the modelling of relationships among prices, production quantities and expenditure on books. He also makes something akin to crude predictions by deriving from estimates of printing costs and printed pages estimates of total money spent on books during a given year, derives a topic-variety adjusted price index (Dittmar, 2012, pp. 29–30) (which reflects similar motivations as our attempts to segment books by price and type), and in particular he focuses on modelling the utility and welfare impact of books based on production quantities, typical income and prices (Dittmar, 2012, p. 8). However, not only do the period and questions differ, many of his choices such as estimating the proportion of expenditure on books for a 'representative' individual (Dittmar, 2012, p. 24) and focusing on labourers' wages (Dittmar, 2012, pp. 6,30–33) frame the socio-economic aspect very differently: we demonstrate that it is crucial to analyse the affordability of books across the income range.

[8] We used the same ESTC data in our previous article on eighteenth-century book prices (Tiihonen et al., 2021).

[9] Recent in relation to the very long history of the question.

knowledge[10] than most people could amass due to the time, cost and effort needed. Hence, the development of demand for some publications such as philosophical works and novels might have been more likely in high-income households even without considering their price. The more equally owned and prominent religious publications might have benefitted from more general appreciation and a better understanding of the topic, thereby increasing the pool of potential consumers. They also tended to be cheap.

Our results also leave open the question of how much prices could have fallen to satisfy greater demand. It might have been increasingly difficult to lower production costs and hence the length-adjusted price during the eighteenth century[11], but our results do not exclude the possibility of competition-limiting practices keeping them higher than they could have been.[12] Minor publications such as newspapers and pamphlets were taxed at a high rate for much of the century[13], making it likely that different public policies could have decreased prices. We can quantitatively demonstrate that the price levels and the amount of supply make it likely that most of the demand that was realised as consumption in the first-hand book market was limited to wealthier households. However, questions such as how much latent demand was left unsatisfied, and how much lower prices could have been, remain open.

The remaining sections of this article cover the methods used, an analysis of the results, the conclusions and the appendices. The methods section discusses the technical aspects of the three elements comprising our price analysis, each in a corresponding subsection. It also briefly describes how the different types of data fit together. In Section 3 we interpret our results regarding price variation and the predicted supply of books in different price segments. In particular, we interpret them in relation to socio-economic information about early-modern households and our proxy for the relationship of price and household income with potential demand, namely price constraint. The data and some historical and technical questions are discussed in more detail in the appendices.

2. Methods

2.1. Data overview

All the data sets[14] used are discussed in more detail in Appendix B, the intention in this section being to describe their role in the overall analysis. Our main sources were the English Short Title Catalogue (ESTC) and Eighteenth Century Collections Online (ECCO), which together constitute the most comprehensive bibliographic and full-text data collections of the early modern Anglosphere. They are also interlinkable, ECCO comprising approximately half of the ESTC records for the eighteenth century. In most cases, a record in the ESTC corresponds with an edition of a book or pamphlet[15], and the metadata describes edition-level properties such as size, publication time and place. Here, edition means a single print-run of copies for an old or a new work, such that one edition groups together all copies of the work that were part of the same 'printing operation'. By default, our observations are ESTC records. Our choise of associating a record with an edition should be understood as a conceptual simplification that enables us to effectively utilise the ESTC in the quantitative analysis of prices. The roughly 30,000 eighteenth-century editions with prices in their imprints in the ESTC make up one of the largest digital data sets of early-modern book prices, a project on earlier continental book prices being the only comparable set of which we are aware (Ottone and Squassina, 2022).

Taking the edition as the unit of observation enabled us to utilise these extensive historical data sets, allowing much of the information about the individual copies of books and pamphlets to be summarised on the edition level. Perhaps the most commonly agreed determinants of price were the material and labour costs. These included properties that we could estimate based on our data such as the number of paper sheets per book and the density of typesetting of the text, most of which were shared among copies of the same edition. Characteristics such as the place and year of publication, publisher and genre are also edition-level properties. The edition was also a reasonably good proxy for quantity in the early-modern period, the widest variation in production numbers per edition coming from certain cheap publications (see Appendix B for more details). Thus, it is possible to use edition-level information to analyse price variation, and the characteristics of editions facilitate segmentation of the book market by various properties. Editions also serve as proxies for quantities (copies) of book production.

However, print products were not completely uniform objects even if they were copies of the same edition. Sheets comprising an edition could be sewed, stitched, or bound together in different ways, boards could be (and often were) added separately, the same illustrations may or may not include colours, and there might even be variants differing in size, format and quality. We did

[10] It may be indicative of this that many eighteenth-century publications advertised themselves in the title as easily understandable. For anecdotal examples from various genres, see ESTC records T17188, T59020, N20806, N18541 and T72233. Many of Hannah More's Cheap Repository titles, famous for their high production numbers, were also very simple in style. See, for example, *The Happy Waterman* (ESTC record T120819) and *The Two Shoemakers in Five Parts* (ESTC record N14164).

[11] Long-term time series suggest significant decreases in book prices before the eighteenth century (Clark, 2010). It is possible that the available printing technology was already used efficiently due to the more than 200 years of accumulated experience, and it was hard to produce books much more cheaply.

[12] Arguably, many eighteenth-century publishers were more concerned with the stability and continuity of their business than with substantial short-term profits. In such a scenario, competition by lowering prices could have led to punitive action from other members of the business community. The Donaldson vs. Becket case introduced in this article could be interpreted as an attempt by established publishers to limit renegade competition.

[13] For taxes on publications, see the well-known Stamp Act (Stat Realm, 1963, pp. 617) of 1712. Some contemporaries involved in the book market, such as Jonathan Swift, argued that the Act had a detrimental effect on the newspaper business, and that it increased prices considerably (Swift, 1901, pp. 453–454).

[14] This article has a related repository of data and code (Tiihonen et al., 2024), for replication purposes.

[15] Deviations from this can be caused by duplicates, within-edition variants in typesetting recorded as separate entities, multi-volume works for which the time between publication of different volumes is long and other complicating factors.

not control for the presence or absence of these exemplary characteristics and many others, which sometimes resulted in several variants of the price or additional costs related to individual copies (e.g. buying boards for the book separately). By default, we used the lowest price given for an edition and our observations based on the ESTC and ECCO records as representations of the entire edition.

The edition was too broad a category of observations to be meaningfully applied in some analyses, being anything from a pamphlet of a couple of pages to a multi-volume dictionary. The latter equals hundreds of the former in terms of size and, most likely, also in terms of price. For this reason, we sometimes distinguished between pamphlets[16] (editions fewer than 128 pages in length) and books (longer or equal to 128 pages).

We gathered information on expenditure and income in early-modern households from primary sources, estimates of modern scholars, and revisions of the latter based on the work of the former. In particular, we used King's, Massie's and Colquhoun's three social tables for the years 1688, 1759 and 1798, respectively, revised and further analysed by Allen (2019). The tables divide the population of England and Wales into groups of households by social status and income, at three time points roughly at the start, in the middle and at the end of the century. Given that the population of England and Wales constituted the majority of the population of Great Britain, it should also represent most of the population and income distribution.[17]

Combining these data sets made it possible to analyse factors related to the supply of and demand for print products. Next, we discuss how we measured the demand-inhibiting constraint that book prices would have set on the consumption of early-modern households.

2.2. Measuring the price constraint

The first challenge was to define the price constraint in a measurable way because we did not have data on consumption to measure the income elasticity of print products. Hence, we had to use indirect approaches to proxy how the demand for books would have varied as a function of household income, and whether some demand possibly remained latent due to high prices. We started from the assumption that most types of books and pamphlets would not have been necessities, and would have been lower on the priority list of consumption than the assumed basic expenses of a household with a given income level. This may not have been true for all content types, given the evidence of relatively equal and wide ownership of religious publications (Ogilvie et al., 2022; Reilly and Hall, 2000) during the early-modern period. We return to the relationship between price, demand and subject matter (e.g., religion) in later sections. We omit savings and taxes from our calculations, equating the total expenditure with income.[18] Formally, we define the price constraint as:

$$C(P, I) = \frac{\alpha \times P}{I - f(I)}$$

in words, the proportion of (annual) income I after the reduction of basic expenses $f(I)$ a household would have needed to purchase a print product of price P (in pence). The constant $\alpha = \frac{365}{240}$ performs temporal and monetary conversions so that the end result is the number of daily portions of available money needed to buy the item.[19]

By basic expenses (BE) here we mean continuous household expenses devoted to basic costs of living that could have been expected from a household of a given income level. In our case, these relate to food, clothing, fuel, possible costs related to having servants, lighting and soap/other costs related to hygiene. The list is not exhaustive (it does not cover costs related to health and education, for example), but it covers most of the expenses of most households. Expected expenses here mean those that would have been typical for a household of a given economic status, not the bare subsistence level.

Our definition differs significantly from standard approaches,[20] given that our focus is not on the money that was potentially available for the consumption of non-necessities, but on the money that typically was available. We consider this to be a more meaningful representation of the role that commodities such as books would have played in household consumption. As the data we gathered demonstrates, households typically used much of their income that went beyond subsistence needs (even on a relatively comfortable level) to increase the quality and quantity of consumption related to basic needs such as food and clothing. Instead of trying to model how much money might have been available for non-necessities such as books if a high-earning household remained very frugal in its consumption of basic commodities, we focus on the typical scenario in which the quality and quantity of items such as food, drink and apparel increased as a function of income, decreasing the portion available for luxury spending. In fact, the model should be generous in estimating this proportion given that basic expenses do not include consumption that could be critical to welfare (such as costs related to schooling or health, for example), and ignore savings and taxes that would have accounted for a portion of the income.

[16] Some classification schemes also include a category between books and pamphlets. This in-between category is incorporated into our definition of a pamphlet.

[17] Scotland became part of the United Kingdom in 1707, but its population was relatively small compared to England and Wales. Ireland had a significant population and was not part of the United Kingdom. In analyses of book consumption per household, it is treated as another country potentially importing and exporting to the United Kingdom (see Appendix D for these analyses).

[18] Given how we define basic expenses, taxes at least could be included under the definition.

[19] Multiplication by 365 scales the results to days of left-over expenses after the basic cost of the book or pamphlet. Division by 240 converts the annual income from pounds to pence.

[20] For example, using a standardised consumption basket to represent the money needed to cover basic costs of living would have been a more conventional approach.

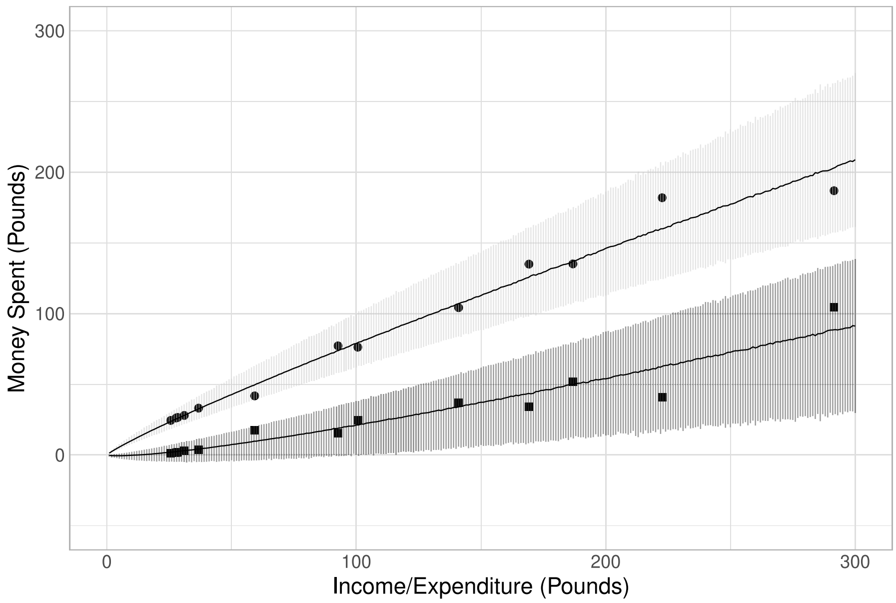

Fig. 1. The upper line with a light grey credible interval depicts the relationship between annual expenditure/income and expenditure on basic expenses. The other line with a dark grey credible interval depicts the relationship between expenditure/income and expenditure on non-basic expenses. Posterior draws from the fitted Bayesian model. The line is the median, the grey area is the 90-per-cent credible interval of the posterior distribution. The black dots are the data points used to fit the model, the squares are other than basic expenses in the data.

In line with these assumptions, the fraction a book or a pamphlet would have taken of the income available after basic expenses could be interpreted as a measure of how significant an expenditure it would have been for a household with "typical" costs of living given its overall expenditure. A notable aspect of this approach is that it incorporates Engel's law into the contextualisation of book prices, as basic expenses (Earle, 1989; Horrell, 1996; Hoffman et al., 2005) consumed a bigger share of the budgets of low- and middle-income households compared to those of affluent families.

The next step is to use the information provided by primary sources and studies on early-modern consumption to fit a model that describes the relationship between income and expenditure on basic expenses. To be consistent with the latter linear regression model, we formulate this one in a Bayesian manner as well, encoding to the priors the assumption that expenditure increases (β is at least zero) as income increases.

$$
\begin{aligned}
f(I) &\sim LogNormal(\alpha + \beta \times \ln(I), \sigma)\\
\alpha &\sim N(0,1)\\
\beta &\sim \Gamma^{-1}(1,1)\\
\sigma &\sim \Gamma^{-1}(1,1)
\end{aligned}
$$

Similar models have proven very successful in the modelling of the relationship between total expenditure and expenditure on a subset of consumption (e.g., food) in previous studies of early-modern household budgets (Stone, 1988). Fig. 1 presents the predictions of the fitted model against the data. It seems to succeed in its intended function to provide an "averaged" depiction of the relationship between expenditure and expenditure on basic expenses during the early-modern period. Table 1 gives more formal support to this notion in providing a summary of the posterior distribution and R^2 when the median parameter values of the posterior are used. With median parametrisation, the income elasticity of the money spent on basic expenses is 0.9[21] The practical implications of the 10-per-cent proportional reduction in the consumption of necessities are visible in Fig. 1: money available for luxury consumption such as of books drastically rises from a barely visible fraction to a considerable proportion of household income.

We still have to be critical when applying the model: we do not have data on the very highest and lowest income groups and the sample size is small. Predictions for incomes lower than 30 pounds annually were sensitive to small changes in the data,[22] hence we do not apply the model to analyse incomes lower than that. Nevertheless, our approach is a significant improvement on the use of comparison points for book prices including income as such. The money available after basic expenses (and hence – we believe – the demand) varies much more than income as such, and our model captures this tendency.

Using the median posterior parameters of the fitted model and the two equations given above, we were able to compute a point estimate of the price constraint for any combination of household income and price. We did this for low and mid-range book prices

[21] If income changes by a factor of e, then the income spent on basic expenses increases by a factor of exp (0.89), the ratio between the two being 0.9.

[22] In the final iteration of the budget data, the model overestimated the income available after basic expenses for the lowest income level.

Table 1
Summary of the model depicting the relationship between expenditure and basic expenditure (BE). The median and two quantiles of the posterior distribution are presented. R^2 is the proportion of basic expenditure explained by the model with the median values of the posterior distribution.

Variable	2.5th Quantile	Median	97.5th Quantile	R^2
σ	0.08	0.13	0.23	0.98
β	0.8	0.89	0.98	–
α	−0.13	0.29	0.69	–

Table 2
Examples of how many day's worth of income available for non-necessities would have been needed by families representing workers (30 pounds annually), the lower-middle level (50 pounds annually) and large property owners (200 pounds annually) to buy moderately expensive (roughly 12 pence) and quite expensive (roughly 33 pence) print products. Incomes and prices are in the real wage/price values of 1688, calculated with the price constraint.

Income (Pounds)	Moderately expensive book	Quite expensive book
30	6.4	17
50	2.5	6.8
200	0.34	0.93

and incomes that roughly represent workers (who comprised the majority of the population), the lower-middle level and owners of large property (e.g., land), as shown in Table 2. Even a relatively cheap item costing roughly one shilling would have taken a week's proportion of other-than-basic expenses from a worker family, and three days' worth from a family representing shopkeepers, for example. A price of roughly 33 pence, which was no longer cheap but not nearly as expensive as books could get, would have already required more than two weeks' proportion from a worker family. Even a relatively well-off family on the lower-middle level would have needed a weeks' proportion to buy it. These results indicate that books and even pamphlets were costly compared to the incomes of most households that sought to maintain their standard of living, but not sufficiently costly to make acquiring them completely impossible.

The price constraint provides an intuitive and computable measure of the relative strain that purchasing books and pamphlets would have put on early-modern households. It extends efforts to contextualise the relative prices of eighteenth-century print products by accounting explicitly for other expenditure and Engel's law. It is a crucial tool in later analyses, as it allows us to incorporate socio-economic information (incomes and their development) into the analysis of bibliographic data, and to consider how income variation between households could have affected the demand for books and left some demand latent.

2.3. Multivariate analysis

Here we discuss our approach to analysing how prices varied between different publications. In particular, we assess the extent to which books vulnerable to falling monopolies decreased in price after 1774. The main issue to consider is that the prices of print products were affected by several factors. If one analyses various sorts of books and pamphlets together, one should do it in a way that disentangles the parallel effects of size, format, quality of printing and other factors. Regression analysis is a standard tool in such cases, and our Bayesian implementation is motivated by our data and our purposes.

By default, we do not argue for a causal impact of any specific feature included in the analysis. Some, such as the number of printed characters per sheet, certainly affected printing costs, but others such as the topic probably covary with features such as the quality of the print and of the illustrations, on which we have no data. Nevertheless, given that the prices of early-modern books and pamphlets have rarely been studied in great detail using multivariate regression, let alone with data sets of similar size, even associations that are not causal yield valuable information. The reasoning behind using variables intended to capture the effect of the legislative change (discussed in more detail in the analysis section) is that an association between them and the price would be a necessary but not sufficient result to argue for a causal relationship. As we did not find effects that would allow us to argue even for an association between the legislative change and the prices, there is no need to use other approaches to test for causality.

We decided to model the price per sheet for the target variable. A paper sheet was the standard unit of printing, from which pages were folded and cut in various formats. Here, the number of sheets is calculated based on the format[23] and the number of pages in an edition. Analysis in per-sheet terms makes editions of different size more comparable, as the physical size in itself explains a large portion of the variation in price (Lindert and Williamson, 1982; Tiihonen et al., 2021). Variation in the size of sheets was one reason for using robust regression (e.g., the effect of extraordinarily large or small sheets in some editions), and for incorporating variables related to certain physical characteristics of books and pamphlets into the analysis (e.g., the possibility that long quartos and folios were also typically printed on larger sheets).

We implemented the regression analysis as Bayesian robust regression with a non-standard level of scepticism towards small effects. This was motivated by the fact that our model needed to be robust to outliers, and we were interested in the effects that

[23] Format indicates how many pages there are per sheet.

remained and were of considerable size even if we were *a priori* sceptical about their existence. This attitude is reasonable given that our data set might have been more prone to large individual errors and missing information than many others, as metadata from the ESTC and ECCO was not originally collected for statistical analysis (Lahti et al., 2019).[24] Ten per cent of the data was reserved for model evaluation. The distribution of residuals and the difference between the mean absolute error and the mean squared error in the test data indicate that the model is a better characterisation of the general trends than the outliers, as we intended. See Appendix A for technical details related to model fitting and evaluation.

2.4. Predicting prices

Whereas multivariate regression analysis is oriented towards interpretability, the aim here is to produce good predictions for the majority of the ESTC records without price information. The more accurate we are in determining prices based on other metadata characteristics of print products, the more we can hope to benefit from the predictions in the empirical analysis. For the most part, predictions enable us to consider price as a factor in analyses of production quantities and the supply of eighteenth-century books and pamphlets.

To predict the prices we split the data into training and test sets in a 4:1 ratio. The motivation for this procedure was that some of the prices were reserved for evaluating whether the model could successfully predict unseen instances of prices. The proportion of test data was larger than in the evaluation of the Bayesian regression model, as a larger test set adds robustness to the evaluation of the model's capability also to predict price variation in the domain of more expensive items, of which there are fewer in the data. We used the training data to fit an Extreme Gradient Boosted Decision Tree and thereby predict the price per sheet, which we then used to predict the price of the edition. Models of this type have performed very well in machine-learning competitions, including prediction tasks (Chen and Guestrin, 2016, p. 785).

After training, we evaluated the performance of the model on the test data. The model explained eighty-four (84) per cent of the variation (mean squared error) in the total price on the logarithmic scale. We are not aware of other studies in this context in which the explained variance was measured with separate test data, except in our previous study (Tiihonen et al., 2021). Fig. 2 shows how the predictions compare to the real prices in the test data.

Complementing the model for predicting prices, we created an ordinal scale to which the predictions were converted. From the price-constraint perspective, differences of magnitude are more interesting than absolute variation. For example, the differing price constraint between a pamphlet costing two or 36 pence would have affected a greater number of people than the difference between two multi-volume works costing one (240 pence) or two (480 pence) pounds, as both of the latter items would have been possible purchases only for a very small segment of households. This is also a more robust approach to analysing the predictions, as our model performs especially well on the logarithmic scale.

Our ordinal scale divides editions into cheap, middle and expensive classes. Cheap is anything less than around 12 pence ($\exp(2.5)$) in 1688 pounds, middle goes to 33 pence ($\exp(3.5)$) by the same metric, and everything beyond that is expensive. Editions exactly at the borderline of cheap and middle are called moderately expensive editions, and editions exactly at the borderline of middle and expensive are called quite expensive editions. As we demonstrated in Section 2, even moderately expensive editions were not trivial compared to the available income of most early-modern households. If accurate enough, this kind of classification scheme would facilitate analysis of the broad composition of the ESTC from the price perspective, as it is both interpretable and less sensitive to large errors than predicted absolute prices.

Our evaluation (discussed in more detail in Appendix B) indicates that our model adequately fulfils the standard requirements of a classifier. The great majority (around 90 per cent) of records are classified correctly and all classes largely comprise properly classified records (the accuracy does not reduce to the large size of the cheap category). We conclude that it is possible to predict large-scale price variation based on bibliographic metadata available for most (95 per cent) records. We use the predictions to form an overview of supply in the eighteenth-century book market from the price perspective.

3. Results

3.1. Multivariate analysis

Our analysis in this section concerns the variation in prices in different segments of the eighteenth-century book market. We are interested in the general variation in relation to the basic properties of print products such as the time and place of publication, physical characteristics and topic. We also add more specific variables as proxies for the possible effect of the DB ruling, which arguably led to falling prices in the late eighteenth century.

[24] On a large scale, noise in the data should, as we understand it, lead to regression attenuation. That is to say, for example, if we miss some of the works published by influential publishers and they get treated as publications of 'others' the effect is to dilute the difference between these two groups. As with our choice of priors, we prefer this harder burden of proof to such biases that could lead to false findings. Additionally, the variables used to test the effect of DB should be largely precise in the sense that most of them included records that we aimed to cover. The precision of the class literature in our evaluation was 94 per cent. In the case of publishers and reprints, it is hard to detect all instances of a work (e.g., the title may vary) or publisher (e.g., the spelling of the name may vary, or the name may be absent from the imprint), but easier to be conservative about what record to classify as a reprint or having a certain publisher. Undetected instances of literature, book-sized reprints or records printed by our group of copyright-defending publishers that go to the comparison groups should be small in number compared to the total size of the comparison groups. Hence, we find it unlikely that they considerably affect them, and the effect of noise on the analysis of the DB question should be limited.

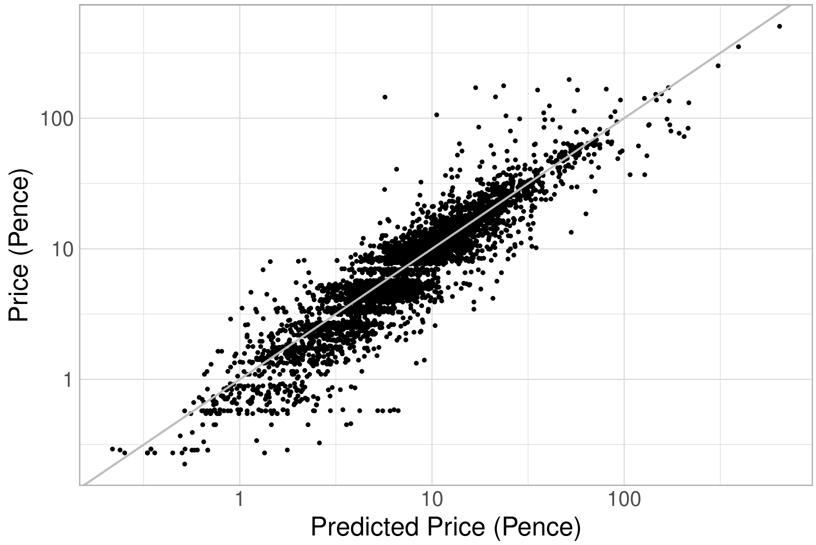

Fig. 2. Predicted prices (x-axis) compared to real prices (y-axis). The scale is logarithmic and the prices are inflation-corrected, as described in Appendix B. Test data set, N = 5888.

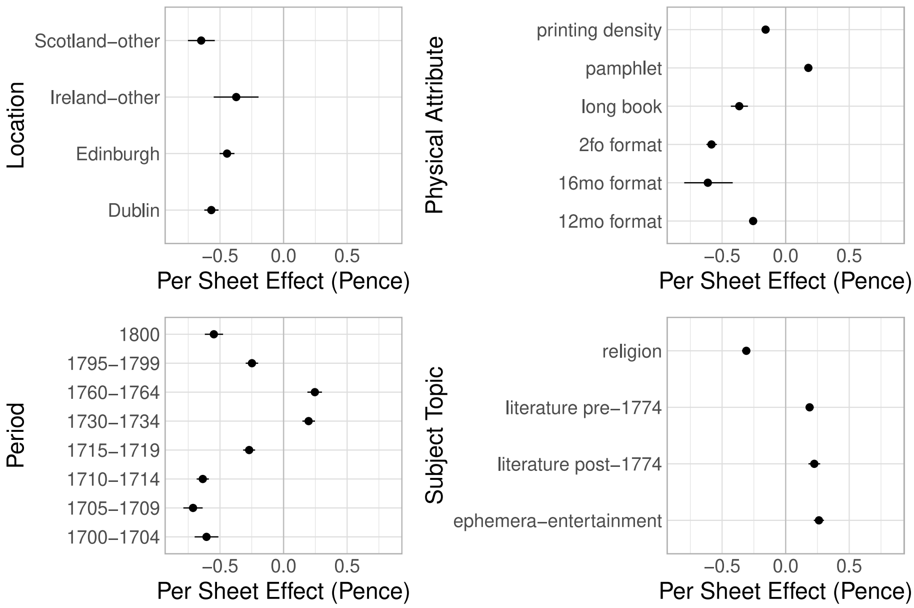

Fig. 3. How many standardised pence per sheet a given effect would have added to the price. Dots represent the medians of the parameters, and horizontal lines the credible interval from the 2.5th to the 97.5th quantile. Derived from the posterior distribution of the multivariate regression model, and includes variables for which the absolute size of the effect is at least 0.15 (considered to be a remarkable effect) with 95-per-cent credibility. N = 24,346.

Before discussing the results we will explain our motives for choosing the included variables (see the full list in Appendix A, Table A.4). Given the results of earlier research in the fields of book history and economic history, they may all relate to early-modern book prices. The size of a book in terms of sheets and format had a virtually direct impact on the price given that the amount of paper and ink as well as labour costs all increased the larger the format and the higher the page count (Hernlund, 1967; McKenzie, 2002). One variable was intended to capture the possible price premium on book-sized quarto and folio editions with visual elements, given that this set of characteristics was associated with some very expensive editions, as were illustrations of certain types in general (Sher, 2006). Different publication places assumed different functions in the British book trade, as Irish and Scottish editions were associated with lower prices (Sher, 2006, pp. 29–30). The variation in wages in different parts of the British

Isles (Hunt, 1986, pp. 940–941) further motivated our analysis of the relationship between publication place and price. Variation in price per sheet depending on the topic has also been observed in previous studies (Fielding and Rogers, 2017a; Duhaime, 2019).

The most interesting variables for testing the hypothesis concerning the effect of the DB ruling on prices are those aimed at capturing the developments it could have caused. A significant proportion of copyrights granted during the latter half of the eighteenth century were held by a small handful of publishers based in London and Edinburgh, but there is no clear-cut way of defining who should be included among them. We use those that were respondents[25] in the DB case alongside Becket[26], as one could argue that they had an expressed interest in maintaining de facto perpetual copyright. The dummy variables for the pre- and post-1774 "premiums" of their publications proxy the capability of the most prominent publishers to keep prices artificially high before and after 1774.

Our choice of dummy variable for reprints of books was similarly motivated, as the DB ruling would have allowed old enough titles to be legally printed, and arguably in cheaper editions. The variable is based on differences in publication years between editions considered to be the same work (Ijaz et al., 2019), with all the ESTC records with a publication year later than the first year linked to the work-id marked as reprints.[27] Third, we divided the subject topic of literature into that published before and after 1774. This was an attempt to test whether the ESTC data at least offered support for the more limited argument that the price of literature as a whole – compared to overall ESTC – fell. For example, St Clair's interpretation of falling prices has been criticised for being based only on literature (Raven, 2007, pp. 232–233).

The results of the multivariate analysis of prices are summarised in Fig. 3. It includes all the effects for which the posterior probability distribution had either a positive or a negative sign at both the 97.5th and 2.5th quantiles, and the absolute value of the effect size at both tails was more than 0.15. A useful rule of thumb is that 0.15 standardised pence equals roughly three per cent of the daily income that a relatively well-off family would have had available for non-necessities.[28] Given that only the briefest of publications comprised just one sheet,[29] and that the effects are reported per sheet, even the smallest ones discussed here could have added (or removed) tens of percentage points of this part of the daily budget to the price, and the largest ones (absolute effect size greater than 0.5) in many instances could have had a bigger effect than a day's share.

The proxies that should be sensitive to the effect of the DB ruling did not indicate such changes that it could arguably have caused. The price of literature did have a premium, but this did not undergo significant change after 1774. Reprints of books and the selected publishers had no positive or negative premiums before or after 1774. In other words, we found no evidence for the supposed effect of the DB ruling on prices.

On the other hand, our analysis provides support for several other claims about the cost of eighteenth-century books. The general trend seems to have been one of increasing prices at the beginning of the century, followed by stagnation, and then a decrease. Editions printed in London were more expensive than those published in most of the provincial locations, and these differences were especially significant in magnitude. Potential explanations include a weaker printing quality (e.g. of paper or type) and lower wage levels compared to London. The subject topics and our estimate of characters per sheet related surprisingly strongly to price. Potential explanations include the quality and type of visual elements, the quality of the edition (a high amount of text compressed in a single page is associated with cheap print), and the wealth of the assumed purchasers of the title, which could vary among the topics. The format also had a surprising effect, as both small and large sizes were among those with a negative premium compared to the octavo.[30] The higher per-sheet price of pamphlets might have related to the Stamp Act under which shorter publications were taxed more heavily than longer ones (Stat Realm, 1963, p. 617).

However, although the spatial and temporal developments align with the idea that a clique of publishers in London kept prices artificially high, a closer examination of the changes after 1774 does not support the theory that such an arrangement was shattered after the DB ruling. Neither reprints, known works of publishers involved in copyright disputes as defendants of their property nor works of literature decreased in price per sheet in particular. It is not hard to find explanations that tie the temporal and spatial differences and developments to factors external to the book trade. In terms of regional variation, for example, the wage (or possibly quality) differences across the British Isles mentioned above could explain the availability of cheaper editions outside the metropolitan area. Some of the spatial price variation could also relate to the availability of cheap, copyright-ignoring Irish editions of works originally printed in London. Nevertheless, legislative changes did not similarly affect pricing on a large scale. Moreover, given that, the overall prices of non-food items compared to bread (the price of which correlated heavily with the price of other foodstuffs (Horrell, 2023, p. 1044))) were declining during the late-eighteenth century (Horrell, 2023, p. 1045), the temporal change could reflect a general trend whereby everything else became cheaper compared to the largest expense category.[31]

[25] For the legal chain of events that led to those defending their copyrights becoming the respondents, see e.g., narration of Deazley (2004, 191-194).

[26] Including Becket.

[27] In addition to the similarity of the title, we required matching author information from editions considered to be the same work. As many of the allegedly overpriced reprints were works of established famous authors that were more likely to be identified in the ESTC, the requirement should strengthen the proxy.

[28] This interpretation can be derived from 2.

[29] For the most common format of the century, octavo, the minimum threshold for book length was eight sheets.

[30] Most of the folios in our data are shorter editions such as broadsheets. The predictive model should be capable of creating more refined distinctions between folio broadsheets and the long richly illustrated folio works than the linear model used here, for example. Effect-sceptical priors and the requirement of remarkable effect size in our analysis make it harder for noise and uncertainties related to physical attributes (e.g., uncertainty related to the exact number of pages and within format variation in actual size) to affect our results significantly.

[31] This could imply decreasing prices of print products when normalisation for inflation entails converting them into real wage/price values (heavily affected by food prices), as we did.

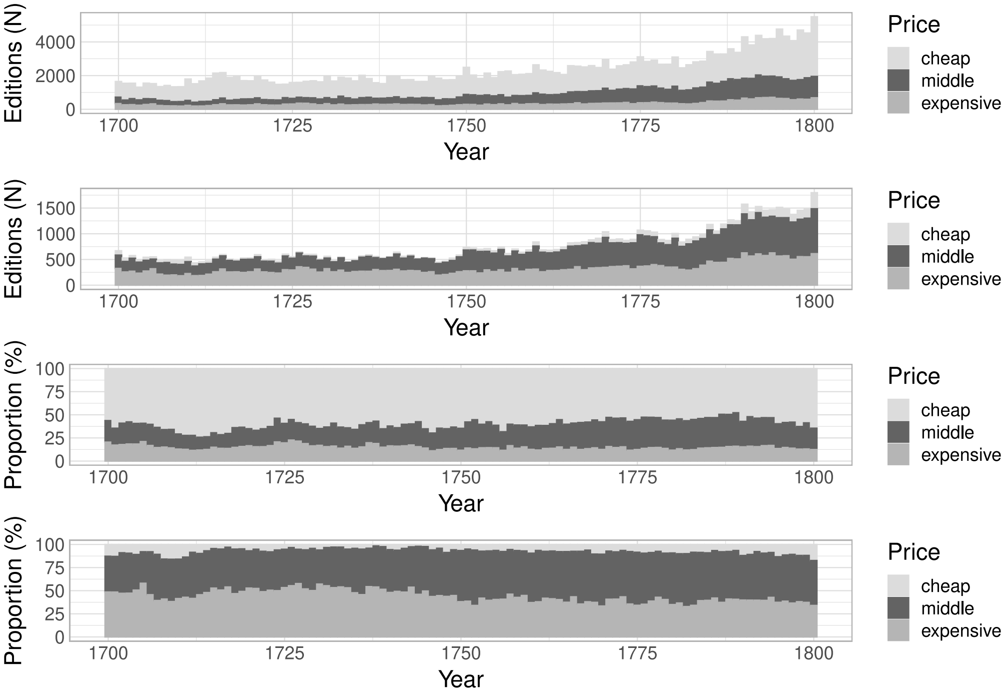

Fig. 4. The number of ESTC records in different price classes by year. Top panel: all records published in Britain and Ireland with predictions longer than one sheet (N = 198,180). Second panel: all records published in Britain and Ireland with predictions longer than 128 pages (N = 65,904). The bottom two panels display the same information as the first (3) and second (4) in terms of the proportion of editions belonging to each of the price classes.

In our analysis, price variation is associated to a significant degree with certain publication places, periods, physical characteristics and subject topics. There are plausible explanations for many of these effects: the relation of high printing density to a generally weaker quality, general price developments in other commodities and food over time, variation in wages depending on the place of publication, and the varying impact of taxes are some examples. Although we found no evidence of an effect of the DB ruling, our results do not exclude the possibility that prices changed significantly during the course of the century. In the next section we use the predictions to analyse whether there was – in the absence of change that could be linked to the copyright narrative – a case for such a change in prices that would have shifted the demand and hence the supply of books in eighteenth-century Britain.

3.2. *Predicted prices*

Predicted prices facilitate analysis of how the supply of books in different price segments developed during the eighteenth century, and combined with socio-economic information allow further analysis of how prices, supply and demand changed in combination. For example, would a potential increase in the supply of cheap publications make it likely that a larger proportion of the population was buying them? Did the incomes of some socio-economic groups change sufficiently to significantly affect their ability to consume non-necessities such as books, and was the change matched by higher quantities of publications?

The first panel in Fig. 4 illustrates the overall development of the predicted prices of books and pamphlets in the ESTC, plotting the number of editions belonging to each price class printed yearly. To ensure that our analysis would not be heavily skewed by categories of print products for which the retail price is not a meaningful or useful predictor variable, we limited it to editions longer than one sheet, thereby excluding jobbing print. Jobbing print is problematic in that not all of it was meant to be sold, much of it has survived to a lesser degree than longer items, and not all forms of it are systematically covered by the ESTC. Although this exclusion criterion is not optimal,[32] it filters out a subset of the ESTC that is large and particularly problematic. We also made a moderate adjustment for lost editions and data filtering.[33]

Even after this precautionary step that also left out many short items that had a retail price, it is evident that what we classified as cheap was the largest category, and increased significantly in absolute terms during the late eighteenth century. Given that the number of copies was not smaller for cheap print products (based on our calculations, see Appendix B) and in some cases even tens (or in some exceptional cases hundreds) of times larger than the so-called "London average" of 1000, it seems likely that most of the physical copies that were produced in the eighteenth century cost less than a shilling in 1688 money. However, even this level

[32] Problems concerning the survival rate, being covered by the ESTC, or not having a retail price are not strictly limited to any well-defined subset of records.
[33] Appendix B includes a slightly longer discussion on these issues.

of accessibility can only be attributed to pamphlets. The second panel of Fig. 4 displays the same editions, with everything less than 128 pages removed. Here – in the domain of book-sized items – the 'cheap' category remains a marginal phenomenon for most of the century, medium-priced and expensive being the main classes. The number of editions in the two latter classes also increased by an order of magnitude.

The relative sizes of the price classes remained much more stable. Panels 3 and 4 of Fig. 4 present the proportions corresponding to the absolute values in panels 1 and 2. The size of the expensive class seemed to be decreasing across the century, but even this was not consistent. Overall, it is hard to argue for clear and stable trends that would have significantly altered the price composition of print products between the start and the end of the century.

We extended the analysis by comparing total production quantities in the book market to the sizes and incomes of different socio-economic groups in early-modern Britain, evaluating how the supply in different price segments related to the (proxied) demand in the different groups. We were especially interested in any significant changes in potential demand and supply indicated by changes in these variables. We used information derived by Allen (2019) from the closest revised social table (1688, 1759, 1798) in D.11 to compare our estimates of book production totals segmented into price classes with information about the number and average income of different kinds (e.g., worker, lower-middle) of households for the years 1700–1704, 1757–1761 and 1796–1800 (details in Appendix D). Our analysis is limited to England and Wales because the social tables do not extend to Scotland and Ireland.[34]

More than half of the items longer than one sheet would have cost at most a shilling at 1688 prices during most of the century. For the worker families that comprised the majority of the population this upper limit would have meant 6–8 days of income/expense following the reduction of basic expenses from the beginning to the end of the century, whereas at the lower end of the middle class the same purchase would have required 2–3 days of income after the same reductions. For the vast majority of families most books (but not necessarily pamphlets) would have taken several days' income after basic expenses. Although we significantly simplified the treatment of single-member servant households (see Appendix B for details), there is no reason to assume that they would have been in a much better position than other working-class households in terms of purchasing print products. The price constraint for many books would have been even more severe: for items on the threshold of middle and expensive it would have been 16–21 days for worker families, and many editions were much costlier than that.

These results give no grounds for arguing that there was a large-scale change in the constraint set by prices for the majority of families during the eighteenth century. Books, in particular, were and remained expensive, which would have significantly limited the overall demand. However, if we focus on the large property owners (around 4–5 per cent of families) of early-modern England and Wales, the century seems to have been much more dynamic in that the increase in real incomes would have made the price constraint fall by a half, much more than for workers or lower-middle class.

From the beginning to the end of the century the significance of the decreasing proportion of income needed by those in the top quantiles to purchase books and pamphlets carried more weight than their relatively small share of the population. Although often more of an assumption than an empirical finding, it is a common claim that, for the most part, the reading public of the eighteenth century comprised the wealthier sections of the middle classes. The fact that books became even more accessible to this section of the population might not have altered the social structure of the reading public, but one could argue that they became significantly cheaper for their primary audience.

A comparison of the number of predicted[35] copies in different price classes with the number of households of different kinds indicates that there was an increase in print products per household, but not to a degree that necessarily related to a socio-economically broadening demand. The number of copies in the two cheaper price classes increased by more than a factor of 1.5 per worker household during the century. Even so, there would have been fewer than 0.2–0.3 expensive copies per year across the century per worker family, and 0.3–0.6 in the middle price class.

Book-sized items could not have supplied a large proportion of English families buying new books frequently. Owners of large properties alone could have consumed the entire supply of expensive editions if they only bought a few editions per year, and a similar pace would have been enough for mid-range print products with the contribution of the lower middle class. The consumption of cheap books and (especially) pamphlets would have at least needed consumers from the latter group unless we assume that the early-modern elite households of England and Wales would have bought tens of books and pamphlets annually. The wealthier farmer households would also have been able to spend on books, especially at the end of the century.[36] There was a quantitative change in production numbers compared to the size of the population, but it is entirely plausible that the demand for the increased supply was generated by the same socio-economic groups.

These results come with some reservations. They do not cover the impact of periodicals, which had a significant role in print culture and its expansion in the provinces during the eighteenth century (Harris, 2009; Ferdinand, 2009). As typically small and cheap publications, they would have increased the difference in production numbers between the more expensive price classes and the cheapest one. Periodicals could also be read in many contexts without needing to pay for them, making them even more

[34] It was a conscious choice not to correct for the number of households or income between 1688 and the early eighteenth century that the social table of the former year is used to represent, as it is not clear whether there was much change in the size of the English population (Wrigley and Schofield, 1981, pp. 573–575), or in wage levels (Wrigley and Schofield, 1981, pp. 640–643), between the earlier and the later periods.

[35] Details of the calculations are presented in Appendix C.

[36] Of the social groups analysed, the farmers undergo the greatest change, as at the end of the century they only need a fraction of the daily income for non-necessities to buy books that they needed at the beginning. Supply per farmer household also increases by and order of magnitude. This development could be attributed to the significant decline in the relative size of the group, parallelled by the increasing per-household wealth. The remaining farmer households of the late-eighteenth century would have been in a much better position to spend on books than the lower-middle classes.

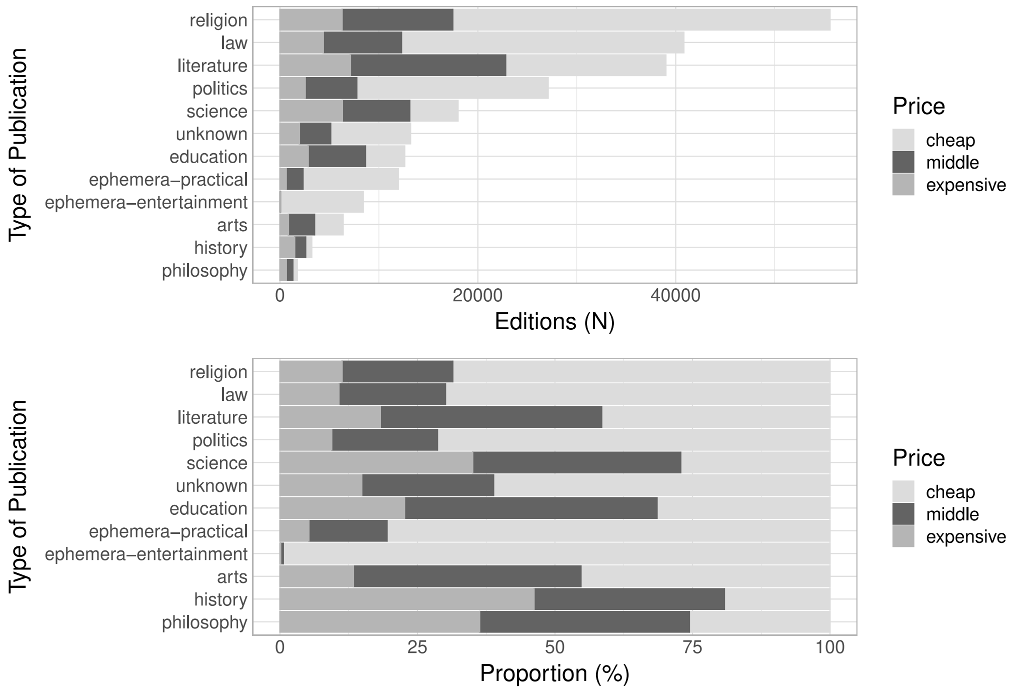

Fig. 5. The Number of ESTC records in different subject topics (N = 198,180). The top panel shows the absolute numbers and the bottom one the proportions.

accessible than their price would suggest. We did not make adjustments for individual publications that were printed in exceptional numbers per copy during the eighteenth century because they were exceptions in terms of supply, exceptionally cheap prices and heightened interest in societal questions.[37]

Some of the products were also intended to circulate freely, although they would have been disproportionately short items that we excluded from the analysis of supply. We do not find it plausible that this content had a democratising effect on the print culture given that it often related to political and commercial interests (e.g., public announcements and advertisements), which motivated their free dissemination.[38] Without having the money to spend on books and pamphlets, an eighteenth-century Briton would have been at the mercy of interest groups and institutions that determined what circulated freely.

On the other hand, there are several factors that could lead to production totals overestimating the level of demand for the editions our analysis covers, including institutional demand, copies that did not sell and collectors of books. They are not particularly problematic, however, as a significant reduction in de-facto supply for households would only strengthen our argument about the effect of price. We also conclude that imports and exports would most likely have added to the income-related inequality of the British book market by means of a significant outflow of more accessible editions to North America and an inflow of luxurious editions in foreign languages (that most people could not understand) to Britain. The argument for this conclusion is laid out in Appendix.

It is worth considering how prices might have affected the demand for print products of different types. Fig. 5 gives the absolute and relative numbers of editions belonging to different price classes by predicted subject topic. The topics (see Appendix B) should be precise and comprehensive enough to allow broad characterisations of the relationship between price and publication type, and

[37] The 1790s witnessed individual publications with exceptional numbers of copies printed. The publications related to the social tensions instigated by the French revolution. Especially noteworthy are Burke's *Reflections on the Revolution in France* (30,000 copies printed over two years (Butler, 1984, pp. 34–35)), Paine's *Rights of Man* (200,000 copies in circulation a year after the complete publication of both parts (Raven, 1998, p. 277)), and the *Cheap Repository Tracts* by Hannah More et al. (two million copies printed within a year (Stoker, 2013, p. 100)). Although these works were printed in several editions and the reliability concerning the number of copies of at least the *Rights of Man* is questionable (Altick, 1957, pp. 70–71), it is likely that they would have significantly added to the late-eighteenth-century production totals had it been possible to adjust for these exceptional numbers. However, as these publications would have added much less to real consumption choices, we can simply conclude that certain specific publications would have been more widely available than the numbers suggest. It should also be noted that both the *Rights of Man* and the *Cheap Repository Tracts* were sold at exceptionally cheap prices, and the relatively high cost of Burke's work has been interpreted as an attempt to make it less appealing to the lower social classes. The price of the *Rights of Man* fell significantly after the publishing of the first part, after appeals to Paine had been made for a cheaper edition and it had become an object of mass demand (Altick, 1957, pp. 69–75). Hence, the characteristics of most popular publications support the notion of an effect of the price constraint. There are also other anecdotal examples of individual publications related to political questions that reached numbers of copies well above the standard levels during the eighteenth century, including those mentioned by Beljame (1948, 309) and Collins (1928, 21).

[38] We discuss these types of print products in slightly more detail in the Appendix.

Table 3
Price constraint of items at the threshold of the cheap and moderately expensive, and moderately and quite expensive price classes, calculated based on the mean income available for non-necessities (NBE income) among given social classes covering three periods and using the closest social table. The Table also shows the average annual number of copies (details in Appendix C) in a price class per number of households in a social class.

Social class	Period	Moderately expensive Daily NBE income	Quite expensive Daily NBE income	Cheap Household	Middle-priced Household	Expensive Household
Workers	1700–1704	6.40	17.40	0.79	0.32	0.28
Workers	1757–1761	7.72	21.00	0.88	0.40	0.24
Workers	1796–1800	5.73	15.57	1.20	0.56	0.30
Farmers	1700–1704	6.27	17.04	1.92	0.78	0.68
Farmers	1757–1761	4.68	12.72	2.63	1.18	0.73
Farmers	1796–1800	2.14	5.81	6.79	3.17	1.67
Lower middle class	1700–1704	2.77	7.52	6.79	2.77	2.41
Lower middle class	1757–1761	3.05	8.30	5.29	2.37	1.46
Lower middle class	1796–1800	2.14	5.81	8.53	3.98	2.10
Large property owners	1700–1704	0.33	0.90	8.48	3.46	3.01
Large property owners	1757–1761	0.37	1.00	8.73	3.91	2.42
Large property owners	1796–1800	0.17	0.47	16.29	7.61	4.01

for publication types other than history, philosophy and ephemera,[39] also indicative of production totals. Not only did there seem to have been no price revolution, the increasingly popular topics of the century were disproportionately covered in more expensive editions. Most editions dedicated to literature and science fell into the more expensive price categories, whereas religion was, on average, cheaper and more abundant.[40]

This trend contradicts the relative decline of the latter category and the rise of the two former ones in the Enlightenment narrative and in the quantitative analyses of publishing outputs (Tolonen et al., 2021; Suarez, 2009) of the century. The cost of buying editions thought to be characteristic of the era would have been comparatively high, and the demand for them probably came mostly from wealthier households. On the other hand, the high production numbers of cheap religious publications align with previous findings indicating socio-economically even ownership of such editions both in Europe and in the Anglosphere (Ogilvie et al., 2022; Reilly and Hall, 2000). Possibly, for example, the expensive publications of literature that constituted only a fraction of all publications could have been consumed by an even smaller segment of the population than wealthy property-owning households.

Our results reflect both the dynamic and the stable elements of eighteenth-century British society. We observed a significant increase in production numbers across the price range over the century, which should not be seen as an internal development of the book trade as it coincides with the increase in the population and in the size of the economy. The number of editions per household also increased. However, the two more costly categories were small enough to have been consumed by owners of medium- and large-sized property even at the end of the century. The cheap category, in turn, was large enough to have supplied a larger proportion of the population engaged in occasional purchases. The lower survival rate, pamphlets with extraordinary numbers of copies, and the excluded shortest editions meant that the size of the cheap category was larger than estimated here, making the possibility even more plausible. If there were a case for identifying a section of the book market that supplied a wider audience, it would be in the domain of cheap pamphlet-sized items, both at the end and at the beginning of the century. If periodicals were considered, this would be even more likely.

Furthermore, the high cost of books could have been a relevant contributory factor in the social arrangements on which the Enlightenment era literary culture relied.[41] It was common in eighteenth-century Britain for a wealthy patron to provide scholars such as David Hume and Adam Smith with resources (Andrew, 2006, p. 35) enabling them to do their work. These resources sometimes included access to the patron's personal library.[42] Given that many of these scholars came from a middle-level[43] background, it is wholly plausible that they were financially constrained from buying books, let alone amassing considerable libraries such as those their patrons could provide. Moreover, given the widening inequality in book purchasing power during the eighteenth century, the economic incentives for an arrangement whereby a scholar's presence would be prestigious for a book-providing patron may well have increased towards the end of the century. Book prices could have shaped the social and economic arrangements in which the eighteenth-century intellectual achievements were created.

Our findings do not support the idea that the book trade underwent a full revolution in the accessibility of its contents. Throughout the entire century, most book-sized items cost enough to seriously inhibit demand from the vast majority of households.

39 We discuss the evaluation of the coverage and accuracy of these labels in Appendix B. The true size of the ephemeral topics is downplayed by the focus on editions longer than one sheet.

40 The argument is somewhat convoluted by the fact that editions shorter than two sheets could not be classified as literature or science in our scheme, but were labelled ephemera-entertainment or ephemera-practical. However, the difference between religion and the 'Enlightenment topics' would hold true even if we were to add to the literature and science categories, respectively, all entertainment and practical ephemera (which would also include items that are neither literature nor science in any sense).

41 For a succinct argument about the importance of patrons in the Scottish Enlightenment, see Emerson (2008, pp. 3–4). See also the second chapter in Andrew (2006) for an analysis of how the commercial print culture affected the patronage system.

42 For an example, see Andrew (2006, p. 167).

43 Sher (2006, p. 122) lists the incomes of a handful of individuals who belonged to the 'Moderate Literati' of Edinburgh. Even if perquisites are omitted, it seems likely that many of them would not have earned as much as average families in the wealthiest social group covered in our analysis. Some are closer to households of the lower-middle class or workers in terms of income.

At the same time, however, our analysis supports the idea of a significant loosening of the price constraint in the top quantiles, as real income was increasing among larger land and property owners. For them, what was already relatively affordable at the beginning of the century became even more affordable towards the end of it. We discuss the potential implications this had for demand in the Conclusions.

These findings may not reflect associations attached to the Enlightenment, but they resonate well with findings from studies on the history of inequality. The relative cost of living for workers increased in late-eighteenth-century England compared to the wealthiest households (Hoffman et al., 2005, p. 162), a development that is evident in the even wider context of increasing wealth inequality in early-modern Europe in general (Scheidel, 2017, pp. 91–101). In the absence of any great change in the distribution of prices, books would have become more accessible to those who had benefited most from the progress of British commercial society, although for the majority they remained very costly. It is plausible that the modest supply of books per household was attributable to low (non-latent) demand, as most households would have had very little money to spend on them. Pamphlet-sized items and certain subject areas such as religion would have been more affordable than books or scientific works.

4. Conclusions

Although historians have enthusiastically made various claims about the affordability of eighteenth-century print products in the past, to our knowledge we are the first to base such claims on the joint analysis of most of the existing comprehensive bibliographic and socio-economic data, and on an interpretable model of money available for non-necessities. In brief, our results indicate that neither income nor production totals imply that a greater proportion of households started to buy books during that period. It is plausible that high prices made and kept much of the demand for books latent for the entire century. The wealthiest households benefited the most from late-eighteenth-century developments in that their real incomes rose, thereby allowing a higher consumption of non-necessities. Most families would have required several days' income put aside for non-necessities to buy even moderately expensive books. On the other hand, high book prices could have had more complicated consequences, possibly affecting the introduction of services such as subscription libraries and patron-client relationships. Indirectly, therefore, they may have shaped the social arrangements on which Enlightenment-era culture relied.

Our multivariate regression analysis revealed no evidence of a revolutionising impact of the DB ruling. General spatial and temporal differences do not contradict the argument that books and pamphlets printed in London during the middle of the century were overpriced, but the observed changes after 1774 did not fit the narrative about the role of copyright legislation. Price was related to almost all the other attributes of a print product, from its physical characteristics to its content, to a non-trivial degree.[44]

Perhaps the most novel contribution of our approach was to use the predictions to establish a data-driven overview of the supply of books in different price segments: one could argue for both a significant change and substantial stability. Excluding the very smallest publications, the volume of items in all price classes increased significantly across the century, but their relative proportions were more stable. The expansion of cheap pamphleteering happened in parallel with an increase in the number of expensive titles.

This is the context in which new variants of luxury printing, cheap abridgments and other innovations introduced at the end of the century should be considered: the book business delivered more of everything in terms of price. Our results strongly support arguments emphasising diversity rather than a general decrease or increase in the prices of late-eighteenth-century print products (Raven, 2007, pp. 222, 232).[45] There was a significant difference between books and pamphlets, with books almost completely comprising the two more expensive categories.

One should also bear in mind this diversification when considering the possible ways in which early-modern Britons might have exploited their increased capacity to spend on non-necessities towards the end of the century. The wealthiest households probably would not have spent their money on more items on the threshold of the expensive price category that we used to demonstrate the shift in their incomes. There is both anecdotal (Altick, 1957, p. 52) and quantitative (Knight, 1854, pp. 222–223, 238–239) evidence indicating that, among the works that would have belonged to our expensive price category, the shift on the domestic market would have been towards even more expensive and lavish editions. The up-and-coming subject topics of the century (science and literature) were typically more expensive than books on religion, for example, production of which was in relative decline. Similarly, luxury editions imported from the continent were even more expensive during the latter half of the century, and as antiquarianism of the period attest, interest in books as material objects was increasing (Raven, 2007, p. 194).

Our results both align with but also stratify claims about increasing numbers of book purchasers and the accelerating rate of consumption among contemporary buyers in eighteenth-century Britain Raven (1998, p. 279). The biggest increase in the number of editions was in the cheap and middle-range price classes, which would have been more affordable for the lower-income households. It may be that the more modest increases in income among these households converted to a higher increase in consumption. Phenomena such as periodicals and the second-hand book market might have played a prominent role in the eighteenth-century culture of reading among the less-earning inhabitants of the British Isles who were still literate, whereas the rigidity of the costly first-hand book market might have affected the development of its competitors. Also, the possible adaptation of the book market to

[44] This is not to say that all physical characteristics or all subject topics related to price.

[45] Despite his price index for new publications that suggests an increase, Raven also refers to the evolution of cheaper segments of the book trade in the late-eighteenth century. The finding also aligns with the results of previous quantitative research indicating some diversification of prices in the ESTC data towards the end of the century (Duhaime, 2019, pp. 129–137).

supply popular (e.g. religious) literature more affordably might have been a contributing factor behind the high number of smaller publications printed during the eighteenth century.

Our results do not fit the narrative of a price revolution or an optimistic take on the Enlightenment era, but they are not surprising when reflected against the history of income and wealth inequality in the early-modern British Isles. For an early-modern society, eighteenth-century Britain was affluent and became even more so as the century ran its course, but this happened in parallel with increasing inequality. There was no qualitative change in income levels, and the printing press had existed for several hundred years without significant technological advances. Given that economic gains were disproportionately concentrated on the landed and property-owning classes, and there were no new technological shocks in the production of books and pamphlets, the lack of revolutionising shifts in the consumption or accessibility of what were mostly luxury items should not come as a surprise.

Our approach could be applied to further research on book prices, and similar analyses could be conducted using a more extensive data set. In combination, catalogues, review journals and advertisements contain price information on tens of thousands of editions at least. There are also hundreds of surviving auction catalogues concerning the re-sale of books, which according to some provide more comprehensive price information than is available for the primary market (Elliott, 2010, pp. 357–360). Gathering, extracting and integrating the information from these sources to the ESTC would require its own project, but it could enhance granularity in analyses conducted for the primary book market and possibly facilitate their extension to the secondary market.

The integration of price data from review journals could also facilitate analysis of the starkest contradiction in our results compared to previous extensive quantitative analyses, namely the differences compared to Raven's book-price index derived from these sources (Raven, 2009, 2007, pp. 97–98, 302-303) and indicating a significant increase in prices during the second half of the eighteenth century, especially in the 1790s. Various factors could have contributed to this difference[46], but the best way to confirm its source(s) would be to integrate data from review journals into our data set and conduct a comparative analysis.

Prices could also be valuable in contextualising other emerging strands of historical research. Machine-readable, full-text collections and the development of computational tools to analyse them have opened up new possibilities for the large-scale quantitative study of historical discourses in recent years (de Bolla et al., 2020; Tiihonen et al., 2022), and attempts have been made to understand the large-scale diffusion of intellectual phenomena such as the Enlightenment (Montoya, 2021; Ryan and Tolonen, 2024). Bibliographic metadata with (predicted) price information could be linked to such analyses to study how the spread of specific discourses or ideas might have been limited by the price of the form in which they manifested, namely the printed edition of a book.

CRediT authorship contribution statement

Iiro Tiihonen: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Leo Lahti:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Data curation. **Mikko Tolonen:** Writing – review & editing, Supervision, Resources, Project administration, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Code and publicly available data is available here: https://github.com/COMHIS/article_2024_print_culture_and_economic_constraints.

Acknowledgements

We acknowledge the preceding work that has made it possible to use the ESTC in quantitative analyses. We especially thank Ville Vaara, Mark Hill, and Ali Ijaz for the work (Ijaz et al., 2019) and actor (Hill et al., 2019) fields used in this article. Similarly, we thank Eetu Mäkelä and Kira Hinderks for contributions towards forming the subject topic data used in this article.

Funding sources

We thank the Finnish Cultural Foundation and the Academy of Finland (decisions 333716 to MT; 348946 to LL) for funding the work on this article. The funders had no involvement in the collection, analysis or interpretation of the data, writing of the article or the decision to submit the article for publication.

[46] Possible reasons for the difference include the temporal variation in the length of volumes (the unit of Raven's analysis), expensive outliers (to which the index is probably more sensitive than our robust regression), and differences in data composition. Raven's data covers new bound publications reviewed by journals, that might, on average, be more expensive than the prices on imprints that make the majority of our data. We see Raven's conversion of the index to purchasing power to be problematic. Deducing from his description and the source cited (Mitchell and Deane, 1962, pp. 346–349), it is based on comparing the price index to money wages of labourers in London. Worker wages in England developed differently depending on location and occupation, did not often comprise the total income of a worker household and they do not relate to the part of the population that was in the best position to buy books anyway.

Table A.4
Variables of the multivariate regression analysis. In column one are the variable names, and column two describes the value ranges with the default value of dummy variables (or possible standardisation in the case of continuous variables) repeated last in the parentheses.

Variable	Values (zero-level of dummy variable)
Format	Gatherings between 2fo and 64mo (octavo, 8vo)
Subject topic	Categories listed in B.7 (politics)
Publication Place	London, Dublin, Edinburgh, (England/Scotland/Ireland)-Other (London)
Five year interval	1700–1704, …, 1795–1799 (1770–1774)
Length of the print product	pamphlet, mid-length, book, long book (mid-length)
Reprint (of a book) before 1774	Reprint (of a book) before/after 1774, other (other)
Luxury characteristics	Present (quarto or folio book with illustrations), not present (not present)
Copyright-defending publisher in imprint information	Not present, present before 1774, present after 1774 (not present)
Characters per sheet	Characters per sheet in ECCO/1000 (standardised)
Proportion of visual elements	Proportion of pages with visual elements (standardised)

Appendix A. Technical details

A.1. Technical details — regression model

Here, we discuss some technical aspects of the Bayesian multivariate regression model in more detail. In particular, we describe the model, its variables and the evaluation more thoroughly than in the methods section of the article.

We implemented the Bayesian regression model with Stan (Stan Development Team, 2023), and implemented robust regression by changing the gaussian error term to a one following Student's t-distribution.[47] By setting up skeptical priors we could encode bias against small effects to the model itself. The intercept was given a prior distribution centred on a typical price per sheet. Our model can be described with the following set of distributions:

$$Y \sim t(2.5, X\beta + \alpha, \sigma)$$
$$\beta \sim L(0, 0.1)$$
$$\alpha \sim N_{+}(2, 1)$$
$$\sigma \sim \Gamma^{-1}(1, 1)$$

Where 2.5 is the degrees of freedom of the t-distribution, X is a matrix of predictors, β is the vector of effect sizes, and σ is the scale. Full list of the variables[48] of the regression model is presented in Table A.4. The normal distribution that defines the prior for the intercept is limited to positive values. The prior distributions of effect sizes are heavily concentrated around zero. The posterior was estimated using Monte Carlo Markov Chains (MCMC) with Stan. To obtain the posterior distributions for the model depicting the relationship between expenditure and basic expenditure and for the multivariate regression model, The MCMC algorithm was run with STAN for four chains with 2000 iterations, and 500 warmup samples.

We wanted to ensure that the fitting of the model was not heavily affected by outlier cases. Ten percent of the data (N = 2706) suitable for the multivariate regression analysis was left out of model fitting for evaluation purposes. The model evaluation suggests that we were successful in reducing the effect of outliers. The distribution of residuals on independent test data is distributed sharply around 0 in Fig. A.6, with most observations varying much less than the intercepts[49] worth from the predicted price per sheet. The difference between the mean absolute error (0.18) and the mean squared error (0.08) explained by the model with the mean values of the posterior distribution of the parameters suggests the presence of heavy outliers, as the mean squared error is more sensitive to them. However, it also means that the model is explaining more of the "typical" price variation than of the extreme cases, as we intended.

A.2. Technical details — extreme gradient boosted model

The training of the model was done with the XGBoost algorithm as implemented in the R package xgboost and the hyperparameter tuning was done with the R package Caret. Only the training data was used in the hyperparameter tuning and the training of the model.[50] The price per sheet prediction was then used to make a prediction for the total price by multiplying it by the number of sheets per edition.

[47] The distribution has heavier tails.
[48] In the variable presented in the Table, the length is defined by sheets in the edition. Pamphlets are 1–4 sheets, mid-length are until 8 sheets, books are until 24 sheets, and long books are longer than or equal to 24 sheets. The definition of a book aligns with the definition used elsewhere in the article for an octavo (the most common format) edition, as an octavo edition with eight sheets has 128 pages.
[49] Median of the posterior distribution = 2.3, can be interpreted as the price per sheet for the "average" edition with default dummy variable values.
[50] E.g. the validation of the performance of the model with different hyperparameters did not include the test data.

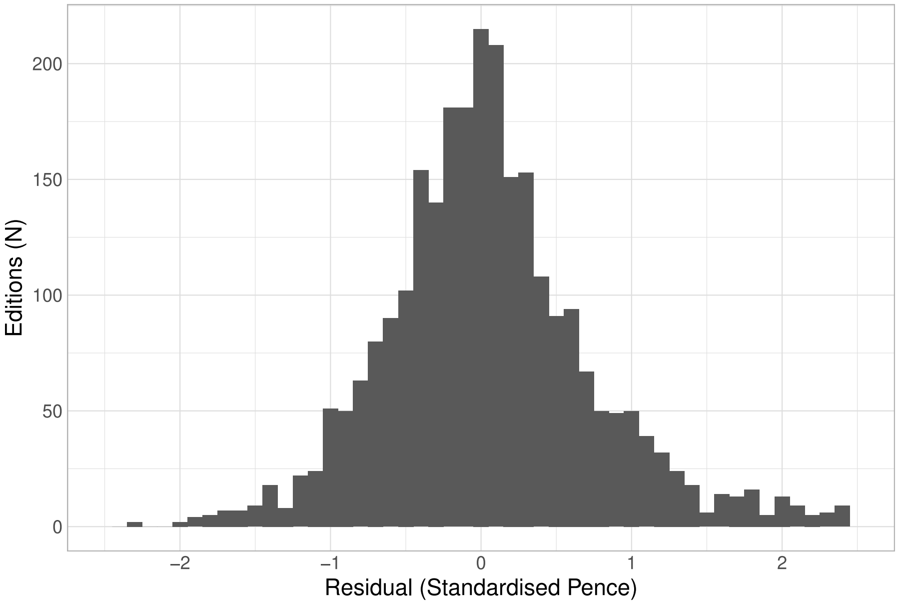

Fig. A.6. Residual plot of the Bayesian multivariate regression model against test data and with the mean parameters from the posterior distribution. Unit of measure: real price adjusted pence. N = 2707, with 70 observations not present in the span of the Figure.

Table A.5
Variables of the Extreme Gradient Boosted Model, used to predict missing price information.

Variable
Format
Publication place
Subject topic (value unknown used for records without one)
Publication year
Proportion of pages with visual elements
Number of pages
Estimated area per page
Is first-year edition (of a book-sized edition)
Sheets

Outliers (mean price per sheet larger or smaller than the mean by a factor of 6) were removed from the training data, as many of them included such items that could potentially distort extrapolations significantly. For example, the few maps and published letters in our price data are examples of items that are very small in terms of physical characteristics, but very expensive. Removing them from the training data means that we are unable to detect some forms of short “luxury” items, but we deemed this better than the possibility that the model would start predicting very high prices for pamphlets that happened to be very similar to these rare items in terms of most characteristics. We also set a lower limit to the predictions of the model by converting predictions of less than 0.4 pence per sheet (less than a fifth of the mean price per sheet) to 0.4 pence.

To evaluate the performance of the model, we computed the balanced accuracy for each price class for the test data. Balanced accuracy is an average of the true positive rate and the true negative rate. True positive rate measures the proportion of observations belonging to a class that were successfully detected, and the true negative rate the proportion of observations not belonging to it that were successfully rejected (were not given the label). The balanced accuracy was more than 85 percent for all of the price classes in the test data. The model is mostly capable of detecting editions belonging to any given price class without inflating them with editions belonging to the other classes.

In addition to summary statistics reducible to single numbers, we produced a confusion matrix for the test data converted to ordinal scale. A confusion matrix expresses the full distribution of observations by their real and predicted class, giving a more nuanced picture of the classifiers performance than e.g. accuracy. The confusion matrix that compares the real and predicted price classes of the records in the test data is presented in Table A.6. Although our model performs quite well, there is room for improvement, especially in the detection of expensive and middle-priced editions. However, this is possibly partially explained by the fact, that a significant portion of the test data is on the borderline between price classes compared to what is on the right (more expensive) side. This would make many instances in our test data harder to label correctly on the ordinal scale than observations from a data set that is less downward-skewed. This property of the test data can be observed in Fig. 2 (see Table A.5 for the variables used by the model).

Table A.6
Confusion matrix of the Extreme Gradient Boosted Model with prices that have been converted to ordinal scale. Columns indicate the real and rows the predicted price class, Values of elements correspond to the percent of records with the given combination of predicted and real class. N = 5888.

Price class	Cheap	Middle	Expensive
Cheap	74	3.4	0.068
Middle	4.5	14	0.8
Expensive	0.017	0.54	2.5

Appendix B. Data

B.1. Data — the ESTC and ECCO

The main data sets we use are the English Short Title Catalogue (ESTC) and the Eighteenth Century Collections Online (ECCO). The ESTC is the largest collection of bibliographic metadata for early modern Anglosphere, comprising the collections of the British National Library and various other institutions, totalling almost half a million records. The raw data has been extensively parsed, harmonised, and enriched to make it a more viable source for quantitative book history and intellectual history (Lahti et al., 2019). ECCO is primarily a collection of digitalised and OCR'd full texts that covers roughly half of the eighteenth-century records of the ESTC. It also has metadata that includes information about the type and location of visual elements in a given document, as well as general information like page estimates. The ECCO and ESTC are interlinkable, ECCO being a subset of the ESTC that covers half of the eighteenth century records of the latter. Almost all of the items with price information are in both collections.

Of the variables used in this article, the publication place, format, and year field existed in the original raw data of the ESTC. The number of pages was also available in ECCO. In cases of conflicting information, the larger page count was chosen[51]. A similar approach was taken to estimate the number of "special" pages in the records. The ESTC has information about the use of plates (pages printed with engraved copper plates), but it is often imprecise, only expressing the presence of plates. The ECCO has more detailed metadata, recording the presence of visual elements at the page level. From the estimated number of plate pages in the ESTC for a record and the number of pages with graphical elements from ECCO, we took the larger number. In the calculations, we assumed that plates were one-sided (e.g. only having visuals on one side of the page). For records not in the ECCO, information from the ESTC was used. We also used information about the number of letters, punctuation marks etc. per sheet in each ECCO document. This can be seen as an approximation of how dense the printing was (cheap editions sometimes used space more efficiently), although the limitations of the OCR process used to transform ECCO documents into a machine-readable form implies that the estimates have a significant amount of noise in them (Hill and Hengchen, 2019).

The subject topic annotations used are not those that the ECCO or ESTC provide. The annotation categories were constructed specifically for early modern works in the context of ongoing research. The multi-step process to obtain these annotations that cover more than 90 percent of the ESTC has not yet been described in any publication, but the most important consideration is that most of these annotations have been predicted with quantitative methods. Hence we share our preliminary evaluation of them in Table B.7. These evaluations suggest, that the subject topics mostly include (precision) relevant records and their sizes are not greatly deflated by records that should definitely belong to them but are not classified to them (coverage). The relatively small categories of history and philosophy are unfortunate exceptions, as for them coverage is rather low.

The work-id's that we use to distinguish between editions of the same text (and to join them together) and the actor-id that we use to recognise individuals (authors, publishers, printers. etc.) are the end results of harmonising and further processing (Hill et al., 2019; Ijaz et al., 2019) of the ESTC data, not found from the original catalogue as such. Especially, the publisher information used comes from the imprint information in the ESTC, and it is also the result of a long-continuing harmonisation effort (Hill et al., 2019). Features like being a reprint (not a first edition), an edition having a certain publisher, etc. are derivatives of these fields. If an edition did not have publisher or work information, the related variable (e.g. dummy variable about edition being a reprint) was given the default value.

Prices were scattered amidst the general notes field 500a that the librarians have used to make additional remarks that do not fit the general scheme of the other fields, and most of them come from the imprints of the print products. These 30 000 records with prices are to our understanding the largest machine-readable collection of such information for eighteenth century Britain.

The collection of the ESTC and ECCO records with price information is to our best knowledge arbitrary: it consists of items with a price on the imprint that has been recorded to the note field. Although the entire eighteenth century is well represented (Duhaime, 2019; Tiihonen et al., 2021), some item types are significantly underrepresented at the expense of others. For example, folios and quartos of book-length are rare, and so are more expensive records in general. On the other hand, the less than 500 editions used

[51] If the number of pages was uneven after using the larger page count (impossible by our definition), it was changed to the closest even number (e.g. to properly count both sides of a broadsheet as pages). This had the largest effect on the few broadsheets in the ESTC that were reported as being one page long, most likely meaning that there was printing only on one side. The use of the larger page count and forcing an even number of pages had in general only a small effect on data: in 97 percent of cases (records) the page count changed less than 5 percent compared to the ESTC data before these article-specific changes.

Table B.7
The preliminary evaluation of the precision (pre.) and coverage (cov.) of subject topic data used based on a sample of 1000 ESTC records for which two historians checked the suggested label. The two annotators scored each label with either 0 (wrong), 0.5 (reasonable classification), 1 (best one possible). The score 0.5 was motivated by significant overlaps of categories and disagreement between annotators about the proper label. For precision, label was deemed correct if its average score of the annotators was at least 0.5. Both annotators also proposed the real category for falsely classified records, which was then (averaging over the annotators) used to calculate the coverage as a proportion of properly classified records belonging to the category compared to all records that should have been classified to a category. The quantiles were obtained by bootstrapping the evaluation sample.

Subject topic	pre. 2.5th q.	pre.	pre. 97.5th q.	cov. 2.5th q.	cov.	cov. 97.5th q.
arts	0.69	0.75	1.00	0.69	0.70	0.97
education	0.90	0.98	1.00	0.85	0.89	0.97
entertainment	0.89	0.93	0.99	0.78	0.84	0.90
history	1.00	1.00	1.00	0.13	0.32	0.56
law	0.81	0.89	0.91	0.92	0.95	0.97
literature	0.89	0.94	0.98	0.83	0.92	0.92
philosophy	1.00	1.00	1.00	0.39	0.65	0.94
politics	0.93	0.97	0.99	0.69	0.77	0.80
practical	0.78	0.82	0.93	0.72	0.77	0.85
religion	0.91	0.96	0.96	0.91	0.93	0.96
science	0.83	0.93	1.00	0.80	0.91	0.95

by Fielding and Rogers (2017a,b) in their analyses of book prices make for a sparse data set to analyse the entire eighteenth century, but the proportion of expensive titles is higher than in our data, and they provide the ESTC id for each observation. We incorporated their data set into ours to the extent that the observations satisfied our selection criteria for editions otherwise.

Bibliographic metadata – even the ESTC in its carefully developed form – contains multiple caveats that make it challenging for the purposes of data analysis. In some cases, there were multiple prices offered for the same record, varying based on attributes (e.g. the type of binding) of which we have no systematically gathered information. By default, we chose the smallest price for each record. The DB question is very much about whether possibilities for cheap reprints expanded to a significant degree due to legislative changes, and for our more general consideration of the price's role as a constraint, the smallest price is the most relevant. In some cases the price was ambiguous, possibly referring to a single volume whereas the ESTC records might contain all issues of a periodical or all pieces of a long edition like a dictionary. We excluded periodicals from our analysis, whereas other multi-volume editions down to the price of 36 pence were checked by hand and used in fitting the models, but otherwise discarded from training and test data (but not from being targets of predictions). The number of volumes as such (when size of the item is already considered) only has a minor overall connection with price in the ESTC data (Duhaime, 2019). However, we wanted to keep as many of the more expensive editions – that are relatively rare in our data – as possible included in our analysis, and many of those are multi-volume editions. This is why we hand-checked and included more expensive multi-volume editions for which the reference point of the price was the entire edition. In some cases in which several volumes were very similar and the price was given at the per-volume level, the given price was multiplied by the number of volumes.

We limited all analyses to eighteenth-century publications from the British Isles[52] with information about basic physical characteristics (page count and format) and publication place at the city level available. These make up 95 percent of the eighteenth century records for the British Isles. The exclusion of periodicals from the data was based on genre, form, surrogate (e.g. a copy of a record being located in a given microfilm collection), citation (e.g. being cited in a bibliography of periodicals), and publication frequency information in the ESTC.

B.2. Data — the social tables

By social tables, we mean estimates of income and size of the English population put together by three early modern authors and scrutinised and corrected by modern scholars. We use social tables of King for 1688, Massie for 1759 and Colguhoun for 1798[53] as they have been corrected by Allen (2019). Allen's revision belongs to a long line of discussion and debate about the tables and follows a previous iteration of revising them by Lindert and Williamson (1982). It reflects the common lack of reliable statistics before the modern era that we must rely on these tables, skewed both by the personal ambitions and the lack of sources of their authors (Holmes, 1977; Lindert and Williamson, 1982), but they are the most comprehensive attempts to provide overviews on incomes and households of early modern England and Wales and benefit from the scrutiny and improvements made on them by economic historians.

52 In some instances, the ESTC record does not contain certain information about the time or place of a publication, but there is an estimate in the data. In rarer instances, the metadata includes information that corrects the publication place information claimed in the imprint of a book. We have used these estimates and corrections for time and place information, and considered their effect on our analyses. Errors in publication year estimates were one reason for segmenting time-related analyses to five year intervals, as this level of granularity is less sensitive to errors. If anything, the significant effect of publication place on price is even more remarkable considering possible noise in the variable.

53 The year is a change proposed by Allen, as usually the table is dated to 1801. We have not corrected for the possible small population change between 1798 and 1801, the census of the latter year being the source of Colquhoun's population count.

Especially, we use the mean income and the number of households for major social groups derived by Allen (2019) from the social tables in calculating the price constraint and the number of print products per household in Table 3. Of Allen's social groups, we omitted paupers and cottagers, as their incomes were so small that our price constraint model would likely not give realistic estimates about their ability to purchase books and pamphlets. We merged the two wealthiest classes of bourgeoisie and owners of land, thus creating the social group of large property owners.

The number of earners per household of a given social class also comes from Allen (2019). As the social class of workers also includes single-member families of servants, using a fixed number of earners per household inflates the mean income of worker families, as these single-member families could not have had more than one earner. On the other hand, these servants only needed to sustain themselves, possibly allowing a greater share of income to be directed to luxury goods. The most meaningful interpretation is that the servant families are handled as if the family of servants consisted of 4.5 members with 2.5 earners (number of earners per worker household) instead of 1 member and 1 earner.

B.3. Data — early modern budgets

The data on expenditure that was used to fit the model f needed to calculate the price constraint C comes from a collection of sources. In total, we had 13 budgets of expenses with information about the proportion spent on basic expenses, and they cover the income range roughly from the middle quantiles to the upper middle class. This data is presented in Table B.8.

Due to a lack of data, we omit savings and taxes from the calculations, and in doing so associate reported expenses with incomes. Taxes at least would have been basic expenses by our definition (and some savings as well), which makes it likely that the proportion of basic expenses would have been even larger for most households than what is estimated here. We scaled the sizes and incomes of the households to 4.5 individuals per household. This is the "expected" size of a family in Allen's analysis of the social tables (Allen, 2019), and it is his derivative tables to which the model fitted with the budget data was applied to, making 4.5 the most reasonable choice. We considered the household to be a better comparison for the price of a print product than earnings per capita, as books and pamphlets can be borrowed and read aloud, especially by those that live together.

We only included household data that had fine-grained enough budgets for our purposes. We did accept data with minor deviations like the absence of soap or other costs related to hygiene in reporting the basic expense categories (food, drink, clothing, fuel, lighting, costs related to having servants, soap/hygiene and rent). However, larger differences lead to discarding some potential data, like the original expenditure tables of Gregory King,[54] for which the granularity only includes the categories of food and drink, apparel, and other. We deemed using Horrell's budgets to be the most efficient way to incorporate the relatively abundant data about the expenditure of worker families to which they are based on Horrell (2023, 1996).

In addition to these general principles, we had to make a collection of changes, merges and other modifications of data that cannot be directly derived from these principles. We list these changes here, and refer to each budget by using the column Budget id of Table B.8. The reason why it is often possible to combine information from several sources is that e.g. Hoffman et al. (2005) derives much of his data from earlier studies.

For budgets 2, 8, 9 and 10 the source for budget shares is based on the calculations presented by Hoffman et al. (2005). However, these budget shares refer to income quantiles (e.g. top 10 percent or top 20 percent) of Gregory King's tables instead of exact incomes. The incomes that correspond with these quantiles and spending distributions were taken from Stone (1988), who reproduces King's table of income distribution of households on per capita terms. We assumed that the per capita estimates were based on family size of 5, as this was a typical family size in King's tables.

Budget 12 was formed by combining two budgets of similar household expenses presented by Boot (1999), which are those of Lowe and Rundell. We take the budget of Lowe as the basis, but remove the savings reported by Lowe and taxes reported by Rundell for a family with the same income (750 pounds). The reductions aim for uniformity of observations, as most of the other budgets were not fine-grained enough for considering savings and taxes.

Budget 7 was otherwise based on calculations of Hoffman et al. (2005, pp. 140–145), but the number of household members was taken from Weatherill (1996) that analysed the same household. The historical household that the budget is based on had a number of part-time or unsure inhabitants, counted by us to the household size with weight of 0.5.

For Budget 6, the shares of expenses come from Hoffman et al. (2005, pp. 140–145), and the income of the household is an upper bound estimate presented in a footnote of the same work (Hoffman et al., 2005, p. 142). Size of the household in 1675 is based on research by Weatherill (1996, p. 128).

Budget 13 comes from Vanderlint (1734, pp. 140–143). We did not consider the money spent on debts or business relationships that Vanderlindt reports to be net income available for the expenses of the household, hence those portions were omitted. Of the 50 pounds that Vanderlindt allocates to taxes and rent jointly, we allocate 25.1 pounds to rent, as this aligns with 10 percent of incomes allocated to rent. We chose 10 percent, because the family in the top 5 percent of incomes in Hoffman et al. (2005, pp. 140–143) with roughly similar income level after adjusting for inflation spends 10 percent to rent.

[54] For example, presented in Stone (1988).

Table B.8
Data on Early Modern British Households and their expenditure Patterns. NBE stands for not basic expenses. P. stands for proportion. For the analyses the nominal incomes of the Table were converted to pounds of the year 1688 (measured in real wage value) and households were standardised to have 4.5 members (linear scaling of incomes).

Income (£)	P. of NBE	Size (n)	Year	Source(s)	Budget id
34	0.047	5	1700	Horrell (2023, Appendix)	1
35	0.1	5	1688	Hoffman et al. (2005, pp. 140–143) and Stone (1988)	2
36	0.067	5	1750	Horrell (2023, Appendix)	3
44	0.059	5	1787	Horrell (2023, Appendix)	4
55	0.1	6	1734	Vanderlint (1734, pp. 76–76)	5
78	0.3	5	1675	Hoffman et al. (2005, pp. 140–143) and Weatherill (1996, p. 128)	6
89	0.17	3.5	1694	Hoffman et al. (2005, pp. 140–143) and Weatherill (1996)	7
112	0.24	5	1688	Hoffman et al. (2005, pp. 140–143) and Stone (1988)	8
157	0.26	5	1688	Hoffman et al. (2005, pp. 140–143) and Stone (1988)	9
208	0.28	5	1688	Hoffman et al. (2005, pp. 140–143) and Stone (1988)	10
175	0.18	3	1695	Hoffman et al. (2005, pp. 140–143)	11
648	0.36	5	1823	Boot (1999, p. 653)	12
251	0.2	5	1734	Vanderlint (1734, p. 653)	13

B.4. Monetary conversions

If not mentioned otherwise, prices and incomes were converted to the corresponding real wage value of 1688 using Measuring-worth (2022). Our understanding is that this is always the same as the real price value provided by the service, as both are based on the Retail Price Index. The conversion was done by querying for the needed years what sum of money would have equalled one 1688 pound in real wage value during that year, and the result of the query was used to compute how many 1688 pounds a pound of the given year was worth of in terms of real wage value. This information was then used to convert prices and wages to their real wage value in the money of the year 1688. The year 1688 was chosen as the basis based on the year of the first social table. Prices of print products are by default in pence. The transformation of different monetary units into pence is done as described in the website of the Old Bailey Proceeding Online project (Hitchcock, 2023).

A slight complication to interpreting the price information of the relatively rare Scottish and Irish editions are the local currencies in which Ireland and Scotland used the same terms for units of different values as the English. We do not, however, think that this could have much affected our data or results. Scotland shifted to using the English Pound officially in 1707, and it is unlikely that prices given in Scots Pound would have affected our calculations, as such items would have appeared as significant outliers in terms of price per sheet, and would have been (and some were) easy to detect. The monetary situation in Ireland in the eighteenth century was more complicated, as the island used both British and foreign coins (McGowan, 1989, p. 47) and it had its own Irish pound with an exchange rate of 13:12 to the British pound (McGowan, 1989, p. 48). In our calculations it was assumed that the prices were given in British Pounds as foreign coins were often preferred (McGowan, 1989, p. 48) and this difference should not significantly affect our results. For example, it is a fraction (and to the opposite direction) of the observed negative price premium of Irish editions.

Appendix C. Number of copies printed, survival rate, excluded records, and other considerations related to output numbers

Here, we discuss the choices that we made in calculating the total output numbers for eighteenth century print products, and how these choices possibly affect the analysis of prices.

In calculating the yearly number of editions per household, we assumed 1000 copies per edition. During the early modern period, the number of copies per edition varied significantly, from only some tens of copies[55] to several thousand, and the number of copies varied between different kinds of books and pamphlets (Jenner, 2011; Watt, 1990; Simmons, 2002). This variation has been recognised as an issue for estimating production numbers in early modern book history (Raven, 2018, p. 65). Still, when a constant is needed, one thousand copies is a frequently used (Raymond, 2011; Gants, 2002; Hill, 2018) number.

It is possible to explore whether this conventionally used number of copies per edition is potentially problematic in our case, for example by being correlated with price. Some of the eighteenth century ESTC records are connected to ledgers of the printing houses that took part in producing them. Especially, there is a significant amount of data about editions at least partially printed by William Bowyer. As the ledgers often report the number of copies produced, this allows us to examine the relationship between the predicted price and the number of copies for a subset of our data. We deemed this worthwhile, as significant variation in the average number of copies related to price would affect the interpretation of an edition-based analysis such as ours.

For information on the number of copies printed, we used 2280 ESTC records with the number of copies in a printer's ledger reported in the field 500a. These records were obtained by searching the ESTC data with regular expressions and filtering out

[55] For an anecdotal example, see for example the ESTC record T172758 at http://estc.bl.uk/T172758.

Table C.9
Summary statistics on the number of copies by (predicted) price class.

Price class	Median	Mean	Std	Max	n
cheap	532.50	1793.98	3273.15	18 000	660
middle	1000.00	1203.33	1228.46	10 150	537
expensive	750.00	1082.92	1078.92	6500	655

other than non-ambiguous information about number of copies printed. Limiting the data to eighteenth-century records for which a prediction was made and the length was longer than 1 sheet dropped this number further down to 1852 observations.

Table C.9 summarises the comparisons between price and the number of copies. Interestingly, the median number of copies for the more costly classes is somewhat higher, but the mean and observed maximum number of copies is lower. This is explained by the significantly larger variation in the number of copies of the cheap titles, skewed towards very large print runs. For the price classes middle and expensive, the mean is very close to 1000, whereas for cheap editions it is closer to 2000.

We did not incorporate these differences into the analyses, as the representativeness of this information mainly coming from one printer (William Bowyer) would need further investigation for being the basis e.g. for a weighting scheme. It should also be checked whether other printing houses were involved in the production of these editions. For now, they provide tentative evidence for arguing that even in the first-hand market cheap editions would have taken a larger share of all copies than what the (predicted) title counts imply, but this is explained more by some editions being printed in very large numbers (almanacs being a common example) than by a general tendency towards a larger number of copies.

For other print product types than jobbing print (short ephemeral items, see for example Andrews (2010, pp. 834–835)) and periodicals, the ESTC has been estimated to cover 90 percent of the printed record for 1701–1800 (Suarez, 2009, p. 40). Additionally, the ESTC does not cover some categories of small print products (Raven, 2018, p. 61). We focused our analysis on those sections of printed records, for which the ESTC provides more reliable coverage. Periodicals were removed from our analyses entirely, and the predictions used in the analysis of supply excluded all records shorter than or equal to 1 sheet. Although not an exact definition, shorter than one sheet is one historical definition given for jobbing print (Andrews, 2010, pp. 834–835). As such thresholds like 1 sheet do not perfectly differentiate what the ESTC covers or to what price can be applied to. Some items we would consider jobbing print are still included, and some that we would not consider being jobbing print are excluded. However, the removal of the shortest items decreases the ambiguity and uncertainty of the data analysis significantly.

We adjusted our calculations for different types of missing data. In the ESTC data that we use, around 2 percent of the records lack either time or place information. Of the records with time and place, roughly 5 percent lack the basic physical characteristics (or place at the city level) we require to predict the price. Together with the estimate of 10 percent of records being lost, we can compute a naive estimate of the proportion of relevant records that our predictions cover. We obtain $0.9 \times 0.978 \times 0.946 \approx 0.83$. All output totals in the results section have been "corrected" by multiplying them by the reciprocal of this constant.

Our analyses provided tentative evidence for the average number of copies for cheap print products being higher. And, generally speaking, the survival rate is probably lower for small, ephemeral records (Suarez, 2009). As the size of a print product is strongly connected to its price, it seems likely that incorporating varying survival rates and number of copies to the analyses would widen price-related differences in output numbers. On the other hand, evaluation of the predicted prices converted to ordinal scale suggested that a higher proportion of the more expensive editions were subject to downward prediction than the other way around.[56] One additional factor for which no correction was implemented was the presence of duplicate editions (e.g. variants of the same edition recorded separately). More comprehensive adjustments and weighting schemes are potential topics for further research.

Appendix D. Supplementary data

D.1. Summary of the posterior distribution of the multivariate regression model

See Table D.10.

D.2. Data overview

See Table D.11.

[56] And our choice of the smallest known price for each edition means that many editions could have cost more with a more expensive 'parametrisation'.

Table D.10
Summary of the posterior distribution of the multivariate regression model. Parameters can be read as the price per sheet added to the mean price α in pence of 1688. In the first column is the name of the variable (in parentheses for dummy variables). The next three columns give the median and two quantiles of the posterior distribution. Excludes variables for which the sign of the 2.5th and 97.5th quantiles was not the same. N = 24,354.

Variable	2.5th quantile	Median	97.5th quantile
alpha	2.25	2.30	2.34
sigma	0.50	0.51	0.52
(publication place) Dublin	−0.62	−0.57	−0.51
(publication place) Edinburgh	−0.50	−0.44	−0.39
(publication place) England (other)	−0.16	−0.12	−0.09
(publication place) Ireland (other)	−0.55	−0.37	−0.2
(publication place) Oxbridge	0.01	0.08	0.16
(publication place) Scotland (other)	−0.75	−0.65	−0.54
(size) pamphlet	0.16	0.18	0.2
(size) book	−0.2	−0.17	−0.14
(size) long book	−0.43	−0.36	−0.3
(format) 12mo	−0.29	−0.26	−0.23
(format) 16mo	−0.80	−0.61	−0.42
(format) 2fo	−0.62	−0.58	−0.54
(format) 32mo	−0.52	−0.33	−0.14
characters per sheet	−0.17	−0.16	−0.15
(period) 1700–1704	−0.7	−0.61	−0.51
(period) 1705–1709	−0.79	−0.71	−0.64
(period) 1710–1714	−0.68	−0.64	−0.59
(period) 1715–1719	−0.32	−0.27	−0.22
(period) 1720–1724	−0.24	−0.19	−0.14
(period) 1725–1729	−0.25	−0.19	−0.14
(period) 1730–1734	0.15	0.20	0.25
(period) 1735–1739	0.02	0.07	0.12
(period) 1745–1749	0.13	0.18	0.23
(period) 1750–1754	0.04	0.09	0.14
(period) 1760–1764	0.19	0.25	0.30
(period) 1765–1769	0.01	0.07	0.12
(period) 1785–1789	0.06	0.14	0.20
(period) 1790–1794	−0.14	−0.09	−0.03
(period) 1795–1799	−0.30	−0.25	−0.20
(period) 1800–1801	−0.62	−0.55	−0.48
(subject topic) arts	0.02	0.08	0.15
(subject topic) ephemera-entertainment	0.22	0.26	0.3
(subject topic) education	−0.11	−0,06	−0.01
(subject topic) history	0.01	0.10	0.18
(subject topic) literature after 1774	0.18	0.23	0.27
(subject topic) literature before 1774	0.16	0.19	0.22
(subject topic) religion	−0.33	−0.31	−0.29
(subject topic) science	0.12	0.16	0.2

Table D.11
Summary table of the different subsets of the ESTC used in the article. The requirement for subject topic information in the multivariate regression decreases the number of editions compared to the number of editions used for training and evaluating the model used for prediction.

Subset	Size (number of records)
Records in the ESTC	484,000
Records with price used for prediction	29,000
Records with price used for multivariate regression	27,000
Records for which price was predicted and production quantities estimated	198,000

Appendix E. Domestic production totals as a proxy for supply: Imports, exports and other factors

E.1. The potential effect of imports and exports

In the analysis of supply, we focus on estimated production numbers of books and pamphlets printed in England. However, print products were imported and exported in significant quantities from and to the Britain. In this section we analyse the potential impact of imports and export on the English book market and conclude, that their joint effect most likely made socio-economic inequality worse than what could be deduced from domestic production alone. Many cheaper editions were exported to America and the continental supply of imports was skewed towards antiquarian editions in foreign languages that most could not read.

Table E.12
The assumed weight of different kinds of book-sized items in the ESTC unbound and per volume.

Book volume type	Weight (kg)
2°	5.4
4°	2
8°	0.54
12°	0.23
16°	0.23
18°	0.091
24°	0.091
32°	0.034
48°	0.034
64°	0.023

Our aim is not to analyse exports or imports in detail, but to gauge the limits of their possible impact on our conclusions. Following this framing, the most significant impact that the imports and exports could have realistically had is on the supply of the book-sized items, as both inflow and outflow was skewed towards such items. Evidence from catalogues[57], earlier research[58] and judgment of scholars who have worked with book trade (Green, 2009, p. 547) suggest that they tended to be skewed towards longer editions. It would have been easier to replace books with imports than shorter items, as the latter were often related to more immediate, local and practical uses. Hence, we focus on comparing quantities of imports and exports to book-sized items produced in England and Wales.

We do this by making use of the extensive existing literature and data[59] on British custom records for the years 1701–1780 that also list imports and exports of books from and to Britain by their estimated value. While the evaluated values themselves, given at rates per a hundredweight (50.8 kg) of cargo that do not virtually change during the century (Barber, 1976, p. 189), cannot be readily compared to real book prices, they can be converted to estimated tonnage. Despite some unofficial streams of incoming and outcoming trade not covered by the records[60], they should give us as good of a understanding of the relative volume of imports and exports compared to domestic production as can be measured. The weights of book-sized ESTC items were approximated by using and slightly expanding and modifying Raven's table of book weights[61], that he used to estimate the size of exports to North America. Our table is presented in Table E.12. As the estimates for the ESTC are calculated for unbound books whereas imports and exports include both types, the comparisons should be generous in considering the impact of incoming and outgoing books on the overall book supply.

Domestic book production is compared to imports and exports in Fig. E.7. Even if somewhat inflated by much of the imports and exports being bound and the possible underestimation of domestic tonnage,[62] it is clear that the imports and exports were of non-trivial size compared to domestic production. However, it is unlikely that these trade flows would have severely impacted the size of the population that would have (based on potential supply) purchased new editions[63] regularly.

If the annually produced supply of editions of books would have increased as much as the tonnage due to imports, the end result would have been 1.3–1.4 additional editions per a wealthy property owning household annually even during the peak intervals of 1720's and 1760's[64]. This would have amounted to only a modest boost to the number of editions supplied per household of the wealthiest segment annually. Even this is probably an exaggeration, as most of the imports were old books or at least so classified in the imports, and many of them would have sold for their antiquarian and decorative value, making it likely that heavy folios

57 One way to proxy for continental editions that were more likely to be exported to Britain are items printed in English, as the main bulk of people capable of reading those publication lived on the British Isles. Of the records published in English outside of the Anglosphere, longer than 1 sheet and with complete enough physical information in the ESTC, more than half are book-sized.

58 For example, only a little over quarter of the imports of the Boston bookseller Henry Knox to North America analysed by Raven were pamphlet-sized (Raven, 1997, p. 34). In the book trade arrangement between the English Nourse and the Dutch Lucthmans analysed by Barber, both the English and Dutch volumes were on average valued at more than 3.9 guilders, or 75 pence (Barber, 1977, p. 50) (currency exchange rate is from Metz (1998)). The average volume (and hence also by necessity the edition) was costly enough to be almost certainly book-sized.

59 We use aggregate tables formed and presented by Barber (1976).

60 For example, pirated editions and books bought by individuals during their travels on the continent do not show on the records (Hoftijzer and Lankhorst, 2009, pp. 516–521). Additionally, imports to the smaller ports of Britain are not recorded, but these have been deemed to have been of negligible size except for Ireland, which we do not consider (Barber, 1982, p. 87).

61 For the table used as the basis for our calculations, see Raven (1997). For the rarer formats not covered by Raven's table, we tried to align the weights to the general rule in his table, that the drop in typical weight is 2.5–4 for the doubling of leaves per sheet. For 64mo we made an exception and set its weight to one ounce, as Raven considered even typical pamphlet to weight 1.5 ounces, and all items for which the table was applied were of book length. The bounding was considered to make 20 percent of weight (e.g. in his table this seems to be the case), so the reported weights for bound items were multiplied by 0.8 to achieve our final table.

62 For example, in the absence of information on the number of volumes, we assumed 1 volume per edition. It is also possible that we were stricter with our page-based criterion in defining a book than Raven was when devising his table.

63 In this context, we consider old editions brought from the continent to be new for the English audience.

64 This was calculated by comparing the number of property owning households in the closest social table to the second panel of E.7.

and quartos were significantly overrepresented. It is also critical to consider, that language would have set an even harder barrier for consumption based on the intention to read than the price. Based on the ESTC, there were 1204 editions printed outside of the Anglosphere[65] in English during the eighteenth century. This is less than 12 editions annually or 12 000 copies with an average print run of 1000, a very small number compared to the total size of the imports. Even if the number of such titles is underestimated by an order of magnitude and all of them would have been imported to England, they would have not had a significant impact on the overall supply of books.[66] For the purpose of purchasing books to read, the majority of imported books would have had an even greater constraint on them than price, the linguistic one.

With exports, it is possible that the proportion of editions would have been larger than their share of weight.[67] Adjusting the estimate for the distribution of exported books in different weight classes[68] results in exports being equivalent to 31 percent of domestic book production in terms of editions during their prime[69] in the early 1770's (1770–1774). By the nature of our calculations, this should be an exaggerated estimate[70], but even if we would accept it and would further assume that the exports would have all been away from the supply of the recently published editions of the book market, they would not have been high enough to qualitatively change our results even during their peak. In this very theoretical scenario, the number of book-sized items per wealthy property owning household would have dropped from 6 to 4[71] during the peak-years of exports from 1770–1774. This would only make the circumstantial evidence provided by supply about the limiting effect of price on consumption of print products somewhat stronger.

A more plausible scenario than the extremes presented in the calculations above is a holistic one that considers the joint effect of imports and exports on the British book market, and the segments of trade they would have affected. In terms of tonnage, the net difference between imports and exports exceeds 10 percent of the estimated weight of domestic book production only on one five-year interval in Fig. E.7. However, rather than cancelling each other out, the imports and exports most likely changed the composition of the book market. The great majority of books published in Britain in the eighteenth century were printed in English, and the exports provided for a large English-speaking colonial population. They would have been away from the regular supply of books that most of the literate population in Britain could have in theory bought for reading purposes. The imports, on the other hand, were primarily works in other languages (e.g. Latin and French), and they contributed significantly enough to auction sales (an important organisation for eighteenth-century antiquarian book trade (Landon, 2009, p. 711)) that in Britain that bursts of imports were followed by bursts of auction sales (Barber, 1977, 1982). They would have typically been an even greater luxury than books bought for reading. And as antiquarianism was characterised by few individuals hoarding great collections[72], the size of the audience was probably much smaller than for a similar number of domestic books. Taken as a whole, imports and exports would have decreased the supply of such books and pamphlets that would have been purchased primarily for the purpose of reading in English, and disproportionately increased the availability of very luxurious works that could not have been read by most and were often bought for their decorative and antiquarian value.

Despite the lack of customs data for the last 20 years of our analysis, it seems likely that this characterisation also holds for that period. The prices of high-quality imported editions were rising towards the end of the eighteenth century, as was antiquarianism in general (Raven, 2007, p. 194). Exports to America might have been severely disrupted by the war and independence of the United States during the period 1780–1800 that the customs data does not cover, but based on anecdotal evidence the British imports had a heavy influence on the American book market until early nineteenth century (Green, 2009, pp. 556–557). Imports and exports might have further contributed to the observed increase in the inequality of consumption possibilities in the British book market of the late eighteenth century.

E.2. Other considerations about supply

The estimated annual production totals that we use as a proxy for supply should not be understood literally as what was consumed or what was available during any given year. Eighteenth-century books often took a long time to sell. For example, in an attempt to estimate sales of American books in late eighteenth-century, Raven assumes that only a quarter of an edition would have sold during the first year of printing, 73 percent within the first five years and 75 during the first 10 years (Raven, 2000, p. 198). It is better understood as the maximum rate of consumption of new editions that the book market could have theoretically supported on a long run with that year's level of production. In practice, like in Raven's calculations, many copies never sold. In addition to

[65] A significant number of imprints deemed false have been removed.

[66] Additionally, imports from Ireland made a very small proportion of total imports as Barber's aggregate tables demonstrate (Barber, 1976).

[67] E.g. in the shipment analysed by Raven, the largest category by far are bound duodecimo books that are relatively light. Raven (1997, pp. 34–35).

[68] This is done using the data and emulating the approach that Raven used to make estimates about the number of volumes exported to North America (Raven, 1997) but we discard the pamphlet category, as we are investigating a scenario in which all imports and exports are books. The process of Raven yields volumes, but we converted them to editions based on the mean number of volumes per edition among book-sized items in our data.

[69] As a proportion of domestic book production, exports were marginally higher in the early 1750s and late 1760s. However, since early 1770's were clearly the peak period in absolute exports and almost so in proportional terms, we deemed it the best interval to explore how 'extreme' the effect of exports could have been on the domestic market.

[70] The comparison point is based only on items longer than 128 pages, and such items make only a fraction of the ESTC. Also, we calculated tonnage of the ETSC assuming unbound editions whereas imports and exports include both.

[71] Using the social table for 1759 as the comparison point.

[72] As an anecdotal example, the size of the private collection of Thomas Rawlinson, an eighteenth-century antiquarian, has been estimated to have contained 200 000 volumes (Landon, 2009, p. 712).

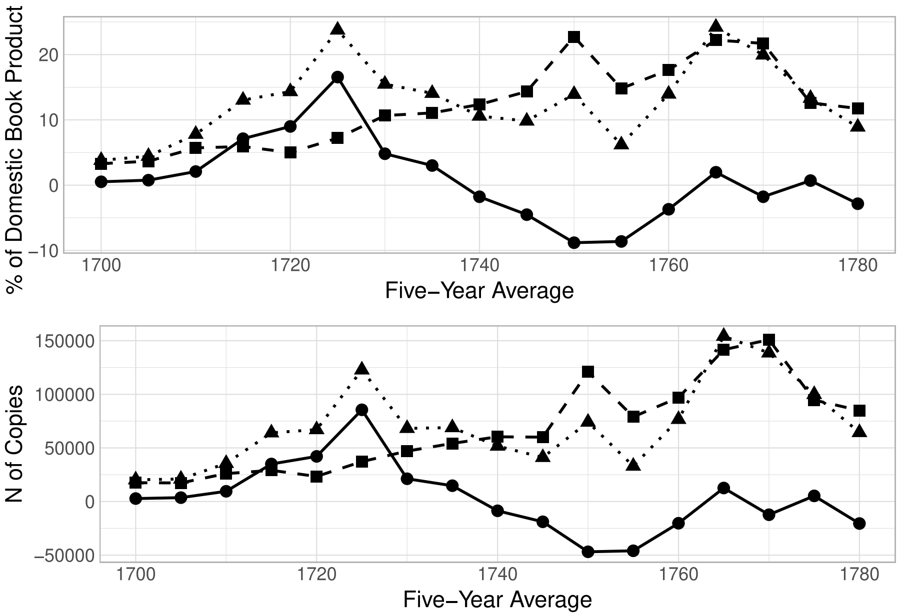

Fig. E.7. An upper-bound estimate of the size of imports and exports compared to the English book market. The Proportion of imports (dotted line and triangles), exports (dashed line and squares) and their difference (solid line and dots) of the estimated weight of books produced in England and Wales, and the number of editions this would have corresponded to, if the weight of the average imported or exported edition was the same as that of a domestic item. Percents and copies are given as five-year averages.

books that were unsold, antiquarian purchasing (Landon, 2009), country house libraries and institutional demand Raven (1998, p. 279) would have consumed a significant proportion of the book production without proportionally expanding the reading public. Given these considerations, production totals as such lead to greater number of copies per household, than what would have been consumed without the contribution of heavy outliers.

Eighteenth-century print culture also included print products that were not meant to be sold or otherwise circulated effectively freely like public announcements, advertisements, some political propaganda pieces and all sorts of practical jobbing print already discussed. The removal of shortest editions from the analysis of supply removed a great proportion of these items, as short size was convenient (e.g. production price and ease of distribution) for dealing with the changing, topical and practical functions that many of the freely circulating editions served. The remaining ones add another source of overestimation to the size of supply that eighteenth-century households could have concumsed from the market. While such items might have circulated more freely than copies bought by consumers, their contents would have been dictated by whomever (state, booksellers, political interest groups) could afford to produce and freely distribute them for the public to read.

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