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EVALUATION OF THE METALLIC CURRENCY

[THE attempts to evaluate the amount of coin circulating in a country which form the subject of this paper, published in the *ECONOMIC JOURNAL*, 1891 and 1892, were conducted partly on the lines of Newmarch's method (discussed by the present writer at the meeting of the British Association for 1888), partly on the fresh lines struck out by Jevons. To the second class belong De Foville's calculation based on three French *enquêtes*, noticed here. Mr. F. C. Harrison's computation of the rupee circulation, which occupies a great part of the paper, is an improvement on the method of Jevons. By bringing to bear on the calculation the evidence afforded by the examination of samples pertaining to several successive years, he has obtained a result which seems to have almost the certainty of physical science.

The reader may like a reference to the *Journal of the Royal Statistical Society* (Vol. LXXXIII, 1920, p. 609 *et seq.*), where the subject is further discussed in connection with Mr. Shirras' excellent Paper on the effects of the war on gold and silver.]

I. Among recent attempts to evaluate the amount of coins circulating in the country a prominent place is due to that which Messrs. Martin and Palgrave have just completed. Their method is similar to that which Newmarch employed to determine the circulation at the epoch 1843-4 (*History of Prices*, vol. vi.). They reason: As the percentage which the pre-Victorian sovereigns formed of the total circulation (previous to the recall of that coin) is to 100, so is the amount of pre-Victorian sovereigns to the total amount of sovereigns in circulation (previous to the recall); and similarly for the half-sovereigns. By means of circulars issued to bankers, Messrs. Martin and Palgrave ascertained that the percentage of pre-Victorian sovereigns was about 4 per cent.; and the number recalled was 2,335,000 nearly. Whence the total of sovereigns

previous to the recall is found to be about 58,375,000. Performing a similar computation for the half-sovereigns, deducting the coin recalled, and making an addition of £11,000,000 on account of the gold coin in the Bank of England which does not conform to the general average, Messrs. Martin and Palgrave (in their latest version, *Economist*, January 23) give £80,000,000 as the amount of the gold circulation.

Of the two data on which the inference mainly rests—the comparative and the absolute amount of the pre-Victorian coin—the former is corroborated, in the case of the sovereigns, by the close proximity between the observations for England and Wales, Scotland, and Ireland; 4·12, 4·1, 4·7 being the respective percentages formed by the pre-Victorian coin.¹ This consilience is not presented by the half-sovereigns, for which the respective percentages are ·84, ·50, and 1·06. But it may be observed that the numbers on which the Irish and Scotch averages rest are very small. The second datum, the absolute quantity of the pre-Victorian coin recalled, is too little by the number of coins not given up—retained, it may be, as curiosities. Against this deficit Mr. Martin—in his letter to *The Times* of July 21, 1861, describing the method of calculation—puts the fact that some of the recalled pre-Victorian sovereigns “undoubtedly came from abroad.” The total officially known to have come from abroad is £162,751.

Both the data have been subjected to severe criticism in recent numbers of the *Economist* (January 2, 16, 23, 30). The majority of the objections which have been made suggest that the result obtained errs in defect. This contention, if it is substantiated, will confer on the computation the important character of a *lower limit* to the amount of coinage in circulation; thus rendering the Martin-Palgrave method complementary to that of Jevons, which—in its simplest form at least, when unmixed with precarious calculations based on the export and import of coin²—affords a *higher limit*. The two methods, if performed jointly, would give two limits between which the quantity of the coinage at the epoch to which the returns relate must lie.

II. Next may be noticed the brilliant attempt to estimate the rupee circulation which has been made by Mr. F. C. Harrison in the *ECONOMIC JOURNAL*.³ His method is that of Jevons as to its

¹ This impression is confirmed by a more detailed inspection of the returns. The English sovereigns which were examined fall into four large classes, for which the percentages (of pre-Victorian coin) are respectively 4·2, 3·8, 3·5, 4·6.

² See Jevons, *Currency and Finance*, pp. 266–7.

³ 1891 and 1892.

essence, but with a specific difference; the foundation is the same, but Mr. Harrison's construction rests, so to speak, on a great number of props, and they support each other archwise. Jevons, seeking to determine the amount of the (sovereign) circulation in 1867, reasoned: As the percentage (ascertained by the inspection of samples) which the coinage of 1863-4 forms of the total circulation is to 100, so is the amount of the coinage of 1863-4 presumed to be in circulation to the total circulation. Mr. Harrison, seeking to determine the amount of the (rupee) circulation in 1890, utilises similarly, not only the amount of the coinage presumed to be in circulation, but also the corresponding data for preceding years, *allowance being made for the greater diminution of the coinage of earlier years*. How is the comparative degree of diminution ascertained? By observing the gradually diminishing proportion which the coinage of any year, say 1874, forms in the circulation of successive years, 1877,¹ 1878, 1879-1890. These proportions are respectively: 2.13, 1.8, 1.6, 1.55, 1.45, 1.4, 1.3, 1.15, 1.2, .95, .9, .95, .9, .9 per cent. of the total circulation in 1890. They measure the decrease of the coinage of 1874, upon the hypothesis that the total circulation is stationary during the period 1877-90; which Mr. Harrison assumes as approximately true (*op. cit.* p. 722). How is this assumption justified? By the consistency of the various results obtained on this hypothesis, a consistency which cannot be ascribed to accident. To show this, let us suppose that the decrease indicated by the row of figures above cited is due, not to the diminution of the amount of the 1874 coinage in the circulation, but to the increase of the total circulation with respect to which the percentages are taken. Upon this supposition the whole coinage of 1874 has passed into the circulation of 1890. But that coinage amounted to 4.352 crores² of rupees (as shown in Mr. Harrison's Table A); and it forms .9 per cent. of the 1890 circulation (*ibid.*). Therefore (by Jevons's method) the circulation of 1890 = $4.352 \div .009$ or 483 crores, a result which is violently inconsistent, not only with all Mr. Harrison's estimates, but also with common sense, since the whole amount of the coinage issued *ab initio* is only about 300 crores (Table F).

It may be suspected, however, that the downward slope of

¹ Assuming with Mr. Harrison that the circulation of 1874 was three years in passing into circulation; and, after him also, at first leaving out of account the loss suffered by that coinage during those three years (*op. cit.* p. 733, and below, p. 411).

² It may be well to remind the reader that a crore = 100 lakhs = 10,000,000 rupees. Thus 4.352 crores = 43,520,000 rupees.

the percentages in question (the row of figures on p. 408), is due only partly to a real decrease in the coinage of 1874, and partly to the increase of the total circulation. But it will appear, I think, that the absolute constancy of the circulation during the period under consideration, 1877-1890, is of all simple hypotheses the one which best squares with the observations. For if the circulation is not constant, let it be allowable to suppose that it increases regularly, say, is multiplied by a factor x which is greater than unity. Also let us suppose (in conformity with the data expressed in Mr. Harrison's Table D) that the whole of the 1874 coinage has passed into circulation by 1877; and that the *apparent* yearly decrease of that coinage—that is, the decrease of the percentage which that coinage forms in the total circulation—is 6.136.¹ Then the *real* yearly decrease of the 1874 coinage is given by the factor $x \times (100 - 6.136) \div 100$, or $x \times .93864$. Therefore the amount of 1874 coinage in the circulation of 1890 (thirteen years after the initial time, 1877) is $x^{13} \times (.93864)^{13} \times 4.352$ crores. But the proportion of 1874 coinage in the 1890 circulation is .9 per cent. (Table A). Accordingly, the coinage of 1890 equals

$$x^{13} \times (.93864)^{13} \times 4.352 \times 100 \div .9.$$

Or, taking logarithms,

$$\log. \text{circulation of 1890} = 13 \log. x + 2.3269....$$

By considering the coinage of 1875 I find another equation of the same form, namely—

$$\log. \text{circulation of 1890} = 13 \log. x + 1.9996....$$

The coinage of 1876 supplies another equation, and so on up to a recent year,² namely, 1886; the equation corresponding to which proves to be

$$\log. \text{circulation of 1890} = 2 \log. x + 2.0982.$$

Here, then, are *twelve*³ simple equations involving two unknown quantities, the logarithm of the circulation of 1890 and the logarithm of the yearly increase x . Proceeding according

¹ This figure is thus obtained from the series cited on p. 408. The difference between the first and second of those figures (2.13 and 1.8) is 15.493 per cent. of the first; the difference between the second and third is 11.112 per cent. of the second, and so on. And 6.136 is the average of the percentages 15.493, 11.112, etc.—the *arithmetic* mean (not the *geometric*, which I should have preferred).

² In conformity with Table D, *op. cit.*

³ Following Mr. Harrison, I do not utilise the returns for 1881 on account of the smallness of the coinage in that year, and the consequent irregularity of its incidents. No great difference, however, would be caused by including these data.

to the received rules prescribed by the Calculus of Probabilities for such cases, I find, as the most probable value of the circulation, 125 (crores); and as the most probable value of the factor constituting the yearly increase .995, approximately unity. This result is confirmed by separately considering the first six and the second six of the twelve equations. From the first batch I find the factor 1.029; from the second batch 1.018. This calculation appears to me to have quite the rigour of physical science.

It will be noticed that the value for the circulation which has been obtained has the worth which attaches to the mean of a great number of observations. We may obtain a mean of equal worth more simply, once it has been ascertained that the currency is stationary, by calculating the circulation for 1890 from the coinage of each year separately and averaging these results. For instance:—Circulation of 1890 = Coinage of 1876 \times (.9486)¹³ \times 100 \div 1.6; where .9486 is the factor whereby the coinage of 1876 yearly shrinks (Table D), 13 is the number of years elapsing from the year in which the 1876 coinage passes fully into circulation (*ibid.*), and 1.6 per cent. is the proportion of the 1876 coinage in the 1890 circulation (Table A). The result, which differs but slightly, and in virtue of a minute technical point,¹ from the result which Mr. Harrison obtains by a parity of reason in his Table J, is 129 crores.² Similarly calculating the circulation from the datum for each year except 1881 from 1874 to 1886 and 1874, 1878, 1886, and taking the mean of all the twelve results, I find 133³ for the circulation.

Or, again, we might have collected into a focus the single rays afforded by each annual observation, after this fashion: Determine the amount to which each coinage must have shrunk by 1890; add these amounts, and put the sum of them \times 100 \div the percentage which the 1874–1886 coinage forms in the 1890

¹ The point is that, in estimating the waste of the 1876 coinage during the eleven years, Mr. Harrison has worked with the decrements for each year, the percentages 6.250, 0, 6.6683 (Table D); whereas I have employed the average decrement 5.140. Mr. Harrison speaks of his principal Table as the bed of Procrustes in which all the coinages have been stretched. In performing this operation he has, so to speak, made each joint of the stretched victim to correspond to a particular part of the bed; whereas I have been content with a coincidence upon the whole—a procedure in favour of which there is not only classical authority, but mathematical convenience. It may be remarked that the difference between us would have disappeared, if I had employed (as I would, if he had given) *geometrical*, not *arithmetical* means of the yearly decrements of the coinage.

² See his account of this Table at the foot of his page 735.

If the year 1881 is included, the result is 128 crores.

circulation (1874 and 1886 being the first and last years with which we operate) for the 1890 circulation. This method of averaging corresponds to Mr. Harrison's Table F.¹

In thus proceeding we assume that each coinage has, if not for every year, at any rate on an average of years, its own rate of waste. But, if we assigned to all the coinages a common average rate of waste, we should come on the conception suggested, but not, I think, very happily worked out, by Mr. Harrison, in his Table E.

So far I have made abstraction of the second approximation, which Mr. Harrison performs by taking account of the waste suffered by each coinage before passing fully into circulation. Upon a probable hypothesis with respect to this waste, he is able to knock off some 10 per cent. from his results; and exhibits in his Tables G and K a new series of estimates smaller than the former, but still consistent with each other.

While we admire the marvellous convergence between different methods, we must not forget what it is they agree in establishing: namely, that a figure somewhere about 120 crores is not the amount of the rupee circulation—but a *superior limit* thereto. If each coinage, while passing into circulation, were to be diminished to any extent in one and the same ratio, multiplied by a common fractional factor y , we should have no means of detecting y . The whole beauty of the computation would survive, though much of its use would disappear. It is as if the arch, while remaining erect, with all its mutually supporting parts compact, should sink down as a whole owing to the treacherous softness of the ground. But the architect has secured his structure by certain external buttresses—let us hope incident on firmer ground—in the shape of independent estimates of the loss suffered by the coinages through export, hoarding, accident, and melting (*op. cit.* p. 739). It is remarkable that this collateral estimate—unlike the corresponding second approximation in the hands of Jevons—points to the conclusion that the primary estimate was *under-estimated*.

III. The only computation which can be compared with Mr. Harrison's in statistical interest is that which M. de Foville has founded on the monetary *enquêtes* which were conducted in 1878, 1885, 1891.² The French statistics are in some respects more imposing than the Indian, extending back over a much

¹ With, as before, a trifling difference.

² See *Bulletin de Statistique* for Oct. 1878, Aug. 1885, and Aug. 1891; also *Journal de la Société de Statistique*, Feb. 1879, Jan. 1886, and Nov. 1891.

greater number of years. The number of *coinages* figuring in the computation is much greater; but the number of *circulations* analysed is much less. Against the ten or twelve analyses of Indian circulation—the *columns* in Mr. Harrison's Table A—there are only three French monetary censuses. The web of the French texture, so to speak, is longer and more beautiful; but owing to the deficiency of warp the stuff has not equal consistency. The contrast thus indicated—the perfection of the French statistics in some senses, but their comparative weakness in that direction in which the strain of the reasoning is felt—may be illustrated by the following tables, relating to 20-franc gold pieces issued from the French Mint. The figures in the first row of Table I. are obtained from the figures (given in the *Bulletin de Statistique* for August, 1891, p. 147) which express the proportion between the number of coins of a certain date found at the *enquête* and the number of coins minted at that date; each of these figures has been divided by a certain fraction, viz., the total number of samples at the *enquête* ÷ total number of coins issued up to the date of the *enquête* (so as to reduce the returns for different *enquêtes* to a common denominator).

Table I. showing the extent to which the coinage of particular years survives in comparison with the average survival of the coinage as a whole; as ascertained from the *enquêtes* of 1891, 1885, and 1878 respectively.

<i>Enquêtes.</i>	1854.	1855.	1856.	1857.	1858.	1859.	1860.	1861.	1862.
1891	1.1	1.1	1.0	1.2	1.1	1.1	1.1	1.1	1.3
1885	1.1	1.1	1.1	1.2	1.2	1.1	1.1	1.0	1.1
1878	1.0	1.1	0.9	1.1	1.03	1.1	1.1	1.1	1.2

Table II. showing for decades what Table I. showed for single years; as ascertained from the *enquêtes* of 1891 and 1878.

<i>Enquêtes.</i>	1803—12.	1813—22.	1823—32.	1833—42.	1843—52.	1853—62.	1863—74. ¹	Remaining period. ²
1891	0.4	0.4	0.5	0.6	1.0	1.1	1.1	0.9
1878	0.4	0.4	0.6	0.7	1.5	1.0	1.2	1.0

¹ There are no returns for 1872 and 1873.

² The remaining periods comprehend 1875, 1876, 1877, and 1878, in the case of the 1878 *enquête*; and, in the case of the 1891 *enquête*, the remaining years up to 1891, including 1891, and excluding 1880–85, during which there was no coinage.

These statistics of the survival of coins are certainly most perfect in their coincidence, probably far more regular than any vital statistics concerned with the ages of man—especially woman.

Yet for the particular purpose now before us it may appear that the French statistics are not so perfect as the Indian. M. de Foville's computation seems to occupy an intermediate position between the simple Jevonian and the highly compound Jevonian, or Harrisonian method. The beautifully regular figures which we have looked at are not those from which an approximate value of the circulation is directly found; the data on which the Jevonian method is best rested are figures formed like those in Tables I. and II., but greater than unity. The annexed table shows such figures as ascertained from the only two

Table III. showing the extent to which the coinage of certain biennial periods survives in comparison with the average survival of the coinage as a whole; as ascertained from the enquêtes of 1878 and 1891.

<i>Enquêtes.</i>	1876—76.	1877—78.	1879—86.	1887—88.	1889—90.	1890—91.
1891	0·7	1	0·7	0·5	2·3	3
1878	1·2	1·3				

enquêtes which are available for this purpose. (For the *enquête* of 1885, made after a cessation of coinage for five years, does not, I think, present this phenomenon of terminal rise.) A little attention will show that the figures in this table, especially the last or penultimate figure in each row, are what we want for the useful application of the Jevonian rule of three. In fact, the result of that method may be defined as the total coinage up to the date of the *enquête* with which we are concerned *divided by* that figure in the corresponding row of Table III. which we select as best to operate with.¹ I cannot think that the proper figure is clearly indicated.

Each figure (e. g. 2·3) in Table III. =

$$\frac{\text{number of samples bearing a certain date (1889-90)}}{\text{total number of samples observed at a certain } \textit{enquête} \text{ (1891)}} \\ \div \frac{\text{coinage of that date (1889-90)}}{\text{coinage of all dates up to that } \textit{enquête} \text{ (1803-91)}}$$

¹ Thus the number of French 20-franc pieces issued, from the initial date (1803) up to the present (1891), amounts to 362,809,000; and accordingly the Jevonian estimate for the present circulation (of French 20-franc pieces in France), as based on the data for 1889-90, is that amount \div 2·3, or nearly 158,000,000.

The last denominator, the coinage of all dates, *divided by* the figure specified (2·3) is the Jevonian formula for the circulation as deduced from the coinage of the biennial period selected (1889-90).

M. de Foville in his computation based on the 1891 *enquête* (*L'Économiste Français*, Sept. 19, 1891) uses in effect, as I understand, the datum corresponding to 1889-90. But was it not at least equally proper to include the datum for 1891; in which case his result would have been increased by some thirty per cent.? Again, as the terminal figures for the *enquête* of 1878 are so much smaller than those for 1891, while the total coinage up to the date of the *enquête* is not materially different—that of 1891 being larger than that of 1878 by only about 2 per cent.—we must suppose the circulation (of French 20-franc pieces within France) in 1878 to have been larger than in 1891. That is not paradoxical, considering that there has been little influx to compensate the evaporation, not to say drainage, of thirteen years. There is here nothing improbable, yet nothing probative. One misses the consilience of results to which the Indian statistics have accustomed us.

I am aware, of course, that M. de Foville has otherwise obtained the probative force of consilience. In particular, the correspondence between his computations of the gold and silver circulation is very reassuring. He first estimates the stock of silver at about 2,500,000,000 francs,¹ of which 1,200,000,000 are 5-franc pieces in active circulation. From the latter figure he passes to the existence of gold to the amount of 2,700,000,000 francs in virtue of the remarkably constant proportion, 31 : 69, between the gold and silver circulation attested by the *enquêtes*. And this estimate—taking account of the coins “immobilised” in the Bank and other circumstances—exactly squares with the application of the Jevonian method to the data of 1889-90, in such wise as to confirm the estimate of the gold circulation at 4,000,000,000 francs. Where several such coincidences concur, it seems as improbable that the computation should fail, as that a party of men roped together should all fall into a crevasse. I only say that there does appear to be a chink in the data to which Jevons's method is applied.

IV. Doubts would be removed and conjecture would be merged in certainty, if we had but one more datum, the net efflux (or influx) of coin in recent times, if only the statistics of the export of money could be relied upon. M. Ottomar Haupt

¹ Nominal value.

indeed does not hesitate to work with those materials; and (in the London *Economist* for October 3, 1891, and January 16, 1892) obtains an estimate for the French silver currency and English gold currency by a method setting the monetary exports against the imports, like that which Newmarch employed to determine the currency in years subsequent to 1844 (*History of Prices*, vol. vi. p. 703). But there are many who think that these statistical materials are too unsound to give support to any inference. As pointed out by Dr. Soetbeer (*Materials*, Taussig's translation, p. 352), there is a total failure of consilience between the recorded imports of precious metal into England from France and exports from France to England and vice versa. Not even when an average over many years is taken does an appearance of regularity arise. And it may be added that, if the difference between the efflux from and influx into England be deduced from the English and French statistics respectively, the results are still found to be totally disparate. Messrs. Martin and Palgrave, in an important letter to the *Economist*, January 23, 1892, add instances which have come under their personal experience showing the worthlessness of the declared values of monetary export. "Proved unsoundness" is the qualification applied to these statistics by the Committee of the British Association on the data available for determining the use of precious metals in a country.¹

In the absence of this desideratum, it is to be feared that the Jevonian method is calculated to afford at best a *higher limit* to the circulation. Hence the peculiar worth of the Martin-Palgrave method, if affording a *lower limit*.

¹ See Report of the British Association for 1888.