ISSN 2279-9362

Collegio Carlo Alberto

Italian Industrial Production, 1861-1913: A Statistical Reconstruction
E. The Metalmaking Industries

Stefano Fenoaltea

No. 416
May 2015

Carlo Alberto Notebooks

www.carloalberto.org/research/working-papers

Stefano Fenoaltea

ITALIAN INDUSTRIAL PRODUCTION, 1861-1913:

A STATISTICAL RECONSTRUCTION

E. THE METALMAKING INDUSTRIES

2015

ITALIAN INDUSTRIAL PRODUCTION, 1861-1913:

A STATISTICAL RECONSTRUCTION

ITALIAN INDUSTRIAL PRODUCTION, 1861-1913: A STATISTICAL RECONSTRUCTION

E. THE METALMAKING INDUSTRIES

CONTENTS

TABLES

SUMMARY TABLES

E. THE METALMAKING INDUSTRIES

E01. Introduction

E01.01 The output data and estimates

The metalmaking industry is here defined to span the transformation of metal from ore to semi-finished products; all further working of the metal, yielding anything from nails to sophisticated machinery, is considered part of the engineering industry (section F). These limits, and the primary internal division into ferrous and non-ferrous metals, agree very closely with those in both the *ISIC* (371 and 372, making up 37) and the 1911 censuses (4.1 and 4.2, with the rest of 4 devoted to engineering); the minor specific discrepancies are discussed in sections E02.01 and E03.01 below.

The reports of the Corpo delle miniere are once again the principal source of output information. The metalmaking industry is examined in detail in the *Statistica mineraria* (expanded, on some points, by the *Relazioni minerarie*), summarily in the *Notizie minerarie*, and with growing regularity in the *Rivista mineraria*. Annual data are available for all major metals by the late 1880s, and the time series in the *Rivista mineraria 1897* and *1899* include some previously unpublished information for earlier years as well (even as they ignore, oddly enough, the usually more comprehensive figures published in the 1860s). At their best, these reports appear to provide a very comprehensive record of the reduction of ore into new metal; but the fabrication of new and old metal into semi-finished products was documented only in exceptional cases (iron, copper), and even then to the exclusion of numerous small shops. As usual, moreover, vertical integration was widespread, and the imperfect continuity of the production process repeatedly opened the flow of materials to transactions with other firms; in most cases, as a result, the available output data are only blurred measures of the actual throughput at any well-defined point of the production process. The present output estimates reflect this uncertainty: the processing of each metal is normally represented by just two output series, one for ingot (from ore) and one for semi-finished products (from ingot or scrap), even though the relevant technology would warrant a more complex breakdown. The series for ingot metal, and for semi-finished iron and copper from the 1880s, are essentially those in the *Rivista mineraria 1899* ff. and the secondary sources, improved by allowing for double-counting, omissions, and the like; as usual, the most significant corrections tend to be those to the early, partial data. The series for other semi-finished metal are instead constructed by estimating input availabilities from the production of new metal and net imports of ingot and scrap, allowing where appropriate for the metal consumed in different forms (as chemical compounds, or to plate or alloy another metal). Directly or indirectly, then, the output estimates for the entire metalmaking industry are derived from the reports of the Corpo delle miniere.

E01.02 The employment data and value added estimates

The disaggregated estimates of value added at 1911 prices are built up from information on goods' prices and technology, much of it available in the *Rivista mineraria*. The estimates so obtained are congruent with the *Rivista mineraria* output and employment data for 1911, assuming relatively high wages (1,200 lire p. a. for an adult male, from the 4 lire per day suggested by the metalmaking and metalworking rates in the *Annuario 1911*, pp. 222-224, and *1913*, p. 268), the usual average annual salary (2,000 lire), and the ratio of white-collar to blue-collar employment obtained from the *Censimento industriale* figures for shops with more than 10 employees (vol. 3: 5.3% in category 4.1, ferrous metals, and 8.8% in category 4.2, non-ferrous metals).

In addition, the aggregate value added estimates for both ferrous metals (98.2 million lire) and non-ferrous metals (20.2 million lire) are congruent with the aggregate census data and the estimated coverage of the disaggregated data in the *Rivista mineraria*. The relevant labor force and employment data are collected in Table E.01 (the *Rivista mineraria* figures are from the 1911 issue; the Sardinian lead and silver data apparently refer to 1910-11, as noted in section E03.06 below, but are here transcribed as reported). In category 4 (metalmaking, engineering) as a whole, the *Censimento demografico* lists 377,300 blue-collar workers, to just 310,600 in the *Censimento industriale* (including half the employment in categories ω.31 and ω.71); but most of the discrepancy is in categories 4.3 (hardware) and 4.5 (light engineering), where the *Censimento demografico* data include the artisanal (and domestic) workers missed by the *Censimento industriale* (see section F01.02 below). In categories 4.1, 4.2, and 4.4 (heavy engineering), the *Censimento demografico* lists 182,800 *operai*, against a total of 172,800 in the corresponding specific categories of the *Censimento industriale*, to which must be added a suitable share of the estimated 34,000 workers in categories 4.ω1, ω.31, and ω.71. This suggests that the *Censimento demografico* blue-collar labor force figures for categories 4.1, 4.2, and 4.4 barely exceed actual employment in those industries, including the appropriate share of integrated shops the *Censimento industriale* counted in categories 4.ω1, ω.31, and ω.71 (and perhaps also some workers in integrated shops erroneously attributed to engineering alone; one notes that the *Censimento industriale* blue-collar figure is closer to that in the *Censimento demografico* in category 4.4 than in categories 4.1 or 4.2). In categories 4.1 and 4.2, then, blue-collar employment is estimated at 97% of the corresponding labor force, or 37,500 and 7,550 workers, respectively; of these, 4,500 and 1,600 workers, respectively, are presumed counted in categories 4.ω1, ω.31, and ω.71.

Total employment in categories 4.1 and 4.2 is similarly estimated at 40,700 and 8,900 workers, respectively. A slight downward revision might be in order, given that shops with more than ten employees account for most of the labor and horsepower in integrated shops (from 88% of each in ω.31 to 99% of each in 4.ω1: *Censimento industriale*, vols. 3 and 4). If total employment in integrated shops were estimated by scaling up the corresponding blue-collar figure in proportion to the ratio of total to blue-collar workers in shops with more than ten employees (1.053 in category 4.1, 1.088 in category 4.2), the resulting estimates of total employment would be some 1% less in category 4.1 and 2% less in category 4.2; since the employment mix surely varied within larger shops as well as between larger and smaller ones, this small difference from the simpler estimates is here considered insignificant.

Horsepower in use in integrated shops is estimated to equal 14,700 (3.26 per blue-collar worker, as in the larger shops) in category 4.1, and 1,500 (.92 per blue-collar worker, as estimated for the larger shops of the industry exclusive of aluminum production; see below, section E03.12) in category 4.2, yielding a total 120,900 horsepower in use in ferrous metals, and 11,300 horsepower in use in non-ferrous metals. These estimated horsepower figures are well below the corresponding *Rivista mineraria* totals of 159,800 installed horsepower (allowing 2,300 horsepower for the coking plants integrated with the iron works: above, section D12.03) in ferrous metals and 14,600 in non-ferrous metals, even though the latter source covers only a subset of the shops included in the census. This result is not unreasonable: even when operating near capacity, an industry which uses power discontinuously (e.g., to pour molten metal; *Rivista mineraria 1909*, p. 390) may report average horsepower in use far below the equipment's aggregate rating; significantly, the gap between the census and *Rivista mineraria* figures is least in the case of electric power in non-ferrous metals, where both totals are dominated by the heavy power needs of aluminum production by an essentially electrochemical, continuous process.

E02. Ferrous metals

E02.01 Introduction

The production and initial fabrication of ferrous metals (*classe* 4.1) is here divided into two stages, corresponding to the production of pig iron from ore on the one hand, and of semi-finished cast iron, wrought iron, and steel from pig and scrap on the other; the latter stage is represented by separate time series for rails, cast iron, and all other semi-finished iron and steel. The pig iron and rail series are transcribed directly from the reports of the Corpo delle miniere; the output of other semi-finished ferrous metal is estimated. From the 1880s, the wrought-iron-and-steel component is estimated by tentatively correcting the *Rivista mineraria* production figures for omissions and double-counting; the cast-iron component is then estimated on the assumption that in final consumption the ratio of cast iron to wrought iron and steel declined smoothly over time. In the earlier years, that same assumption is used to separate the cast-iron and wrought-iron-and-steel components of a total estimated from the apparent consumption of pig and scrap iron.

The reports of the Corpo delle miniere provide abundant output data, and a relatively extensive discussion of the industry's development. Other useful sources include Giordano (1864) and the wartime *Notizie metallurgiche*. Different statistics are occasionally found in the secondary literature, but these are typically no more than mishandled transcriptions of Corpo delle miniere figures (e.g., Molinari, 1920, p. 832n: the "cast iron" figures are the sum of the *Rivista mineraria* data for pig iron and cast iron; the "wrought iron" figures are the sum of the *Rivista mineraria* data for puddled iron and wrought iron).

Next to the production of ferrous metals proper, that of ferroalloys (from ore, and for use in the manufacture of special steels) is comparatively trivial. Italy produced some ferromanganese in 1875-80 (the output figures for 1910 and 1911 given by Molinari, 1920, p. 828n actually refer one to manganese ore, the other to manganiferous iron ore); since this alloy was obtained in an ordinary blast furnace, it is here simply added to pig iron production. Some ferrosilicon was produced from 1907, and is here counted as an electrochemical furnace product (see above, section D10.06). This classification differs from the *ISIC*, which includes ferroalloys with iron and steel, but appears to correspond to that of the *Censimento industriale*: while the latter does not mention ferrosilicon (or ferroalloys) at all, the absence of a category straddling chemicals and metalmaking suggests that the producers of ferrosilicon (in the same electric furnaces that were used for calcium carbide) were there attributed entirely to the chemical industry.

E02.02 Output: the aggregate data and their principal characteristics

The output series in Table E.02 are taken from the *Rivista mineraria 1881* ff.; like those in the *Rivista mineraria 1897* and *1899* and the *Annuario 1884* ff., they exclude the typically imprecise or unsystematic output figures to be found in a number of earlier publications.

The earliest source is Giordano (1864); collecting the relevant indications (pp. 3, 336, 338, 341, 416), one obtains the following set of figures. Pig iron output was about 29,000 tons, of which some 2,000 were exported (to France and to the Roman provinces) and the rest transformed into some 3,500 tons of castings, 500 tons of steel, and 15,000 tons of bar and crudely fabricated iron. A further 1,000 tons of iron, at most, may have been obtained directly from the ore by the rapidly disappearing Catalan process, while another 4 - 5,000 tons were obtained from imported pig (most of which, however, was used for castings); in addition, a growing but unspecified amount of iron was obtained from scrap (in machine shops, reprocessing their works scrap; in at least one large plant, in Savona, working old rails; and in many small coastal works that had switched away from the Catalan process). Production

elsewhere in geographic Italy is also discussed; it appears to have been relatively small in the Venetian provinces, but conspicuous in the Roman one, where there were two large works (producing some 2,600 tons of bar and fabricated iron) and five other ones (one of them, perhaps the largest, producing 200 tons of bar and fabricated iron) working pig and scrap.

The *Statistica mineraria*, pp. XXIV, 40-41, reported national output at 22,162 tons of pig iron, 8,330 tons of cast iron, 16,661 tons of bar iron, 3,596 tons of iron hardware, 1,042 tons of crude steel, and 3,000 tons of fabricated steel; these were aggregated directly, with no concern for double-counting, into a reported total of 54,791 tons of ferrous metals (as usual, these figures are dated 1865, but the detailed comments, pp. 20-41, show that they can refer to any year between 1861 and 1866). These figures cover neither Latium nor Venetia, and omit railway shops, arsenals and yards, and some other Ligurian firms (pp. XXI-XXII); they also appear to omit most of the iron cast by the foundries and machine shops (whose pig iron consumption is reported at 20,725 tons, p. XXIII; note that only 40 such shops are counted, compared to 62 in Giordano, 1864, pp. 354 ff.).

Maestri (1868), p. 226, reproduced the figures from the *Statistica mineraria*; these no doubt corrected the slightly different ones, "from still unpublished official statistics," in Maestri (1867), pp. 190-191. The *Annuario 1878*, p. 131 and *1881*, p. 621, published the following output figures, obtained from the Corpo delle miniere: pig iron, 22,200 tons p. a. in 1850 and 1860-71, and 26,000, 25,480, 21,054, and 20,278 tons, respectively, in the succeeding years to 1875; cast iron, 4,600 tons p. a. in 1850 and 1860-76; bar iron, 30,000 tons in 1860, 32,000 tons in 1866, 38,000 tons p. a. in 1867-71, and 49,000 tons p. a. in 1872-76 (compare *Sommario*, p. 129); and steel, 650 tons p. a. in 1850 and 1860-69, and 1,250, 1,400, 1,550, 1,800, 2,000, 2,000, and 2,800 tons, respectively, in the succeeding years to 1876. The *Notizie minerarie* dealt extensively with iron production (pp. 26-27, 109-204), and is in fact the source of the now familiar early pig iron data (presented from 1860 to 1880, by region; p. 125). Aggregate wrought iron and steel output is reported there at an average 46,000 tons p. a. in 1875-79, but with peaks of 70,000 tons (pp. 26-27), and at a maximum of 74,000 tons, nearly 5/7 from scrap, in 1877 (p. 127); cast iron production from domestic pig is reported at 2,400 or 2,500 tons p. a. (pp. 26, 125). Finally, the *Rivista mineraria 1880*, p. XLIII estimated current aggregate cast iron, wrought iron, and steel production at about 60,000 tons.

The only ferrous metal output data to run continuously from 1861 to 1913 refer to pig iron. The figures in Table E.02, col. 1 are those in the *Rivista mineraria 1899*, p. LXXXVIII, and *1900* ff. (also *Notizie minerarie*, p. 125, and *Sommario*, p. 129), modified as follows. First, the pig-iron output reported for 1878 is reduced to 13,995 tons, the figure obtained by summing over the local figures in the *Notizie minerarie*, p. 125 and indirectly confirmed by the text, p. 123. Second, these figures are increased to include the ferromanganese production reported in the *Rivista mineraria 1899*, p. XCVII (90 tons in 1875, 250 tons in 1876, 375 tons p. a. in 1877-79, and 300 tons in 1880; see also the *Notizie minerarie*, p. 27, and the *Rivista mineraria 1877*, pp. 96-97, *1880*, p. 109); in addition, the 1888 output figure here includes the 138 tons of iron cast directly from the Follonica blast furnace (*Rivista mineraria 1888*, p. XLIX; compare *1885*, p. 89, *1889*, p. CVII, and the *Annuario 1892*, p. 415, *1900*, p. 487). There is evidence that the data for pig iron obtained on the Tuscan coast (Follonica, Cecina, Valpiana) in conjunction with the Elban mines refer to a lagged July-to-June fiscal year, at least through 1890-91; but the concomitant distortion of the time series seems to be minimal, as these works were largely or wholly inactive from June to December (*Notizie minerarie*, pp. 125, 192-197; *Rivista mineraria 1881*, p. 166, *1883*, p. 93, *1885*, p. 89, *1887*, p. 99, *1889*, p. 121, *1890*, p. 303, *1891*, p. 115). In other respects, this output series appears to be of very high quality. Its coverage is no doubt exceptionally good, as there were only a comparative handful of blast furnaces in activity, particularly from the 1890s (*Rivista mineraria 1899*, p. LXXXVIII, *1909*, p. XXVIII); and the

final product was relatively homogeneous. On the other hand, there was a significant evolution in the techniques of production: small charcoal furnaces accounted for the industry's slowly shrinking production to the turn of the century, while its subsequent rapid growth reflected the construction of large coke furnaces at Portoferraio (Livorno) in 1902, Piombino (Pisa) in 1905, and Bagnoli (Napoli) in 1910 (the pause in 1907-08 was due to technical difficulties at the Portoferraio works, that in 1911 to strikes at Portoferraio and Piombino; in addition, the Darfo (Brescia) works obtained 2,500 tons of pig iron in an electric furnace in 1912, and 160 tons in 1913 (*Notizie metallurgiche*, pp. 5-7, 12-13; *Notizie minerarie*, pp. 123-124; *Rivista mineraria 1894*, p. 207, *1902*, p. LXXXIII, *1905*, p. XCII, *1907*, p. 234, *1908*, p. CIV, *1910*, p. CXXVIII, *1911*, p. CLXI, *1912*, p. CLXXXII, *1913*, p. XLII).

The balance of Table E.02 is devoted to the subsequent transformations of ferrous metal, as measured in the national metalmaking reports included in the *Rivista mineraria* from 1881; according to the *Rivista mineraria 1899*, pp. LXXXIX, CV, these are the first "official" data for this part of the industry. Table E.02, cols. 2 and 3 transcribe the aggregate output data for puddled iron and steel in ingots (and other castings obtained directly from the furnace), available from 1899; a breakdown by district is also available through 1906. Most of Italy's wrought iron was of course busheled (from scrap) rather than puddled (from pig); but there is no comparable series for the initial (furnace) output of busheled iron. Table E.02, cols. 4 - 7 transcribe the aggregate output data for the final products of the ferrous metals industry: cast iron, processed wrought iron and steel, and plate. Aggregate cast iron output data are available from 1886 (in the comparison of output and international trade, and, from 1893, in the output report as well). This series is not very meaningful, as the data refer only to a relatively small and fluctuating number of foundries, typically integrated with works producing wrought iron and steel (e.g., *Rivista mineraria 1890*, p. CXXX, *1900*, p. XXIX, *1913*, p. LXX). In 1886, 1898, 1899, and 1912, moreover, the reported aggregate is less than the sum of the available disaggregated figures (by 10,000, 382, 406, and 1,300 tons, respectively: *Rivista mineraria 1886*, pp. XXXVI-XXXVII, 252, *1898*, pp. XXIX, 357, *1899*, pp. XXIX, 361, *1912*, pp. XXXIV-XXXVIII); it exceeds that sum in 1888 and 1889. Aggregate data (and district- or province-specific subaggregates) for processed (*lavorato*) wrought iron and steel are available from 1881; the legends to the geographically disaggregated data in the national or district reports make clear that these always include fabricated as well as semi-finished or even unprocessed metal (their disaggregation by product type is discussed below; see cols. 8 - 11). The present aggregate figures are true to the original with one exception: in the *Rivista mineraria 1885* (pp. XXXI, 198), the Bergamo subaggregates switched the figures for processed iron and natural steel; the present aggregates correct this error (the same correction appears in the *Rivista mineraria 1899*, p. LXXXIX, and the *Sommario*, p. 129; note that both these sources understate iron output in 1894 by 30,000 tons, and that the *Sommario* steel series shifts from processed steel in 1881-1900 to ingot steel in 1901-13). Finally, aggregate (and district- or province-specific) output data for plate are available from 1892. The national reports refer exclusively to tin plate through 1908, and then to black plate, terne plate, and zinc plate (galvanized sheet) as well; these are all counted together in Table E.02, col. 7. These plate figures are presented as comprehensive, starting with the initial output of Italy's first works at Piombino (Pisa), and omitting only the initial output of Italy's second works at Darfo (Brescia) in 1893 (*Rivista mineraria 1892*, p. LXII, *1893*, p. LXXII).

In addition to these aggregates (and the corresponding geographical subaggregates), the national reports include a disaggregation of the processed wrought iron and steel data by major product type. In fact, there are two such disaggregations: one in the output report, beginning in 1895, and growing in detail to include 28 separate categories in 1913; and another in the comparison of output and international trade, in a few stable major categories corresponding to

those in the *Movimento commerciale*. Table E.02, cols. 8 - 11 transcribe the latter disaggregation, without however separating steel springs from (other) fabricated metal (*ferro e acciaio di seconda lavorazione*). From 1882 through 1894, the "sheet, bar ..." figures (col. 10) include all the reported output of wrought iron and steel except rails (from 1886; the present correction to the 1887 data is discussed below) and steel springs (from 1888; they are double-counted in 1889: *Rivista mineraria 1889*, pp. CVIII, CXXXII, 157). From 1895, balls (*masselli*, of puddled iron) and ingots are also separately counted (col. 8); both these and the rail data (col. 9) correspond exactly to their direct counterparts in the output reports. From 1895, also, fabricated metal (other than steel springs) is separated out of the "sheet, bar ..." figures; but the correspondence of these "sheet, bar ..." and fabricated metal figures (cols. 10, 11) to their counterparts in the output reports is direct, and exact, only until 1898. In subsequent years, with the growing disaggregation in the output reports, that correspondence becomes increasingly variable and uncertain. In 1900, the two sets of disaggregated data yield the same total, which is 318 tons over the sum of the aggregate wrought iron and steel data; in 1907, the disaggregated data in Table E.02 yield a total 6,540 tons over the sum of the disaggregated data in the output report, which sum is in turn 408 tons short of the sum of the aggregate data; and in 1913, the disaggregated data in Table E.02 include steel only (in 1910 and 1911, the data in col. 10 are said to include 6,000 tons and 12,800 tons, respectively, of blackplate; the aggregate output data count it as plate, rather than as processed wrought iron and steel). In 1907, and again in 1912, the correspondence between the two sets of disaggregations could not be established at all; as to the rest of this period, col. 10 apparently includes both wire and nails, tacks, etc. (including *punte di Parigi* but not screws) in every year except 1899 (when the output report's single figure for wire, nails, etc. was apparently split between cols. 10 and 11), farm tools only in 1904, steel castings only in 1905 and 1908, unspecified "fabricated steel" only in 1911, and unspecified "forged steel" only in 1913.

The distinction between the fabricated metal and the semi-finished metal (other than rails) included in the aggregate processed wrought iron and steel figures is accordingly a fairly ambiguous one, even within the national reports; and this ambiguity is compounded by the extreme difficulty of relating these national product-specific figures to the local data in the district reports, as the latter did not standardize their subaggregation of product types. For present purposes, moreover, this product count displays two further defects: on the one hand, in the presence of vertical integration through the limits of "metalmaking" into "engineering," the *Rivista mineraria* counts output as it left the firm (fabricated products) rather than the industry (semi-finished metal); on the other hand, in the presence of a lack of vertical integration within metalmaking and a lack of complete coverage by the Corpo delle miniere (the latter counted 89 ferrous metal plants in 1911, against 701 listed by the *Censimento industriale* in categories 4.11 and 4.12, with another 277 in 4.ω1), the product data in the *Rivista mineraria* fail to reflect the transformations contributed by many small metal-processing establishments. For all these reasons, the disaggregated data in the *Rivista mineraria* provide only a poor and uncertain guide to the actual mix of relatively highly processed wrought iron and steel products; the figures in Table E.02, cols. 10 and 11 are accordingly of little immediate use. In contrast, the figures in cols. 8 and 9 -- the ingot and rail components of the aggregate processed wrought iron and steel data in cols. 5 and 6 -- are altogether better defined; and both are here of particular interest, albeit for very different reasons.

Rails are worth separating from other semi-finished metal because they are a major component of aggregate output, and uniquely cheap to manufacture; since they are a distinctive final product obtained exclusively in large works, moreover, the available data are unusually reliable and complete. The output figures' appearance in 1886 coincides with the start of rail production at Terni (Perugia); and their only significant omission appears to be in 1887, when

reported rail output (29,522 tons) still refers to Terni alone, despite the reported extension of rail production to Savona and Pra (Genova) as well (*Rivista mineraria 1886*, pp. XXXVI-XXXVII, LXVII, *1887*, pp. XLIV, LXXV, 120, 266). Since Savona and Pra produced a reported 26,000 tons of rails in 1888 and 44,000 tons in 1889, their initial output is here estimated at 10,000 tons in 1887; this correction is incorporated in the rail output series in Table E.02, col. 9. Some small batches of (iron) rails may have been produced in earlier years as well; but recent suggestions that significant production began in Savona or Pra well before 1886 appear to be in error (*Atti ferroviari 1881*, part 2, vol. 1, pp. 407-408; *Centenario ferroviario*, vol. 1, pp. 343-344; Doria, 1969, vol. 1, p. 322; Loria, 1890, vol. 1, pp. 304-305). The only further corrections to the aggregate figures presented by the Corpo delle miniere are very minor. In 1893 and 1907, the present figures are the sums of the district-level figures; in 1893 the reported aggregate appears to include (and double-count) 82 tons of steel springs, in 1907 the reported aggregate is rounded down to even thousands (*Rivista mineraria 1893*, pp. LXI, 100, 219, *1907*, pp. XXXVI, 148, 341).

The ball and ingot component of the aggregate processed wrought iron and steel data is instead worthy of note because it disappears abruptly in 1912, and because at least part of that aggregate output was reportedly obtained not from pig or scrap but from purchased ball or ingot (e.g., *Rivista mineraria 1897*, p. 204, *1909*, p. 334-335, *1913*, p. LXXI; see also the ingot import data in Table E.03, col. 5). This implies that the ball and ingot metal included in the processed-metal figures may well have been double-counted; and it is no doubt the growing awareness that such was indeed the case, nationally if not locally, that led the Corpo delle miniere finally to exclude from the aggregate processed metal data all the ball and ingot metal sold to other firms (the notes to the output table count 174,603 tons of such metal, including 68,271 tons of Bessemer steel from Livorno/Portoferraio, in 1912, but only 29,932 tons of Bessemer steel from the latter works -- apparently the only ones not to work beyond the ingot stage -- in 1913; examples of ingot metal noted in the district reports but excluded from the aggregate processed metal figures, even though it was probably shipped to other works, may be found in earlier years as well, e.g., *Rivista mineraria 1888*, pp. L, 415, *1898*, p. 214, *1905*, p. 389). The difficulty, of course, is that this ball and ingot metal was actually double-counted only so long as it was sold to other works covered by the Corpo delle miniere; the indication in the *Rivista mineraria 1913*, p. LXXI, that the recorded output of processed metal was obtained from "most" of the available ingot may refer to omitted processing figures, or to inventory accumulation. On balance, then, the abrupt end of the ball and ingot metal series in Table E.02, col. 8 appears to indicate a sudden shift in the bias of the aggregate processed wrought iron and steel series in cols. 5 and 6, from a growing and (by 1911) probably severe upward bias to a slight downward one in 1912 and 1913.

The effect of this discontinuity on the aggregate processed metal series seems partly offset by a simultaneous change in the treatment of plate. From the plate series' beginning through 1911, the reports appear to treat plate as an alternative to (and on a par with) processed wrought iron and steel, so that there is in principle no duplication between Table E.02, cols. 5, 6, and 7; subsequently, however, plate is increasingly considered a transformation of processed steel, and the figures in col. 6 apparently include much (in 1912) or all (in 1913) of the blackplate that was the proximate input to the plate figures in col. 7 (e.g., *Rivista mineraria 1897*, pp. XXVIII, 138, *1899*, p. XXIX, *1902*, p. XXV, *1907*, pp. XXX, 206, *1911*, pp. XXX-XXXII, XCVII, *1912*, pp. XXXIV-XXXVIII, LXXIV, CXIV, *1913*, pp. XL-XLIV, LXVI, LXXI, CI). As usual, the interlocal movement of intermediate products creates difficulties: some plate output was obtained from purchased imported or domestic "large plate," and the latter was almost certainly not excluded from the processed steel data -- suggesting partial duplication between processed steel and plate even before 1912, and within processed steel in

1913. For present purposes -- in view of the uncertainty surrounding the actual mix of relatively highly processed wrought iron and steel, discussed above -- the separation of plate from other semi-finished ferrous metal, excluding rails, does not appear worth while; the disaggregated plate output data do however remain useful as a guide to the consumption of plating metal (whose relatively high cost, particularly in the case of tin, accounts in large measure for the relatively high unit value of the corresponding plate; see below, sections E03.06, E03.09, E03.10).

The processed wrought iron and steel data in the *Rivista mineraria* incorporate yet another accounting change between 1911 and 1912, as mild steel (*ferro omogeneo*) was counted largely as iron through 1911, and then entirely as steel (e.g., *Rivista mineraria 1900*, p. 290, *1906*, p. 276, *1912*, p. 135). This suggests that there is little point to a distinction between reported iron and steel, even apart from the lack of meaningful differences in unit value added (differences in average value, as reported, are dominated by differences in vertical integration); to a juxtaposition of the steel ingot data (which no doubt include all mild steel from the start) and the processed iron data; or especially (recalling the two accounting changes discussed above as well as the present one) to a direct comparison of the aggregate processed steel output figures for 1911 and 1912 (Gerschenkron, 1962; *Sommario*, p. 129; *Rivista mineraria 1912*, p. CLXXXII).

In addition to these systematic changes in the processed wrought iron and steel series' coverage between 1911 and 1912, a number of relatively small-scale and typically unsystematic changes, over the years, are revealed by a reconstruction of province-specific time series from the detailed data in the national or district reports. The less significant of these, concerning small firms with a very limited output (e.g., Roma province was attributed no production in 1897, and 212 tons by 9 firms in 1898; the latter entry was subsequently repeated, unchanged, through 1906), will simply be ignored; the more significant ones will be described below, as they become relevant to the calculation of the present output estimates.

E02.03 Output: the estimates

As indicated in the preceding section, acceptable output series for pig iron and rails can be obtained directly from the reports of the Corpo delle miniere (Table E.02, cols. 1 and 9); but the output of other ferrous metal products must be estimated. The procedure adopted here is to revise and combine the 1881-1913 output data for processed wrought iron, processed steel, and plate into an estimate for those years of semi-finished wrought iron and steel output, net of rails; to extend these estimates to include cast iron, on the assumption that the relative consumption of cast iron and other ferrous metal (net of rails) varied smoothly over time; and finally to extrapolate these aggregate estimates of cast iron and other semi-finished ferrous metal output (net of rails, from 1886) to 1861 on the basis of estimated availabilities of pig and scrap. Both rails and other semi-finished metal will be considered to be produced from pig and scrap, and the production of ingots or other intermediates will not be separately calculated.

The *Movimento commerciale*, which as usual provides the principal body of relevant non-output data, yields the net import figures for pig iron, scrap iron, cast iron, and wrought iron and steel transcribed in Table E.03, cols. 1 - 8. Half of these series are obtained directly from the source, the other half by aggregating over narrower categories (whose identifying numbers in the *Movimento commerciale 1913* are provided below). In general, the present figures are obtained from those currently reported for the *commercio speciale*; most series are affected, albeit not seriously, by the change in the source's classification schemes between 1877 and 1878 (described below), and by the varying treatment of temporary imports and corresponding exports (e.g., *Movimento commerciale 1897*, p. VIII, *1899*, p. VIII, *1902*, p. VIII, *1907*, pp. VIII-IX, *1913*, pp. CCXL-CCXLI). To correct, at least in part, for the latter heterogeneity, the

present figures in Table E.03, cols. 7 and 8 include temporary imports of tin plate and the corresponding exports of cans even before 1899, on the one hand, and the tin (and other) cans made from temporarily imported plate and filled before reexport even after 1907, on the other; a comparison of the currently reported *commercio speciale* data for 1905 and 1906 with the figures for those years revised to incorporate the post-1907 treatment of temporary imports and reexports (e.g., *Movimento commerciale 1909*) suggests that the discrepancies attributable to items other than plate and cans amount, on balance, to no more than a few hundred tons p. a.

The pig iron series in col. 1 is obtained directly from the source; through 1877, it includes scrap cast iron (*ghisa in rottami*) as well as pig iron proper. The scrap iron series in col. 2 is also obtained directly from the source; it includes only scrap wrought iron through 1877, and then scrap cast iron and steel (plus iron filings and the like) as well. The crude cast iron import figures in col. 3 refer, from 1878, to those identified as *ghisa lavorata in getti greggi* (in 1913, categories 665-667); all other *ghisa lavorata* (categories 668-673) is counted as fabricated cast iron (col. 4). Before 1878, col. 4 refers to *ghisa lavorata pulita o tornita* and to *ghisa lavorata semplice o guarnita da altri metalli* (counted in the 1860s separately from, or instead of, other *ghisa lavorata*); col. 3 refers instead to *ghisa lavorata non pulita né tornita* and to railway chairs (*cuscinetti*, identified first as *di ghisa* and then as *di ferro*). This grouping is somewhat uncertain, even though it follows the parallel aggregation in the source, and receives some support from the structure of unit values as well (e.g., *Movimento commerciale 1867*, pp. 110-111, *1871*, p. 180, *1877*, p. 225, *1878*, p. 178); in particular, *ghisa lavorata semplice* may well refer to crude, not fabricated, cast iron (suggesting that in the 1860s the larger entries in Table E.03, col. 4 may actually belong partly, or even mainly, in col. 3). Imports of cast iron railway chairs were significant only in the early years (before the flange rail had quite displaced the bull-headed type; Giordano, 1864, p. 94): from 7,000 tons in 1861 and 13,000 tons in 1862, they dropped to 1,000 tons p. a. in 1863 and 1864, 2,000 tons p. a. in 1865 and 1869, and utter insignificance in other years.

The figures in Table E.03, cols. 5 - 8 refer to net imports of wrought iron and steel, disaggregated as in Table E.02, cols. 8 - 11. Balls (*masselli*) and ingots (Table E.03, col. 5) were separately counted from 1878; before that, they were included with iron and steel bars. The *Notizie metallurgiche*, pp. 11, 74, point out that in 1890-95 much ball and ingot metal, broken into small pieces, was imported as scrap (also *Rivista mineraria 1896*, p. 228). The rail import figures (Table E.03, col. 6) are also obtained directly from the source; curiously, the *commercio generale* data yield net imports for 1866 and 1867 well above the *commercio speciale* figures transcribed here (by 3,000 and 6,000 tons, respectively), without an offsetting shortfall in later years. The "sheet, bar ..." figures in Table E.03, col. 7 are obtained by aggregating over all semi-finished metal (in 1913, categories 675-696) other than rails (category 683); they include all wrought iron and steel in bars and rods, wire, sheet, railway cross-ties, pipes, crude (or only minimally processed) forgings or castings, and plate (and also, until 1878, small quantities of iron balls, steel ingots, and "fabricated steel" counted with steel wire). The fabricated metal figures in Table E.03, col. 8 are obtained by aggregating over all other wrought iron and steel products (categories 697-729, 748): steel springs, fireboxes, wire ropes, enamelware, fabricated plate, nails, unspecified fabricated metal (*ferro e acciaio di seconda fabbricazione*), tools and implements, files and rasps, burnished products, pins and needles, and wire mesh. As indicated above, the series in cols. 7 and 8 include some imported plate and exported cans that the *Movimento commerciale* excluded from the *commercio speciale*.

The immediate message of the international trade data summarized in Table E.03, cols. 1 - 8, is that ferrous metal was traded at an almost endless number of points in the production process. The semi-finished metal actually delivered to other sectors of the economy by Italian metalmaking firms may thus have been obtained not only from pig or scrap, but from (imported)

cast iron, wrought iron, and steel intermediates as well. On the other hand, the uncertainty surrounding the initial state of the metal processed by Italian industry is no greater than that surrounding its final state, which includes, beyond rails, anything from simple beams to fine wire or plate; and it may be rather less, as imported and domestic pig iron and scrap clearly far outweighed imports of cast iron, wrought iron, and steel intermediates (the former include Table E.02, col. 1 and Table E.03, cols. 1 and 2, plus domestic scrap; the latter include Table E.03, col. 5 and probably no more than a small part of Table E.03, cols. 3 and 7). In view of this, and of the further difficulties created by unknown inventory fluctuations, weight losses in processing, and the like, there seems little point to estimating different output series for successive points of the production process between the furnace input (pig and scrap) on the one hand and the industry's final product (semi-finished metal) on the other: the production of ferrous metal beyond pig iron is accordingly measured here only once, as if intermediates were not imported at all. As noted above, therefore, the measured output of rails or other semi-finished metal covers, in principle, the full transformation from pig iron or scrap; in practice, measured output is here intended to include semi-finished metal obtained from imported balls and ingots, but not from imported intermediates that could themselves be considered semi-finished (and were thus counted in Table E.03, cols. 3 and 7). This implicit assimilation of imported balls and ingots to pig or scrap seems venial: in the first place, the structure of unit values suggests that the transformation from pig or scrap to ball or ingot is usually relatively unimportant, compared to that from ingot to semi-finished metal; second, imports of balls and ingots (col. 5) appear to have been small and relatively constant in proportion to output; third, part of this already small sum did in fact enter the furnace charge as if it were pig or scrap (*Notizie metallurgiche*, p. 11); and fourth, imported balls and ingots appear to have consisted largely of specialty metal (*Notizie metallurgiche*, pp. 67-68), which presumably received relatively extensive processing beyond the ingot stage. Some other imported intermediates may also have received sufficient further processing (from billet to fine wire, say) to involve a unit value added not far below the average for semi-finished metal (other than rails) obtained from pig or scrap; but in the set of goods counted in Table E.03, cols. 3 and 7 these were surely exceptions. Given the absence of time series information on their actual magnitude, it seems best to exclude them from the output series, in effect letting these imported crude shapes that were processed further by Italian metalmaking firms offset the domestically-produced crude shapes that were sold as such outside the industry (e.g., to construction firms). The estimates of semi-finished wrought iron and steel output, excluding rails, in 1881-1913 will accordingly use the *Movimento commerciale* figures only as a guide to a reasonable allowance for output from imported balls and ingots neglected by the *Rivista mineraria*; the other import data for those years will serve only to estimate consumption levels, and thence the output of cast iron.

The present estimates of semi-finished wrought iron and steel output, excluding rails, in 1881-1913 (Table E.03, col. 12) are obtained by adding the three sets of partial figures (corrections) in Table E.03, cols. 9 - 11 to a first approximation equal to the rounded sum of the processed wrought iron and steel output data, net of balls and ingots and rails (Table E.02, cols. 5 - 6 less cols. 8 - 9).

The "net output of plate" in Table E.03, col. 9 covers the amount to be included in the aggregate estimates in col. 12 that is not already counted in the first approximation. In principle, then, this net output excludes the plate obtained from purchased intermediates, whether foreign (since these are here treated as if they were final products) or domestic (since these are already counted at the point of origin); in 1912 and 1913, moreover, this net output excludes the plate already included, as blackplate, in processed steel. The (gross) output data in Table E.02, col. 7 cover the output of five plate works: the Piombino (Pisa) works eventually of

the Magona d'Italia, active from 1892, and processing purchased intermediates through 1896; the Darfo (Brescia) works eventually of the Ferriere di Voltri, active in 1893-95 and from 1902, apparently always working from imported intermediates; the Savona (Genova) works of the Siderurgica di Savona, active from 1904, and vertically integrated from the start; the Milano works of the Origoni company, which simply plated purchased blackplate and pipes, counted apparently from 1911 but probably active earlier as well (as finishers of Darfo products); and the Cornigliano (Genova) works of the Nasturzio company, active from 1912, and also working from purchased intermediates (*Rivista mineraria 1891*, p. 116, *1894*, p. 208, *1896*, p. 147, *1902*, p. 269, *1904*, p. 151, *1911*, pp. 125, 128, *1912*, pp. 57-58, 133, 135, *1913*, p. 73). Through 1911, accordingly, the net output estimates are simply the rounded sums of the output reported for Piombino from 1897, and Genova from 1904. In 1912, the processed steel data in the national report include 31,800 tons of Piombino blackplate (apparently the input to the 26,000 tons of Piombino tin, terne, and zinc plate counted as plate), but not the (intermediate) blackplate obtained at other works; the net output estimate is thus just an allowance of 3,000 tons for the Savona works (as in 1911; the growth of Genova plate, to 4,625 tons in 1912 and 7,507 tons in 1913, is here attributed to the Nasturzio works). In 1913, finally, the processed steel data in the national report include 50,905 tons of blackplate, apparently the immediate input to all of the reported tin, terne, and zinc plate; net output is accordingly negative, to allow for the (counted) plate obtained from purchased (imported or double-counted) intermediates. Its magnitude is here calculated from the 8,987 tons of tin, terne, and zinc plate reported for Milano and Brescia, plus an estimated 4,507 tons from Genova. All these net output estimates must be considered tentative: even apart from the need to estimate the Nasturzio firm's output in 1912 and 1913, no allowance is made for weight losses in processing, or for fluctuations in the stocks of intermediates (neither of which appears insignificant: *Rivista mineraria 1899*, p. 156, *1900*, p. 155, *1913*, p. 101).

The "net output from (purchased) ingot" in Table E.03, col. 10 refers to the output from purchased ingots (and balls) that is not already counted in the first approximation obtained from Table E.02; as noted above, this is just the output from ingots purchased by small firms neglected by the Corpo delle miniere (their output from intermediates does not create similar problems, since domestic intermediates are already counted at the point of origin, and imported ones are assimilated to the final products of the metalmaking industry). This output is of course extremely difficult to gauge; it is here obtained as the sum of two components, referring to the working of domestic and imported raw material, respectively, and tentatively estimated as follows. In 1912 and 1913, when domestic production of puddled iron was negligible (Table E.02, col. 2) and the processed steel data included all *ferro omogeneo*, the net output of small firms working domestic ingot can be estimated directly. The *Rivista mineraria 1913*, pp. LXX-LXXI, reports that (part of) 940,000 tons of steel ingots (of which 7,000 tons were imported, along with 2,000 tons of iron balls) yielded some 846,000 tons of processed steel, here reduced to 833,000 tons by the elimination of double-counted plate. Semi-finished steel appears to average some 92% of the ingot input (from the ingot/pig and scrap ratio of .90 and the steel products/pig and scrap ratio of .83 obtainable from the input and output figures in the *Rivista mineraria 1913*, pp. LXXI, 173); neglecting inventory movements, the net output of small firms from domestic ingot is estimated, in 1913, at 32,000 tons (92% of 940,000, less 833,000). The *Rivista mineraria 1912*, p. LXXIV, reports that 922,000 tons of steel ingots (of which 4,000 tons were imported) were used for 802,000 tons of processed steel, here increased to 805,000 tons by the inclusion of net plate output. These figures suggest a neglected output from domestic ingot of 43,000 tons in 1912, or about 25% of the reported deliveries of ingot to other firms that appear to be analogous to the ball and ingot figures in Table E.02, col. 8; in the absence of further information, the net output of small firms from domestic ingot is estimated,

in 1895-1911, as 25% of that series. Judging from the Vicenza district figures (which account for the early entries in that series), deliveries of iron balls to other firms amounted to negligible amounts through 1893, and 2,100 tons in 1894; the domestic-ingot net output of small firms is accordingly estimated as *minus* 75% of 2,100 tons in 1894. The second component of the net output figures in Table E.03, col. 10 refers to the working of imported balls and ingots. The *Rivista mineraria 1912* and *1913*, as noted, counted 13,000 tons of such imports, compared to 20,000 tons for those two years (with a rather different time profile) reported by the *Movimento commerciale*. Allowing for imported ingot that was added to the furnace charge rather than used directly, the imported-ingot net output of small firms is here estimated at 25% of the net import figures in Table E.03, col. 5. This percentage is applied from 1881 to 1913, with the following exception: since reported net imports underestimate actual consumption of imported balls and ingots in 1890-95, as noted above, and probably overestimate it in 1896 (as inventories were probably rebuilt after the cut in the tariff on balls and ingots went into effect), the standard 25% coefficient is doubled in 1890-95, and halved in 1896.

The "other net output" figures in Table E.03, col. 11 are the sum of a variety of disparate corrections to the first approximation obtained from the aggregate data in Table E.02, suggested by the detailed local data in the *Rivista mineraria*. As noted above, the present corrections deal only with the more significant discontinuities in the reports' coverage, in the order in which they appear; many small changes involving only a few hundred tons of output are simply ignored.

The first correction adds the output reported for Pisa in 1882 (9,500 tons), as this province was omitted from that year's national summary (*Rivista mineraria 1882*, pp. XXXVI-XXXVIII, 115).

The second correction adds a tentative 15,000 tons to the Genova district output reported in 1884. In the early 1880s, the Genova district reports (filed by L. Mazzuoli, later head of the Corpo delle miniere) were unusually brief and uninformative: output was reported only as a round aggregate (in 1881-87, 35, 37, 50, 40, 65, 70, and 100 thousand tons, respectively), and the accompanying commentary is usually very limited. The suggestion that in 1884 output continued, rather than reversed, the previous year's growth stems from the indication that significant new capacity came on stream in both those years, despite the crisis brought on by German competition through the new St. Gotthard railway tunnel. Subsequent cutbacks and lay-offs -- presented as something of a vindication of the author's predictions -- would actually appear to mark only a partial retrogression; and the subsequent silence on the ostensible 60% growth in 1885 (in contrast to the comment on the 40% growth in 1887) suggests an awareness that it was in fact largely spurious (*Rivista mineraria 1883*, p. 117, *1884*, pp. LXI, 137, *1885*, p. 126, *1887*, p. 120). In broader terms, one notes that the new railway tunnel was inaugurated in May 1882, so that its effects should not have been delayed until 1884; that it would presumably affect the Milano district, where output grew slightly in both 1883 and 1884, more than the Genova district; and that in any case its effects are ambiguous, since it lowered input prices as well as output prices (in fact, the Italian propensity to import semi-finished ferrous metals would appear to be slightly lower after it opened than before, particularly if one allows for the more rapid growth in consumption; the impact of the correction at hand on the propensity to import implied for 1884 is small but appropriate).

The third correction refers to the Udine province figures in the mid-1880s. In 1883-88, the national output reports allow the Udine works 1,665 tons, 7,540 tons, 4,870 tons, 10,285 tons, 12,135 tons, and 5,776 tons, respectively; but the comments and disaggregated data in the district reports make clear that the major year-to-year movements are due to the double-counting of the iron balls produced and consumed within the firm in 1886 (5,220 tons), 1887 (6,370 tons), and most probably in 1884 as well, but not in 1883, 1885, and 1888, or indeed in any subsequent year (*Rivista mineraria 1883*, pp. LIII, LXXV, 327, *1884*, pp. XXVI, 277, *1885*, pp.

XXXI, 269, *1886*, pp. XXXIII, 292, *1887*, pp. XXXII, 362, *1888*, pp. L, 415). The present correction accordingly reduces the reported aggregate figures by the reported ball output in 1886 and 1887, and an estimated 4,000 tons in 1884.

The fourth correction allows for the extension of the Milano district report's coverage, in 1889, to include over 100 more firms, all of them very small shops manufacturing hardware from scrap iron (*Rivista mineraria 1888*, pp. 262-263, *1889*, pp. CLXXX, 250-255). A comparison of the detailed data in the 1888 and 1889 district reports suggests that this extension was negligible for the province of Como, small for that of Bergamo, and considerable for that of Brescia: in 1889 Bergamo is attributed 9 more small shops, producing perhaps half the 400 tons of hardware listed for all small shops in that year (in 1888, the report contains a single iron figure, that apparently includes the output of the large Castro works); Brescia is attributed another 89 small shops, probably producing over 3,000 tons of hardware (out of 6,700 tons listed for all small shops, against 3,300 tons in 1888). Since these firms were engaged in a traditional activity, their output had probably grown only slowly in previous years; in the absence of further evidence, the present correction adds 2,000 tons of output p. a. in 1881-84, and 3,000 tons in 1885-88.

The fifth correction allows for the Milano district reports' neglect of the province of Milano before 1890. The *Rivista mineraria 1890*, pp. 483, 552-553, lists 1,500 tons for the Rogoredo works that shut down in May, having been active since 1886, and 3,500 tons for the Vanzetti plant active since August of 1889. The present correction accordingly adds an estimated 2,000 tons of output in 1886, 4,000 tons p. a. in 1887 and 1888, and 6,000 tons in 1889.

The sixth correction is again related to the small firms in the Milano district. The *Rivista mineraria 1895*, p. 220, notes that the current output figures for those firms is particularly accurate, as some relatively old information was brought up to date. The present correction accordingly replaces the aggregate output figures for the small firms in Bergamo, Brescia, and Como for 1893 (12,178 tons) and 1894 (11,155 tons) by a linear interpolation of those for 1892 (12,100 tons) and 1895 (9,413 tons), for a net reduction of 1,000 tons p. a. in 1893 and 1894 (since 12,720 tons were reported for 1891, the alternative of interpolating between 1891 and 1895 would lead to no correction in 1892, and the same one in 1893 and 1894).

The seventh correction is prompted by the suggestion in the *Rivista mineraria 1897*, p. 328, that part of the increase in the Torino district output figure (from 14,151 tons to 32,279 tons) may be due to more accurate counting. Most of the increase is in the output reported for the province of Novara, that increases from 600 tons from one firm to 12,000 tons from two firms; in the absence of further indications, the present correction allows the Torino district a further 3,000 tons in 1895 and 7,000 tons in 1896.

The eighth and last correction is also related to the small firms in the Milano district, as most of these were dropped from the report's purview in 1902. This exclusion does not appear to be symmetric to the inclusion of many of these same small firms in 1889, however, as in the interim they had transformed themselves from metalmaking works, producing hardware from scrap through ball and semi-finished iron, to purely fabricating works, producing hardware directly from suitable pieces of scrap that served essentially as semi-finished metal (*Rivista mineraria 1902*, p. 269; also *Notizie metallurgiche*, pp. 39-40, and *Annuario 1914*, p. 465). Rather than estimate neglected output to be added to the data from 1902 (Gerschenkron, 1962), then, the present correction seeks to estimate hardware production directly from scrap to be deducted from the data through 1901. In 1896-1902, the small firms in the provinces of Bergamo and Brescia (Como is again ignored: it seems unaffected by the change in coverage, in 1902 as in 1889) are attributed annual outputs of 4,360 tons, 5,475 tons, 8,414 tons, 7,228 tons,

9,543 tons, 8,676 tons, and 1,120 tons, respectively; these last two figures suggest that in 1901 over 7,500 tons, or nearly 90% of the reported output of these small firms, was in fact properly excluded from metalmaking. For 1899 and 1900, comparable figures of 7,450 and 6,210 tons, respectively, are obtainable from the detailed figures in the *Notizie metallurgiche*, p. 40; they agree well with the above figures for those two years if considered together, but not if considered separately (unless one assumes that the reference dates are in fact inverted). In the absence of further information, the relevant technological transformation is here assumed to have occurred over the five years from 1895; the present correction thus excludes 18% of the small firms' reported output in 1896, 36% in 1897, 54% in 1898, 72% in 1899, and 90% in 1900 (as in 1901), for annual reductions in 1896-1901 of 1, 2, 5, 5, 9, and 8 thousand tons, respectively.

As noted, the above eight corrections are the only ones entering Table E.03, col. 11; but a few other candidates for inclusion may be worth mentioning. The Milano district reports add a large firm in 1889 (producing 2,000 tons of metal at Tavernole, near Brescia) and again in 1899 (producing 8,400 tons of metal in Milano), while in 1894 the Roma district reports drop the large firm at Corneto (attributed 3,600 tons in 1893); none of these events is mentioned in the accompanying commentaries, so they may well correspond to changes in coverage rather than to actual production movements. In 1905, again, the Torino district report attributes part of the output increase (from 43,278 tons to 48,111 tons) to better data-gathering (*Rivista mineraria 1905*, p. 428); in view of the rapid output growth during this period, however, the spurious component of this particular increase is here considered negligible.

The output of semi-finished wrought iron and steel, excluding rails, in 1881-1913 (Table E.03, col. 12) is thus estimated from the aggregate data in the *Rivista mineraria* (Table E.02, cols. 5 - 6, 8 - 9) through a set of corrections (Table E.03, cols. 9 - 11) that are themselves based very largely on the reports of the Corpo delle miniere. On the other hand, as noted above, the cast iron output data (Table E.02, col. 4) are too weak to serve as the basis for acceptable estimates, and the latter must be obtained indirectly. Since cast iron and wrought iron or steel have different properties that often make it profitable to use them together, either in the small (as in different parts of an individual machine, depending on the stresses they are to bear) or in the large (as construction uses beams of wrought iron and steel, and columns and pipes of cast iron), it seems reasonable to assume a relationship of complementarity, and estimate cast iron consumption from that of wrought iron and steel. In principle, the ratio of cast iron to wrought iron and steel should be separately estimated for each product sub-group and time period; but the available information allows only the crudest approximation to this ideal. The product mix is here simply divided to distinguish rails (attributed a zero cast-iron complement, after the passing of the chaired rail) from all other wrought iron and steel; and the cast-iron complement to this broad residual is itself estimated at only two points in time.

A late estimate is obtained from the *Rivista mineraria 1913*, pp. LXX-LXXI, according to which some 482,000 tons of pig iron were converted into steel (and none into puddled iron); given that current pig iron output and net imports summed to 648,000 tons, some 166,000 tons of pig iron were left over for use as cast iron. The Terni foundry input and output data (*Rivista mineraria 1913*, p. 173) suggest that cast iron production equaled 96% of the pig iron input (which was stretched by the addition of scrap); this ratio yields a national cast iron output estimate of 159,000 tons. Omitting machinery and other ferrous-metal products whose composition cannot be known, identifiable consumption in 1913 is thus estimated at 176,000 tons of cast iron, including 17,000 tons of crude and fabricated cast iron imports, (Table E.03, cols. 3 and 4). The comparable estimate of the identifiable consumption of semi-finished wrought iron and steel excluding rails equals 1,086,000 tons, that is, an estimated 836,000 tons produced domestically (Table E.03, col. 12), plus a net 172,000 tons imported as such (Table

E.03, col. 7), plus the equivalent of another net 78,000 tons imported as fabricated metal (the 58,000 tons in Table E.03, col. 8, times 1.35, as estimated in section F04.02 below); the resulting ratio is .162 tons of the cast iron per ton of wrought iron and steel.

An early estimate is obtained for 1862, using output data provided by Giordano (1864). The algorithm is somewhat complex, as those data cover only the supply of wrought and cast iron from pig iron, and wrought iron was also obtained from scrap. The supply of worn rails can be estimated from the growth of the railway net, but the residual supply of domestic scrap has to be estimated indirectly. In essence, the estimate assumes that the ratio *R* of cast iron to wrought iron and steel in identifiable consumption followed a smooth path from 1862 to 1913, and that the supply of non-rail scrap (dominated, presumably, by worn agricultural implements) grew slowly over time. On these assumptions, *R* is pinned down by the iron-and-steel output data for the early 1880s. Given the direct estimate of *R* in 1913, indeed, any value assigned to *R* in 1862 determines *R*, and therefore cast-iron consumption and output, in the early 1880s. Since iron and steel output is then known, that estimate implies a total supply of raw materials, and therefore a supply of domestic scrap in the 1880s. The latter in turn implies a supply of domestic scrap in 1862, and therefore a production of iron-from-scrap, that itself returns a value of *R*. The higher the initial estimate of *R* in 1862, the higher the estimated supply of *cast* iron in the 1880s, scrap in the 1880s, scrap in 1862, and *wrought* iron in 1862: the lower, therefore, the implied value of *R* in 1862. And vice versa; the logically consistent estimate of *R* in 1862 is the unique value that (with the given assumptions, and the available information) just returns itself.

The output figures in Giordano (1864) are not dated, but the pig iron output and export figures (29,000 and 2,000 tons, respectively) both seem appropriate only to 1862 (Table E.02, col. 1; *Movimento commerciale 1861-1864*). In fact, pig iron production in 1862 appears to have been 28,000 tons within Italy's then current borders, with the residual 1,000 tons coming from the Tolfa works in the Papal States (*Notizie minerarie*, p. 125; the discussion and figures in Giordano, 1864, p. 3 appear somewhat ambiguous on this point). Deducting exports, this pig iron appears to have yielded some 3,500 tons of castings (as reported) and perhaps 17,500 tons of semi-finished wrought iron and steel (allowing 1.12 tons of pig iron per ton of cast iron and 1.25 tons of pig iron per ton of semi-finished wrought iron and steel, and implying a reasonable 1.13 tons of semi-finished metal per ton of bar or crudely fabricated wrought iron and steel, as reported; Giordano, 1864, pp. 3, 40, 62, 90, 110, 190 ff., 201, 247, 341, 410). Imported pig iron (actually just over 22,500 tons) yielded perhaps 5,000 tons of semi-finished wrought iron and steel (again, 1.13 times the reported amount of bar and fabricated iron), leaving a residual equal to (22,500 − 1.25(5,000))/1.12), or approximately 14,500, tons of castings. Adding 500 tons of iron from Catalan furnaces, one obtains a total output (within Italy's then current borders) of 18,000 tons of castings and 23,000 tons of semi-finished wrought iron and steel newly obtained from pig iron (and ore).

The corresponding imports (Table E.03) are some 4,000 tons of crude and fabricated cast iron (excluding 13,000 tons of railway chairs) and 51,000 tons of semi-finished metal (43,000 as such, plus 6,000 tons of fabricated metal again times 1.35). Added to output, these yield an identifiable consumption of 22,000 tons of cast iron (excluding railway chairs) and 74,000 tons of semi-finished wrought iron and steel excluding rails, or .297 tons of the former per ton of the latter; but this is only an upper bound to *R*, as the (busheled) wrought iron produced from scrap has yet to be considered.

Scrap is here divided into four categories: foreign scrap; domestic scrap rails; domestic works scrap; and other domestic scrap. Data exist for the first of these; they suggest that some 2,000 tons of foreign scrap were imported in 1862 (Table E.03, col. 2).

The estimated supply of worn rails is transcribed in Table E.3, col. 14. Giordano (1864), p. 98, allows rails a twenty-year life, with medium traffic levels, and assumes that in a

mature system 5% of the net would be replaced each year. The Italian system was then rapidly growing, and traffic levels would appear to have been relatively light; the present estimates accordingly allow a twenty-five-year average life, and assume that the quantity of worn rails removed in year *t* was (proportional to) one ninth of the rails newly installed in the nine years from (*t* − 29) to (*t* − 21). The rails newly installed each year are themselves assumed proportional to the newly opened length of the lines, obtained simply as the first differences in the year-end length of the railway net reported in the *Sommario*, p. 137. In 1861-65, some 103,000 tons of rails were imported (Table E.03, col. 6), and some 2,200 kilometers of rail lines were built, including some 200 kilometers in regions not yet part of the Kingdom (*Relazione S.F.I. 1899*, pp. 64 ff.); allowing for these, and for wear, the supply of worn rails is estimated at a round 50 tons per (relevant) kilometer. In practice, therefore, the estimates in Table E.03, col. 14 in year *t* are the difference between the *Sommario* railway-net kilometers in (*t* − 21) and (*t* − 30), times (50/9) tons per kilometer. In 1862, no more a hundred tons or so of scrap rails would appear to have come on the market.

Works scrap -- the odds and ends left over as metal is processed -- may have averaged 10% of the metal produced, half of it obtained as it was worked to the semi-finished stage, and half in its subsequent fabrication (Giordano, 1864, pp. 40, 90, 110, 112); summing 10% of the estimated domestic output of new semi-finished wrought iron and steel and 5% of the reported imports of semi-finished metal (other than rails; Table E.03, col. 7), works scrap is here estimated at approximately 4,000 tons in 1862.

The supply of other domestic scrap is estimated with the twin auxiliary assumptions noted above, and the evidence on wrought iron and steel production in the early 1880s. First, that supply is assumed to have grown at an even 1% per year, or approximately 1.5 times the rate of demographic growth. Second, *R* is presumed to have fallen over time, in view of the decline in the relative price of steel; and since the latter decline took place as a result of technical innovations that date from the very beginning of the period at hand, it is further presumed that the relative consumption of cast iron declined rather faster through the 1860s and 1870s than in later decades. The present estimates of the ratio of cast iron to semi-finished wrought iron and steel in identifiable consumption (net of rails and railway chairs) in 1862 and 1913 are accordingly interpolated by the quadratic function

$$(1) \qquad R_t = R_{1913} + b(1913 - t)^2 ,$$

where *R* is the ratio to be estimated, *t* is the date, R_{1913} equals .162, and *b* is the coefficient that yields the appropriate R_{1862}.

Third, in 1881-85, one obtains five-year totals equal to 632,000 tons of wrought iron and steel (Table E.03, cols. 12), and an unknown quantity *x* of castings; using the input/output ratios (1.25 and 1.12, respectively) derived above from Giordano (1864), the corresponding aggregate input works out to 1.25 times 632,000, or 790,000, plus 1.12 times *x* tons of pig and scrap (and imported balls and ingots). The corresponding totals, on the input side, equal some 111,000 tons of domestic pig iron (Table E.02, col. 1); 277,000 tons of imported pig iron (Table E.03, col. 1); 362,000 tons of imported scrap (Table E.03, col. 2); 32,000 tons of imported balls and ingots (Table E.03, col. 5); 64,000 tons of domestic scrap rails (Table E.03, col. 14); 27,000 tons of works scrap from imported metal (5% of Table E.03, col. 7); and 63,000 tons of works scrap from domestic metal (10% of Table E.03, col. 12). These sum to 936,000 tons; other domestic scrap *y* is accordingly estimated as the residual input into total output, or (790,000 + 1.12*x*) − 936,000. In 1881-85, again, the equivalent imports of wrought iron and steel (Table E.03, col. 7, plus 1.35 times col. 8) equal 690,000 tons, and those of cast iron (Table E.03, cols. 3 - 4) equal 75,000 tons; the ratio *R* in 1883 is accordingly estimated, from these quinquennial

figures, as (x + 75,000)/(632,000 + 690,000).

In 1862, allowing for growth at 1% per year, the supply of other domestic scrap is estimated as 81% of one fifth of y, or .162y, within the borders of 1871. Within the then Kingdom, allowing for the population of Venetia and Latium (*Sommario*, p. 39), it may have been 87% of that, or .141y. Total scrap consumption in 1862 thus equals the 6,000 tons estimated above, plus .141y; allowing for net weight losses, the corresponding product in semi-finished wrought iron equals perhaps 93% of that. In 1862, therefore, R equals 22,000/(74,000 + .93(6,000 + .141y)).

Recapitulating and simplifying, within rounding error

(2) $y = 1.12x - 146{,}000$

(3) $R_{1862} = 22{,}000/(79{,}600 + .131y)$

(4) $R_{1883} = (x + 75{,}000)/1{,}322{,}000$

implying that x and y move together, but with opposite effects on R in 1862 and in 1883; the further constraint imposed by equation (1) above yields a unique solution. Rounding off, the solution corresponds to R = .253 in 1862; equation (1) then yields b (near .000035), and the full time series for R.

The estimates of cast iron production in 1881-1913 (Table E.03, col. 13) are accordingly obtained by taking the output estimates for semi-finished wrought iron and steel excluding rails (col. 12); adding the corresponding net imports (col. 7, plus 1.35 times col. 8) to estimate the corresponding identifiable consumption; multiplying the latter by the corresponding ratio R to estimate identifiable consumption of cast iron; and then deducting net imports of crude and fabricated cast iron (cols. 3 - 4). The time path of the resulting output estimates, and their relationship to the partial data in Table E.02, col. 4, are both reassuringly reasonable. So is the estimated supply of non-works domestic scrap: the implied y is near 56,000 tons, or well under half a kilogram per capita in the early 1880s.

For what it may be worth, moreover, the *Notizie minerarie*, pp. 26-27, report average output in 1875-79 as 46,000 tons of bar and fabricated wrought iron and steel (equivalent to perhaps 52,000 tons of semi-finished metal); castings were obtained from about 20% of domestic pig output (which averaged 16,000 tons in 1875-79) and almost all of the imported pig (which averaged 23,000 tons in 1875-79), for an implied average output of about 23,500 tons of castings. Adding average net imports (about 5,500 tons of castings and 80,500 tons of semi-finished wrought iron and steel excluding rails, of which 14,500 tons as the equivalent of 11,000 tons of fabricated metal), one obtains an identifiable consumption of 29,000 tons of cast iron and 132,500 tons of wrought iron and steel, or .219 tons of the former per ton of the latter. With the corresponding estimates obtained from equation (1) near .213 in 1875 and .202 in 1879, these *Notizie minerarie* figures provide some support to the present quadratic extrapolation; however, since the output figures appear badly underestimated (see below), they only support the present estimates to the extent that the Corpo delle miniere actually estimated output on the basis of the import data and a similar consumption ratio, which is thereby seen to be reasonable for the period in question.

In 1861-80, the output estimates for non-rail semi-finished wrought iron and steel (Table E.03, col. 12) and cast iron (col. 13) are obtained on the basis of aggregate availabilities of pig and scrap, and an otherwise similar logic.

Import figures for pig, scrap and ingot metal are available in the sources (Table E.03, cols. 1, 2, and 5); these of course refer to the Kingdom, and exclude Latium and Venetia in the

early years. Venetia's trade in 1861-65 is documented in Glazier (1966, pp. 191, 203). The reported figures point to annual net imports of pig and scrap near 1,500 tons in 1861, 1,000 tons in 1862-63, and 500 tons in 1864-65; other net imports appear to have been negligible, save for some 1,000 tons of ingot and other metal in 1861. For the Papal States, the trade statistics in Bonelli (1961, pp. 191, 195) end in the late 1850s; the latest figures point to annual net imports near 4-5,000 tons of pig and scrap, 2-3,000 tons of plate, and under 1,000 tons of fabricated metal. Total net imports of pig and scrap at constant borders are here tentatively estimated as the sum of Table E.03, cols. 1, 2 and 5, plus an annual 6,500 tons in 1861, 5,500 tons in 1862-63, 5,000 tons in 1864-66, and 4,500 tons in 1867-70.

Works scrap from the processing of imported metal is again calculated as 5% of imported semi-finished wrought iron and steel excluding rails, including the reported amount for the Kingdom (Table E.03, col. 7) and a further 3,000 tons annually in 1861-70 to allow for Latium (and Venetia).

Other figures already refer to Italy at constant borders. Pig iron production is reported (Table E.02, col. 1). The supply of domestic scrap rails is estimated above (Table E.03, col. 14). So too, implicitly, is the supply of other non-works scrap metal: assigning one fifth of calculated y (56,124 tons) to 1883 and extrapolating at the assumed 1% annual growth rate, one obtains rounded annual totals equal to 9,000 tons in 1861-66, 10,000 in 1867-76, and 11,000 in 1877-83.

The rounded sums of these figures from 1861 to 1881 are transcribed in Table E.03, col. 15. They do not include the works scrap from the production and processing of domestic semi-finished metal (including that obtained from scrap); but this is allowed for in the aggregate input/output ratio, here estimated at (150/132) from the ratio of col. 15 to the sum of cols. 12 and 13 in 1881.

The sum of cols. 12 and 13 is accordingly estimated simply as col. 15, divided by (150/132). Total consumption (net of rails and railway chairs) is estimated as that sum, plus net cast iron imports (Table E.03, cols. 3 and 4, less the railway chairs indicated above; those of Latium and Venetia are presumed negligible), plus equivalent wrought iron and steel imports (Table E.03, col. 7, plus 1.35 times col. 8, plus 4,000 tons annually in 1861-70 for the two together to allow for Latium and Venetia). The output of wrought iron and steel (Table E.03, col. 12) is then estimated as $1/(1 + R)$ times total consumption, less the corresponding net imports (Table E.03, col. 7 plus 1.35 times col. 8 plus 4,000 tons annually in 1861-70); that of cast iron (Table E.03, col. 13) is analogously estimated as $R/(1 + R)$ times total consumption less the corresponding net imports (Table E.03, cols. 3 and 4, net of railway chairs).

E02.04 Value added and employment

Value added in the production of pig iron, cast iron, rails, and other semi-finished ferrous metal in 1911 is estimated from output values and input costs.

The average value of pig iron reported by the *Rivista mineraria 1911*, pp. XXX-XXXII, is near 93 lire per ton; but this average results from a figure of 90 lire per ton applied to the large-scale producers, and a figure of 205 lire per ton applied only to the few thousand tons produced in Bergamo. On the assumption that the latter reflects further processing, pig iron proper is here attributed a unit value of 90 lire per ton.

The average value of cast iron reported by the *Rivista mineraria 1911*, pp. XXX-XXXII, is near 250 lire per ton. Local averages range from 204 to 264 lire per ton, with a single outlier at 630 lire per ton (Firenze, possibly producing the artistic castings mentioned on p. LVIII); since the data are in any case very partial, the overall average is here accepted as representative.

The average value of domestic rails is not reported in 1911; it is here estimated at 170 lire per ton, as suggested by the 180 lire per ton reported in the *Rivista mineraria 1909*, pp. 117,

169, and the decline in the *Movimento commerciale* valuation of imported rails, net of the 60 lire unit tariff, from 160 lire per ton in 1909 to 150 lire per ton in 1911 (the *Rivista mineraria* value in 1909 is less than the reported world price plus tariff, presumably because it is a price at the factory, and the domestic product was burdened by higher domestic transport charges than the imported material available anywhere along the coast).

An average value for other semi-finished wrought iron and steel is again reconstructed from the detailed data in the *Rivista mineraria 1911*, pp. XXX-XXXII, LVIII. Iron output is reported at 303,223 tons, with a total value of 59.27 million lire; only small quantities appear to have been unprocessed balls, or final products (agricultural implements). Steel output, net of plate, is reported at 697,958 tons worth 148.82 million lire. Of that, 107,431 tons were rails, here valued at 18.26 million lire; another 160,777 tons were ingot steel, here valued at 130 lire per ton (the lowest reported figure, for the province of Livorno), or 20.90 million lire in all, for a net figure of 429,750 tons worth 109.66 million lire. Adding the 37,000 tons of net plate output estimated above (Table E.03, col. 9), and valuing it all at the 345.44 lire per ton reported for blackplate, or 12.78 million lire, one obtains totals of 769,973 tons and 181.71 million lire, for an average value of some 236 lire per ton.

Power costs are estimated, very roughly, from the census horsepower-in-use figures. In category 4.1, the *Censimento industriale* reports 106,211 unduplicated horsepower, of which 21,931 hydraulic, and 35,701 total workers, against a labor force of 41,942 reported by the *Censimento demografico* (which includes workers in integrated shops counted by the industrial census in category 4.ω1; Table E.01). Since production was at an all-time peak actual employment may be estimated at 97% of the labor force, or 1.14 times the industrial-census figure; this suggests that total non-hydraulic horsepower in use was near 1.14(106,211 − 21,931), or approximately 96,100. Allowing the standard 43 lire per thousand horsepower-hours, and assuming an average annual use of 4,500 hours, the total power bill is estimated at some 18.6 million lire. This total was incurred in the production of some 303,000 tons of pig iron, 145,000 tons of cast iron, 107,000 tons of rails, and 813,000 tons of other metal; plausible relative power intensities equal to .75 for pig iron, .30 for cast iron, .85 for rails, and 1.00 for the residual yield a weighted output of some 1,175,000 tons, implying power costs per ton near 12 lire for pig iron, 5 lire for cast iron, 14 lire for rails, and 16 for other semi-finished iron and steel.

In the case of pig iron, other unit inputs included some 2 tons of 53% iron ore, .95 tons of coke, and half a ton of limestone (Austin, 1926, p. 310; *Enciclopedia italiana*, vol. 15, p. 83; *Rivista mineraria 1911*, p. XVIII), costing perhaps 38, 31, and 1 lire, respectively, at the unit values in the *Rivista mineraria 1911* (pp. XVIII, XLII, LXXX-LXXXI). With the power costs estimated above these materials costs sum to 82 lire per ton of output; value added works out to 8 lire per ton of output, or 2.4 million lire in all. This figure is near 9% of the value of output; this ratio dovetails with the contemporary American figure near 22% (*U.S. 13th Census VIII*, p. 512), as materials were there significantly cheaper, and labor more expensive, than in Italy.

The inputs consumed to produce semi-finished iron and steel other than rails are estimated from the technical data in the *Enciclopedia italiana*, vol. 15, pp. 93-94, adjusted to allow for processing beyond the ingot stage. These suggest that a ton of output absorbed some 1.2 tons of pig or scrap (worth perhaps 112 lire, including a small allowance for transport costs), .4 tons of coal (worth perhaps 12 lire, allowing 27 lire per ton of New Pelton on the coast and again including domestic transport costs). A further 6 lire are attributed to ferro-alloys, based on a total cost of some .5 million lire for domestic ferro-silicon (*Rivista mineraria 1911*, p. XXXII), and another 4.5 million for some 9,000 tons of imports (*Notizie metallurgiche*, p. 57), at the unit value near 500 lire per ton suggested by the *Movimento commerciale*). Adding the above power costs, estimated materials costs total 146 lire per ton of output; value added works

out to 90 lire per ton, or 73.2 million lire in all.

The production of rails involved relatively little fabrication, and the corresponding unit inputs are correspondingly scaled down from the preceding estimates. Pig and scrap are allowed 100 lire per ton of output, and coal 8 lire (reflecting both reduced input/output ratios and a lower unit prices, as rail production was predominantly coastal); adding 14 lire allowed for power costs, these sum to 122 lire. Value added works out to 48 lire per ton, or approximately 5.2 million lire in all.

Cast iron, finally, is taken to have consumed pig iron again worth 112 lire (with higher transport costs to inland locations offsetting the lower input/output ratio), coal worth perhaps another 6 lire (again assuming a lower input/output ratio, partly offset by a higher local price), and, at a guess, another 7 lire for the materials consumed by the molds. Adding the above estimate of power costs one obtains a total of 130 lire per ton of output; value added works out to 120 lire per ton, or 17.4 million lire in all.

These estimates sum to 98.2 million lire. The *Rivista mineraria 1911* counts only some 40,000 tons of cast iron, against an estimated total of 145,000 tons; the omitted 105,000 tons correspond to a value added of some 12.6 million lire, implying that the Corpo delle miniere figures cover some 87% of the industry. The Corpo delle miniere counted near 32,600 blue-collar workers, excluding an estimated 1,000 in the coking plants (Table E.01 and section D12.03), against a total employment, estimated as 97% of the blue-collar labor force counted by the *Censimento demografico*, near 37,500 (Table E.01); the implied coverage is again 87%.

Allowing an annual wage of 1,200 lire for the nearly all adult male labor force (from the 4 lire per day suggested by the metalmaking and metalworking rates in the *Annuario 1911*, pp. 222-224, *1913*, p. 268), the usual average annual salary (2,000 lire), and the 8% ratio of white-collar to blue-collar employment obtained from the *Censimento industriale* (Table E.01), each of the estimated 37,500 blue-collar workers is attributed a wage-and-salary cost of 1,360 lire, for a total of 51.0 million lire. The residual 47.2 million lire are attributed to capital costs; allowing some 121,000 total horsepower in use (1.14 times the census total for category 4.11, as above), capital costs work out to some 390 lire per horsepower in use.

In the part of the industry covered by the Corpo delle miniere the estimated 32,600 blue-collar workers would similarly correspond to some 44.3 million lire; the estimated value added of (98.2 − 12.6) million lire leaves a residual 41.3 million for capital costs. The corresponding installed horsepower are the reported 162,100, less the 2,300 allowed the coking plants (Table E.01 and section D12.03), implying capital costs just under 260 lire per installed horsepower.

E03. Non-ferrous metals

E03.01 Introduction

The production and initial fabrication of non-ferrous metals (*classe* 4.2) is here represented by separate series for ingot aluminum, semi-finished aluminum, antimony, ingot copper, semi-finished copper and copper alloys, gold, silver, ingot lead, semi-finished lead and lead alloys, mercury, semi-finished tin, and semi-finished zinc. The inclusion of mercury in this industry group conforms to Italian practice, as manifested for instance in the *Reddito nazionale*, p. 83, and in the *Rivista mineraria* (and therefore, in all probability, in the 1911 censuses as well, though no census category is explicitly said to include mercury); it departs instead from the *ISIC*, which considers mercury an industrial chemical rather than a metal.

As noted in section E01.01 above, the series for ingot metal are completions and corrections of the output data provided by the Corpo delle miniere, as is the semi-fabricated copper and copper alloys series from the late 1880s. All the other estimates of semi-fabricated metal output are instead based on input availabilities, calculated as estimated ingot production, plus net imports of ingot and scrap (smoothed, to allow for offsetting fluctuations in inventories or domestic scrap), less estimated consumption for other purposes (chemicals, alloys and plate); the average contribution of domestic scrap and the (largely offsetting) average waste in fabrication are both neglected (as is the early trade of Latium and Venetia). These estimates of semi-finished metal output, obtained from indirect evidence through a sequence of uncertain adjustments, are obviously tentative; but so too, for different reasons, are most of the ingot output estimates obtained relatively directly from the available data. The allowances for neglected output, often significant in early years, are uncertain; at best, they are estimated on the basis of the relevant disaggregated figures for ore output or value (depending on the apparent relative stability of the ore's unit metal content on the one hand, and the metal's unit value on the other) provided by the *Notizie minerarie*. The more important source of difficulty, however, is rooted in technology: most non-ferrous metal is produced not in a single fusion of the ore, but through a complex sequence of (sometimes alternative or optional) separate treatments, and the intermediate products are readily bought and sold. As a result, the available aggregates are often clouded by heterogeneity and double-counting; but at the same time the disaggregated data are not so rich as to allow a detailed reconstruction of production by narrowly defined stages and techniques. In the circumstances, the present series attempt only to reduce the aggregate's heterogeneity by measuring the unduplicated flow through the central stages of the process (to the exclusion, e.g., of refined ingot metal obtained from purchased crude ingot metal or scrap); but the relevant criteria are at times relatively arbitrary. The representation of the entire transformation from ore to ingot metal by a single series remains a serious simplification, and the corresponding output estimates are relatively weak indices of real value added.

E03.02 Aluminum

In Italy, aluminum was obtained from bauxite in a single plant at Bussi (Aquila) that came on stream in 1907 (Molinari, 1920, p. 730; *Rivista mineraria 1906*, p. 385, *1907*, p. 417). Its output was reported by the Corpo delle miniere (Table E.04, col. 1); the average value of this product (1,550 lire per ton in 1911, equal to the unit value of ingot aluminum reported by the *Movimento commerciale*) confirms that it was not fabricated beyond the ingot stage. Some aluminum was also reclaimed from scrap; but the quantities involved appear to have been negligible (the *Rivista mineraria 1902*, p. XXVII, reports less than 300 kg; none were reported in other years).

In the absence of output figures for semi-finished aluminum and aluminum alloys (with only trivial exceptions: *Rivista mineraria 1909*, p. XXX, *1910*, p. XXXVI), their production is

here estimated as the sum of ingot output and net imports (Table E.04, cols. 2 and 3). International trade in ingot aluminum (including its iron and copper alloys) was separately recorded in the *Movimento commerciale* only from 1901; but imports in earlier years would appear to have been negligible.

The 798 tons of aluminum ingot produced in 1911, worth 1,550 lire each, were obtained from 5,288 tons of bauxite (*Rivista mineraria 1911*, p. 151). Bauxite is attributed a value of 11.20 lire per ton; but transport costs from the mine in Lecce dei Marsi to Bussi (*Rivista mineraria 1906*, p. 388) probably raised its delivered value to perhaps 20 lire per ton, or 133 lire per ton of aluminum. Power was purchased from the Bussi electrochemical works' hydroelectric plant; at 17 lire per 1,000 kilowatt hours (above, section D10.01) and an average 26,000 kilowatt hours per ton of aluminum (Molinari, 1920, p. 725), unit power costs appear close to 442 lire. Other unit inputs included about 7 tons of coal, 600 kg of electrodes, and 100 kg of cryolite (*Grande dizionario enciclopedico*, vol. 1, p. 395); these were worth perhaps 245 (New Pelton), 315 (*elettro-carbonium*), and (at a guess) 15 lire, respectively, for aggregate materials and fuel costs of about 1,150 lire. Value added is accordingly estimated at 400 lire per ton, or 319,000 lire for 798 tons. The corresponding blue-collar employment is reported at 278 adult males, working with 5,250 electric horsepower. Value added at 1911 prices thus appears to have covered little more than current labor costs; the implied near-zero capacity rental value is probably best understood in terms of the unusually low output values current in that year (just 70% of the unweighted average for 1907-13).

Value added in the initial fabrication of aluminum is estimated from the unit values reported in the *Movimento commerciale*. These indicate that a ton of aluminum sheet, bar, and wire was worth some 800 lire more than a ton of ingot; allowing 12% of that difference for waste, fuel, and other deductible expenses, value added is estimated at 700 lire per ton, or 503,000 lire for 718 tons.

Aggregate value added in the production and initial fabrication of aluminum in 1911 is accordingly estimated at .8 million lire; of that, .3 million were in activity covered by the Corpo delle miniere.

E03.03 Antimony

Antimony metal (regulus) was recovered from the ore in a variety of ways (Hayward, 1952, pp. 351-361; Molinari, 1920, pp. 426-427). The traditional method began by liquating the ore to separate the antimony sulfide (crudum); the latter was then roasted into (stable) oxide, mixed with sodium carbonate, and reduced to metal. A little oxide was obtained with the liquated sulfide, and a little sulfide was obtained with the regulus. The French method roasted the ore directly into (volatile) oxide, which was then reduced in a reverberatory furnace; and the English process obtained impure metal directly from the ore by decomposing the antimony sulfide with iron. This complex technology is mirrored by the available data, which refer to a variety of intermediate products and by-products as well as to regulus; a satisfactory output series is correspondingly difficult to construct, and even a good output series will be a poor index of real value added.

Caltanissetta district output data are reported for 1878 in the *Notizie minerarie*, p. 353, and sporadically for later years in the *Rivista mineraria* (e.g., *1882*, p. 96, *1887*, p. 54, *1894*, p. 42, *1904*, p. 57). These are transcribed as the reported figures (1878, 1882, 1886-87, 1889-90, 1894, 1901-08) in Table E.05, col. 1 (with one exception: 40 tons of sulfide are reported in the *Rivista mineraria 1883*, p. 71; but this output is tied to an ore figure of 200 tons, well below the 573 tons reported -- perhaps as a correction -- in the output tables). As noted, this output is sometimes referred to as sulfide (crudum), and sometimes as regulus; the distinction does not appear to be very significant in this particular case, as the "regulus" itself was obtained from the

ore through a single liquation (*Rivista mineraria 1899*, p. 97, *1904*, pp. 57, 93). The evidence suggests that the ore was liquated, with or without iron, to obtain a crude product (regulus or sulfide) that would require further processing; because this product was sold abroad (*Rivista mineraria 1904*, p. 93), however, it can here be considered a final product.

The antimony ore obtained in the Caltanissetta district appears to have been processed in other years as well (e.g., *Rivista mineraria 1885*, p. 64, *1899*, p. 97); the corresponding output is here roughly estimated on the basis of ore production (Table B.07, col. 3). The 1866-77 estimates in Table E.05, col. 1 are 35% of the corresponding ore output, as in 1878; the 1879-81, 1883-85, and 1888 estimates are 25% of the ore figure, against 20% in 1882 and 1889 and 28% in 1887; and the 1891-93 and 1896-1900 estimates are 40% of the ore figure, as in 1890, 1894, and 1901 (the 1895 estimate is that year's "ore" figure, which apparently refers to the liquated product: see above, section B02.06).

The Firenze district output data, reported in the *Notizie minerarie*, p. 290, and the *Rivista mineraria 1880* ff. (e.g., *1880*, p. 109, *1890*, p. 303, *1900*, p. 187, *1909*, p. 171), are transcribed in Table E.05, cols. 2 - 4. The early figures refer to a foundry near Porto Santo Stefano (Grosseto) that worked local ores, and closed in 1862. The 1880-92 figures refer to the output of the foundry at Ponte a Rosaio (Siena), obtained from both local (Rosia) and Sardinian ores and sulfide (crudum); these works moved to Livorno in 1893, and were active there apparently through 1904, producing regulus and some sulfide (Table E.05, cols. 2 - 3). The oxide output reported from 1899 (col. 4) was obtained at Rosia (Siena); it was apparently reduced to metal in Livorno (along with Sardinian crudum), though some may have been used as a pigment (Molinari, 1920, p. 431; *Rivista mineraria 1900*, pp. 187, 202, *1902*, p. 195). From 1905, this oxide appears to have been reduced to metal near Siena (possibly at Rosia); and new works, also based on the French process, were set up near Grosseto (*Rivista mineraria 1906*, pp. 192 ff., 201).

The Iglesias district data (Table E.05, cols. 5 - 7, are perhaps the best documented. From 1883 through 1900, the foundry at Su Suergiu (Cagliari) produced crudum (and the by-product oxide) by the traditional method; from 1901, it roasted poorer ores for oxide (*Rivista mineraria 1883*, p. LXXVIII, *1902*, p. 230). These intermediates were sent to the Tuscan foundries (which belonged to the same company) for final working through 1906; in 1907 and 1908, and again in 1913, the oxides (but not, apparently, the sulfide) were reduced to metal on site (e.g., *Rivista mineraria 1885*, p. 174, *1907*, p. 277).

The Corpo delle miniere reported aggregate output data annually from 1889; the *Rivista mineraria 1899*, p. XCIII, brings this series back to 1880. This series coincides with the sum of the Firenze district figures (Table E.05, cols. 2 - 4) from 1880 through 1900 (except for 1890-91, when it excludes the sulfide); in 1901-06, it includes the Caltanissetta district data (col. 1) as well. Up to that point, the Iglesias figures were excluded to avoid double counting; but from 1907 the aggregate data are the simple sum of all the local data (Table E.05, cols. 1 - 7).

The present aggregate series (Table E.05, col. 8) is rather differently conceived. It would no doubt be best to obtain separate series for the two principal stages of production (from ore to crudum, oxide, and probably Sicilian "regulus" on the one hand, and from crudum and oxide to regulus on the other); but these cannot be usefully distinguished in the absence of independent evidence on the production of intermediates in the Firenze district. Even short of this, however, the single aggregate series in the sources can be improved by the inclusion of neglected final output and the exclusion of double-counted intermediates. The present series is accordingly obtained as the sum of the Caltanissetta district output (col. 1), Firenze district regulus (col. 2; the figures for 1901-04 are reduced by 10% to allow for the by-product sulfide, those for 1905-07 by 60% to allow for double-counted oxide), and Iglesias district regulus (col.

5; these late mineralworking figures appear to refer to calendar year production: *Rivista mineraria 1913*, pp. XLVI, 131). The by-product sulfide obtained with regulus is excluded from this series, mainly because even the Firenze district sulfide figures at times appear to include some crudum as well (e.g., *Rivista mineraria 1884*, p. 113).

Antimony metal is not used alone: it serves to harden other metals, especially lead, with which it is alloyed. The working of antimony is accordingly subsumed under that of lead and its alloys (section E02.05), and is not considered here.

Value added in the production of antimony regulus, at 1911 prices, is difficult to estimate, not least because none was produced in that year. Cianci (1933) reports antimony regulus at 91 lire per quintal in 1909, when the output reported by the *Rivista mineraria* was valued at 750 lire per ton, and 93 lire per quintal in 1911; this suggests a *Rivista mineraria*-basis price of about 765 lire per ton in 1911. The Iglesias ore produced in that year, containing 15% antimony, was worth 33.44 lire per ton. Allowing 8.5 tons of ore (for a yield close to 80%), 1.3 tons of charcoal (at 122 lire per ton), .5 tons of coke (at 40 lire per ton), and .5 tons of soda ash (at 120 lire per ton) per ton of output (compare Hayward, 1952, pp. 354-358), direct materials and fuel costs are estimated at 523 lire per ton of output; with a small allowance for other costs (power costs for the ancillary equipment, etc.: *Rivista mineraria 1913*, pp. 131-133), value added is here estimated at 230 lire per ton of output. This yields a peak estimate of just 191,000 lire in 1901; it is compatible with the aggregate employment of 136 *operai* and 99 horsepower reported in the *Rivista mineraria 1901*, pp. 63, 191, 236, on the plausible assumption of a relatively short work year (compare in particular the Siena oxide output value and employment data and the corresponding ore value figure, pp. 187, 189).

E03.04 Copper and its alloys

The production of copper and its alloys is taken to cover the production of ingot copper from ore, on the one hand, and the production of semi-finished copper and copper alloys (brass, bronze) from ingot or scrap copper and alloying metal (tin, zinc), or of course from scrap alloys, on the other. Output estimates for both of these stages of production are presented in Table E.06, cols. 3 and 5; once again, however, they must be evaluated with a good deal of caution, as the data they incorporate are often far from satisfactory.

The documentation of the first stage of copper metalmaking is facilitated by the relatively small number of establishments engaged in this activity; but considerable difficulties are created by the complexity of the relevant technology (Hayward, 1952, pp. 18-142; Hofman and Hayward, 1924; Wysor, 1908, pp. 184-208; *Relazioni minerarie*, pp. 116-128). The metal is extracted from the ore not in a single operation, but in a number of successive ones; some of these can be performed in different ways, and some can be skipped altogether. In a once typical sequence, the ore is successively fused into matte, black copper, blister copper, and finally refined copper; alternatively, matte can be converted directly into blister copper, and the latter can be refined through electrolysis. In addition, the ore can be initially leached rather than fused; and the cement copper obtained in this way can enter the fusion sequence at any point. Finally, some material is only partially transformed, as the industry can buy and sell intermediates as well as ore or refined metal. The copper output data refer, at various times, to all the different products mentioned here; but they are not sufficiently detailed to warrant separate time series for these various intermediates. The industry is accordingly represented by a single "copper ingot" series, intended to count production in the central black or blister copper stage of the process. In principle, then, trade in matte and cement will be ignored; the concomitant error is normally small, as metal production from imported intermediates was largely offset by sales of domestic intermediates to copper sulfate producers, but there are exceptions (note the heavy imports of intermediates during the first surge of metal output in the

late 1880s, and the occasionally heavy sales of cement copper in later years: e.g., *Rivista mineraria 1888*, p. 124, *1889*, p. CX, *1911*, p. LVIII). In a similar vein, the present estimates are intended to exclude the copper reclaimed from scrap, as the latter was normally subjected only to a single treatment in the refining works.

The *Rivista mineraria* reported current production of copper and copper alloys only from 1885, though partial figures are available in earlier years as well. The 1861-84 figures in Table E.06, col. 1, are those in the *Rivista mineraria 1899*, p. XC, and transcribed as aggregate ingot output data in the *Sommario*, p. 129. In fact, the notes in the earlier source (p. CV) indicate that through 1872 these figures refer to the average output of the Briglia foundry (in the Firenze district) only, to the exclusion of other active works. The 1873 figure covers the Accesa foundry (also in the Firenze district) as well as the Briglia works; the 1874-78, 1880, and 1882-83 figures refer to Accesa output only. The 1881 figure instead refers only to the output of the San Giovanni a Teduccio works (Napoli); the *Rivista mineraria 1881*, pp. LXI, 330 indicates that these works, then 10 years old, worked copper and its alloys from purchased ingot and scrap.

The present 1861-84 ingot copper output estimates (Table E.06, col. 3) correct these figures with the aid of information in the earlier reports of the Corpo delle miniere. The *Statistica mineraria*, pp. 42-43, reports copper ingot output in 1865 at 208 tons for the Firenze district (the Briglia works), 113 tons for the Torino district, and 224 tons for the Vicenza district (all but half a ton at Agordo), for a total of 545 tons. The estimates for 1861-64 and 1866-84 are similar sums of district-specific estimates, obtained as follows.

In the Firenze district, the Briglia works are reported to have produced 4,276 tons of metal in 17 years to 1873 (*Notizie minerarie*, p. 322); deducting 208 tons in 1865 and about 100 tons in 1873, average output in other years is estimated at 265 tons p. a. This figure is used here as the district output in 1861-64 and 1866-72; in contrast, the 322 tons p. a. figure in the *Rivista mineraria 1899* would exhaust these works' reported total output in the 1860s alone, with none left for the late 1850s. Year-specific estimates for these years cannot be obtained, however, as most Firenze district ore was rich enough to be exported (*Notizie minerarie*, p. 29). In 1873-84, the Firenze district is attributed the figures reported in the *Rivista mineraria 1899* (Table E.06, col. 1, excluding 1881), plus allowances for omitted Accesa output of 70 tons in 1879 and 100 tons in 1881; the *Rivista mineraria 1882*, p. LXXII indicates that those works remained open in that year. The present figure for 1882 (117 tons) appears to be a correction of that reported in the *Rivista mineraria 1882*, p. 109 (710.7 tons), which implies an impossibly low unit value; that for 1884 (400 tons) appears to be an estimate that includes the black copper obtained at the Valpiana works and sent to Sestri Levante to be refined, as well as the 261 tons of metal obtained at Accesa (*Rivista mineraria 1884*, p. LXIV, 112).

The copper ore produced in the Torino district was generally too poor to be exported, and can thus serve as a rough indicator of foundry output (*Notizie minerarie*, pp. 29, 281). The 1865 datum is crudely extrapolated to 1861-64 and 1866-84 in proportion to reported ore production (*Notizie minerarie*, p. 280, *Rivista mineraria*, e.g., *1883*, p. 309).

Finally, the Agordo figures for 1861-64 (284, 224, 191, and 218 tons, respectively) are obtained in the *Relazioni minerarie*, p. 128; in view of the variability of local yields, metal output is simply assumed equal to 225 tons p. a. in 1866-82, close to its level in 1865, and to 100 tons in 1883-84 (against 98 tons in 1885). In point of fact, the ore output and value figures suggest that the decline in metal output occurred perhaps a decade earlier; but the *Notizie minerarie*, p. 28 reports an aggregate 400 tons of metal produced "on average" at the time. In view of the relatively sturdy Firenze and Torino district figures for the late 1870s, it seems best to attribute this aggregate figure to 1880, and to assume that the decline in Agordo output took place only after that (this decline is here placed between 1882 and 1883 to minimize the

possibly spurious variation in the aggregate). It may be noted, finally, that the aggregate estimates so obtained for the later 1860s are rather below the 1,000-plus tons p. a. cited by Maestri (1867, p. 195, 1868, p. 227).

In 1885-1913, the copper ingot figures in Table E.06, col. 3 are obtained, relatively directly, from the current reports of the *Rivista mineraria*. The 1885 and 1886 data are the sums of the ingot copper figures in the national reports; except for negligible experiments (half a ton at Pont St. Martin in 1885), only Accesa and Agordo appear to have been active in those years. The 1887 figure is the sum of the ingot copper output data in the district reports for the old works at Accesa (351 tons) and Agordo (105 tons), and the new ones at Pont St. Martin (Torino; 463 tons) and Torretta (Livorno; 174 tons), plus 161 tons for the Casarza/Sestri Levante (Genova) works; the latter reported 300 tons, but part of these appear to have been obtained from the black copper produced at Valpiana in 1884 and already counted in that year's output (*Rivista mineraria 1884*, p. 112, *1885*, pp. 125, 252, *1886*, p. LXXII, *1887*, pp. 121-122). The 1888-92 and 1895-98 figures are obtained by summing over the local data in the current national copper output tables, and the accompanying notes, excluding copper reclaimed from scrap (or obtained from inventory, *Rivista mineraria 1892*, pp. XXVI-XXVII). The present ingot figures for 1893 and 1894, in turn, are the reported national figures (2,371 and 2,670 tons, respectively), corrected to exclude the copper contained in cement that was worked for copper compounds (27 and 30 tons, respectively). The 1899 figure is the reported national total, confirmed by the local data in the district reports. The 1900-13 figures are obtained from the notes to the current national reports; save in 1908, however, these cannot be checked against the disaggregated figures from which they were obtained, as the latter were reported on a different basis (through 1909) or not at all (from 1910). The 1906-10 figures exclude some ingot copper obtained at chemical plants and used for sulfate (e.g., *Rivista mineraria 1910*, p. XXXV); but the corresponding amounts were presumably very small. The *Rivista mineraria 1899*, pp. XC, CIV indicates that the 1898 and 1899 output data exclude over 700 tons of such ingot copper; but the current reports suggest that this was in fact the copper content of the cement used for sulfate.

Overall, the present 1885-1913 copper ingot figures are generally the same as those in the *Sommario*, p. 129. The exceptions are threefold: first, the 1885-88 *Sommario* figures are the *Rivista mineraria* data for ingot and worked copper together; second, the *Sommario* series inaccurately transcribes the ingot data for 1891 and 1896, and omits that for 1900; and third, the *Sommario* figures for 1892-94 do not incorporate the corrections to the data described above.

The output estimates for semi-finished copper and copper alloys (Table E.06, col. 5) are obtained through a rather different route. The data in the *Rivista mineraria 1885* to *1893* include an annual national aggregate figure for "copper and its alloys" that sums over the output of both primary producers and fabricating firms; these data are here transcribed in Table E.06, col. 1. In these same years, however, the output of the copper-working firms can be obtained from the partial figures in the district or national reports; these figures are here presented in col. 2. The 1885 figure in col. 2 is the sum of the outputs reported for the San Giovanni a Teduccio and Donnaz (Torino) works; oddly, it is higher than the aggregate that ostensibly includes it (*Rivista mineraria 1885*, pp. XXXII, LXXIV). The 1886 figure in col. 2 is the reported aggregate (col. 1) less the ingot copper obtained at Accesa and Agordo (col. 3); the balance refers to the same two copper-working firms as the 1885 entry. The 1887 figure in col. 2, obtained from the Napoli and Torino district reports, refers to these same two firms; the aggregate in col. 1 is the sum of this worked copper figure and the reported ingot copper figure (the 1,254 tons in col. 3, plus the 139 tons of Casarza refined copper excluded from the present ingot estimate). In 1888-93, the present figures in col. 2 are again the sum of the outputs reported for the copper-working firms; these include the new works at Torretta and Limestre

(Pistoia) from 1888, the Arenaccia and Granili engineering firms (Napoli) from 1889, and the new Cornigliano Delta plant from 1891. These figures include relatively small amounts of ingot copper included in the Torretta and Limestre outputs (except for 182 tons of apparently double-counted Limestre refined copper in 1890: *Rivista mineraria 1890*, p. CI), as these were presumably sold to small fabricators excluded from the present tally (*Rivista mineraria 1899*, p. CXXX). With the appearance of the integrated Firenze district works in 1888, the reported aggregate "copper and its alloys" figure (which includes only the final output of integrated firms and of primary producers) no longer equals the sum of the reported final output of fabricating firms plus the reported aggregate output of ingot copper (which includes that obtained by integrated firms, as well as the output of primary producers); curiously, the "worked copper" figures for 1888-93 in the *Rivista mineraria 1899*, p. XC are just the difference between aggregate "copper and its alloys" and aggregate ingot copper, thus excluding the worked copper obtained from domestic ingot.

In 1894-98, the figures in Table E.06, col. 2 are the reported aggregate output of worked copper and copper alloys; these figures exclude the ingot copper sold by the Torretta and Limestre works (440 tons in 1894, 403 in 1895, 320 in 1896, 784 in 1897, and 868 in 1898). From 1899, on the other hand, the data in col. 2 are the reported aggregate output of "copper and its alloys"; these data include the ingot copper sold by those copper-working firms, on the grounds that it was processed by small enterprises whose output was not separately counted (*Rivista mineraria 1899*, p. CXXX). In addition, the *Rivista mineraria 1897*, p. 249 indicates that the Napoli district data for that year exclude the output of three engineering firms formerly included in the data base; these produced some 348 tons of brass and bronze products in that year. These firms are not mentioned in 1898-1900; but they are included again from 1901, when their output was 118 tons.

In summary, there appear to be reasonably good output data for worked copper from 1885; but these cover only the larger enterprises, and neglect the many small firms that were also in the industry (*Rivista mineraria 1897*, p, 249). Some of these no doubt processed the output of the larger copper-working firms, thus adding value but not weight to the recorded totals; but others most probably worked scrap, or imported ingot, or even domestic ingot sold by primary producers, so that even the recorded tonnages must be considered biased downward. The 1885-1913 data are accordingly to be corrected; and their absence in earlier years must somehow be overcome. The *Movimento commerciale* yields the rounded net import figures for ingot or scrap copper, brass, and bronze reported in Table E.06, col. 4; with the aid of this information, the desired estimates can be obtained either from aggregate input availabilities (essentially as the sum of these imports and domestic ingot output) or by estimating the import-based output of small processing firms (and adding this estimate to the worked copper output reported by the Corpo delle miniere). In both cases, one lacks direct evidence on the contribution of alloying metals and domestic scrap; since the estimates thus tend to be lower bounds, the higher of the two will be preferred when both are available.

This is, in essence, the basis of the present estimates in Table E.06, col. 5; the details of the calculations are as follows. First, the ingot output series in col. 3 is corrected to the desired availabilities basis: the estimated 139 tons of copper obtained at Valpiana in 1884 and not finally refined (at Casarza) until 1887 are thus attributed to the latter year. Second, the import figures in col. 4 are replaced by their three-year moving average (in 1862-1912; the first and last are replaced by their average with the second and second last) as a rough allowance for counteracting fluctuations in inventories or in availabilities of domestic scrap. Third, output is estimated from the availabilities side as the sum of (corrected) ingot output and (smoothed) imports, less the estimated copper consumption of the chemical industry (28% of Table D.31, col. 2), times 1.1 (to allow for the contribution of alloying metals and domestic scrap, less

weight losses in production), rounded. Fourth, the reported output series in Table E.06, col. 2 is corrected to include the omitted ingot copper sales of the Torretta and Limestre works in 1894-98 (see above), and an allowance for the neglected Napoli district engineering firms of 348 tons in 1897, 291 tons in 1898, 233 tons in 1899, and 176 tons in 1900. Fifth, aggregate output of processed copper and its alloys is estimated directly as the sum of the (corrected) reported output of large firms, plus 20% of (smoothed) ingot and scrap imports as an allowance for small firms (again allowing for alloying metals, domestic scrap, and weight losses), rounded. Sixth and last, the final estimates in col. 5 are obtained from aggregate input availabilities in 1861-84 (when the alternative is not available) and in 1885-88 (when the alternative estimates are lower), and by expanding the worked copper output data in 1889-1913. The output estimates are thus unaffected by the start of reporting of large works' output in 1885; in addition, they reasonably imply that the neglected output of small-scale producers accounted for a relatively constant market share from 1885, with a permanent decline in 1888-89 as the large integrated works in the Firenze district came on stream. In absolute terms, this neglected output is implicitly assumed to have stopped growing in 1888, and then declined (partially offsetting that of the new large works) in 1889; the implied lag in output response is not unreasonable for small, competitive firms that react to perceived changes in the profits realized from the sale of completed production.

In 1911, ingot copper was worth 1,550 lire per ton. Judging from the value of domestic ore (an average 18 lire per ton for 3% ore), ore costs were probably close to 630 lire per ton of output. The *Rivista mineraria 1913*, pp. XLIV-XLV, LXXI, suggests that about half the output was obtained through matte, and about half through 80% cement. In the former process, further net materials costs appear to have been close to 450 lire per ton of output, most of it for some 10 tons of coal and coke (the amount used to smelt 5% ore two decades earlier: *Rivista mineraria 1893*, p. 115; also Thorp, 1920, pp. 613, 616); in the latter, they were probably closer to 100 lire, of which about half for acid and most of the rest for fuel to convert the cement. These yield an average 225 lire per ton of output, for a unit value added of approximately 700 lire per ton (1,166,000 lire for 1,666 tons).

The 22,908 tons of worked copper, brass, and bronze reported in the *Rivista mineraria 1911*, pp. XXII, LIX, were worth an average 1,980 lire per ton; an allowance of 50 lire per ton for the small amount of further processing of these goods performed, on average, by neglected small shops yields an estimated average value of 2,030 lire per ton (the *Movimento commerciale* suggests export values of 1,850 to 2,300 lire per ton; import values were identical, net of a 140 to 400 lire per ton tariff). This reported tonnage includes 14,100 tons of worked copper, 6,920 tons of worked brass, 1,113 tons of worked bronze, and 775 tons of other alloys; assuming the bronze was 15% tin and the brass and other alloys were 25% zinc, and allowing a 3% weight loss, the combined metal inputs come to approximately 21,400 tons of copper, 2,000 tons of zinc, and 200 tons of tin. At 1,550 lire per ton of copper, and 700 and 5,000 lire per ton of zinc and tin, respectively (Cianci, 1933), these were worth an aggregate 35.57 million lire, or 1,553 lire per ton of output. Allowing a further 27 lire per ton of output for fuel and other materials costs, value added is here estimated at 450 lire per ton of semi-finished metal, or 12,735,000 lire for 28,300 tons.

Total value added in the production and initial fabrication of copper and its alloys is thus estimated at 13.9 million lire in 1911. Of that, the 3,645 *operai* (3,269 of them adult males) and 8,667 horsepower covered by the Corpo delle miniere contributed about 10.4 million lire (1.17 million producing ingot copper, and some 405 lire for each of 22,908 tons in fabrication). Allowing 1,200 lire p. a. per adult male wage-earner, half that for other *operai*, and 2,000 lire p. a. for an estimated 321 white-collar personnel, total labor costs appear to have been close to 4.8 million lire, for a residual 5.6 million lire to capital; this is equivalent to some 650 lire per

installed horsepower.

E03.05 Gold

In Italy, most gold metal was obtained from the auriferous quartz and pyrite mined near Novara (Torino). The *Statistica mineraria*, pp. XXXIV-XXXV, 54-55, reports 94 kg of gold metal from the mines and 125 kg, of varying purity, from a number of mineralworking plants; the actual date of this production is far from clear (compare the ore output data in the *Notizie minerarie*, p. 287; note that all the ore is said to be treated near the pit head). An 1875-79 average annual output of 100 kg (worth 3,300 lire each) is reported by the *Notizie minerarie*, p. 30; and year-specific data for 1878 ff. are available in the *Rivista mineraria 1879* ff. The latter are transcribed here as Table E.07, col. 1; the earlier figures are from the *Rivista mineraria 1899*, p. XCI, where they were apparently published for the first time.

These figures appear to be relatively heterogeneous, as average values per kg vary from under 2,000 lire in 1910-13 to 3,500 lire and more in 1894-1902; the more valuable product appears to be refined gold, the cheaper one a crude metal that includes varying proportions of silver (e.g., *Rivista mineraria 1879*, p. 24, *1889*, p. 396, *1899*, p. XXX, *1909*, p. 462; also *1911*, pp. XXXIV, 159). A more homogeneous series is constructed here (Table E.07, col. 2) by dividing the value of output, as reported, by the current value of a kg of fine gold, estimated from the gold lira's metal content (.29984 grams of fine gold, or 3,335 gold lire per kilo of fine gold) and the current value of a gold lira in paper currency (from the gold price index in the *Sommario*, p. 172; recall that the lira was at par in 1861-65). The error from failing to allow for the value of the silver in the alloy, or for refining charges, is usually trivial: in 1911, when the alloy was worth just 1,613 lire per kg, the calculated output of 26.6 kg is still close to the gold content figure of 25 kg (against 30 kg of silver) included in the district report (*Rivista mineraria 1911*, p. 159); and in other years, when absolute output was much larger, the relative error appears to be much smaller (e.g., *Rivista mineraria 1895*, p. XXIV). The present series includes the correct reported output, rather than the calculated output, in 1911; it also includes the reported output in 1895 (280 tons), as the calculated output (287 tons) appears exaggerated by a downward error in the *Sommario* gold price index (compare the gold prices in Cianci, 1933, p. 111). In 1883, the *Rivista mineraria* does not report the value of output; the present output estimated for that year is the reported output figure multiplied by the average of the corrections (Table E.07, col. 2 divided by col. 1) for 1882 and 1884. Finally, the 1861-65 and 1871-74 output estimates are obtained on the basis of reported aggregate ore values (*Notizie minerarie*, p. 287): these are multiplied by an estimated metal value/ore value ratio, and the estimated aggregate gold values so obtained are then transformed in the usual way. In 1861-65, the metal value/ore value ratio is set equal to that which prevailed, on average, in 1866-70: in 1871-74, it is obtained by geometric interpolation of that 1866-70 average and the corresponding average for 1875-79.

Value added in gold production is estimated on the assumption that the ore was transformed into refined gold, as most or all of it appears to have been when the industry was active on a significant scale. In other years, the crude alloy counted by the Corpo delle miniere may have been refined abroad, at least in part; but the probable error is too small to matter. In 1911 lire, a kg of fine gold was worth 3,338 lire; that year's reported ore value (40 lire for a ton containing 14 grams) suggests ore costs of at least 2,857 lire per kg of gold. Allowing for losses, fuel (mainly for heat; the industry's large power needs were met by hydraulic motors), and other materials, value added is here estimated at approximately 400 lire per kg of output. This yields an aggregate value added of .1 million lire at the 1894 output peak, and a negligible 10,000 lire in 1911; the latter figure suggests that the 15 *operai* and 70 horsepower listed by the *Rivista mineraria 1911*, pp. LIV-LV, worked a relatively short year (see also *Rivista mineraria*

1901, p. 377).

The 1911 censuses include goldsmithing in category 4.5; category 4.22 includes only the manufacture of gold leaf. This product is not separately considered here, as the corresponding activity appears to have been insignificant. In the *Censimento 1901*, just 168 *operai* and 29 owners and artisans identified themselves as founders, pullers, and beaters of precious metals (category IV.7); allowing for foundry employment and for unemployment (gold foundries alone employed 57 *operai* in 1901, and close to 100 just a few years earlier, according to the *Rivista mineraria*), the likely residual corresponding to the initial fabrication of gold and silver appears very small indeed.

E03.06 Lead and silver

This section covers the production of ingot lead and silver from ore on the one hand, and the production of worked lead and lead alloys from ingot or scrap metal on the other. As in the case of gold, the initial fabrication of silver into sheet or thread is considered negligible (see above, section E03.05; also *Rivista mineraria 1883*, p. 140).

In Italy, ingot lead and silver were obtained together from the crude silver-bearing "work lead" produced by the initial smelting of silver-bearing lead ore; significant amounts of silver were also obtained from silver ore in the 1880s and 1890s (see above, section B02.05). The output data in Table E.08, cols. 1 and 2 are obtained from the *Notizie minerarie* and the *Rivista mineraria*; the nineteenth-century figures typically coincide with the retrospective data in the *Rivista mineraria 1899*, p. XCII, with the addition of 45 tons in 1882 (and a single ton, apparently because the retrospective alternates between rounding and truncating, in 1868, 1869, 1873, 1874, 1876, 1877, and 1880). The early data cover the output of the small Bottino foundry (Lucca) from 1861 until it closed in 1883 (and include the entire small quantities of litharge, without discounting them back to their lead content), the Pertusola foundry (Genova) from 1867, and the Cogoleto foundry (Genova) from 1878 until it was converted into a pigment works in 1884 (*Notizie minerarie*, pp. 284-285; *Rivista mineraria 1883*, pp. LXXIV, 138, *1884*, pp. LIX-LX). The 1885 ff. data (from the metalworking tables in the current issue of the *Rivista mineraria*) cover the output of the Pertusola works, small contributions from the Torino and Vicenza districts from 1894, and the significant output of the Monteponi works (Cagliari) active from early 1895 (*Rivista mineraria 1895*, p. 180). This Monteponi output (including up to 90 tons p. a. of antimonial lead and potter's lead as lead ingot from 1904) appears to have been recorded on the mines' fiscal-year basis, ending on June 30 of the calendar year relevant to the other data (Table E.08, cols. 3 - 4; *Rivista mineraria 1898*, p. 199, *1902*, p. 231; Società di Monteponi, 1952, appended output graph).

The early data do not appear to be complete. In the first place, the Pertusola works were active from before 1861; their output in 1866, apparently equal to their average output in 1861-65, is reported at 3,000 tons of lead and 1.5 tons of silver (from 6,000 tons of 65% galena: *Relazioni minerarie*, p. 51). Second, the Cogoleto works were actually set up (also to process lead ore) "a few years" before 1878, when they entered the data base as a result of their purchase by the owners of the Pertusola works (who used Cogoleto to process Sardinian silver ores that had apparently been exported up to that point); this also suggests that the Cogoleto output recorded in 1878 (just 27 tons of lead, against 331 tons of lead and 13.784 tons of silver from 1,427 tons of ore in 1879) was only a small part of the year's output (*Notizie minerarie*, p. 31; *Rivista mineraria 1877*, p. 101, *1883*, pp. 137-138). Third, and most awkwardly, a number of foundries appear to have been active in Sardinia; their output of work lead (containing perhaps one-half to one kg of silver per ton) is reported through fiscal 1866 in the *Relazioni minerarie*, pp. 382-383, and from 1882 until the last one closed, in 1891, in the *Rivista mineraria*, e.g. *1882*, p. 196, *1883*, p. LXXIV, *1884*, p. LX, *1891*, pp. XXXII, LXXV (Table E.08, col. 5). In

later years, this Sardinian work lead was desilvered at Pertusola and Cogoleto, along with small amounts of similar Spanish and Greek materials (*Rivista mineraria 1877*, p. 101, *1882*, p. LXVIII, *1883*, pp. 139-140, *1885*, p. LXIII); and the Pertusola lead/ore ratio in 1867 ff. is sufficiently high (.54 to .70, from the data in the *Rivista mineraria 1883* ff.) to warrant belief that the reported lead output was obtained from work lead as well as from the reported ore input (despite the opposite assumption in the *Rivista mineraria 1882*, p. LXVIII; see *1885*, p. LXIII). In 1861-66, on the other hand, the reported Pertusola output (just half the ore input) almost certainly excludes any lead that was simply desilvered; in fact, the Sardinian work lead may have been desilvered elsewhere in the Genova district (at San Pier d'Arena, active in the early 1860s only, and later at Marassi: *Relazioni minerarie*, p. 52), or even at the ore foundry. The *Statistica mineraria*, pp. 54-55, allows Genova the 3,000 tons of ingot lead obtained at Pertusola, 5.5 tons of silver (either as 1.5 tons for Pertusola and 4 tons for other works, or as an erroneous transcription of 1.5 tons), and also 3,450 tons of work lead (the apparent counterpart of 3,500 tons of purchased ingot, some of which may have been worked lead); it allows Sardinia 1,146 tons of ingot lead and .862 tons of silver; and it allows Bottino its 1866 output of 30 tons of lead (including litharge, not double-counted). The reported total of 4,198 tons of ingot lead and 7.021 tons of silver (cf. Maestri, 1868, p. 227) includes 22 tons of lead from the Auronzo works in the Vicenza district; these appear to have produced little or nothing in other years, except for 1881, when 100 tons of lead were apparently obtained from accumulated inventories of ore (*Notizie minerarie*, pp. 29, 285; *Rivista mineraria 1882*, p. LXVIII).

The aggregate output estimates in Table E.08, cols. 6 - 7, are obtained as follows. In 1861-66, first of all, they draw on the information in the *Relazioni minerarie*, in preference to the more ambiguous figures in the *Statistica mineraria*. The ingot lead estimates are thus the rounded sum of the data in col. 2, an estimate for Auronzo (22 tons in 1865, none in other years), an allowance of 3,000 tons p. a. for Pertusola, and estimated Sardinian work lead output (obtained, in year *t*, as the average of the figures in col. 5 for years *t* and *t + 1*), assumed to have been desilvered in other works; the corresponding silver estimates are the rounded sum of the data in col. 1, an allowance of 1.5 tons for Pertusola, and .75 kg per ton of estimated Sardinian work lead. In 1867-78, on the other hand, the necessary corrections are a good deal smaller, as the data neglect only the products obtained at Marassi and Cogoleto; but they are highly uncertain, as there is very little evidence on these plants' scale and period of operation. In the late 1860s, Pertusola output from ore can be estimated at half the reported ore input (as in 1861-66; in the early 1880s, the ore yield suggested by lead output less Sardinian work lead was closer to 60%); this suggests that Pertusola desilvered some 300 tons of work lead in 1867, and roughly 500 to 1,100 tons in the following years. Roughly interpolating the Sardinian work lead figures in col. 5, this suggests that Marassi desilvered perhaps 1,700 tons of work lead in 1867 and roughly 1,000 tons p. a. in later years. In the mid-1870s, on the other hand, Cogoleto can be assumed to have processed roughly 1,400 tons of ore p. a., as it did in 1879, albeit mostly for lead rather than silver, for a probable output in the neighborhood of 700 tons of lead from ore; allowing for its desilvering operations and assuming that the scale of the latter remained relatively constant (even as the work lead was increasingly manufactured rather than purchased), an aggregate estimate of perhaps 1,000 tons of lead p. a. is again not unreasonable. For the sake of simplicity, the present estimates are obtained as the rounded sum of the data in cols. 1 - 2 and a constant 1,000 tons of lead or, correspondingly, .75 tons of silver p. a., in 1868-77; in 1867, these estimated corrections are increased to 1,700 tons of lead and 1.28 tons of silver, and in 1878 they are reduced to 300 tons of lead and .25 of silver (to allow for the disruption of work during the transfer and conversion of the Cogoleto works). In 1879-1913, finally, the reported data are considered complete (with the addition of the 100 tons of Auronzo lead omitted in 1881); they are here corrected to the extent of replacing the Monteponi data (cols. 3 - 4) by the

corresponding calendar-year estimates (obtained, for year *t*, as the average of the data for years *t* and *t + 1*; since production began in 1895, that year's estimates are the sum of the reported figures for 1895 plus half those for 1896), and rounded.

In the absence of suitable output data (with only imperfect exceptions: *Statistica mineraria*, p. 45; Maestri, 1868, p. 227), production estimates for semi-finished lead and lead alloys are here obtained from lead and antimony output and net imports, deducting the consumption of the chemical industry. The metal output figures are the estimates in Table E.05, col. 8, rounded, and Table E.08, col. 7. The net import figures are the sum of those in Table E.09, cols. 1 and 2; to allow for offsetting variations in inventories or in availabilities of domestic scrap, this sum is replaced in the present calculation by its three-year moving average (in 1862-1912; the first and last entries are replaced by their average with the second and second last). The chemical industry's consumption of ingot or scrap lead (Table E.09, col. 3) is estimated as 70% of minium output, 94% of litharge output, and 53% (70% times .76) of nitrated lead oxide output, as estimated above (Tables D.18, cols. 2 and 3, and D.34, col. 3; sections D08.02 and D11.13); the lead consumed for lead white or lead acetate is not deducted, as it was worked before being processed by the chemical industry (sections D08.02 and D12.09). The figures in Table E.09, col. 3 also include, in 1909-13, an allowance of 100 tons p. a. for the lead consumed in manufacturing some 2,000 tons of terne plate p. a. (reported separately in 1909-10 and 1912, and as part of larger totals in 1911 and 1913; e.g., *Rivista mineraria 1910*, p. XL, *1911*, p. LIV). The desired output estimates (Table E.09, col. 4) are obtained directly as the sum of these output and smoothed import figures, net of the chemical industry's consumption; the (average) contribution of domestic scrap and losses in fabrication are assumed to offset each other to a negligible approximation.

The 1911-price values added in the production of silver and ingot lead are of course somewhat arbitrary, to the extent that these were jointly obtained from silver-bearing galena. On the other hand, as noted above, roughly half of Italy's total silver output in the 1880s and 1890s was obtained from silver ore. Since silver output is here represented by a single series that does not distinguish the product according to its source, it seems best to attribute to silver the unit value added contributed by its extraction from silver ore, and to ingot lead the corresponding unit residual (aggregate value added in the silver and lead obtained jointly, less that attributed to silver, divided by lead output).

In 1911, the silver output recorded by the Corpo delle miniere was worth 89,060 lire per ton; a ton of silver ore, containing 13.6 kg of silver (not unrepresentative of the ore obtained in the early 1880s: *Rivista mineraria 1883*, p. 138), was valued at 1,154 lire. These figures suggest an ore cost of at least 85,000 lire; allowing for losses, fuel, and other materials, value added is here tentatively estimated at 3,500 lire per ton, or approximately 44,000 lire for 12.5 tons. In 1911, as noted (Table B.08), silver ore output was very small, and can be attributed no more than some 350 kg of silver; this leaves some 12.15 tons, with a market value of 1,082,000 lire, as the estimated yield of silver-bearing galena. Ingot lead, on the other hand, was valued at 333 lire per ton, or 5,594,000 lire for 16,800 tons; the total market value of the lead and silver obtained from galena was thus some 6,676,000 lire. The galena was itself valued at 170 lire per ton, or perhaps 175 lire delivered at the seaside works; at 1.85 tons of ore per ton of lead output (*Rivista mineraria 1911*, p. CLX), aggregate ore costs appear to have been close to 5,439,000 lire. Fuel and other materials cost perhaps 300,000 lire: say 200,000 lire for some 6,700 tons of coal and coke, again allowing for the principal works' seaside location, and 100,000 lire for some 10,000 tons of limestone and 3,000 tons of iron ore used as fluxes (*Rivista mineraria 1883*, p. 128, *1904*, pp. 154-155; Austin, 1926, p. 520). These figures yield an aggregate value added of 937,000 lire in ingot lead and silver together; of that, just 43,000 lire are attributed to 12.15 tons of silver, leaving 894,000 lire for the ingot lead, or approximately 53.2 lire per ton.

The *Rivista mineraria 1911* reports 371 blue-collar workers (almost all of them men) and 572 horsepower in the production of lead and silver from galena and silver ore; replacing the Iglesias component (98 men, 72 horsepower) by its average with that reported for 1912 (134 men, 42 horsepower), one obtains a corrected employment of 389 *operai* and 557 horsepower as the counterpart to a value added of 938,000 lire. Allowing 467,000 lire for wages (at 1,200 lire per man year) and 68,000 lire for salaries (for an estimated 34 white-collar workers), capital costs appear to have been close to 403,000 lire, or approximately 720 lire per horsepower.

The *Movimento commerciale 1911* valued a ton of imported worked lead and lead alloys, including tariff, at 430 lire (sheet), 470 lire (pipes), and 500 lire (other products), against 375 lire for a ton of ingot or scrap. These suggest (weighted) average transformation costs of the order of 100 lire per ton; attributing 15 lire of that to fuel and other materials, value added is here estimated at 85 lire per ton of semi-finished lead, or 2,559,000 lire for 30,100 tons.

Aggregate value added in 1911 in the production of ingot lead and silver from galena and silver ore and the initial fabrication of lead and its alloys is thus estimated at 3.5 million lire; of that, .9 million were in activity covered by the Corpo delle miniere.

E03.07 Mercury

Mercury metal was obtained at the mines in the Firenze district and, until 1880, in the Vicenza district (see above, section B02.07). Through 1892, the Corpo delle miniere counted the metal, rather than the ore, as the mines' output; the complete time series here transcribed in Table E.10, col. 1 is accordingly available in the sources (*Notizie mineraria*, p. 288; *Rivista mineraria 1880* ff.; *Sommario*, p. 129).

Italy's mercury output was largely exported, as can be seen from the net export figures in Table E.10, col. 2 (from the data in the *Movimento commerciale*, reduced by one sixth to allow for the weight of the iron flasks the mercury was shipped in: Molinari, 1920, p. 688; *Notizie minerarie*, p. 288). The 1861-66 trade data are not particularly significant, as the site of the major producers was not then part of the Kingdom of Italy; but net exports are well in excess of current output in the early 1870s. Inventories may well have been very high by the late 1860s (note the reference to overproduction in the *Statistica mineraria*, p. XXXVI); but the output series may also underestimate output growth during the subsequent recovery.

In 1911, 955 tons of mercury, worth 5,253,000 lire, were produced from 85,000 tons of ore (*Rivista mineraria 1911*, p. CLXIII). This is 87.5% of the year's output, worth 4,665,000 lire; since the balance was not discarded but treated the following year (*Rivista mineraria 1912*, pp. CLXXXV-CLXXXVI), ore costs are estimated *pro rata* at 4,081,000 lire. Allowing another 217,000 lire for fuel and other materials (including 15 kg of coke, worth some .6 lire, and 600 kg of limestone, worth some 1.8 lire delivered, per ton of ore: *Grande encyclopédie*, vol. 23, p. 702; von Wagner, 1904, p. 211), value added is here estimated at approximately 955,000 lire, or 1,000 lire per ton of output. All of this activity was covered by the Corpo delle miniere, who reported the corresponding employment at 354 men and 100 horsepower; these suggest a wage bill of 425,000 lire and perhaps another 62,000 lire in salaries (for 31 white-collar workers), for a residual estimate corresponding to capital costs of about 4,700 lire per horsepower. This figure seems reasonable in the context of the relevant technology, as the metal is essentially distilled from the ore (Molinari, 1920, p. 685).

Mercury, being liquid, is not subject to fabrication.

E03.08 Nickel

As noted in section B02.14 above, Italy produced small amounts of nickel ore in the 1860s and 1870s. This ore was apparently exported without being processed in the early 1860s; but in later years the Torino district ore was exported after being reduced to matte (*Notizie*

minerarie, pp. 33, 289). The *Statistica mineraria*, pp. 54-55, reports the production of 38 tons of nickel matte, from 574 tons of ore, presumably in 1865 (when 700 tons of ore were extracted, against much lower amounts in neighboring years). The Torino district ore output and value figures in the *Notizie minerarie*, p. 289, suggest that matte production remained far below even its 1865 level, except perhaps in 1873-77. In those years, ore quantities were from 1.4 to 3.5 times their 1865 level (with a strong peak in 1875); ore values, however, were just from .7 to 2.3 times their 1865 level, and most of this increase appears due to changes in metal prices (from 100 in 1870 to 240 in 1875: Molinari, 1920, p. 846) rather than to actual increases in gross metal content. In general, then, matte output does not appear to have ever been much above its 1865 level; at a 1911-price value added of no more than 500 lire per ton (against 700 lire per ton of ingot copper, which includes the further processing and weight reduction of the matte), nickel reduction can clearly be neglected.

The *Movimento commerciale* indicates that net imports of nickel ingot and scrap were insignificant through the turn of the century, then rose to 200 or 300 tons p. a. in 1901-09, 400 in 1910, 600 in 1911 and 1913, and 900 in 1912. Since almost all of this would appear to have been used to alloy other metals (especially steel for armaments), semi-finished nickel output is not separately estimated.

E03.09 Tin

The reports of the Corpo delle miniere suggest that tin was not produced in Italy at all, with the exception of trivial quantities reclaimed from scrap tin plate (*Notizie minerarie*, p. 31; *Rivista mineraria*, e.g., *1899*, p. CVI, *1906*, p. XXX); the corresponding output data are transcribed in Table E.11, col. 1. These may be incomplete: e.g., no output of tin was reported for 1913, though 951 tons of scrap tin plate were imported to be de-tinned (*Movimento commerciale 1913*, p. 215); this input corresponds to perhaps 25 tons of ingot tin (Molinari, 1920, p. 777). Even allowing for such omitted output, however, (the value added by) the domestic production of ingot tin can clearly be neglected.

In the absence of better indicators, the production of semi-finished tin is here estimated from net imports of ingot and scrap tin and tin alloys, allowing for the tin consumed by other branches of industry. The net import figures (Table E.11, col. 2) are derived from the *Movimento commerciale*. In 1878-1913, these figures are obtained directly from the reported imports and exports of scrap, ingot and bar tin (and tin alloys); in earlier years, however, the data are somewhat more complex. In 1861-69, the *Movimento commerciale* separately records trade in ingot and scrap (200-300 tons) and in bar (0-100 tons); in 1868-77, ore is included with ingot and scrap (200-500 tons), and bar is again separately recorded (0-100 tons). The present figures are obtained from these two sets of data together: no allowance is made for the presumably negligible imports of ore.

The tin plate figures in Table E.11, col. 3 are transcribed from the current issues of the *Rivista mineraria*; the only correction is the addition of 1,500 tons to the reported figure for 1893, as an allowance for the neglected output of the Darfo (Brescia) works that produced 3,000 tons the following year (*Rivista mineraria 1893*, p. LXXII, *1894*, pp. XXII, 208). The *Rivista mineraria 1905*, p. 206, suggests that tin plate output was considerably larger than the recorded amount, as imported blackplate was "indubitably" tinned; but this does not appear to be the case, at least on any significant scale. The available information on the destination of imported blackplate, though restricted to temporary imports, indicates a variety of uses (e.g., *Movimento commerciale 1913*, p. 201; also Brady, 1944, p. 626); it was generally not imported to be tinned, and Italy's thriving manufacture of tin cans for export was based on temporary imports of tin plate rather than blackplate.

The bronze output figures in Table E.11, col. 4 are obtained as follows. The national

output tables in the *Rivista mineraria* (e.g. *1895*, p. XXIII, *1913*, p. LXXII) report bronze output separately in 1904 and 1908-13, and together with brass in 1895-98 and 1905-07; the present bronze output figures are the reported ones in 1904 and 1908-13, and 12% of the combined brass and bronze figures in 1895-98 and 1905-07 (against 11% in 1904 and 13% in 1907). In 1899-1903, the present figures are obtained by simple linear interpolation of those for 1898 and 1904; in 1861-94, finally, the present estimates extrapolate the 1895 figure as a constant 5% of the aggregate copper and copper alloys estimates in Table E.06, col. 5. No use is made of the input data reported in the *Rivista mineraria 1894*, p. XXIII (1,200 tons of zinc and 190 tons of tin, for only 7,048 tons of worked copper, brass, and bronze): their derivation is uncertain, and they agree poorly with the disaggregated output data available in later years.

The semi-finished tin output estimates in Table E.11, col. 5 are obtained as the net import figures in col. 2 (smoothed by taking a 3-year moving average; the first and last entries are replaced by their average with the second and second-last), less 4% of the tin plate figures in col. 3 and 15% of the bronze figures in col. 4; the 1895-1903 estimates are further reduced by 100 tons p. a., as a rough allowance for the tin absorbed by the chemical industry (see above, section D11.21). Weight losses are assumed to be offset by neglected domestic scrap.

Value added at 1911 prices is estimated, very simply, from the differences between import prices plus tariffs for semi-finished tin (5,050 to 5,250 lire per ton) and ingot or scrap tin (4,800 lire per ton), as reported in the *Movimento commerciale 1911*. Allowing for fuel costs and minor weight losses, these suggest an average value added of about 300 lire per ton of semi-finished tin, or .39 million lire for 1,300 tons; none of the corresponding activity was covered by the Corpo delle miniere.

E03.10 Zinc

The production of ingot zinc in Italy appears to have been negligible. The output figures reported by the Corpo delle miniere are transcribed in Table E.12, col. 1. The 1865 output refers to ingot zinc obtained from calamine at the Auronzo foundry in the Vicenza district (*Statistica mineraria*, pp. 54-55); extrapolating this figure on the basis of the gross value of Vicenza district calamine from 1861 to 1871, when this foundry is plausibly assumed to have shut down (*Notizie minerarie*, pp. 29, 282), ingot zinc production can be estimated at approximately 100 tons p. a. in 1862-70. The 1897-1907 figures include zinc reclaimed from industrial by-products at the Torino zinc white works that failed in 1903 (*Rivista mineraria 1897*, p. XXIX, *1903*, p. 437); these account for 250 tons p. a. in 1897-99, and 500, 404, and 301 tons in 1900, 1901, and 1902, respectively. The balance of these output data refer to the Monteponi works (Cagliari). With the exception of the 5-ton output reported in 1905, this zinc was all obtained from calamine, apparently in the first foundry active since Auronzo closed down three decades earlier; but this venture too lasted only a few years (*Rivista mineraria 1899*, p. 216, *1905*, p. XCII, *1908*, p. CIII). These Monteponi output data appear to refer to fiscal years that end on June 30 of the calendar year covered by the national report (e.g., *Rivista mineraria 1902*, p. 231); shifted and rounded, the Monteponi foundry output appears to have been about 100 tons p. a. in 1900, 1901, 1904, and 1906, and 200 tons p. a. in 1902 and 1903.

At 1911 prices, a ton of ingot zinc was worth 700 lire; allowing some 350 lire for nearly 4 tons of low-grade ore, and 150 lire for 4 or 5 tons of coal and other materials (*Rivista mineraria 1900*, p. XXX, *1911*, p. XX; *Enciclopedia italiana*, vol. 35, p. 950), value added reduces to just 200 lire per ton of zinc obtained from calamine. This yields an insignificant aggregate value-added in the production of at most 100 to 200 tons of zinc from calamine and *a fortiori* in that of at most 500 tons of zinc from industrial by-products.

In the virtual absence of output data for semi-finished zinc (the *Rivista mineraria 1899*, pp. XCVII, CVI, reports just 280 tons in 1895, 275 in 1896, and 250 in 1897, from the San

Giovanni a Teduccio copper works), suitable estimates are again obtained by estimating availabilities of ingot and scrap net of that consumed by other branches of industry. The net import figures in Table E.12, col. 2 are taken from the *Movimento commerciale* data for ingot zinc and scrap zinc (these were recorded separately through 1877, and together from 1878). Gross availabilities of ingot and scrap are estimated as net imports, smoothed by taking a three-year moving average (with the first and last figures replaced by their average with the second and second-last), and augmented by the rounded ingot output estimates discussed above, gross of the metal reclaimed from industrial by-products (for a total of 100 tons p. a. in 1862-70, 300 tons p. a. in 1897-99, 600 tons p. a. in 1900-01, 500 tons in 1902, 200 tons in 1903, and 100 tons p. a. in 1904 and 1906).

The output of brass and other zinc-copper alloys (Table E.12, col. 3) is estimated as follows. The *Rivista mineraria* reported brass output separately in 1904 and 1908-13, and together with bronze in 1895-98 and 1905-07; other copper alloys, mostly with zinc, are reported in 1895-98 and 1904-13. In 1904 and 1908-13, the present figures are the sum of the reported brass and other alloy figures; in 1895-98 and 1905-07, they are the sum of estimated brass output, calculated as 88% of the brass-bronze total (against 89% in 1904 and 87% in 1908), and the reported output of other alloys. In 1899-1903, the present estimates are obtained by simple linear interpolation of those for 1898 and 1904; in 1861-94, finally, the present estimates extrapolate the 1895 figure as a constant 38% of the aggregate copper and copper alloys estimates in Table E.06, col. 5. As in the case of tin, no use is made of the suspect 1894 input data (above, section E03.09). Zinc consumption in the manufacture of brass and other copper alloys is estimated as 25% of the figures in Table E.12, col. 3.

The chemical industry's consumption of zinc (Table E.12, col. 4) is estimated as 75% of zinc-based pigments (Table D.18, cols. 5 - 6) plus 30% of other zinc compounds (Table D.42, col. 4).

In addition, the Corpo delle miniere reported zinc plate output at 3,000 tons in 1909, 6,800 tons in 1910, and 7,650 tons in 1912; in 1911 and 1913, output appears to have been close to 6,000 and 8,000 tons, respectively (against 7,890 and 10,513 tons, respectively, of zinc and terne plate together). These suggest a further deduction of 100 tons of zinc in 1909, 200 tons in 1911, and 300 tons p. a. in 1910, 1912, and 1913.

Assuming, as usual, that domestic scrap and weight losses are mutually offsetting to a negligible error, output of semi-finished zinc (Table E.12, col. 5) is obtained from the above data and estimates as gross availabilities less consumption for brass, chemicals, and zinc plate. These figures suggest that zinc was not worked as such on any significant scale until the 1880s.

Value added at 1911 prices is again estimated, very simply, from the differences between import prices plus tariffs for semi-finished zinc (790 lire/ton) and ingot or scrap zinc (650 lire/ton) as reported in the *Movimento commerciale 1911*. Allowing for fuel costs and minor weight losses, these suggest a value added of about 100 lire per ton of output, or .66 million lire for 6,600 tons; none of the corresponding activity was covered by the Corpo delle miniere.

E03.11 Other metal and alloys

The *Movimento commerciale* reports trade in (unspecified) other ingot and scrap metal and alloys from 1879. Net imports were insignificant through 1887, then rose to 1,200 tons in 1890, dropped to 500 tons in 1892, and recovered to about 1,000 tons p. a. through the mid-1890s; they then rose to some 2,700 tons p. a. around the turn of the century, to 3 - 5,000 tons p. a. in 1903-08, and, in a final spurt, to 10,100 tons in 1913. Since this metal appears to have consisted essentially of ferro-alloys used in the production of steel (*Notizie metallurgiche*, pp. 55 ff.; also *Rivista mineraria 1913*, p. LXXI), its yield is implicitly counted above; these import

data are accordingly not used to estimate a putative output of other semi-finished metal and alloys, even though such a category appears in the *Movimento commerciale*.

E03.12 Aggregate value added and employment

The above estimates of value added in the production and initial fabrication of non-ferrous metals in 1911 sum to 20.2 million lire. The corresponding employment reported by the *Censimento industriale* includes the 6,000 *operai* and 9,800 horsepower in use in category 4.2, and part of the far larger numbers in categories 4.ω1, ω.31, and ω.71 (Table E.01); as noted in section E01.02 above, the *Censimento demografico* figures for category 4.2 suggest an aggregate employment of about 7,550 *operai* (equal to 97% of the reported labor force) and, correspondingly, perhaps 11,300 horsepower in use (assuming .92 horsepower in use for each of the extra 1,600 *operai*, as suggested by the *Censimento industriale*, vol. 3 figures for the larger shops in category 4.2, excluding the approximately 300 men and perhaps 4,700 horsepower in use engaged in the production of aluminum by essentially electrochemical means).

The *Rivista mineraria* covered activity worth 12.6 million lire in value added, employing just over 4,650 *operai*; this leaves a balance of 7.6 million lire and 2,900 *operai* in the rest of the non-ferrous metals industry (the horsepower figures are less useful here, in view of the uncertainty surrounding horsepower utilization rates; see above, section E01.02). Excluding such *sui generis* items as ingot aluminum and mercury, the *Rivista mineraria* figures reduce to 11.3 million lire in value added and 4,000 *operai* employed, for a value added of some 2,800 lire per man; this figure includes about 1,200 lire for the worker's own wages, 200 lire for *pro rata* salaries, and a residual 1,400 lire for *pro rata* capital costs. In the part of the industry not covered by the *Rivista mineraria*, on the other hand, estimated value added per man is just 2,600 lire; given roughly equal wages and *pro rata* salaries, this figure implies *pro rata* capital costs of about 1,200 lire per man. Since the *Rivista mineraria* covered mostly large shops, and the balance of the industry consisted mostly of small shops presumably employing less capital per worker, the discrepancy between these two estimates of capital costs per worker appears very reasonable.

REFERENCES

Annuario. Direzione generale della statistica. *Annuario statistico italiano* (1878 ff.).

Atti ferroviari 1881: Commissione d'inchiesta sull'esercizio delle ferrovie italiane. *Atti della commissione d'inchiesta sull'esercizio delle ferrovie italiane... presentati dal ministro dei lavori pubblici (Baccarini) nella tornata del 31 marzo 1881*, Parte I, 3 vols; Parte II, 3 vols; Parte III, 1 vol. (Roma: Botta, 1881-84).

Austin, Leonard S. (1926). *The Metallurgy of the Common Metals*, 6th ed. (New York: Wiley).

Bonelli, Franco (1961). *Il commercio estero dello Stato Pontificio nel secolo XIX*. Archivio Economico dell'Unificazione italiana, serie I, vol. 11, fasc. 2 (Torino: I.L.T.E.).

Brady, George S. (1944). *Materials Handbook*, 5th ed. (New York: McGraw-Hill).

Censimento 1901: Direzione generale della statistica. *Censimento della popolazione del Regno d'Italia al 10 febbraio 1901*, 5 vols. (Roma: Bertero, 1902-04).

Censimento demografico: Direzione generale della statistica. Ufficio del censimento. *Censimento della popolazione del Regno d'Italia al 10 giugno 1911*, 7 vols. (Roma: Bertero, 1914-16).

Censimento industriale: Direzione generale della statistica. Ufficio del censimento. *Censimento degli opifici e delle imprese industriali al 10 giugno 1911*, 5 vols. (Roma: Bertero, 1913-16).

Centenario ferroviario: Direzione generale delle ferrovie dello Stato (1940). *Il centenario delle ferrovie italiane, 1839-1939*, 2 vols. (Roma: Direzione generale delle ferrovie dello Stato, 1940).

Cianci, Ernesto (1933). *Dinamica dei prezzi delle merci in Italia dal 1870 al 1929*. Istituto centrale di statistica. *Annali di statistica*, serie VI, vol. 20.

Doria, Giorgio (1969). *Investimenti e sviluppo economico a Genova alla vigilia della prima guerra mondiale*, 2 vols. (Milano: Giuffrè, 1969-73).

Gerschenkron, Alexander (1962). "Description of an Index of Italian Industrial Development, 1881-1913," in Alexander Gerschenkron, *Economic Backwardness in Historical Perspective* (Cambridge, Mass.: Belknap Press), pp. 367-421.

Giordano, Felice (1864). *L'industria del ferro in Italia: relazione dell'ingegnere Felice Giordano per la Commissione delle ferriere istituita dal Ministero di marina* (Torino: Cotta e Capellino).

Glazier, Ira A. (1966). *Il commercio estero del Regno Lombardo-Veneto dal 1815 al 1865*. Archivio economico dell'Unificazione italiana, serie I, vol. 15 (Torino: I.L.T.E.).

Grande dizionario enciclopedico: Unione Tipografico-Editrice Torinese. *Grande dizionario enciclopedico*, 2nd ed., 12 vols.(Torino: U.T.E.T, 1954-62).

Grande encyclopédie: H. Lamirault et Cie. *La grande encyclopédie, inventaire raisonné des sciences, des lettres et des arts...*, 31 vols. (Paris: Lamirault, 1886-1902).

Hayward, Carle R. (1952). *An Outline of Metallurgical Practice*, 3d ed. (New York: Van Nostrand).

Hofman, Heinrich O., and Carle R. Hayward (1924). *Metallurgy of Copper*, 2nd ed. (New York: McGraw-Hill).

ISIC: United Nations. *Indexes to the International Standard Industrial Classification of All Economic Activities*, Statistical Papers, Series M, No. 4, Rev. 2, Add. 1 (New York, 1971).

Loria, Leonardo (1890). *Le strade ferrate*, 2 vols. (Milano: Hoepli, 1890-92).

Maestri, Pietro (1867). *L'Italie économique en 1867*: *avec un aperçu des industries italiennes à l'Exposition universelle de Paris* (Firenze: Barbèra).

Maestri, Pietro (1868). *L'Italia economica nel 1868* (Firenze: Civelli).

Molinari, Ettore (1920). *Treatise on General and Industrial Inorganic Chemistry*, 2nd ed., tr. from the 4th Italian ed. by T. H. Pope (Philadelphia: Blakiston).

Movimento commerciale: Direzione generale delle gabelle. *Movimento commerciale del Regno d'Italia nel…* (1861 ff).

Notizie metallurgiche: Comitato nazionale per le tariffe doganali e i trattati di commercio. *Notizie sulla industria metallurgica in Italia* (Milano: La stampa commerciale, 1917).

Notizie minerarie: Corpo delle miniere. *Notizie statistiche sulla industria mineraria in Italia dal 1860 al 1880* (Roma: Regia tipografia, 1881).

Reddito nazionale: Istituto centrale di statistica. *Indagine statistica sullo sviluppo del reddito nazionale dell'Italia dal 1861 al 1956. Annali di statistica*, serie VIII, vol. 9 (Roma, 1957).

Relazioni minerarie: Corpo delle miniere. *Statistica del Regno d'Italia: Industria mineraria: Relazioni degl'ingegneri del Real Corpo delle miniere* (Firenze: Tip. Tofani, 1868).

Relazione S.F.I.: Commissariato generale delle strade ferrate. *Relazione sulle strade ferrate italiane* (1867-1868); Direzione generale delle strade ferrate. *Relazione statistica sulle costruzioni e sull'esercizio delle strade ferrate italiane* (1871-1872, 1875-1884); R. Ispettorato generale delle strade ferrate. *Relazione sull'esercizio delle strade ferrate italiane* (1885-1903).

Rivista mineraria: Corpo delle miniere. *Relazione sul servizio minerario* (1877-82); *Rivista del servizio minerario* (1883 ff.).

Società di Monteponi (1952). *Società di Monteponi. Centenario, 1850-1950* (Torino: Tip. Bona).

Sommario: Istituto centrale di statistica. *Sommario di statistiche storiche italiane, 1861-1955* (Roma: Istituto poligrafico della Stato, 1958).

Statistica mineraria: Direzione generale della statistica. *Statistica del Regno d'Italia. Industria mineraria. Anno 1865.* (Milano and Firenze: Civelli, 1868).

Thorp, Frank H. (1920). *Outlines of Industrial Chemistry*, 3rd ed. (New York: Macmillan).

U.S. 13th Census VIII: United States Bureau of the Census. *Thirteenth Census of the United States taken in the year 1910. Volume VIII. Manufactures 1909. General Report and Analysis* (Washington, D.C.: G.P.O., 1913).

von Wagner, J. Rudolf (1904). *Manual of Chemical Technology*, W. Crookes and F. Fischer, tr. and ed. (New York: Appleton).

Wysor, Henry (1908). *Metallurgy: a Condensed Treatise for the Use of College Students and Any Desiring a General Knowledge of the Subject* (Easton, Pa.: The Chemical Publishing Co.).

Table E.01
Reported Labor Force and Factor Employment in Metalmaking in 1911

A. Census data

Census category	Industry group	*Censimento demografico* (labor force) Blue-collar	*Censimento demografico* (labor force) Total	*Censimento industriale* Employment Blue-collar	*Censimento industriale* Employment Total	*Censimento industriale* Unduplicated HP in use Primary	*Censimento industriale* Unduplicated HP in use Electric
4.11	Ferrous metal, ingot	8,923	9,536	6,369	6,699	19,197	3,385
4.12	do., semi-finished	29,699	32,406	26,661	29,002	75,138	8,491
4.1	Ferrous metal, total	38,622	41,942	33,030	35,701	94,335	11,876
4.21	Non-ferrous metal, ingot	1,574	1,877	573	635	391	5,405
4.22	do., semi-finished	6,206	7,296	5,378	6,327	3,022	1,026
4.2	Non-ferrous metal, total	7,780	9,173	5,951	6,962	3,413	6,431
4.ω1	(4.1 - 4.5)[a]			27,411	29,286	18,884	9,513
ω.31	(3.1[b], 3.2[c], and 4[a])			9,588	10,980	1,657	1,893
ω.71	(4[a] and 5[d])			3,607	4,371	3,062	520

B. Corpo delle miniere data

Rivista mineraria 1911 Sector	Blue-collar workers	Installed HP Primary	Installed HP Electric
Ferrous metal	33,558	130,293	31,824
Aluminum	278	0	5,250
Copper and its alloys	3,645	5,888	2,779
Gold	15	70	0
Lead, silver	371	572	0
Mercury	354	84	16
Non-ferrous metal, total	4,663	6,614	8,045

[a]metalmaking, engineering.
[b]wood products excluding cane, reed, and straw ware.
[c]cane, reed, and straw ware.
[d]non-metallic mineral products, construction.

Sources: *Censimento demografico*, *Censimento industriale*, *Rivista mineraria 1911*.

Table E.02
Reported Output of Ferrous Metals, 1861-1913 (tons)

Year	(1) pig iron[a] 1861-1913	(2) puddled iron 1899-1913	(3) ingot steel[b] 1899-1913	(4) cast iron 1886-1913	(5) processed wrought i. 1881-1913	(6) processed steel 1881-1913	(7) plate 1892-1913
			Reported aggregate output of ferrous metals				
1861	26,551						
1862	28,745						
1863	23,556						
1864	20,523						
1865	17,492						
1866	20,330						
1867	21,580						
1868	20,136						
1869	18,166						
1870	19,914						
1871	16,641						
1872	24,000						
1873	28,770						
1874	28,736						
1875	28,563						
1876	18,849						
1877	15,991						
1878	14,370						
1879	12,472						
1880	17,636						
1881	27,800				94,941	3,630	
1882	24,778				90,630	3,450	
1883	24,306				125,482	2,965	
1884	18,405				120,129	4,645	
1885	15,991				143,722	3,382	
1886	12,291			30,000	161,633	23,760	
1887	12,265			13,924	172,834	73,262	
1888	12,538			18,223	176,769	117,785	
1889	13,473			18,784	181,623	157,899	
1890	14,346			12,680	176,374	107,676	
1891	11,930			8,120	152,668	75,925	
1892	12,729			5,859	124,273	56,543	320
1893	8,038			8,159	138,046	71,380	2,500
1894	10,329			10,060	141,729	54,614	5,750
1895	9,213			10,287	163,824	50,314	5,860
1896	6,987			8,334	139,991	65,955	2,918
1897	8,393			9,256	149,944	63,940	6,500
1898	12,387			12,675	167,499	87,467	7,200
1899	19,218	23,986	149,450	20,289	197,730	108,501	8,000
1900	23,990	20,445	135,120	18,581	190,518	115,887	10,000
1901	15,819	22,265	129,229	15,071	180,729	123,310	7,550
1902	30,640	22,298	134,989	12,695	163,055	108,864	8,800
1903	75,279	18,129	187,361	15,465	177,392	154,134	11,275
1904	89,340	16,340	201,148	23,258	181,335	177,086	16,465
1905	143,079	15,455	270,199	38,169	205,915	244,973	18,560
1906	135,296	10,600	390,740	45,644	236,946	332,924	16,350
1907	112,232	17,600	430,000	36,764	248,157	346,749	24,423
1908	112,924	13,232	537,000	45,176	302,509	437,674	28,277
1909	207,800	8,900	661,569	47,104	281,098	608,795	35,880
1910	353,239	12,800	732,000	46,461	311,210	670,983	42,670
1911	302,931	2,000	736,000	39,655	303,223	697,958	46,352
1912	379,989	1,500	917,911	38,686	179,516	801,907	40,126
1913	426,755		933,500	32,051	142,820	846,085	39,698

Table E.02 (continued)

Year	(8) Processed wrought iron and steel, by product: balls and ingots 1895-1913	(9) rails[c] 1886-1913	(10) sheet, bar, pipes, etc.[d] 1882-1913	(11) fabricated metal 1888-1913
1861				
1862				
1863				
1864				
1865				
1866				
1867				
1868				
1869				
1870				
1871				
1872				
1873				
1874				
1875				
1876				
1877				
1878				
1879				
1880				
1881				
1882			94,080	
1883			128,447	
1884			124,774	
1885			147,104	
1886		15,000	170,393	
1887		39,522	206,574	
1888		70,167	222,887	1,500
1889		105,994	233,528	1,000
1890		69,895	213,005	1,150
1891		47,176	181,417	
1892		31,301	149,465	50
1893		39,344	169,918	82
1894		25,200	170,593	550
1895	1,200	17,653	173,527	21,758
1896	1,000	15,741	171,149	18,056
1897	310	16,047	172,761	24,776
1898	537	21,926	213,752	18,751
1899	14,856	20,734	233,403	37,238
1900	13,736	8,190	254,715	30,082
1901	22,647	24,833	225,647	30,912
1902	22,137	13,646	215,415	20,721
1903	25,200	39,239	247,823	19,264
1904	16,300	22,724	298,473	20,924
1905	34,594	34,568	350,849	30,697
1906	45,291	52,750	429,625	42,204
1907	54,699	75,400	443,670	27,669
1908	81,707	67,710	531,760	59,006
1909	105,494	123,290	629,678	31,431
1910	134,185	121,370	688,328	44,310
1911	162,777	107,431	694,177	49,596
1912		130,067	781,948	69,408
1913		173,560	591,763	80,762

Table E.02 (continued)

[a]includes ferromanganese; in 1878, corrected: see text.

[b]includes all steel obtained directly from the furnace, as ingots and other castings.

[c]in 1887, includes 10,000 tons transferred from col. 10.

[d]in 1887, excludes 10,000 tons transferred to col. 9.

Source: *Rivista mineraria*.

Table E.03
Estimated Output of Semi-Finished Ferrous Metals, Net of Rails, 1861-1913 (thousand tons)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Net imports of ferrous metals							
			cast iron		wrought iron and steel			
Year	pig iron 1861-1913	scrap iron 1861-1913	crude 1861-1913	fabri-cated 1861-1913	balls, ingot 1878-1913	rails 1861-1913	sheet, bar pipes, etc. 1861-1913	fabri-cated 1861-1913
1861	32	2	7	3		17	39	5
1862	21	2	13	4		13	43	6
1863	14	2	1	6		27	51	11
1864	16	2	6	0		24	48	10
1865	13	2	6	0		22	51	8
1866	14	3	5	0		16	40	8
1867	16	1	2	6		11	53	8
1868	13	1	1	2		6	56	8
1869	20	2	4	2		20	71	11
1870	19	5	3	2		27	62	10
1871	17	8	2	2		15	67	12
1872	18	18	4	2		23	60	11
1873	11	8	3	4		26	59	12
1874	29	14	4	3		49	67	11
1875	21	14	4	3		52	68	12
1876	22	23	3	2		39	68	10
1877	28	18	2	2		56	74	12
1878	19	18	4	3	0	36	61	9
1879	27	58	3	1	2	55	59	11
1880	28	53	6	2	1	58	70	13
1881	44	52	11	2	1	73	94	20
1882	39	70	16	2	1	133	98	23
1883	74	80	14	3	5	119	114	23
1884	67	82	12	3	12	99	111	23
1885	53	78	8	4	13	103	122	23
1886	80	116	13	4	19	52	153	23
1887	230	174	18	7	27	67	189	33
1888	88	164	13	7	20	34	125	22
1889	168	157	15	7	10	10	117	24
1890	128	168	7	5	5	5	79	19
1891	109	137	6	3	2	3	67	15
1892	99	145	5	2	1	11	60	13
1893	114	177	8	2	1	9	65	12
1894	118	157	4	2	4	7	67	11
1895	131	180	4	1	5	6	62	10
1896	118	162	3	2	21	4	55	11
1897	156	131	1	1	13	11	58	13
1898	168	138	2	2	10	15	55	16
1899	191	245	1	2	13	12	72	20
1900	160	197	2	5	17	23	81	23
1901	160	148	2	3	10	37	74	22
1902	155	199	2	4	15	10	98	26
1903	126	206	2	4	20	11	97	27
1904	149	246	2	4	23	14	94	20
1905	135	275	3	4	24	8	109	20
1906	170	342	7	6	23	21	173	43
1907	231	358	13	7	32	31	241	70
1908	254	324	14	8	43	31	203	79
1909	247	415	14	9	53	13	184	60
1910	205	384	18	9	29	17	174	67
1911	234	389	20	10	19	11	180	63
1912	267	338	14	8	13	2	190	61
1913	221	319	11	6	7	-6	172	58

Table E.03 (continued)

Year	(9) Estimated output of semi-finished ferrous metals: wrought iron and steel, net of rails: partial estimates of net output: plate 1881-1913	(10) from ingot 1881-1913	(11) other 1881-1913	(12) total 1861-1913	(13) cast iron 1861-1913	(14) Estimated supply of worn rails 1861-1885	(15) Estimated aggregate input supply 1861-1881
1861				47	22	0	78
1862				41	20	0	69
1863				31	19	0	57
1864				30	18	0	55
1865				26	18	1	50
1866				32	16	1	54
1867				34	16	1	57
1868				28	20	2	54
1869				29	23	2	60
1870				36	21	3	65
1871				30	21	3	58
1872				47	21	4	77
1873				39	18	3	64
1874				56	23	4	89
1875				51	22	5	82
1876				50	23	5	82
1877				48	25	6	83
1878				46	17	7	72
1879				79	27	7	120
1880				82	26	9	123
1881	0	0	2	101	31	9	150
1882	0	0	12	106	28	11	
1883	0	1	2	131	36	13	
1884	0	3	13	141	39	15	
1885	0	3	3	153	46	16	
1886	0	5	0	175	50		
1887	0	7	1	215	58		
1888	0	5	7	236	52		
1889	0	3	6	243	49		
1890	0	3	0	217	46		
1891	0	1	0	182	39		
1892	0	1	0	151	34		
1893	0	1	-1	170	34		
1894	0	0	-1	170	38		
1895	0	3	3	201	43		
1896	0	3	6	198	41		
1897	7	3	-2	206	46		
1898	7	3	-5	238	49		
1899	8	7	-5	281	61		
1900	10	8	-9	293	61		
1901	8	8	-8	265	57		
1902	8	9	0	253	58		
1903	9	11	0	287	64		
1904	15	10	0	344	71		
1905	16	15	0	413	83		
1906	11	17	0	500	107		
1907	19	22	0	506	117		
1908	23	31	0	645	133		
1909	31	40	0	732	139		
1910	34	41	0	802	146		
1911	37	45	0	813	145		
1912	3	46	0	900	168		
1913	-13	34	0	836	159		

Sources: cols. 1 - 8: *Movimento commerciale*.
cols. 9 - 15: see text.

Table E.04
Estimated Output of Aluminum, 1861-1913 (tons)[a]

Year	(1) Reported output of ingot aluminum 1901-1913	(2) Net imports of ingot aluminum[b] 1901-1913	(3) Estimated output of semi-finished aluminum 1861-1913
1901		5	5
1902		19	19
1903		74	74
1904		36	36
1905		42	42
1906		124	124
1907	322	256	578
1908	602	-123	479
1909	751	77	828
1910	827	-119	708
1911	798	-80	718
1912	824	-191	633
1913	874	-17	857

[a]production is assumed negligible before 1901.
[b]includes aluminum alloys.

Sources: col. 1: *Rivista mineraria*.
col. 2: *Movimento commerciale*.
col. 3: col. 1 + col. 2.

Table E.05
Estimated Output of Antimony, 1861-1913 (tons)

Year	(1) Estimated Caltanis. district output[a] 1861-1913	(2) Reported Firenze district output regulus[b] 1861-1913	(3) Reported Firenze district output sulfide[c] 1861-1913	(4) Reported Firenze district output oxide 1861-1913	(5) Reported Iglesias district output regulus[d] 1861-1913	(6) Reported Iglesias district output sulfide[e] 1861-1913	(7) Reported Iglesias district output oxide 1861-1913	(8) Estimated aggregate output 1861-1913
1861		33						33
1862		54						54
1863								0
1864								0
1865								0
1866	88							88
1867	88							88
1868	88							88
1869	88							88
1870	88							88
1871	88							88
1872	88							88
1873	88							88
1874	88							88
1875	70							70
1876	70							70
1877	49							49
1878	70							70
1879	35							35
1880	35	80						115
1881	35	57						92
1882	100	130						230
1883	143	222				106		365
1884	143	270	130			191		413
1885	143	220	20			435	22	363
1886	30	198	22			277	13	228
1887	70	17	5			135	3	87
1888	8							8
1889	2	195	2			30	1	197
1890	105	182	25			110	5	287
1891	71	218	21			81	12	289
1892	12	286	29			327		298
1893		366	10			411		366
1894	6	327	24			425	30	333
1895	12	388	35			535	37	400
1896	137	490	48			730	24	627
1897	25	357	47			564	36	382
1898	70	320	60			518	34	390
1899	28	380	61	140		506	35	408
1900	10	526	48	600		324	61	536
1901	16	905		800		250	195	831
1902	8	539		542		216	226	493
1903	1	383		521		196	242	346
1904	48	335		447		113	173	350
1905	10	317				106	213	137
1906	22	515				78	156	228
1907	30	420			70	90		268
1908	14	83		137	60	51		157
1909		48		11				48
1910								0
1911								0
1912								0
1913					71	5		71

Table E.05 (continued)

[a]in 1878 and 1901-08, reported as regulus; in 1882, 1886-87, 1889-90, and 1894 reported as sulfide.

[b]in 1901-04, includes sulfide; in 1905-07, includes oxide.

[c]in 1890-91, reported as mining output.

[d]in 1908, includes 44 tons of regulus and 3 tons of alloys obtained at a lead foundry.

[e]in 1892-93, includes oxide.

Sources: cols. 1, 8: see text.

cols. 2 - 7: *Notizie minerarie*, *Rivista mineraria*.

Table E.06
Estimated Output of Copper and Copper Alloys, 1861-1913 (tons)

Year	(1) Reported output of copper and copper alloys 1861-1893	(2) Reported output of worked copper and copper alloys 1885-1913	(3) Estimated output of ingot copper 1861-1913	(4) Net imports of ingot and scrap copper, brass, bronze 1861-1913	(5) Estimated output of semi-finished copper and copper alloys 1861-1913
1861	322		947	600	1,800
1862	322		629	700	1,500
1863	322		508	1,000	1,200
1864	322		805	0	1,500
1865	322		545	700	900
1866	322		620	100	1,200
1867	322		620	700	1,400
1868	322		620	1,100	1,900
1869	322		620	1,500	2,100
1870	322		620	1,300	2,000
1871	322		582	900	1,600
1872	322		613	300	1,400
1873	138		455	900	1,400
1874	49		370	1,300	1,800
1875	49		376	1,500	2,000
1876	11		300	1,500	1,900
1877	21		306	1,300	1,800
1878	22		250	1,200	1,600
1879			325	1,200	1,500
1880	128		448	700	1,900
1881	100		348	2,000	1,900
1882	117		343	1,400	2,500
1883	319		431	2,500	2,900
1884	400		530	2,700	3,300
1885	1,651	1,750	407	2,800	3,400
1886	2,239	1,831	408	2,500	3,400
1887	3,197	1,804	1,254	3,000	3,800
1888	5,332	4,065	2,955	1,200	6,100
1889	6,904	6,431	2,369	4,300	7,000
1890	6,406	5,963	1,381	2,700	6,600
1891	5,977	5,615	1,558	2,300	6,100
1892	6,039	5,474	2,172	2,000	6,000
1893	6,911	6,345	2,344	2,900	6,900
1894		7,048	2,640	3,700	8,200
1895		6,133	2,375	4,300	7,300
1896		7,477	2,842	4,100	8,700
1897		8,545	2,980	4,800	10,600
1898		8,535	3,230	4,600	10,500
1899		10,236	3,032	3,400	11,400
1900		10,405	2,797	5,500	11,600
1901		9,639	3,483	5,900	10,900
1902		10,230	3,863	6,900	11,500
1903		11,217	3,620	5,900	12,800
1904		11,873	3,593	11,300	13,900
1905		16,133	3,578	12,600	18,800
1906		15,457	4,311	15,500	18,800
1907		17,491	4,024	21,800	21,300
1908		18,280	2,825	19,400	22,000
1909		20,005	2,535	14,400	23,600
1910		22,467	1,766	20,700	26,700
1911		22,908	1,666	27,800	28,300
1912		26,659	2,319	31,900	32,600
1913		24,625	2,091	28,800	30,700

Sources: cols. 1 - 2: *Rivista mineraria*.
cols. 3, 5: see text.
col. 4: *Movimento commerciale*.

Table E.07
Estimated Output of Gold, 1861-1913 (kilograms)

Year	(1) Reported output 1861-1913	(2) Estimated output 1861-1913	Year	(1) Reported output 1861-1913	(2) Estimated output 1861-1913
			1890	206	162
1861		75	1891	284	247
1862		78	1892	330	299
1863		48	1893	362	313
1864		84	1894	349	346
1865		73	1895	280	280
1866	173	134	1896	275	266
1867	162	124	1897	316	315
1868	163	116	1898	188	184
1869	182	141	1899	113	111
1870	200	154	1900	58	57
1871		130	1901	4	4
1872		113	1902	1	1
1873		45	1903	63	50
1874		14	1904	10	9
1875	28	22	1905	15	14
1876	109	80	1906	78	71
1877	124	104	1907	58	52
1878	145	120	1908	71	63
1879	197	162	1909	15	10
1880	217	178	1910	24	16
1881	214	175	1911	55	25
1882	218	177	1912	33	17
1883	180	147	1913	27	14
1884	171	140			
1885	209	189			
1886	195	159			
1887	234	188			
1888	187	151			
1889	216	171			

Sources: col. 1: *Rivista mineraria*.
col. 2: see text

Table E.08
Estimated Output of Ingot Lead and Silver, 1861-1913 (tons)

Year	(1) Reported aggregate output silver 1861-1913	(2) Reported aggregate output ingot lead 1861-1913	(3) Reported Monteponi output silver 1895-1914[a]	(4) Reported Monteponi output ingot lead 1895-1914[a]	(5) Reported Sardinian output of work lead 1861-1891[a]	(6) Estimated aggregate output silver 1861-1913	(7) Estimated aggregate output ingot lead 1861-1913
1861	.541	73			1,281	3.1	4,500
1862	.856	89			1,513	3.8	4,900
1863	.701	78			2,207	3.9	5,300
1864	.640	56			2,192	3.8	5,200
1865	.676	50			2,121	3.7	5,100
1866	.659	41			1,887	3.6	5,000
1867	1.723	2,302			2,045	3.0	4,000
1868	3.039	4,687				3.8	5,700
1869	2.130	4,441				2.9	5,400
1870	2.033	3,883				2.8	4,900
1871	2.565	4,333				3.3	5,300
1872	2.557	4,656				3.3	5,700
1873	2.822	5,107				3.6	6,100
1874	2.818	4,445				3.6	5,400
1875	3.117	6,118				3.9	7,100
1876	3.314	4,852				4.1	5,900
1877	4.333	6,241				5.1	7,200
1878	7.335	8,174				7.6	8,500
1879	21.122	8,734				21.1	8,700
1880	24.035	10,712				24.0	10,700
1881	24.018	11,835				24.0	11,900
1882	24.128	13,315			1,226	24.1	13,300
1883	30.128	13,619			1,297	30.1	13,600
1884	31.191	15,000			1,613	31.2	15,000
1885	33.346	16,461			1,145	33.3	16,500
1886	33.839	19,508			1,030	33.8	19,500
1887	33.387	17,795			961	33.4	17,800
1888	34.891	17,481			637	34.9	17,500
1889	33.505	18,165			946	33.5	18,200
1890	34.248	17,768			585	34.2	17,800
1891	37.600	18,500			1	37.6	18,500
1892	43.000	22,000				43.0	22,000
1893	40.095	19,898				40.1	19,900
1894	58.626	19,605				58.6	19,600
1895	44.189	20,353		300		44.8	20,800
1896	38.075	20,786	1.139	948		38.2	21,100
1897	45.313	22,407	1.367	1,535		45.2	22,600
1898	43.437	24,543	1.181	1,849		44.2	24,800
1899	33.645	20,543	2.784	2,267		33.7	21,100
1900	31.169	23,763	2.871	3,300		31.6	24,200
1901	32.464	25,796	3.671	4,248		32.6	26,000
1902	29.522	26,494	4.009	4,753		29.5	26,100
1903	24.388	22,126	4.058	4,007		24.1	22,000
1904	24.943	23,475	3.446	3,666		24.8	23,400
1905	20.215	19,077	3.142	3,433		20.2	19,000
1906	20.362	21,268	3.112	3,268		20.2	21,100
1907	20.502	22,978	2.699	3,030		20.5	23,300
1908	20.746	26,003	2.746	3,623		20.6	25,800
1909	20.534	22,133	2.534	3,133		20.4	22,100
1910	14.237	14,495	2.237	2,995		14.2	14,800
1911	12.143	16,684	2.143	3,684		12.5	16,800
1912	14.363	21,450	2.863	3,922		14.5	22,100
1913	13.094	21,674	3.094	5,279		13.9	21,500
1914			4.754	5,019			

Table E.08 (continued)

[a]fiscal year: 12 months to June 30 of indicated year.

Sources: cols. 1 - 4: *Notizie minerarie*, *Rivista mineraria*.
col. 5: *Relazioni minerarie*, *Rivista mineraria*.
cols. 6 - 7: see text.

Table E.09
Estimated Output of Semi-finished Lead and Lead Alloys, 1861-1913 (thousand tons)

Year	(1) Net imports of ingot and scrap lead, lead alloys 1861-1913	(2) Net imports of antimony 1861-1913	(3) Estimated ingot and scrap lead consumed for chemicals[a] 1861-1913	(4) Estimated output of semi-finished lead, lead alloys 1861-1913
1861	4.7	.0	.1	7.1
1862	.7	.0	.1	7.7
1863	3.1	.0	.1	6.8
1864	.9	.0	.1	7.5
1865	3.2	.0	.1	6.9
1866	1.6	.0	.1	6.7
1867	.3	.0	.1	5.1
1868	1.4	.0	.1	6.8
1869	1.5	.0	.2	7.1
1870	2.6	.0	.2	7.2
1871	3.1	.0	.3	7.5
1872	1.5	.0	.3	8.0
1873	2.8	.0	.3	9.2
1874	5.4	.1	.4	8.4
1875	1.6	-.1	.4	10.9
1876	5.2	.1	.4	9.1
1877	3.8	-.2	.5	10.3
1878	2.0	-.2	.5	10.6
1879	1.9	.2	.5	10.3
1880	2.4	.1	.5	12.6
1881	2.1	.2	.6	13.4
1882	1.0	.1	.7	14.8
1883	2.4	.1	.8	15.5
1884	3.3	-.1	.9	17.0
1885	1.8	-.1	1.1	17.2
1886	-.4	-.2	1.2	19.3
1887	1.4	.0	1.3	17.5
1888	1.8	.1	1.2	19.2
1889	5.4	.0	1.6	19.9
1890	1.9	.0	1.9	20.0
1891	4.0	.0	2.3	18.6
1892	.8	-.3	2.7	21.1
1893	.1	-.2	3.0	17.5
1894	.3	-.2	4.4	15.0
1895	-1.2	-.2	4.2	16.4
1896	- .3	-.3	4.3	16.1
1897	-1.6	-.2	4.7	15.9
1898	-4.4	-.3	3.7	19.8
1899	1.5	-.2	3.1	16.6
1900	-1.6	-.4	2.9	20.8
1901	-1.5	-.7	2.2	23.7
1902	1.9	-.3	2.0	25.1
1903	2.4	-.2	1.9	22.5
1904	2.6	.0	1.7	25.6
1905	5.8	.0	1.5	23.3
1906	8.9	-.2	1.8	26.9
1907	7.7	.0	1.8	30.8
1908	10.5	.1	1.9	33.4
1909	9.2	.3	2.3	31.2
1910	13.7	.3	2.1	27.2
1911	19.6	.4	2.1	30.1
1912	11.5	.6	1.8	34.8
1913	10.9	.5	1.9	31.5

Table E.09 (continued)

[a]in 1909-13, includes 100 tons p. a. consumed for terne plate.

Sources: cols. 1 - 2: *Movimento commerciale*.
cols. 3 - 4: see text.

Table E.10
Reported Output of Mercury, 1861-1913 (tons)

Year	(1) Reported output 1861-1913	(2) Reported net exports 1861-1913	Year	(1) Reported output 1861-1913	(2) Reported net exports 1861-1913
			1890	449	364
1861	24	-6	1891	330	449
1862	26	-5	1892	325	196
1863	22	-11	1893	273	185
1864	26	-9	1894	258	271
1865	26	-5	1895	199	169
1866	20	-3	1896	186	104
1867	15	-1	1897	192	172
1868	18	2	1898	173	171
1869	24	0	1899	205	134
1870	47	44	1900	260	175
1871	36	51	1901	278	221
1872	27	71	1902	259	132
1873	31	69	1903	312	162
1874	32	78	1904	352	201
1875	82	90	1905	369	155
1876	99	88	1906	417	222
1877	111	65	1907	434	283
1878	124	68	1908	684	462
1879	132	98	1909	771	593
1880	116	115	1910	894	648
1881	128	119	1911	955	862
1882	140	195	1912	1,000	826
1883	206	169	1913	1,004	827
1884	267	288			
1885	237	244			
1886	251	228			
1887	244	289			
1888	339	215			
1889	386	318			

Sources: col. 1: *Notizie minerarie*, *Rivista mineraria*.
col. 2: see text.

Table E.11
Estimated Output of Tin, 1861-1913 (thousand tons)

Year	(1) Reported output of ingot tin 1861-1913	(2) Net imports of ingot and scrap tin[a] 1861-1913	(3) Reported output of tin plate[b] 1861-1913	(4) Estimated output of bronze 1861-1913	(5) Estimated output of semi-finished tin 1861-1913
1861		.3		.1	.3
1862		.3		.1	.3
1863		.4		.1	.3
1864		.3		.1	.3
1865		.3		.0	.3
1866		.4		.1	.3
1867		.3		.1	.4
1868		.4		.1	.3
1869		.3		.1	.3
1870		.3		.1	.3
1871		.3		.1	.3
1872		.3		.1	.3
1873		.4		.1	.4
1874		.4		.1	.4
1875		.5		.1	.5
1876		.6		.1	.5
1877		.5		.1	.4
1878		.1		.1	.4
1879		.5		.1	.4
1880		.5		.1	.6
1881		.7		.1	.6
1882		.7		.1	.7
1883		.8		.1	.8
1884		1.0		.2	.8
1885		.8		.2	.9
1886		.9		.2	.9
1887		1.0		.2	.9
1888		.9		.3	.9
1889		.9		.4	.8
1890		.8		.3	.8
1891		.9		.3	.9
1892		1.0	.3	.3	.9
1893		1.1	4.0	.3	.9
1894		1.3	5.8	.4	1.0
1895		1.4	5.9	.4	1.1
1896		1.7	2.9	.5	1.2
1897		1.5	6.5	.5	1.2
1898	.002	1.7	7.2	.5	1.0
1899	.005	1.2	8.0	.5	1.0
1900	.015	1.5	10.0	.4	.9
1901	.006	1.7	7.6	.4	1.2
1902	.012	1.9	8.8	.4	1.4
1903	.015	2.1	11.3	.3	1.4
1904	.015	2.0	16.5	.3	1.3
1905	.014	2.0	18.6	.5	1.5
1906	.014	3.1	16.4	.7	1.7
1907	.002	2.4	24.4	.9	1.5
1908		2.4	28.3	1.0	1.2
1909	.007	2.5	30.9	.9	1.1
1910		2.6	27.8	.8	1.2
1911		2.3	25.7	1.1	1.3
1912		2.5	28.9	1.0	1.2
1913		2.8	29.2	.9	1.3

Table E.11 (continued)

[a]includes ore, 1868-77.

[b]in 1893, estimated: see text.

Sources: cols. 1, 3: *Rivista mineraria*.
col. 2: *Movimento commerciale*.
cols. 4, 5: see text.

Table E.12
Estimated Output of Zinc, 1861-1913 (thousand tons)

Year	(1) Reported output of ingot zinc 1861-1913	(2) Net imports of ingot and scrap zinc 1861-1913	(3) Estimated output of brass[a] 1861-1913	(4) Estimated ingot and scrap lead consumed for chemicals 1861-1913	(5) Estimated output of semi-finished zinc 1861-1913
1861		.0	.7	.0	.0
1862		.4	.6	.0	.2
1863		.4	.5	.0	.3
1864		.2	.6	.0	.2
1865	.080	.0	.3	.0	.2
1866		.3	.5	.0	.1
1867		.1	.5	.0	.1
1868		.0	.7	.0	.0
1869		.1	.8	.0	.0
1870		.1	.8	.0	.0
1871		.2	.6	.0	.0
1872		.1	.5	.0	.0
1873		.1	.5	.0	.0
1874		.2	.7	.0	.0
1875		.2	.8	.0	.0
1876		.2	.7	.0	.1
1877		.3	.7	.0	.1
1878		.3	.6	.0	.2
1879		.4	.6	.0	.1
1880		.1	.7	.0	.2
1881		.5	.7	.0	.2
1882		.4	1.0	.0	.3
1883		.6	1.1	.0	.3
1884		.7	1.3	.0	.5
1885		1.3	1.3	.0	.6
1886		.9	1.3	.0	.8
1887		1.3	1.4	.0	1.0
1888		1.8	2.3	.0	1.1
1889		2.0	2.7	.0	1.2
1890		1.8	2.5	.1	1.1
1891		1.6	2.3	.1	1.0
1892		1.6	2.3	.1	1.0
1893		1.7	2.6	.3	.9
1894		2.2	3.1	.5	.8
1895		2.3	2.8	.6	1.0
1896		2.5	3.5	.5	1.2
1897	.250	3.0	3.7	.7	1.4
1898	.250	2.7	3.8	.7	1.7
1899	.251	3.3	3.6	.6	1.9
1900	.547	3.3	3.3	.4	2.8
1901	.511	3.6	3.1	.5	2.8
1902	.485	3.5	2.8	.6	2.9
1903	.126	4.0	2.6	.1	3.6
1904	.189	4.9	2.3	.6	3.8
1905	.005	5.6	3.6	.1	4.6
1906	.069	6.2	5.5	.7	4.3
1907	.088	7.0	6.8	.7	4.8
1908		8.3	6.5	.9	5.3
1909		8.2	6.8	.9	5.5
1910		8.2	7.3	.9	5.8
1911		10.1	7.7	1.0	6.6
1912		10.8	12.2	1.2	6.0
1913		10.8	12.1	1.5	6.0

[a]includes other zinc-copper alloys.

Sources: col. 1: *Statistica mineraria*, *Rivista mineraria*.
col. 2: *Movimento commerciale*.
cols. 3 - 5: see text.

Summary Table E.1
The metalmaking industries: physical output, 1861-1913

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ferrous metals				Non-ferrous metals			
		Wrought iron, steel						
	Pig iron (tons)	Rails (tons)	Other products (tons)	Cast iron (tons)	Ingot aluminum (tons)	Semi-finished aluminum (tons)	Antimony (tons)	Ingot copper (tons)
code:	ea01	ea02	ea03	ea04	eb01	eb02	eb03	eb04
source:	e02c01	e02c09	e03c12	e03c13	e04c01	e04c03	e05c08	e06c03
note:	(a)	(a)	(b)	(c)	(a)	(d)	(e)	(e)
1861	26,551	0	47,000	22,000	0	0	33	947
1862	28,745	0	41,000	20,000	0	0	54	629
1863	23,556	0	31,000	19,000	0	0	0	508
1864	20,523	0	30,000	18,000	0	0	0	805
1865	17,492	0	26,000	18,000	0	0	0	545
1866	20,330	0	32,000	16,000	0	0	88	620
1867	21,580	0	34,000	16,000	0	0	88	620
1868	20,136	0	28,000	20,000	0	0	88	620
1869	18,166	0	29,000	23,000	0	0	88	620
1870	19,914	0	36,000	21,000	0	0	88	620
1871	16,641	0	30,000	21,000	0	0	88	582
1872	24,000	0	47,000	21,000	0	0	88	613
1873	28,770	0	39,000	18,000	0	0	88	455
1874	28,736	0	56,000	23,000	0	0	88	370
1875	28,563	0	51,000	22,000	0	0	70	376
1876	18,849	0	50,000	23,000	0	0	70	300
1877	15,991	0	48,000	25,000	0	0	49	306
1878	14,370	0	46,000	17,000	0	0	70	250
1879	12,472	0	79,000	27,000	0	0	35	325
1880	17,636	0	82,000	26,000	0	0	115	448
1881	27,800	0	101,000	31,000	0	0	92	348
1882	24,778	0	106,000	28,000	0	0	230	343
1883	24,306	0	131,000	36,000	0	0	365	431
1884	18,405	0	141,000	39,000	0	0	413	530
1885	15,991	0	153,000	46,000	0	0	363	407
1886	12,291	15,000	175,000	50,000	0	0	228	408
1887	12,265	39,522	215,000	58,000	0	0	87	1,254
1888	12,538	70,167	236,000	52,000	0	0	8	2,955
1889	13,473	105,994	243,000	49,000	0	0	197	2,369
1890	14,346	69,895	217,000	46,000	0	0	287	1,381
1891	11,930	47,176	182,000	39,000	0	0	289	1,558
1892	12,729	31,301	151,000	34,000	0	0	298	2,172
1893	8,038	39,344	170,000	34,000	0	0	366	2,344
1894	10,329	25,200	170,000	38,000	0	0	333	2,640
1895	9,213	17,653	201,000	43,000	0	0	400	2,375
1896	6,987	15,741	198,000	41,000	0	0	627	2,842
1897	8,393	16,047	206,000	46,000	0	0	382	2,980
1898	12,387	21,926	238,000	49,000	0	0	390	3,230
1899	19,218	20,734	281,000	61,000	0	0	408	3,032
1900	23,990	8,190	293,000	61,000	0	0	536	2,797
1901	15,819	24,833	265,000	57,000	0	5	831	3,483
1902	30,640	13,646	253,000	58,000	0	19	493	3,863
1903	75,279	39,239	287,000	64,000	0	74	346	3,620
1904	89,340	22,724	344,000	71,000	0	36	350	3,593
1905	143,079	34,568	413,000	83,000	0	42	137	3,578
1906	135,296	52,750	500,000	107,000	0	124	228	4,311
1907	112,232	75,400	506,000	117,000	322	578	268	4,024
1908	112,924	67,710	645,000	133,000	602	479	157	2,825
1909	207,800	123,290	732,000	139,000	751	828	48	2,535
1910	353,239	121,370	802,000	146,000	827	708	0	1,766
1911	302,931	107,431	813,000	145,000	798	718	0	1,666
1912	379,989	130,067	900,000	168,000	824	633	0	2,319
1913	426,755	173,560	836,000	159,000	874	857	71	2,091

Summary Table E.1 (continued)

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	Non-ferrous metals (continued)							
	Semi-finished copper (tons)	Gold (Kilo-grams)	Silver (tons)	Ingot lead (tons)	Semi-finished lead (tons)	Mercury (tons)	Semi-finished tin (tons)	Semi-finished zinc (tons)
code:	eb05	eb06	eb07	eb08	eb09	eb10	eb11	eb12
source:	e06c05	e07c02	e08c06	e08c07	e09c04	e10c01	e11c05	e12c05
note:	(f,g)	(e)	(e)	(e)	(d,f)	(a)	(d)	(d)
1861	1,800	75	3.1	4,500	7,100	24	300	0
1862	1,500	78	3.8	4,900	7,700	26	300	200
1863	1,200	48	3.9	5,300	6,800	22	300	300
1864	1,500	84	3.8	5,200	7,500	26	300	200
1865	900	73	3.7	5,100	6,900	26	300	200
1866	1,200	134	3.6	5,000	6,700	20	300	100
1867	1,400	124	3.0	4,000	5,100	15	400	100
1868	1,900	116	3.8	5,700	6,800	18	300	0
1869	2,100	141	2.9	5,400	7,100	24	300	0
1870	2,000	154	2.8	4,900	7,200	47	300	0
1871	1,600	130	3.3	5,300	7,500	36	300	0
1872	1,400	113	3.3	5,700	8,000	27	300	0
1873	1,400	45	3.6	6,100	9,200	31	400	0
1874	1,800	14	3.6	5,400	8,400	32	400	0
1875	2,000	22	3.9	7,100	10,900	82	500	0
1876	1,900	80	4.1	5,900	9,100	99	500	100
1877	1,800	104	5.1	7,200	10,300	111	400	100
1878	1,600	120	7.6	8,500	10,600	124	400	200
1879	1,500	162	21.1	8,700	10,300	132	400	100
1880	1,900	178	24.0	10,700	12,600	116	600	200
1881	1,900	175	24.0	11,900	13,400	128	600	200
1882	2,500	177	24.1	13,300	14,800	140	700	300
1883	2,900	147	30.1	13,600	15,500	206	800	300
1884	3,300	140	31.2	15,000	17,000	267	800	500
1885	3,400	189	33.3	16,500	17,200	237	900	600
1886	3,400	159	33.8	19,500	19,300	251	900	800
1887	3,800	188	33.4	17,800	17,500	244	900	1,000
1888	6,100	151	34.9	17,500	19,200	339	900	1,100
1889	7,000	171	33.5	18,200	19,900	386	800	1,200
1890	6,600	162	34.2	17,800	20,000	449	800	1,100
1891	6,100	247	37.6	18,500	18,600	330	900	1,000
1892	6,000	299	43.0	22,000	21,100	325	900	1,000
1893	6,900	313	40.1	19,900	17,500	273	900	900
1894	8,200	346	58.6	19,600	15,000	258	1,000	800
1895	7,300	280	44.8	20,800	16,400	199	1,100	1,000
1896	8,700	266	38.2	21,100	16,100	186	1,200	1,200
1897	10,600	315	45.2	22,600	15,900	192	1,200	1,400
1898	10,500	184	44.2	24,800	19,800	173	1,000	1,700
1899	11,400	111	33.7	21,100	16,600	205	1,000	1,900
1900	11,600	57	31.6	24,200	20,800	260	900	2,800
1901	10,900	4	32.6	26,000	23,700	278	1,200	2,800
1902	11,500	1	29.5	26,100	25,100	259	1,400	2,900
1903	12,800	50	24.1	22,000	22,500	312	1,400	3,600
1904	13,900	9	24.8	23,400	25,600	352	1,300	3,800
1905	18,800	14	20.2	19,000	23,300	369	1,500	4,600
1906	18,800	71	20.2	21,100	26,900	417	1,700	4,300
1907	21,300	52	20.5	23,300	30,800	434	1,500	4,800
1908	22,000	63	20.6	25,800	33,400	684	1,200	5,300
1909	23,600	10	20.4	22,100	31,200	771	1,100	5,500
1910	26,700	16	14.2	14,800	27,200	894	1,200	5,800
1911	28,300	25	12.5	16,800	30,100	955	1,300	6,600
1912	32,600	17	14.5	22,100	34,800	1,000	1,200	6,000
1913	30,700	14	13.9	21,500	31,500	1,004	1,300	6,000

Summary Table E.1 (continued)

NOTES

(a) Production is taken as reported by the Corpo delle miniere.

(b) Production is estimated, from 1881, from the abundant data provided by the Corpo delle miniere; in earlier years it is estimated from the apparent consumption of pig and scrap, allowing for cast iron.

(c) Production is estimated assuming a smoothly declining ratio of cast iron to wrought iron and steel in final consumption.

(d) Production is estimated from the apparent consumption of ingot and scrap metal.

(e) Production is estimated from the abundant data provided by the Corpo delle miniere.

(f) Includes semi-finished alloys.

(g) Production is estimated, from 1889, from the abundant data provided by the Corpo delle miniere; in earlier years it is estimated from the apparent consumption of ingot and scrap metal.

Summary Table E.2
The metalmaking industries: value added in 1911

1. By product

(1) Physical series code	(2) product	(3) Value added per unit	(4) Total value added million lire	(5) series code
Ferrous metals				
ea01	pig iron	8.000 lire/ton	2.423	ea01v
ea02	rails	48.000 lire/ton	5.157	ea02v
ea03	other w. iron etc.	90.000 lire/ton	73.170	ea03v
ea04	cast iron	120.000 lire/ton	17.400	ea04v
Non-ferrous metals				
eb01	ingot aluminum	400.000 lire/ton	.319	eb01v
eb02	semi-f. aluminum	700.000 lire/ton	.503	eb02v
eb03	antimony	230.000 lire/ton	.000	eb03v
eb04	ingot copper	700.000 lire/ton	1.166	eb04v
eb05	semi-f. copper	450.000 lire/ton	12.735	eb05v
eb06	gold	400.000 lire/kilogram	.010	eb06v
eb07	silver	3,500.000 lire/ton	.044	eb07v
eb08	ingot lead	53.200 lire/ton	.894	eb08v
eb09	semi-f. lead	85.000 lire/ton	2.559	eb09v
eb10	mercury	1,000.000 lire/ton	.955	eb10v
eb11	semi-f. tin	300.000 lire/ton	.390	eb11v
eb12	semi-f. zinc	100.000 lire/ton	.660	eb12v

2. By industry

(1) Code	(2) Industry	(3) Value added (million lire)	(4) Component series
eav	ferrous metals	98.150	ea01v--ea04v
ebv	non-ferrous metals	20.234	eb01v--eb12v

3. By industry group

(1) Code	(2) Industry	(3) Value added (million lire)	(4) Component series
ev	metalmaking	118.384	eav--ebv

Note to Panel 1: the disaggregated value added series identified in col. 5 are the physical series identified in col. 1, weighted by by the unit value added estimates in col. 3. The latter are variously obtained from evidence on output prices and per-unit raw material costs, or on (total or per-unit) labor and capital costs.

Note to Panels 2 and 3: the aggregate value added series identified in col. 1 are simple sums of the component series identified in col. 4.

Summary Table E.3
The metalmaking industries: value added at 1911 prices, 1861-1913
(million lire)

code:	(1) Ferrous metals eav	(2) Non-ferrous metals ebv	(3) Metal-making ev
1861	7.082	2.478	9.561
1862	6.320	2.223	8.543
1863	5.258	1.930	7.189
1864	5.024	2.336	7.360
1865	4.640	1.822	6.462
1866	4.963	2.016	6.979
1867	5.153	1.936	7.088
1868	5.081	2.358	7.439
1869	5.515	2.471	7.986
1870	5.919	2.435	8.355
1871	5.353	2.257	7.610
1872	6.942	2.236	9.178
1873	5.900	2.257	8.157
1874	8.030	2.261	10.291
1875	7.459	2.738	10.196
1876	7.411	2.474	9.885
1877	7.448	2.594	10.042
1878	6.295	2.603	8.898
1879	10.450	2.650	13.099
1880	10.641	3.306	13.948
1881	13.032	3.374	16.406
1882	13.098	3.919	17.017
1883	16.304	4.372	20.676
1884	17.517	4.916	22.433
1885	19.418	4.997	24.415
1886	22.568	5.329	27.897
1887	28.305	5.848	34.154
1888	30.948	8.280	39.228
1889	32.945	8.445	41.390
1890	28.520	7.633	36.153
1891	23.420	7.398	30.818
1892	19.274	8.218	27.492
1893	21.333	8.275	29.608
1894	21.152	8.914	30.066
1895	24.171	8.438	32.609
1896	23.551	9.446	32.997
1897	24.897	10.474	35.371
1898	28.452	10.949	39.401
1899	33.759	10.737	44.496
1900	34.275	11.300	45.575
1901	32.009	11.969	43.978
1902	30.630	12.600	43.231
1903	35.996	12.705	48.700
1904	41.285	13.509	54.795
1905	49.934	15.372	65.306
1906	61.454	16.482	77.936
1907	64.097	18.311	82.408
1908	78.163	18.373	96.536
1909	90.140	18.840	108.980
1910	98.352	19.067	117.419
1911	98.150	20.234	118.384
1912	110.443	23.217	133.660
1913	106.065	22.114	128.179