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Abstract

I provide the first annual time series of coin and money supply estimates for about six hundred years of English history. I propose two main estimation methods. The first, which I call the "direct method", is used to measure the value of government-provided, legal-tender coin supply only. Additionally, I propose an "indirect method" which relies on a combination of information about nominal GDP with the value of coin supply or M2 known at certain benchmark periods. The latter permits estimating the growth of financial intermediation over time. The new methodologies which I set out here may serve as a blueprint for a similar reconstruction of coin and money supply series for other economies for which analogous data is available.

JEL classification: E10, E40, E51, N13

Keywords: historical money supply, financial intermediation

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1. Introduction

In this paper I provide the first annual time series of coin and money supply estimates for about six hundred years of English history. I present a baseline set of estimates, but also consider a variety of alternative scenarios and provide several robustness checks. I concentrate on carefully setting out the details for the data construction, rather than on analysis, but the hope is that these new estimates – the longest such continuous series ever assembled, for any country – will open new vistas to help us understand the complex interaction between the real and the monetary sides of the English economy, at both business-cycle and long-run frequencies. Furthermore, the new methodology which I set out here may serve as a blueprint for a similar reconstruction of coin and money supply series for other economies for which the analogous required data is available.[2]

I propose two new estimation methods. The first, which I call the "direct method", is used to measure the value of government-provided, legal-tender coin supply only. I do not consider broader forms of money such as banknotes, deposits, bills of exchange or private tokens. Notice, however, that these were not as liquid or widely accepted as coin, and it is important not to exaggerate their early importance as a share of the total means of payment: as late as 1790 the monetary base was composed of £44 million of commodity-based coin but only £12 million in notes – £8 million Bank of England notes and £4 million for all other, including bills of exchange (Capie 2004; O'Brien and Palma 2015). For the "direct method", I discuss the results for the 1279-1790 period first, and then in section 4 present an extension until 1870. Additionally, I propose an "indirect method" which relies on a combination of information about nominal GDP with the value of coin supply or M2 known at certain benchmark periods. This permits estimating the growth of financial intermediation over time.

2. Historical background

In this section I discuss how the English monetary system differed from that of today, both in terms of what constituted money, and how monetary policy was conducted. I start by discussing the role of the government in providing liquidity in the English context.

[2] Flandreau (2004, p. 75-96 and 220-225) discusses a related method, which requires a different kind of data and makes more restrictive assumptions.

In modern economies central banks issue fiat currency and engage in monetary policy. In early modern economies including England central banks with these functions did not exist – the Bank of England was created in 1694, but it was a private institution and not a central bank in the modern sense, although it did gradually began to play a public role by providing liquidity to the economy, in particular to other banks and to the government (O'Brien and Palma 2015); still, it took a while until it began to play the "lender of last resort" role (Bordo 2007).

Yet to say that a central banks officially endowed the modern functions did not exist is not the same as saying that governments did not engage in monetary policy. In a nutshell, monetary policy can be for premodern economies helpfully identified with mint policy (Sargent and Velde 2002). Agents were free to take precious metals to the mint and the government chose at which rate these were exchanged for currency, whether to charge a mint fee[3], and, out of a given set that was offered, which denominations to issue.

Given the market price of precious metals and that of minting (in some but not all countries a minting fee was charged), the public decided how many coins to mint and how many to melt or export. In terms of circulation value, there was a premium in low denomination coins due to both cost (lower denominations were proportionally more expensive to produce) and convenience (lower denominations had proportionally higher value due to additional convenience as small change). The low denomination premium meant that coins were valued not just proportionally to their precious metal content but also by tale, that is, according to their denomination itself (Sargent and Velde 2002, p. 322.)

Since central banks in the modern sense did not exist during this period money, cannot be helpfully defined as liabilities of central banks and credit institutions towards the public. An alternative, if close, definition for M0, M1 and M2 are required. The main point to be realized is that these are progressively less liquid assets, defined as such both in terms of divisibility and general acceptability as well as how quickly redeemable they are.

[3] This is a fixed cost and hence different from the seigniorage fee which is the difference between the market value of the precious metals and the cost to produce the currency which was given in exchange.

It is important set out some definitions at the outset. I use the term *coin* referring to official (legal tender) bullion-based coin, regardless of whether it was circulating by tale or not (it usually was). One major distinguishing characteristic of legal tender coin was that, measured in value, the "intrinsic" component was an important part of the overall value, that is, much of it was silver or gold coins (though there was some copper issues as well, but they were worth much less). As for private tokens and other fiat money, these are, conceptually, part of the currency or M0, but are not here defined as "coin".[4] Hence my definition of coin supply is a subset of M0.

Thus coin supply differs from currency supply: it excludes bills of exchange, tokens, and notes in circulation.[5] To avoid confusion, I avoid the term M0 altogether, as doing so would imply excluding notes which would depart from modern practice.[6] However, it is important not to place too much emphasis on anachronistic classifications such as M0 and M2. What for the present purpose does matter is to separate coin (for practical purposes, "quasi-M0") from "everything else", that is, all other assets sufficiently liquid to be potentially classified as "money".

3. Baseline estimates

The baseline estimation method relies on information about the value of the coin stock which is known for certain periods. When the type changed (e.g. 1279), or when the hammered coins were demonetized (1696), all the previous coinage still in circulation was called in and we know the value (and the distribution) of the total coin stock quite precisely. In other periods, only earlier coins of good weight would have yielded a profit on recoinage, but painstaking work by monetary historians has led to several secure values for the stocks at several points in time (Table 1, first column).

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[4] Capie (2004), for instance, defines the monetary base as including banknotes and bank balances at the Bank of England, but also recognizing that "privately issued tokens were at times widespread" (p. 225)

[5] In modern terms, it is usually made clear that only money in circulation counts, that is, we do not include those in the hands of central banks and in the vaults of depository institutions. Since no reserve requirements existed in the period under study, however, no such proviso is not necessary, though it is possible that under some periods some currency was being hoarded as such, instead of circulated.

[6] Unlike what would be true for a modern economy, notes were less liquid than currency, since until quite late they were only issued in high denominations – only in the last decade of the eighteenth century were £1 notes issued by the Bank of England, for instance, only then just low enough to pay a laborer's monthly wage (Schwarz 1985) – but even then, and throughout the nineteenth century, these were less credible than bullion-based currency (often circulating at discount), and of less wide acceptance (especially those issued by provincial banks). Of course, as time goes by, these were increasingly closer substitutes to money, so the boundaries become fuzzier.

Evidently, some estimates are more secure than others. The most secure estimate is that of 1870 (Capie and Weber 1985, p. 192-202), but earlier figures that are based on either full or even partial recoinages can also be safely trusted. An example of the latter is the "Great Recoinage" of 1696: it was a partial recoinage because gold was not subject to it, but together with complementary information it leads to what is almost certainly a good approximation (Mayhew 1995, p. 277)

Still reasonably secure are the figures marked as "proxies" in Table 1. These cases are inferred by indirect evidence. The first form of such evidence comes from the dies used to produce the coinage. Coins were struck to completion by placing a blank between two dies and hammering. Surviving coins individually identify their corresponding dies, allowing the number of dies used to estimate the volume of coinage (Allen 2001, p. 597). Another form of indirect evidence used have been archaeological evidence for site finds of coins (hoards). The English civil war produced many coin hoards as a side-effect, which have been put to use in this context, as they indicate which proportions of currency date from which periods (Mayhew 1995, fnt. 4, Mayhew and Viner 1987, Besly 1987, Mayhew 2013, fnt. 38). Finally, the figures marked as "guestimates" are the least secure. There are based on historians' overall understanding of available quantitative and narrative evidence. Unfortunately, there is concentration of these during the Tudor period.

Year	Coin stock value (preferred estimate)	Implied V of coin stock	Type of estimate	Year	Coin stock value (preferred estimate)	Implied V of coin stock	Type of estimate
1279	0.6	6.09	Full recoinage	1548	1.76	3.97	Guestimate
1282	0.835	5.49	Proxies	1549	1.92	4.35	Guestimate
1290	1.0	3.31	Proxies	1551	2.02	5.71	Guestimate
1299	1.1	4.37	Proxies	1560	1.71	6.89	Guestimate
1310	1.5	3.85	Proxies	1561	1.45	8.82	Guestimate
1319	1.5	2.68	Proxies	1600	3.5	6.65	Proxies
1331	1.2	3.16	Proxies	1643	10	3.91	Proxies
1351	0.6	5.98	Partial recoinage plus proxies	1670	12	3.90	Proxies/Guestimate
1377	1.92	2.27	Proxies	1688	10	5.14	Proxies
1422	1.285	2.06	Proxies	1700	10.75	7.07	"Great Recoinage" of 1696-7
1470	0.9	4.53	Full recoinage	1750	18	5.06	Guestimate
1526	1.4	3.5	Guestimate	1790	44	3.88	Guestimate
1546	1.45	5.98	Guestimate	1870	95	10.80	Proxies*

Table 1. Benchmarks for the value of English nominal coin supply and implied velocity, 1270-1870. Sources: For 1279-1470, see Allen (2012). The partial recoinage leading to the figure for 1351 is discussed in Mayhew (1987), and the full recoinage leading to that of 1470 is discussed in Mayhew (1974a), and further improved by Challis (1992, p. 195) and Mayhew (1995, p. 245). For 1526 to 1700, see Mayhew (2013, p. 26-29), where 1551 corresponds to an average of the two available estimates for that year. For 1643, civil war coin hoards were used (Mayhew 1995, 2013). For 1688-1750, these are the estimates of Cameron (1967), endorsed by Mayhew (2013, p. 30). For 1790 and 1870, see Capie (2004, p. 222-225), which in the latter case relies on Capie and Weber (1985, p. 192-202), which in turn largely rely on Jevons (1868). * Despite being based on proxies, the 1870 benchmark is quite secure; see the discussion in Capie and Weber (1985), and the figures in table 3 below.

While the figures discussed so far provide a static snapshot of the value of currency for given years, mint output data provides much useful information about the flows for the in-between years between the stocks in Table 1.[7] Detailed annual estimates exist for the Tower of London mint output (Figure 1) and up to the 1840's it is safe to say that these would have gone directly into circulation (Capie and Weber 1983, 1985).[8] However, simply summing up mint output over time to any given stock from Table 1 would lead to numbers which overestimate the amount of coin in circulation, and hence are inconsistent with the following corresponding stock also observable from Table 1. This is because using that method coin melted down but subsequently again minted is double-counted. Further, much coin was carried abroad in the context of war, diplomatic payments, or trade, and this means that total coin supply at each given moment differed from the accumulated sum of mint output.

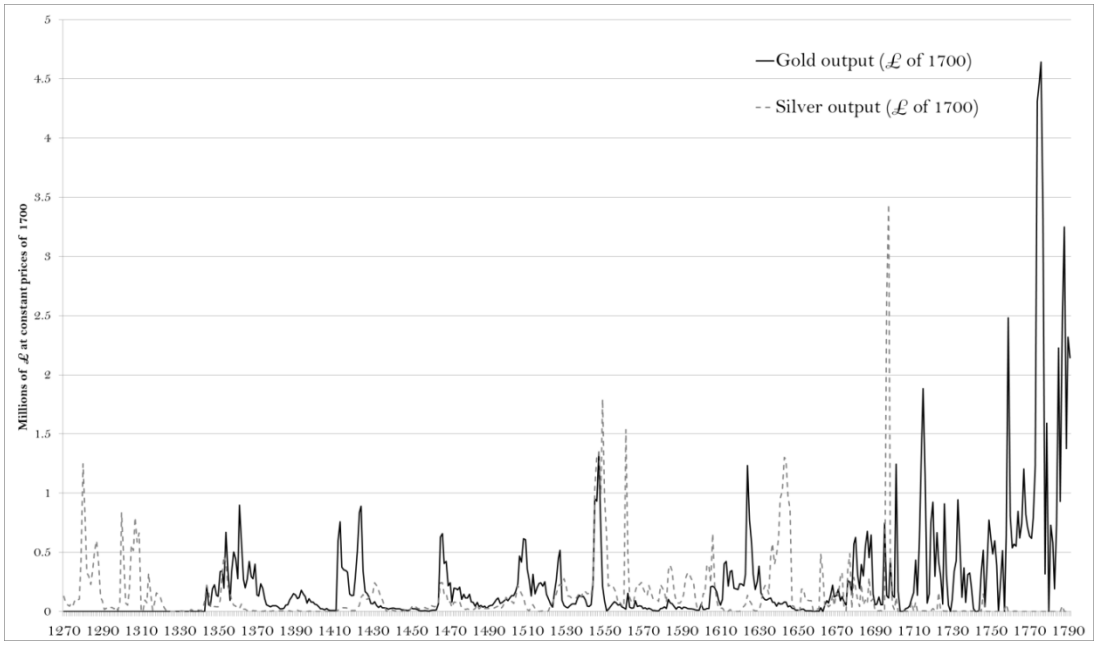

Figure 1. Gross mint output at constant prices of 1700. The peaks in the 1690's and 1770's are correspond to re-coinages; see Horsefield (1960, p. 51-52). Source: Challis (1992); the GDP deflator is from Broadberry et al (2015)

Since the true value of coin supply is known at relatively regular intervals, however, it is possible to "correct" for this bias by factoring out the observed residual from the annual

[7] All stocks are end-of-period stocks (when necessary appropriately annualized to the year on which the majority of the period refers to; after 1660 all variation corresponds exactly to the civil year).
[8] I also consider provincial mints below.

estimates. The precise way in which this is done is what distinguishes the "direct method A" from the "direct method B", the latter corresponding to the baseline estimates, which I argue that are the best.

3.1. Previous estimates

In a related piece of work Mayhew (2012b) acknowledges the need to target successive known stocks by estimating annual currency by deducting estimated wastage from known output, alternatively using 2% or 4% assumptions on annual wastage. Notwithstanding the usefulness of Mayhew's attempt, I use a different approach, with the objective of arriving at estimates for which much less true variation is lost. Annual variation in wastage can be estimated with much additional precision for two reasons. First, some components of wastage can be accounted for annually from annual data, as explained in detail below. Second, even after this is controlled for, instead of assuming fixed percentage wastage rate levels over the remainder, it is possible to let these vary endogenously at an arithmetic rate, such that wastage is whatever it needs to be annually such that we arrive at the following available coin supply benchmark as discussed below.

3.2. General methodology

Changes to the value of coin supply are given by

$$dC_t = O_t + P_t + X_t$$

Where dC_t is a flow variable corresponding to the change in the value of coin supply (C_t), O_t stands for net mint output for that year, P_t is the change in hoarding, and X_t is a residual. I now discuss each of these right hand side variables in detail.

O_t is expressed in net terms because gross mint output overstates the annual change in the money stock in years of recoinage or those of net outflows of specie.[9] Hence,

[9] As Glassman and Redish (1985, p.32) notice when discussing the French case, "Balance of payments surpluses were recorded in mint output, at least when settled in coin taken to French mints. Balance of payments deficits, however, caused specie exports not recorded in mint output".

$$O_t = new\ coinage_t - recalls_t$$

Because I estimate the value of coin supply (assumed to be circulating by tale) I do not need to consider clipping or melting down. However, one limitation to the estimation of O_t from mint output data by using the Tower records (reproduced in Challis 1992) is that these only cover the Royal mint, but until 1553 other mints were in operation in several English towns.[10] I have applied a partial correction for this by using the additional information in Munro (1983, p. 127-37), but it must be recognized that much variation in provincial mint output remains unaccounted for at an annual level. However, notice that this will not lead to systematic biases over the long run since the stocks in table 1 above have already corrected for this by using estimates adjusted to the output of provincial mints (Allen 2001, 2012).[11]

The presence of P_t, the change in hoarding, is required because the proportion of precious metals which finds its way into the monetary base changes as agents change how much is held in plate (Mayhew 2012).[12] Much of the value of currency melted down for hoarding purposes can be inferred from the Goldsmiths' company data (Mayhew 2012a), as it had the monopoly over hallmarking – of silverware and jewellery as well as gold, despite the name of the company. Finally, X_t denotes a "wastage" residual that includes coin melted down or exported.

[10] Regional mints opened during some exceptional periods of the early modern period such as the Civil War when a Royalist mint was briefly set up and the Great Recoinage; Challis (1992) includes supplementary information for these periods, which I include in my calculation.

[11] For the medieval period, Allen (2012) provides estimates based on information from the distribution of finds in coin hoards. Until the early modern period, the residual includes undocumented provincial and ecclesiastical mint output from the Bristol, Bury St. Edmunds, Calais, Canterbury, Chester, Coventry, Durham, Lincoln, Norwich and York mints. In the earlier periods, the unrecorded outputs of provincial mints could be substantial – more than one third of total estimated output in three periods between 1279 and 1351 (Allen 2012, p. 312). Hence during the medieval period the money supply must have grown faster than what would be suggested by looking at the (Royal mint) Tower records only. But using my baseline method, the residual between benchmarks will automatically absorb this bias, and only some of the short-term variation associated with between-benchmarks variation in provincial mint output will be lost. Furthermore, this lost variation is always limited since as previously mentioned Tower mint output was never less than two thirds of total mint output, and usually it was a good deal more.

[12] Notice that precious metals melted to be used as plate leave circulation but not those hoarded as coin; when savings increase and people are hoarding currency the circulating fraction of money supply decreases but in an aggregate model this simply corresponds to a decrease in velocity.

3.3. Direct method A: the naïve direct method

Since for some years we know the value of the stock of coin in circulation (Table 1), it is possible to calculate the annual residual as an annually uniform "whatever it needs to be" in the intervening period between benchmarks so that the estimated coin supply at the next period for which we observe it matches the predicted value, that is, after all the intervening $\{O_t\}$ and $\{P_t\}$ have been accounted for.[13] I call this the "direct method A". The resulting annual estimates are shown in the broken grey line of Figure 2.

3.4. Direct estimates B: the baseline direct method

Direct estimates A implicitly assume that recalls were uniformly distributed between the known stocks. This was not the case: recalls were often concentrated in time – usually in the context of full or partial recoinages – and ignoring this would lead to misleading estimates, with predicted but spurious peaks of coin supply, due to double-counting, at the time of re-coinages, such as the 1690's and the 1770's, clearly visible in Figure 1.

Hence the estimates can be further improved upon by paying close attention to each of the "suspect" periods which can be identified both from the narrative literature and from informal comparison with the indirect estimates which will be discussed in section 3, and making appropriate adjustments as necessary.[14] I now discuss the periods for which I have done so to improve the credibility of the resulting baseline estimates.

The Tudor debasement period. The Tudor debasement period (1542-1560)[15] constitutes an important period of monetary disruption. The bullion content of the pound sterling fell by 25% in gold and 83% in silver (Ling-Fan 2012, p. 75); even once the fineness was partly restored during Elizabeth's reign, the bullion content of English coin was 25% less than it had

[13] Hence notice that while this residual is unobserved at an annual level, the information contained in stocks which we observe force it to be "correct on average" between these. Using the more complicated alternative method of Chow and Lin (1971) does not lead to significantly different results. (The same is true if this method is applied to the baseline estimation method to be discussed next.)

[14] Since velocity only changes very slowly at best over the long run, a prolonged deviation of the direct estimates from the indirect is a red flag.

[15] There is some debate in the literature concerning wherever the Great Debasement started 1544 or at an earlier date (see Challis 1978 and Munro 2010).

been before Henry VIII's Great Debasement (Ling-Fan 2012, p. 88). In practice, this would have meant that more coin was minted than otherwise would have been possible, but when assuming that money circulated by tale and accounting for money supply *in pounds*, as I am doing here, these developments are automatically accounted. So I make no adjustment to the Tower records.

The great recoinage of 1697-8. The great recoinage was caused by a number of factors including the need to substitute the badly worn out coinage. The intellectual debate surrounding the recoinage has been studied in detail and does not need to be repeated here (see for instance, Horsefield 1960, p. 256 or Sargent and Velde 2002). It is, however, important to understand that because the Locke-Newton position prevailed *vis a vis* that of Lowdes, the money supply may have fallen by up to 40%. According to Craig (2010/1953, p. 193), about £9.6 million in face value was retrieved for recoingae, £4.7 million of which was accepted in face value, being that the rest was only accepted by weight. Clancy (1999, p. 15) writes that "[t]he vast majority, in the region of 10 million, of the old currency was withdrawn over the course of several years and what remained unaccounted for was in any case demonetised in January 1698 … 6.8 million was produced to replace the hammered money, which meant that the resulting silver circulation was reduced by 38 per cent".

Hence I input that in the 1696 and 1697 years the residual has to be Clancy's 10 million (by assumption divided evenly between 1696 and 1697), and otherwise I following the usual methodology as in the previous subsection. This leads to an important – and much more historically realistic – result when compared with the direct A (naïve) estimates of the previous subsection. (The practical difference is illustrated in figure 3.) Hence my direct B (baseline) estimates indicate that the value of the coin stock fell in real terms from 12.4 million in 1695 to 10.2 in 1696 and 9.0 in 1697. Then, it restarted growing.

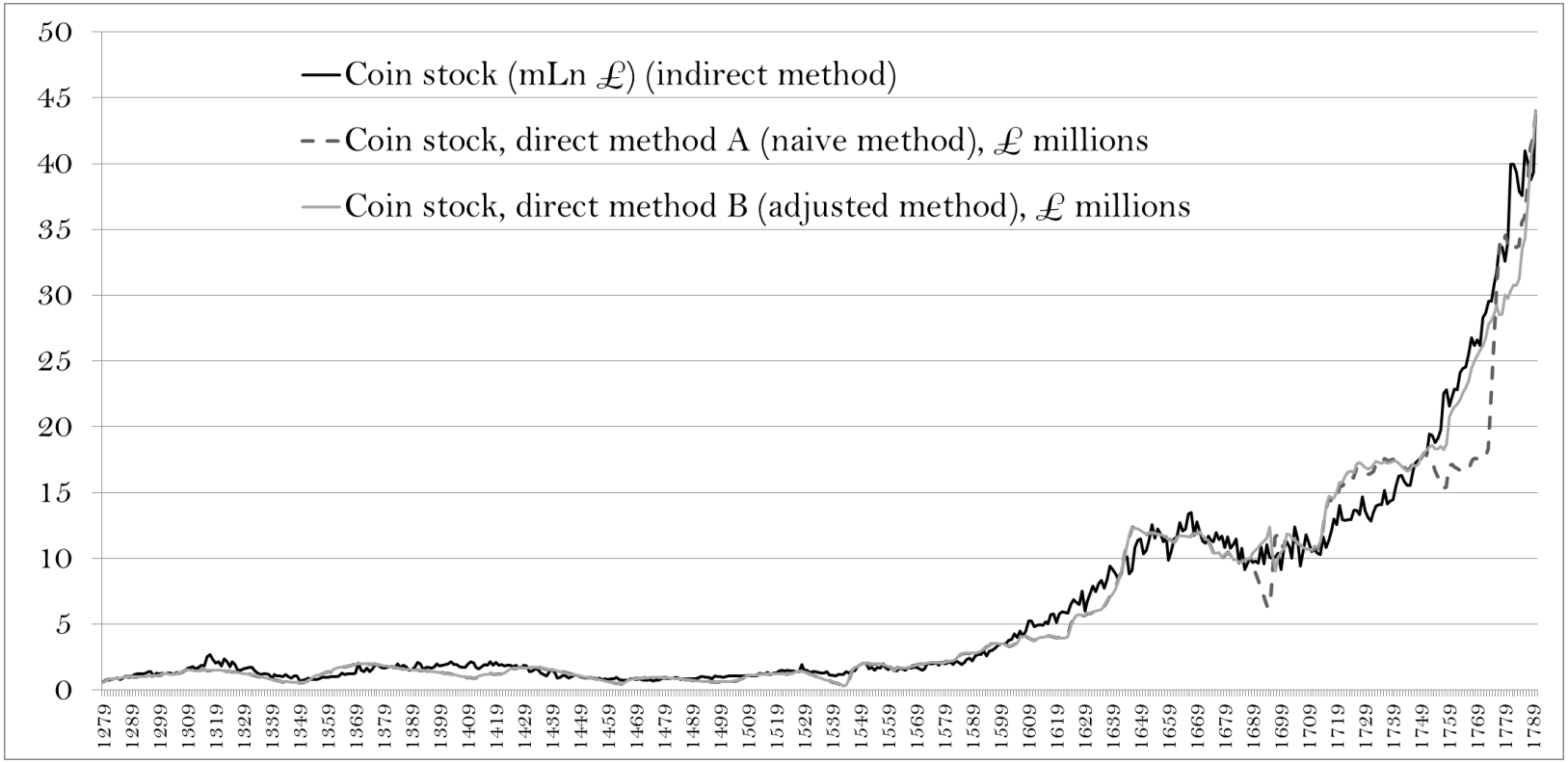

Figure 2. English nominal money supply 1279-1790. Sources: my calculation based on a series of sources; see text for details.

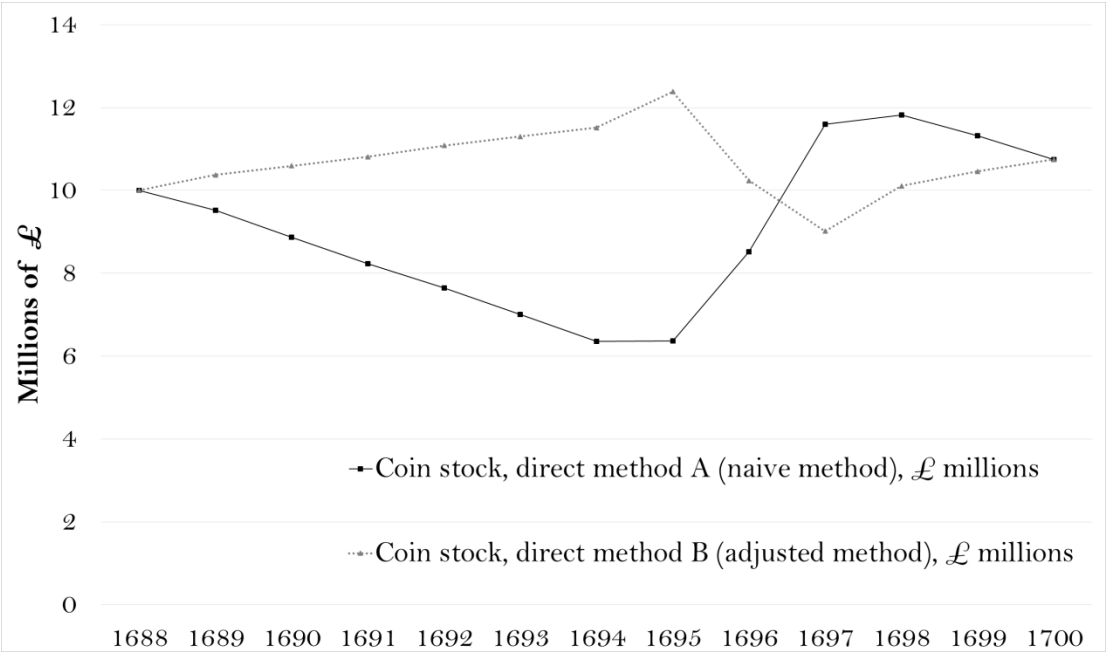

Figure 3. Recalls correction made for the Great Recoinage period.

The 1733-4 recoinage. Challis (1992, p. 439) mentions a partial gold recoinage in these years of "more than 15,500 lb of old hammered coins", which were withdrawn and recoined; cross-checking with the totals in table 63, p. 432, we can see that one lb corresponds to about 46.725 pounds; hence an average of about £362 thousands per year will have been recoined in those two years. These are the additional outflows I assume for those two years in the baseline estimates. (In addition to the 207 thousands estimated residually).

The 1773-7 recoinage. Once the quality of coinage began to be threatened, a gold recoinage took place in the 1770s. Challis (1992, p. 440) suggests the £16.5m in gold minted then represented about 75% of the total gold currency. Also according to the same source, the recoinage took four years to complete, 1773-7. I hence assume an additional outflow of £4.125m per year over this period in the baseline estimates. Adding the regular residual then increases the total to £4.397m over these four years).

4. Robustness: the indirect method estimates

The indirect method estimates do not rely on tower output mint at all, and instead simply linearly interpolate implied velocity between the available benchmarks and exploit annual variation in nominal output to arrive at a measure of annual coin supply. Formally, coin supply can be calculated by writing the equation of exchange as,

$$M = \frac{PY}{V}$$

Where M stands here for coin supply, PY is nominal GDP, and V is the velocity of circulation *of coin*.[16] Nominal GDP is available from Broadberry et al (2015). In order to arrive to a series for V, I proceed as follows. For the years in table 1, I simply write the equation as V=PY/M and apply the figures for M known from the first column of table 1. I then linearly interpolate between those V's, which leads to a series that will map into a series for M.[17] The resulting estimates for V are shown in figure 4, and they suggest that velocity was at times volatile but did not exhibit a long-term trend. (See table A1 in the appendix for some comparative figures.)

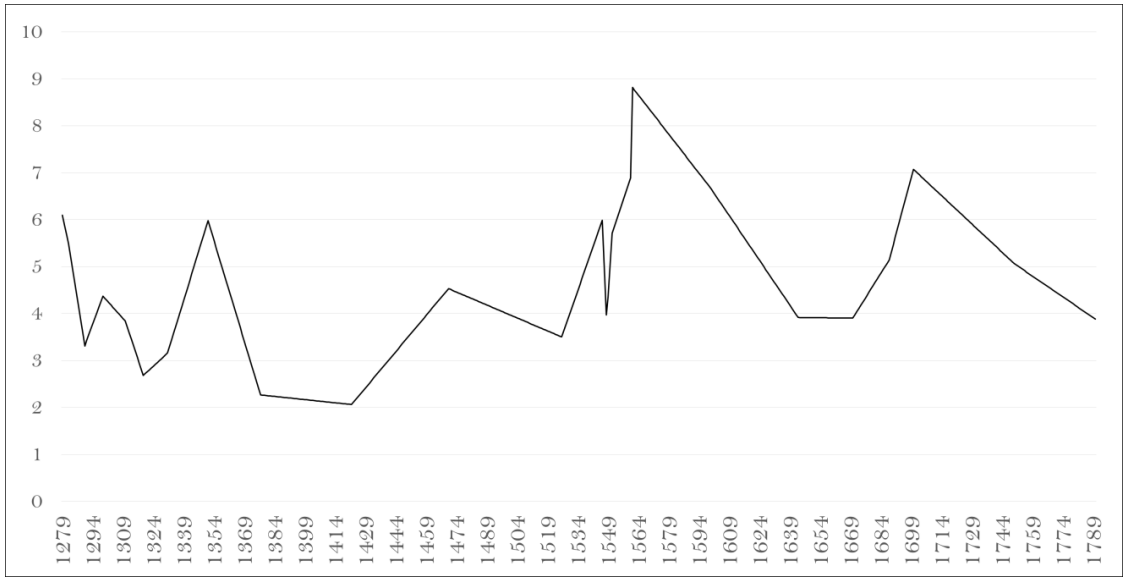

Figure 4. Benchmark velocity estimate used in the indirect method. Sources: see text.

[16] It is possible to define M is as coin supply rather than M2 as long as the definition of V is consistent with it.
[17] Note there is no circularity in this construction: the benchmark years are simply assumed, and all calculations are made for the intervening years only.

I call the resulting estimates the "indirect estimates" and they are shown in the solid black line of Figure 2. The most obvious disadvantage of the indirect method is that it relies on a linear interpolation of velocity between the observed benchmarks. So when calculating the annual estimate, the numerator – nominal GDP – does change in accordance to the "truth", but the volatility of the denominator between benchmarks is underestimated, and hence the estimates for the value of coin supply are more volatile than they should. A second disadvantage is that by relying on income data for its construction, the indirect estimates for coin supply cannot be used in econometric applications which aim to explain variations in income itself. The indirect method does have the advantage that "on average and in the long run", it should be approximately right, since velocity only changes slowly under long horizons (Bordo and Jonung 2004).

5. Discussion

I am now in a position to compare the baseline and the indirect estimates. The baseline estimates, shown in the solid grey line of Figure 2, direct method B, can be compared with the naïve direct method (A) the broken grey line. The comparison suggests considerable improvement, especially at the times where a correction has been applied, such as the late seventeenth century and the 1770's. The baseline estimates are closer to the narrative evidence presented in Sargent and Velde (2002) and Challis (1992). In turn, comparison with the indirect method estimates in black suggests a smoother and also more historically realistic path, which further has the advantage of being independent of any income data in its construction. The fact that output data does not enter in any way in the construction of the direct estimates allows these estimates to be used in econometric work in which output is an outcome variable. Table 2 presents some descriptive statistics for the data produced by the different methodologies.

	Direct method A	Direct method B (baseline estimates)	Indirect method
Sample mean, 1279-1790	5.85	6.06	8.49
Sample standard deviation (standard error), 1279-1790	7.69	7.90	12.11

Table 2. Descriptive statistics for the different methodologies.

5.1. Why are the indirect estimates useful?

The direct method estimates may be biased over a long period of time if no sufficient regular recoinage information is available. Hence, the indirect estimates can be helpful in identifying periods when the direct method estimates may need adjustment using supporting narrative evidence.

I now explain what are the main difficulties associated with extending the methodology to the 1790-1870 period, and these further serve to illustrate the advantages of using the indirect method as a robustness check over the long run levels resulting from the direct method estimates. The basic problem of the 1790-1870 period results from the known benchmark stock estimates being far apart combined with the fact that this period includes several periods which the narrative evidence suggests to be of monetary disruption, as discussed below.

5.2. The 1790-1870 period: what are the difficulties at hand?

It is harder to give precise estimates for coin supply over this period than for earlier periods. An important difficulty is caused by the fact that after the creation of the issue department of the Bank of England with the Bank Charter of 1844, royal mint coin output can no longer be considered to go directly into circulation. It hence becomes more difficult to infer the timing of coin supply increases from mint output data. It also needs to be realized that the gradual growth and increasing complexity of the financial intermediation system means that coin supply increasingly loses relative importance.

The year 1870 is the first for which we have relatively certain data. Table 3 compares the existing competing estimates for the stock in 1870 (Table 3). Annual estimates for both coin and M2/3 under circulation which go as far back as 1833 are available (Huffman and Lothian 1980, Collins 1983). However, as emphasized by Capie and Webber (1985), a key element underlying both is Sheppard's (1971) coin circulation figures for 1880, which Capie and Webber argue persuasively to have been an overestimate – hence the earlier estimates would have been too small.

	Huffman and Lothian (1980)	Collins (1983) (1866-1870 mean of end-of-year figures)	Capie and Webber [1985, tables I(1), I(4) and I(9)]	Capie (2004, p. 222, 224)
Coin stock	95.4	87.5	85.449	95
Monetary Base/High-powered money (M0 or H)	153.4	128.4	134	141.4
Money stock (M2/3)	-	379.7	540	540

Table 3. Value for the several monetary aggregates circa 1870, as proposed by several authors. Unit: £ millions.

I have inflated Huffman and Lothian's (1980, p. 170) figure of £41.4 million by an admittedly arbitrary 20%, and I have done the same with Collins's (1983, p. 384) estimate for £38.8 million for 1846 – which leads to £46.56 million, similar to Huffman and Lothian's £46.2 million for the same year (Figure 5). Clearly, the resulting estimates for this period carry a greater margin of uncertainty than for others, and hence the temporal span of this paper remains fixed at 1279-1790.

However, although I have no intention of settling this debate at present, it needs to be emphasized that while the Capie-Webber critique is not unsubstantial, it needs to be put under some perspective. First, since these series are nonstantionary, for many econometric applications the series will need to be used in first differences. This means that divergences about the exact stocks at each moment are much less important that the timing of growth rates, which we can indeed estimate with a reasonable degree of accuracy.[18] Second, there is agreement about the broad magnitudes at stake, and the divergence is not as large as one might think (Table 3). Indeed, Capie's more recent estimate for both coin and M0 has moved closer to that of Huffman and Lothian (Capie 2004). Third, as before, informal comparison

[18] Though of course, the absolute levels will still matter if cointegrating or error-correction relationships are involved.

with the indirect method can ensure that the absolute level of the direct method estimates do not fall too much out of line.[19]

In any case, there is no question that the period after 1790 is one for which there is more fundamental uncertainty about the true value of money supply for both coin and broader forms of money, until the light is turned on again around 1870. Figure 5 illustrates the "double-dip" divergence which results from the baseline and indirect estimates for this period.

5.3. The "bullion crisis" period, approx. 1797-1821

The bullion crisis which goes from approximately the period immediately preceding the bank restriction act (1797) to the formal establishment of the gold standard (1819-21), could have turned into a full-fledged financial crisis and indeed it is one of the "crises which did not happen".[20] For the present purposes, this period is relevant because of the likely negative effect on not just coin output but also possibly hoarding, though massive quantities of export from the country were unlikely due to the ongoing war. As suggested by the direct estimates in figure 5, there was very little minting of coin during this period (Challis 1992). The bullion crisis was due to the sharp divergence of the market price from the official prince of gold (Figure 6).

[19] This is where the usefulness of the indirect estimates most clearly comes to light – they put discipline on the long term trends of the direct estimates.

[20] These are too often ignored by economic historians for that very reason, though in principle we should all agree that from a policy perspective we can learn at least as much from them as from those that did turn sour. The reasons why this crisis did not turn into a full-fledged financial crisis are explored in O'Brien and Palma (2015).

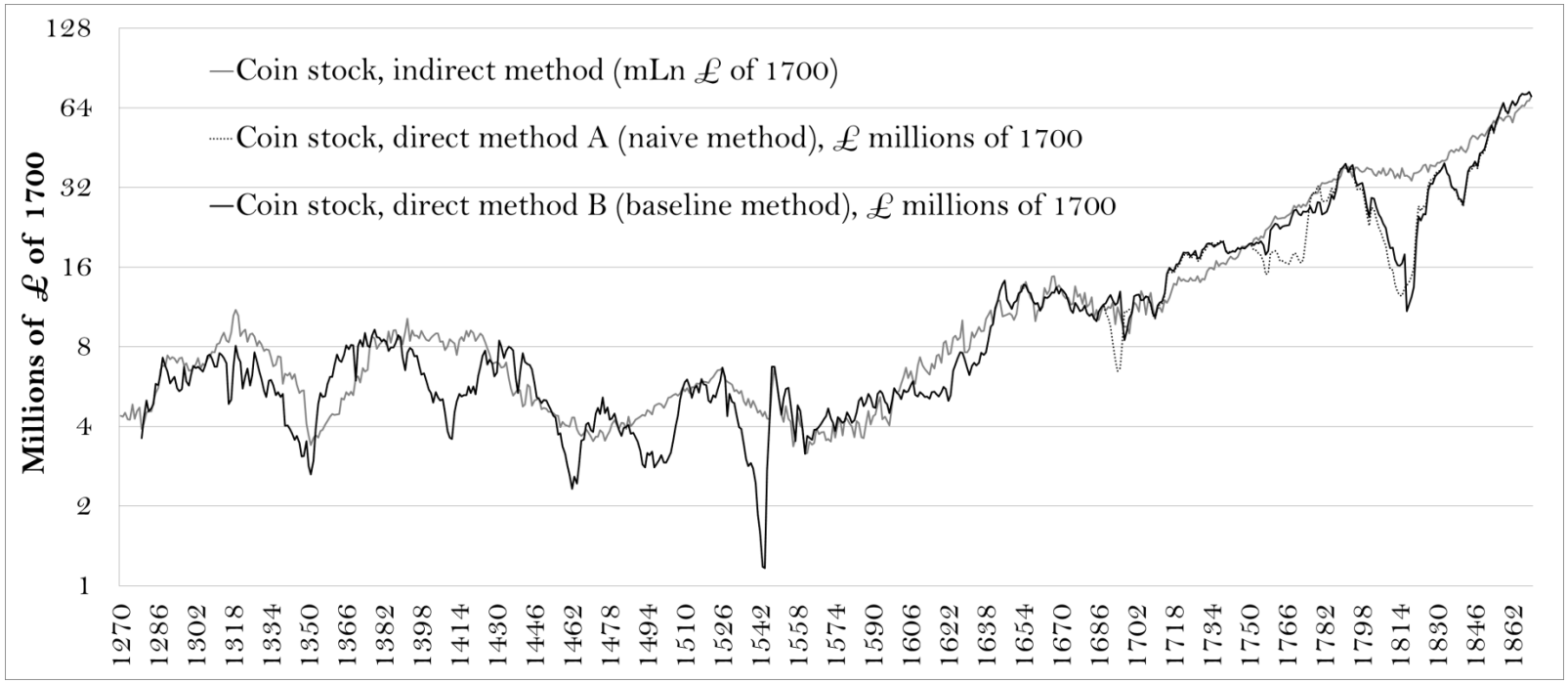

Figure 5. Coin supply estimates for the 1270-1870 period (log scale of base 2). Notice the periods when direct method A cannot be seen means it coincides with the baseline method (aka direct method B).

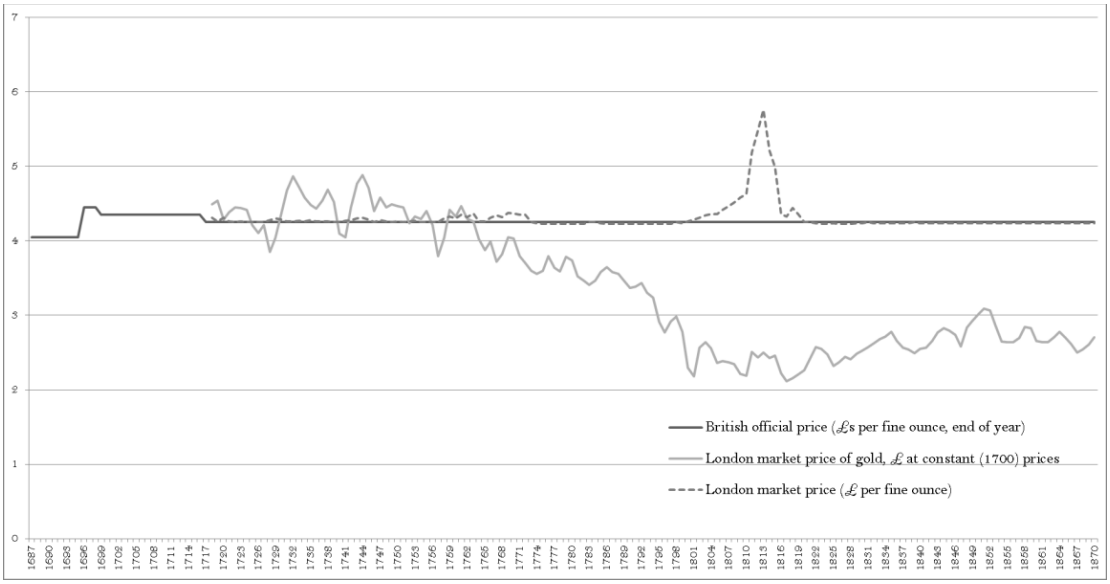

Figure 6. Official and market price of gold. Sources: Officer (2012), Clark (2013)

5.4. The 1816-21 recoinage and exchange

The immediate motivation for the 1816-21 recoinage was the end of the Napoleonic war and the need to pave the way for the Bank of England to return to convertibility, which had been suspended with the restriction act of 1797. It is known that 12.6 million of old silver coin were withdrawn from circulation in 1817 (Clancy 1999, p. 22, 145, and 181-207), and I have accounted for this in the baseline estimate.[21] Still, the "double-dip" behavior of the baseline direct estimates visible in Figure 6 remains suspect, especially in light of the fact that the indirect estimates based on nominal GDP suggest no similar behavior, so there would have needed to have existed sharp changes in velocity at those times. It seems more likely to me that due to capital inflows and other monetary experiments which resulted from the Napoleonic wars the monetary stock around 1815 was much higher than is suggested by the direct method, and much more in line with what is suggested by the indirect method. But without a good estimate of the stock from a source independent of income, the adjustment required by the baseline method cannot be made. The best hope for such a measure would be the 1816-17 "Great Recoinage", but unfortunately Clancy (1999) does not offer an overall figure for the amount withdrawn.

[21] For the crisis of 1847, see Dornbusch and Frenkel (1984).

5.5. The growth of financial intermediation

Using a series of available benchmark data points for the size of M2 (described in table A2 of the appendix), the indirect method can be extended (following a procedure identical to that described in section 4 to allow for the annual estimation of M2. It is then possible to study the growth of financial intermediation, as shown in Figure 7. Using this method, the ratio of M2 to coin supply is 1 until 1470 and 5.75 by 1870, which is broadly consistent, for instance, with the finding by Broadberry et al (2015) that per capita output of financial services increased, in index terms, from 109 in the 1500s to 685 in 1870.

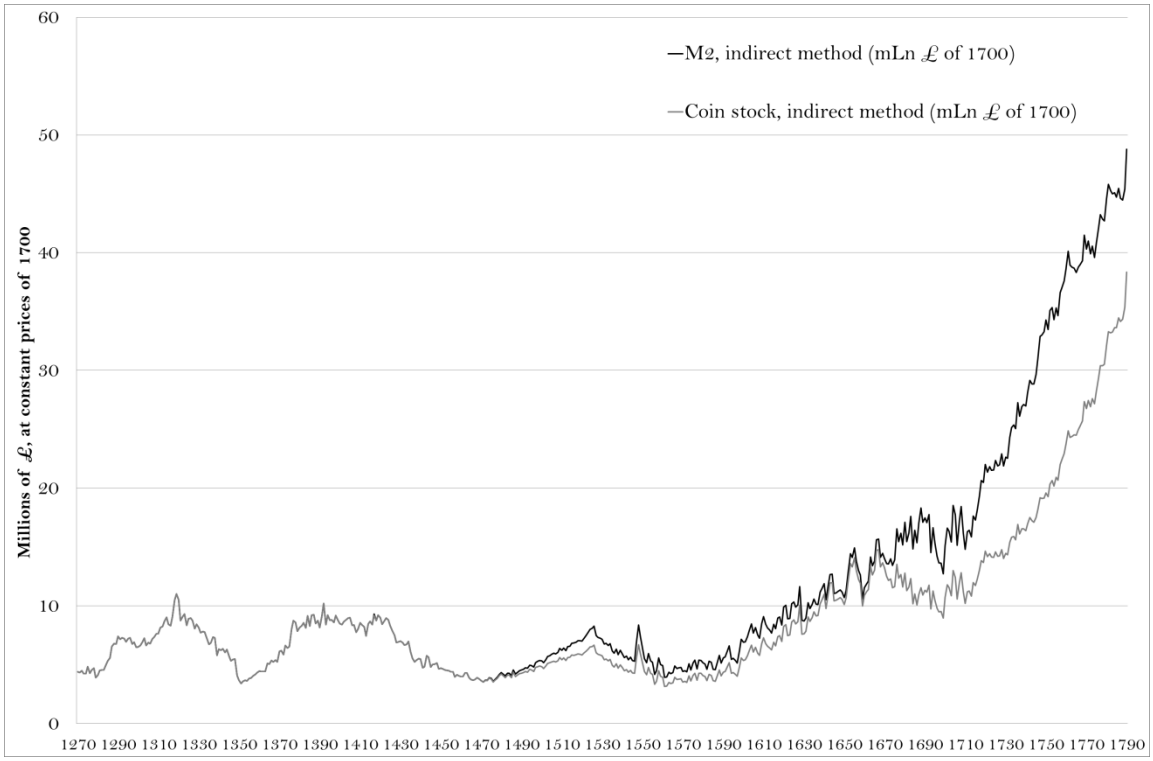

Figure 7 . British per capita coin supply and M2 at constant prices of 1700.

6. Conclusion

As usually in economic history, my estimates are subject to a high degree of uncertainty. I have detailed the assumptions underlying the construction of the series so that anyone can change these as preferred or as new information that I am not aware of may come to light.

For the reasons set out in section 4, the estimates for the 1790-1870 period carry higher levels of uncertainty than those for other periods. Nonetheless, I have linked my estimates to those of Capie and Webber (1985), which start in 1870, but it seems likely that the estimates for this period can be improved in the future. It is also the case that the sharp drop in nominal and real money supply around the time of the Tudor debasements in the mid-sixteenth century is a little suspect, and it may also be possible to improve on this in the future. For the moment however, the estimates needed for our understanding of first-order variation of English coin and money supply over the long run seem secure. Furthermore, it is my belief that the methodology that I have here set out can be used for reconstructing coin supply for other premodern economies.

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Appendix

	Bordo and Jonung (1987)	Capie and Webber (1983)	Capie (2004)	Mayhew (1995)	Mayhew (2013)
England 1300	-	-	-	-	4.91
England 1470	-	-	-	-	4.56
England 1526	-	-	-	-	3.61
England 1546	-	-	-	-	5.95
England 1561	-	-	-	-	8.73
England 1600	-	-	-	-	5.73
England 1643	-	-	-	-	3.81
England 1670	-	-	-	3.40	-
England 1688	-	-	-	-	2.65
England 1700	-	-	4	-	2.64
England 1750	-	-	3	-	2.23
UK 1790	-	-	2.5	-	-
UK 1870	2	1.75	-	-	-

Table A1. Estimates for velocity of circulation.

	Coin supply	Coin supply (preferred estimate)	Implied V of coin supply (preferred)	M2	M2 (preferred estimate)	Implied V of M2 (preferred)
England 1279	0.5 – 0.8	0.6	6.09	0.5 – 0.8	0.6	6.09
England 1282	0.8 – 0.87	0.835	5.49	0.8 – 0.87	0.835	5.49
England 1290	1.0 – 1.3	1.0	3.31	1.0 – 1.3	1.0	3.31
England 1299	1.1. – 1.4.	1.1	4.37	1.1. – 1.4.	1.1	4.37
England 1310	1.5. -1.9	1.5	3.85	1.5. -1.9	1.5	3.85
England 1319	1.8. – 2.3.	1.5	2.68	1.8. – 2.3.	1.5	2.68
England 1331	1.5. – 1.9	1.2	3.16	1.5. – 1.9	1.2	3.16
England 1351	0.6 – 0.95	0.6	5.98	0.6 – 0.95	0.6	5.98
England 1377	1.42 – 2.39	1.92	2.27	1.42 – 2.39	1.92	2.27
England 1422	1.22 – 2.39	1.285	2.06	1.22 – 2.39	1.285	2.06
England 1470	0.75 - 0.95	0.9	4.53	0.75-0.95	0.9	4.53
England 1526	1.4	1.4	3.5	1.4 – 1.71	1.56	2.82
England 1546	1.45	1.45	5.98	1.45 – 1.77	1.61	4.80
England 1548	1.76	1.76	3.97	1.76 - 2.15	1.96	3.18
England 1549	1.92	1.92	4.35	1.92 – 2.35	2.14	3.49
England 1551	2.02	2.02	5.71	2.02 - 2.47	2.25	4.58
England 1560	1.71	1.71	6.89	1.71 - 2.09	1.90	5.52
England 1561	1.45	1.45	8.82	1.45 - 1.77	1.61	7.08
England 1600	3.5	3.5	6.65	4.5	4.5	5.17
England 1643	10	10	3.91	12.22 – 14.07	13.15	3.69
England 1670	12	12	3.90	14.67 – 16.88	15.78	3.68
England 1688	10	10	5.14	11.75 - 20	15.88	3.24
England 1700	7 - 14.5	10.75	7.07	8.5 - 21.75	15.13	5.03
England 1750	15 - 18	18	5.06	23 - 40	31.5	2.89
England 1790	44	44	3.88	56	56	3.05

Table A2. Benchmarks for English nominal money supply, 1270-1790. Sources: For coin supply 1279-1470, Allen (2011, 2012); coin supply from 1526 to 1700 is based on Mayhew (2013, p. 26), where 1551 corresponds to an average of the two available estimates for that year; for the coin supply of 1700, see Mayhew (2013, p. 29). For the 1688-1750 coin supply figures, these are the estimates of Cameron (1967), also endorsed by Mayhew (2013, p. 30). Note that Mayhew's 1688 number in table 3 of page 26 corresponds to Cameron's M1 estimate. For the coin supply estimate see Cameron (1967), also discussed in Mayhew (2013, p. 30). For the M2 preferred estimates: 1279-82, 1377 and 1422 simply the average of both of Allen's bounds. For all other 1290-1470, Mayhew (2013)'s choices. With regards to the bounds to the broader measure of money (M2), the key is to realize Capie's (2004) numbers are more conservative than those of Cameron (1967). For the upper bound during the period before 1600, I use the Mayhew 1600 relative numbers. This bound is hence tantamount to assuming bills of exchange were relatively used as much in the middle ages as in 1600. For sure, this bound should tighten the far back we go in time, but since we know credit was used in the middle ages but have no way to estimate how much of it was transferable or its size, as this is an upper bound there is no harm to assume it all the way it back to 1270. Still in calculating the higher bound, for 1600-1688 I use proportionality with Cameron's 1688 relative M2/coin supply size, and for 1688-1750, Cameron's 1750 M2/ coin supply size. As for the lower bounds, for 1600-1700, use Capie's 1700 relative size (itself a lower bound, as it includes notes but not bills of exchange), and for 1700-1750 use Capie's 1750 relative size, for 1750-1790 use proportionality with Capie's 1790 relative M2/coin supply size.

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