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Stefano Fenoaltea

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CONTENTS

TABLES

SUMMARY TABLES

J. THE UTILITIES INDUSTRIES

J01. Introduction

J01.01 The output data and estimates

In the 1911 *Censimento industriale* and *Censimento demografico*, the production and distribution of power, light, water, and heat are grouped into a single category (*sotto-classe* 8.21); in the *ISIC*, major division 4 comprises the production and distribution of electricity (4101), gas (4102), and steam (4103) in division 41, and the collection and distribution of water (4200), excluding however the operation of irrigation systems (part of 1120), in division 42. Since almost all industrial establishments use heat or power, and most generate at least some of what they use themselves directly from fuel or prime movers, the production of energy is in fact ubiquitous; the energy industries are thus uniquely characterized not by their production as such but by the fact that they distribute the energy they produce rather than consume it themselves. This is spelled out in the *ISIC*, where the general convention is in any case to classify entire establishments by their major kind of activity. It is not spelled out in the 1911 censuses, where the general convention is instead to classify production strictly by the nature of technical processes; but it is implicit in the fact that the *Censimento industriale* counts the prime movers of establishments in industry-specific categories, and takes only a handful of establishments to straddle the utilities and other industries (see above, section A03.02, and below, section J01.02). Here too, the in-house production of heat and power is considered part of the consuming industry, and the utilities industry is correspondingly defined to exclude it. The definition of the industry at hand is thus consistent with that of the other industries; if it remains exceptional in covering only part of the industry's characteristic activities, it is *pro tanto* closer to the criteria underlying both the 1911 censuses and the *ISIC*. Where these differ, the present classification follows the *ISIC*: in excluding the operation of irrigation systems (which the 1911 censuses appear to include in category 8.21, at least up to the point where that operation was taken over by the water-consuming agricultural unit), and of course in disaggregating the industry into components covering electricity, gas, and water (steam is instead neglected, since little or none seems to have been produced for distribution).

The evidence of production movements, and the corresponding estimation procedures, are specific to each branch of the industry. In the case of electric power, licensing fees and consumption taxes generated data on capacity and consumption. The data on the capacity of commercial power stations, and estimates of utilization rates, are used to estimate the industry's production of thermal and hydraulic electricity through most of the period at hand; these are then extrapolated to 1913 with the aid of the aggregate consumption data. The gas industry is here identified with the production and distribution of gas from coal and oil, since commercial sales of natural gas appear to have been negligible. The distillation of coal and oil was also subject to licensing fees and to consumption taxes; but production data were provided by the Corpo delle miniere, and the present estimates of the industry's output of gas, coke, and tar are obtained directly from the latter. The water-supply industry, in turn, is here disaggregated into three components. The growth of the Apulian aqueduct, which was much the largest single such project in Italy, is estimated from the investment data in the concessionaire's annual report. The growth of other aqueducts is instead estimated from the aqueduct-specific data on capacity, length, and year of construction in a comprehensive survey sponsored by the Health office of the Department of the Interior in 1903, and subsequently with the aid of analogous data for a broad sample of cities in the *Annuario città 1934*. Finally, the growth of the local distribution networks is estimated from the publications of some major cities, from various current editions of the *Annuario città*, and, indirectly, from the growth of aqueduct capacity.

J01.02 The employment data and value added estimates

The disaggregated estimates of value added at 1911 prices are also obtained in disparate ways. In the case of electric power, aggregate value added is estimated both from the value of the output and the raw materials, and from the annual capital and personnel costs per unit of capacity and output. In the case of gas production, aggregate value added is estimated directly from the value of the outputs and the raw materials, and then allocated among the outputs in proportion to their value. In the case of water supply, value added figures are tentatively obtained by estimating 1911-price capital values, converting these to annual capital costs, and allowing for labor costs. The estimates so obtained equal some 106.9 million lire, including 18.3 million lire for wages and salaries, in the electric power industry; 38.1 million lire, including 8.8 million lire for wages and salaries (judging from the blue-collar employment reported by the Corpo delle miniere), in the gas industry; and 43.6 million lire, including 9.7 million lire for wages and salaries, in the water-supply industry. These aggregate to 188.7 million lire, of which 36.8 for wages and salaries.

In the *Censimento industriale,* category 8.21 is attributed 32,449 persons, including 26,421 wage-earners (all but 574 of them adult males), and some 790,600 primary horsepower (including 569,300 of water power and 172,500 of steam power). Some 767,800 primary horsepower were used to drive generators yielding 617,000 electric horsepower, of which all but 36,900 were delivered outside the producing establishment. A further 36,900 electric horsepower were listed as operating on purchased electricity; but these no doubt duplicated the power of prime movers in other establishments of this same census category. Category ω.62, in turn, straddles categories 3. (industries working animal and vegetable products, excluding textiles) and 8.21. It is attributed 1,738 persons, including 1,354 wage-earners (all but 163 of them adult males), some 8,000 primary horsepower (of which 4,400 were used to drive generators yielding 3,600 horsepower, 68% of them delivered outside the producing establishment), and 600 horsepower operating on purchased electricity. These data suggest that some 3,000 primary horsepower and (given the proportions that characterize category 8.21) some 123 persons (including 100 wage-earners) counted in category ω.62 can be added to those in category 8.21; the other 1,615 persons and 5,600 unduplicated horsepower in category ω.62 would seem largely attributable to flour mills (category 3.33, with an average 3.9 unduplicated horsepower per person) or lumber mills (part of category 3.11, with an average 1.5 unduplicated horsepower per person). On balance, then, the *Censimento industriale* suggests an aggregate employment in the utilities industries of about 32,600 persons, including 26,500 wage-earners, and some 793,600 primary horsepower. The *Censimento demografico*, by way of comparison, lists some 32,800 persons in the industry's labor force; curiously, however, only 26,200 of these were wage-earners.

In general, the present estimates of labor costs seem eminently compatible with the available employment data. Excluding the gas industry's labor cost and employment (since these were derived together from the *Rivista mineraria*, and are therefore compatible by construction), one obtains a residual labor cost equal to 28.0 million lire and a residual employment of 25,400 people, including 20,700 wage-earners. At the standard allowance of 2,000 lire per manager or white-collar employee, and about 1,000 lire per wage-earner, that employment corresponds to some 30.1 million lire in wages and salaries, or 2.1 million lire above the present figure. That margin is further to be reduced by the personnel costs of irrigation works, which the census includes among the utilities: the public budget data for the State-owned irrigation works point to a personnel cost of perhaps .5 million lire (e.g., *Rendiconto consuntivo 1910-11*, pp. 512-521, budget item 74 plus, say, one third of items 87 and 92, allowing for contract labor counted in the construction industry), and the total irrigation industry was about 3.5 times the State-owned component (below, section K04.08). The small residual is well within the margin of error in the round figures allowed for unit wages and salaries.

J02. Electricity

J02.01 Introduction

The electric light and power industry is here defined to include the generation and distribution of electric energy for sale to household and business users, but not the generation of electric power consumed directly by the producing firm. This definition is unusual, in the present context, to the extent that it excludes part of the industry's characteristic production; as noted in section J01.01 above, however, it is consistent with the definitions of other industries, analogous to those of the other utilities, and essentially identical to its counterparts in the 1911 censuses and the *ISIC* (category 4101).

Data on the production of electric power were not compiled, and the existing time series consist of relatively recent estimates (*Sommario*, p. 135; *Reddito nazionale*, p. 107). However, the indirect evidence is relatively rich, as the *legge 8 agosto 1895, n. 486* subjected the generation of electricity to a licencing fee, and the consumption of electricity for private lighting and space heating to an excise tax (Alleg. F, arts. 1 and 6). The *Imposte di fabbricazione* thus contains data on taxed consumption from 1895-96, and on tax-exempt consumption from 1908-09. Since the latter accounted for some 90% of the total, the early partial data are of little value; on the other hand, the aggregate includes private as well as commercial energy, so that for present purposes its coverage is excessively broad. The licencing procedures instead resulted in the publication of two statistical surveys of Italy's generating capacity: the *Statistica elettrica 1898*, concerned primarily with the plants extant at the end of that year, and the *Statistica elettrica 1908*, concerned primarily with those added in 1899-1908. Both of these report installed power (kilowatts) rather than output (kilowatt-hours); but they include a variety of useful technical, commercial, and chronological indications. Production is here accordingly represented by separate series for hydraulic and thermal electric power. These are obtained, from the birth of the industry in 1883 through 1908, by using the data in the *Statistica elettrica* to estimate the aggregate hydraulic and thermal generating capacity of the commercial power stations, and then converting these with the aid of plausible annual utilization figures based on those in Mortara (1934). In the absence of better evidence, the resulting estimates are then extrapolated to 1913 on the basis of the aggregate consumption figures reported in the *Imposte di fabbricazione*.

An aggregate estimate of value added is obtained from evidence on the value of output and of the materials consumed in production on the one hand, and on annual capital and personnel costs on the other. In the absence of direct evidence on the relative value of hydraulic and thermal power, the desired disaggregated estimates reflect the relative interest, depreciation, and labor costs per unit of capacity in production, and output, in distribution.

J02.02 Output

In Table J.01, cols. 1 and 2 transcribe the taxed and aggregate consumption reported by the *Imposte di fabbricazione*; one notes that a significant proportion of taxed consumption was estimated indirectly rather than actually metered (e.g., *Imposte di fabbricazione 1898-99*, pp. 62-63, *Annuario 1900*, p. 494). The analogous time series in the secondary sources display occasional minor discrepancies from the present figures (*Sommario*, p. 135; Mortara, 1934, vol. 2, p. 174)

Data on the capacity of commercial power stations, disaggregated by the nature of the prime mover, are available only for the end of 1898 (*Statistica elettrica 1898*, pp. 32-33). The present figures for 1898 in cols. 7 and 8 are obtained directly from those data, distributing the 3,200 kW powered by both thermal and hydraulic motors equally over these two categories, and ignoring the 200 kW powered not by prime movers but by electric energy. The other figures in cols. 7 and 8 are obtained with the aid of the less direct information provided by the *Statistica elettrica* and summarised here in cols. 3 – 6. Col. 3 transcribes the aggregate capacity of commercial plants by reported year of introduction. The present figures for 1895-98 are from the *Statistica elettrica 1898*, p. 49; they distribute the capacity available at the end of 1898 by the year in which it was introduced, grouping all those introduced before 1896 in a single category. The data are further disaggregated only to separate out the minority of plants that provided power but not light; the difference between the sum of col. 3 over 1895-98 (55.5 thousand kW) and the sum of cols. 7 and 8 in 1898 (55.3 thousand kW) is the 200 kW powered by electric energy which could be excluded from cols. 7 and 8 but not from col. 3. The corresponding figures for 1899-1908 are from the *Statistica elettrica 1908*, pp. 96-109, aggregating over the province-specific data (with the Chieti figure for 1899 set equal to 150 kW, as defined by the available subtotals, rather than 15 kW); the introductory note (p. 95) indicates that the current capacity of radically transformed plants is attributed entirely to the year in which they were transformed, while that of plants that were merely enlarged is attributed entirely to the year in which they first came on stream. A comparison of the sum of the figures disaggregated by year and commercial purpose but not by motive power (pp. 96-109) with those disaggregated by motive power but not by year or commercial purpose (pp. 54-61) indicates that the figures in col. 3 for 1899-1908 include the capacity of generators powered by electricity rather than by prime movers, as do those for the earlier years; however, the aggregate power of those generators was only about 7,000 kW (p. 61), and much of that was probably private (some 43%, judging from the comparable figures for 1898 in the *Statistica elettrica 1898*, p. 33), so that the average share of these generators in the figures in col. 3 from 1899 to 1908 is unlikely to exceed 1.5%. From the present perspective, the more serious weaknesses of col. 3 as an extrapolator of cols. 7 and 8 lie elsewhere: first, obviously, in the fact that it is not disaggregated by motive power, or by year before 1896; and second, in the fact that it approximates the relevant net increments in capacity only with a number of varying biases.

The desired disaggregation of col. 3 is based on the figures in cols. 4 – 6, obtained from the plant-specific data for a broad sample of power stations in the *Statistica elettrica 1898*, pp. 60-127 (for 1883-98) and *1908*, pp. 112-156 (for 1899-1908). The present figures are obtained by summing over the reported generating capacities, grouped by year and motive power. Plants not reporting the date, the capacity, or the type of motive power are omitted, as are those powered exclusively by electricity (those powered by a combination of electricity and prime movers are included, treating the electric power as if it were thermal). Where adjoining capacity figures are linked in a way that suggests a single system, and only one of these is dated, the others are attributed to that same year; where a single capacity figure is related to two dates, or to a span of years, it is evenly distributed over those dates or that span (e.g., in the *Statistica elettrica 1898*, pp. 68-69, the sum of the capacity figures listed under item 63 is divided between 1895 and 1896, while the capacity listed under items 62 and 68 is attributed to 1898). Plants listed in the *Statistica elettrica 1908* and dated between 1893 and 1898 are ignored, while those dated 1001 and 1993 are attributed to 1901 and 1903, respectively (e.g., p. 143); those attributed to 1907-08 dominate the present figures for those two years, so that the differences between these year-specific estimates are less than usually significant. In general, moreover, the correspondence between cols. 4 – 6 and col. 3 is not very close: even if the sum of cols. 4 – 6 is generally not too far below col. 3 (with 1897 and 1903 the significant exceptions), serious discrepancies may stem from the inclusion of private power stations in cols. 4 – 6 (whence, presumably, the excess of cols. 4 – 6 over col. 3 in 1900-02). On the other hand, cols. 4 – 6 appear to correspond to col. 3 where one would have preferred them not to, i.e., in the attribution of the plant's current power to the year the plant was first activated (or, perhaps, transformed); the Santa Radegonda plant in Milan, which was the first in Italy (and one of the very first in the world) is thus duly attributed to 1883, but with 1,400 kW rather than the original 400 (*Statistica elettrica 1898*, pp. 92-93; Mortara, 1934, vol. 2, p. 94). Finally, one notes the extremely limited correspondence between the list of power stations activated in 1899 included in the *Statistica elettrica 1898*, pp. 128-139 (totaling 4.8, 7.9, and 1.3 thousand thermal, hydraulic, and mixed kW, respectively), and those attributed to 1899 in the *Statistica elettrica 1908*, pp. 112-156, and underlying the figures in cols. 4 – 6. One can readily believe that most of those listed in the 1908 publication were in fact older plants transformed in 1899; but it is rather harder to believe that no fewer than two thirds of those listed in the 1898 publication were radically transformed within a decade. The differences in the aggregate capacity figures are instead less significant, particularly since most of the large difference in hydraulic capacity seems traceable to the attribution of the large plant in Tivoli, near Roma, to 1899 in the earlier publication, and to 1899-1903 in the later one (*Statistica elettrica 1898*, pp. 136-137, *1908*, p. 147). In general, therefore, the comparison of these different samples attributed to 1899 suggests that the figures in cols. 4 – 6, and also in col. 3, are heir to significant gross biases from the dating conventions that attribute the plants' current capacity entirely to the year in which the plant was first built or last transformed; but that these gross biases largely cancel each other out (as the figures for the early years covered by each source exclude the capacity installed then but subsequently transformed, but include the capacity added later to the plants built then and subsequently only enlarged; conversely, the figures for the later years include the entire capacity of transformed plants rather than the mere increment in capacity, but exclude the increments in the capacity of the plants that were merely enlarged).

In the circumstances, the 1898 data in cols. 7 and 8 are extrapolated through the following simple steps. First, the thermal and hydraulic capacity figures in cols. 4 and 5 are each augmented by half the mixed-capacity figures in col. 6. Second, the resulting figures for 1896-1908 are multiplied by the ratio of col. 3 to the sum of cols. 4 – 6; the result is of course a disaggregation of col. 3 into thermal and hydraulic components in the proportions suggested by the figures in cols. 4 – 6. Third, the resulting figures for 1899-1908 are cumulatively added to the data for 1898 in cols. 7 and 8 to extrapolate these forward to 1908, while those for 1896-1898 are cumulatively deducted from those same data to extrapolate them backward to 1895. This procedure implicitly assumes that the upward biases in the resulting estimates from the inclusion of electric-powered generators in col. 3 and from the failure to allow for the share of capacity available in 1898 that was simply dismantled in subsequent years are offset by the downward bias from the presumable exclusion from col. 3 of the capacity increments that represented mere augmentations, rather than transformations, of the capacity available in 1898 (in contrast, Mortara, 1934, vol. 2, p. 114 deducts 10% of the capacity available in 1898 to allow for the second of these three biases, but does not seem to consider the first and the third). The present procedure also implicitly assumes that the 200 kW of electrically-powered capacity present in 1898 were installed before 1896 (whence the difference between the 1895 figure in col. 3, and the sum of the corresponding figures in cols. 7 and 8). Fourth, the augmented versions of cols. 4 and 5 in 1883-95 resulting from the first step above are multiplied, respectively, by the ratio of the 1895 figure in col. 7 to the sum of col. 4 and half of col. 6 over 1883-95, and by the ratio of the 1895 figure in col. 8 to the sum of col. 5 and half of col. 6 over those same years; the result of this step is a disaggregation of the estimated thermal and hydraulic capacity in 1895 by year of introduction analogous to the disaggregation of the subsequent annual capacity increments in col. 3 by type of motive power. Fifth, these estimated annual increments are cumulatively deducted from the estimates for 1895 in cols. 7 and 8, as in the third step above, to extrapolate these backward to 1883. The resulting figures are transcribed in col. 8 from 1883, and in col. 7 from 1890. The earlier figures in col. 7 are instead those resulting from the preceding step less an allowance set equal to 1,700 kW in 1883 and

1,500 kW in 1884, and then declining by 250 kW p. a. to 250 kW in 1889 (and none in 1890); this sixth and last step is designed to force the earliest figures in col. 7 into agreement with the data for the first thermal plant reported in Mortara, 1934, vol. 2, p. 94 (the comparable data for the first hydraulic plant also reported there suggest that the early figures in col. 8 are instead essentially correct even without an ad hoc adjustment of this sort).

In 1883-1908, the present output estimates in cols. 9 and 10 are obtained as follows. First, the average capacity available over the year is estimated from the year-end figures in cols. 7 and 8 by shifting these forward half a year (recalling that capacity equaled zero at the end of 1882); second, these capacity estimates are multiplied by annual utilization figures that grow geometrically from 2,000 hours p. a. in 1883 to 2,900 hours p. a. in 1913 in the case of hydraulic power, and decline geometrically from 700 hours p. a. in 1883 to 500 hours p. a. in 1913 in the case of thermal power. These rough estimates of annual utilization are designed to be compatible with the corresponding year-specific estimates for 1898, 1908, 1913, and 1920 in Mortara, 1934, vol. 2, pp. 103, 120, 142, and 321, the capacity and output data for the Milanese thermal plant in 1893 in Mortara, 1934, vol. 4, p. 160, and the general evidence that thermal capacity was increasingly relegated to a stand-by role (Ungaro, 1946, p. 149).

The output estimates for 1909-13 are instead obtained by extrapolating the estimates for 1908 with the aid of the aggregate consumption figures in col. 2, as follows. First, one observes that commercial capacity was a virtually constant share of the total: it equaled 63.9% of the total in 1898, and 64.2% of the aggregate increment in 1899-1908 (*Statistica elettrica 1898*, pp. 32-33, *1908*, pp. 34-35); it is thus reasonable to extrapolate total commercial production (the sum of cols. 9 and 10) in constant proportion to total consumption (col. 2). Since the earliest figure in col. 2 refers to 1908-09, that proportion is estimated by multiplying the capacity estimates for the end of 1908 in cols. 7 and 8 by annual utilization rates mid-way between those assumed for 1908 and 1909; the sum of the resulting output estimates for 1908-09 equals 62.57% of the corresponding consumption figure in col. 2 (less than the ratio of commercial to total capacity, particularly if one allows for distribution losses and the attendant discrepancy between production and consumption, thus reasonably implying that private power plants had higher average utilization rates than commercial stations). Total output in 1909-13 (the sum of cols. 9 and 10) is accordingly estimated as 62.57% of the calendar-year consumption figures obtained as the geometric average of the current and succeeding fiscal-year figures in col. 2 (i.e., as col. 2 shifted half a year backwards, but taking a geometric rather than arithmetic average to minimize the distortion from the series' rapid growth). The division of this aggregate between cols. 9 and 10 is of course quite tentative. The present figures assume that the relative increase in col. 10 was 2.2 times that in col. 9 in each of these years, as it was, on average, from 1903 to 1908; the resulting estimates are not unreasonable in themselves, or in comparison to the aggregate (private and commercial) thermal and hydraulic output figures for 1920 (Mortara, 1934, vol. 2, p. 177).

Finally, the estimates for 1909-13 in cols. 7 and 8 are obtained from the figures in cols. 9 and 10 for later use (see below, section K04.07). The estimates of annual output, divided by the estimates of annual utilization noted above, yield average capacity figures over the year; the figures in cols. 7 and 8 are so constructed as to yield those same averages, within rounding error, when shifted forward half a year.

J02.03 Value added

Aggregate value added in electric power production is here estimated at approximately 107 million lire in 1911; both the value of the industry's activity and the value of its results appear close to that figure. This aggregate is distributed between thermal and hydraulic power in proportion to the relative value of activity, as there is no direct evidence on the relative value of its results.

G. Motta, managing director of the Italian Edison company, quoted an average net revenue of .109 lire per kWh for a sample of 11 companies in 1913 (cited in Mortara, 1934, vol. 2, p. 344); applied to the electricity produced in 1911, this yields an estimated total revenue equal to 110.6 million lire. Fuel costs to generate the thermal electricity are estimated to equal 2.8 million lire, on the basis of the quantity estimate in col. 9, an input-output ratio of 1.0 kg of coal per kWh, and a coal price of 41.55 lire per ton. The input-output ratio is based on the .75 kg of coal per electric horsepower-hour reported for 1904 in the *Amministrazione Torino 1903-08*, vol. 2, p. 250 (as the consumption to be expected in a new plant, and plausibly close to the average actually achieved a few years later). The coal price is equal to the 1911 Genova price of Cardiff coal reported by Cianci (1933), or 35.65 lire/ton, plus a transportation allowance (5.9 lire/ton) equal to that calculated in section J03.04 below for the coal distilled by the gas industry. The cost of other materials is estimated at 3.3 million lire, on the basis of the above sales value and a 3% ratio to sales, reduced from the 4% ratio to sales suggested by the 1915 budget data for the Milanese municipal power company to allow for the rapid rise in materials costs from 1911 to 1915 (*Consuntivo elettrico*, pp. 24-35; Table K.06, col. 8). Deducting these costs from the sales figure, the value of the results of activity is estimated at 104.5 million lire. Given the great variation in power rates (by a factor of ten even within a single city: e.g., *Statistica elettrica 1908*, pp. 229 ff.; *Statistica Milano 1916*, p. 264), and the possibility of rate changes from 1911 to 1913, the present estimate of total revenue is subject to significant error; the present estimate of value added is therefore rather weaker than most such figures.

Annual capital and personnel costs can also be estimated from the capital values and operating cost data for 1915 reported for the Milanese municipal power company (*Consuntivo elettrico*, pp. 6-7, 24-35). In 1915, the average value of the hydraulic complex (the hydraulic works proper, the generating plant and equipment, the transmission line, and the receiver in the city) equaled 15.5 million lire gross, and 13.0 net, of depreciation; the average value of the thermal complex (plant and equipment) equaled 3.90 million lire gross, and 2.45 net, of depreciation; and the average value of the distribution complex (power lines, transformers, etc.) equaled 14.9 million lire gross, and 10.9 net, of depreciation. Current depreciation charges, based on standard lives and historical costs, equaled .624, .305, and 1.204 million lire for the hydraulic, thermal, and distribution complexes, respectively. The corresponding current interest charges are estimated at .598, .115, and .501 million lire, respectively, on the basis of the current depreciated capital values, a standard interest rate of 4.5% p.a. (typical of that facing the industry in 1911; *Notizie S.p.A. 1912*, pp. 393 ff.), and allowances for circulating capital costs equal to an additional 0.1% p.a. for the hydraulic and distribution complexes, and 0.2% p.a. for the materials-intensive thermal complex, consistent with the 3% ratio of circulating to fixed capital suggested by the capitalization of the company, which was formed on January 1, 1911 with a capital of 30.0 million lire to take over real assets valued at 29.1 million lire; *Notizie S.p.A. 1920*, p. 1279; *Consuntivo elettrico*, p. 6). Personnel costs are estimated from the disaggregated budget date to equal .370 million lire in overhead, .110 in the hydraulic complex excluding the receiver in the city, .060 in that receiver and the thermal complex together, and .475 in the distribution system. Dividing the figure for the receiver and the thermal complex together in proportion to their relative undepreciated values (respectively .66 and 3.90 million lire: *Consuntivo elettrico*, p. 6), adding overhead costs to distribution costs (on the assumption that these are both output-related rather than capacity-related), and dividing the results by 1.114 to approximate 1911 cost levels, personnel costs are here estimated at .107, .046, and .759 million lire in the hydraulic, thermal, and distribution complexes, respectively. These estimates of capital and personnel costs sum to 1.329, .466, and 2.464 million lire in the hydraulic, thermal, and distribution complexes. The maximum power output of the Milanese municipal works is reported at 12,000 horsepower (8,832 kW) for the hydraulic plant and 10,000 horsepower (7,360 kW) for the thermal plant, and their output in 1915 equaled some 54.1 million kWh (*Statistica Milano 1912*, p. 487; *Consuntivo elettrico*, p. VII and graph following p. XXI). Assuming that the capital and labor costs of the hydraulic and thermal complexes were proportional to capacity, and those of the distribution complexes (and overhead) were proportional to output, the above cost estimates for the Milanese company are here divided by these capacity and output figures, and then multiplied by the corresponding national estimates for 1911 (respectively 334,950 kW, from col. 8, 130,750 kW, from col. 7, and 1,014.5 million kWh, from cols. 9 and 10). The aggregate capital and personnel cost estimates so obtained for 1911 equal 50.4, 8.3, and 46.2 million lire, respectively, for a total of 104.9 million lire, of which 19.1 for personnel.

In addition to labor and capital, hydroelectric power in particular consumed significant natural resources ("land"). The cost of the water rights are here estimated to equal 6.9 million lire, on the basis of the average capacity in 1911 (334,950 kW, from col. 8) and a unit cost of 20.5 lire per kW (15.1 lire per horsepower). The latter unit cost is the average of the figures obtained for the municipal works in Milano and Torino. The Milanese *Consuntivo elettrico*, p. 28, reports payments of 222,500 lire (including 156,900 to the State) for an electric capacity of 12,000 horsepower (*Statistica Milano 1912*, p. 487), or 18.5 lire per horsepower. The *Amministrazione Torino 1903-08*, vol. 2, pp. 250-251, reports an effective yield of 8,000 horsepower, and budgets both an annual payment to the State (78,700 lire) and a sum spent to purchase the concession from its current holder (330,000 lire); summing the interest on the latter at 4.5% p. a. to the former, one obtains a total equivalent to 11.7 lire per horsepower. Since the payments to the State were based on a standard fee of 3 lire per horsepower generated by the waterfall (*Enciclopedia italiana*, vol. 1, p. 415; *Annuario 1904*, p. 270), these figures suggest a combination of power losses and unused potential of 60 to 70%.

Adding in the cost of the water rights the total value of activity is thus estimated as 57.3 million lire in hydraulic power production, 8.3 million lire in thermal power production, and 46.2 million lire in distribution, for a total of 111.8 million lire (including 19.1 for personnel). This estimate of the value of activity is gratifyingly close to the almost entirely independent estimate of the value of the results of activity (104.5 million lire) obtained above. Both are of course subject to considerable uncertainty; and the second estimate is more uncertain than the first, since it is based on a much smaller sample. The present best estimate of value added in 1911 is the average of these two estimates, assigning the first twice the weight of the second; it equals 106.9 million lire.

The present estimates of value added per unit of output are obtained by taking the above disaggregated figures for thermal production, hydraulic production, and distribution (8.3, 57.3, and 46.2 million lire), dividing them by 1.0455 (to obtain the desired total) and by thermal, hydraulic, and aggregate output (cols. 9, 10, and their sum), respectively, and then adding the estimate of distribution value added per million kWh (43,600 lire) to each of the two estimates of production value added per million kWh (118,800 and 57,800 lire, respectively). The results equal 162,400 lire per million kWh of thermal power, and 101,400 lire per million kWh of hydraulic power.

The estimate of production value added in thermal power is about twice that in hydraulic power, as its lower annual resource cost per unit of capacity (ca. 58,000 lire, against ca. 150,000 for hydraulic power) is more than offset by the much lower than average utilization rate (ca. 500 hours p.a., against ca. 2,800 for hydraulic power). These estimates further imply that the delivered cost (value) of thermal power was also about twice that of hydraulic power, since fuel cost some 42,000 lire per million thermal kWh (for a total cost excluding ancillary materials over 200,000 lire per million kWh of thermal power, against just over 100,000 lire for hydraulic power). Finally, they imply that in 1911 "land," labor, and capital accounted for 6.2% (6.6 million lire), 17.1% (18.3 million lire), and 76.7% (82 million lire), respectively, of the industry's value added.

J03. Gas

J03.01 Introduction

The gas industry is here defined to include the generation and distribution of gas for sale to household and business users, but not the generation of gas consumed directly by the producing firm. As noted in section J01.01 above, this definition seems to correspond to those of the *ISIC* and the 1911 censuses. It parallels those of the other utilities, and is consistent with those of the other industries; unlike the latter group, however, it excludes that part of the industry's characteristic production that was carried out in vertically integrated firms. In practice, this industry here coincides with the production and distribution of illuminating gas, as surplus coke-oven gas does not appear to have been sold off (*Rivista mineraria 1905*, p. 162, *1908*, p. 202, 206, *1910*, p. 133), and the quantity of natural gas not consumed for power at the wells seems quite negligible (about .1 million cubic meters in 1913: *Rivista mineraria 1912*, p. CXC, *1913*, p. CLXX).

The Corpo delle miniere included aggregate production data for illuminating gas and the principal by-products in the *Statistica mineraria*, pp. 48-51, and the *Rivista mineraria* from 1891 (e.g., *1891*, p. XLVIII, *1911*, p. LII; Table J.02, col. 1, Table J.03, cols. 1 – 2); some district-specific data were reported in other years as well (Caltanissetta in 1884, Milano and Roma in 1887, and Torino in 1887-90: e.g., *Rivista mineraria 1884*, pp. 58-59, *1887*, pp. 199, 269, 340). The present gas and by-product output estimates (Table J.02, col. 13, Table J.03, cols. 4 – 5) are derived from these data, and the corrections and extensions of the existing series are based on internal evidence only. Other evidence of production, not incorporated in the present estimates, consists mainly of gas consumption data. The *Annuario città* (e.g., *1913-14*, pp. 230-233) reports gas consumption for private and public lighting in a broad sample of cities in 1904, 1906, 1908, and 1911; and the *Imposte di fabbricazione* (e.g., *1898-99*, pp. 60-63, *1911-12*, pp. 126-131) reports taxed gas consumption from 1895-96, and aggregate gas consumption from 1908-09 (Table J.02, cols. 14 – 15; *Sommario*, p. 135). The consumption tax was levied on gas distilled from coal or oil and used for private lighting or for space heating; it was introduced, along with a licensing fee on gas generating plants, by the *legge 8 agosto 1895, n. 486* (Alleg. F, arts. 1 and 6). Taxed consumption remained equal to just 60 to 80% of reported output, with a rising trend that presumably reflected the relative growth of private illumination. Aggregate consumption, allowing for the discrepancy between fiscal and calendar years, rose instead from 92% of reported output in 1909 to some 107-108% of it in 1911 ff. This increase, and the resulting excess of consumption over output, appears due to the inclusion of the gas from the coke ovens of the Bagnoli steel works, near Napoli, which came on stream in 1910 (e.g., *Imposte di fabbricazione 1912-13*, p. 129; *Rivista mineraria 1910*, p. CXXVIII), and, secondarily, to the apparently aberrant tax-exempt consumption of oil gas reported for the province of Mantova in 1911-12 alone (e.g., *Imposte di fabbricazione 1911-12*, p. 129). Allowing for other private gas works, the tax-based consumption figures point to an aggregate consumption of gas from commercial works in the neighborhood of nine tenths of the reported output; the aggregate output and consumption figures thus appear substantially to confirm each other, as this residual discrepancy is about what should be allowed for distribution losses (*Enciclopedia italiana*, vol. 16, p. 421). The *Rivista mineraria* admittedly counted fewer gas works than the *Imposte di fabbricazione*; but the implied omission again seems negligible, if one allows for the likely size of the works in question. In 1911, for example, the Corpo delle miniere counted 198 illuminating gas works; the tax authorities counted 250 active gas works, of which 15 or 16 were tax exempt, another 26 were private, and another 22 were in municipalities with less than 5,000 inhabitants (*Rivista mineraria 1911*, p. LII; *Imposte di fabbricazione 1911-12*, p. 130). The Corpo delle miniere thus apparently neglected some 10 to

26 gas works (depending on the distribution of the exempt works as between private and commercial establishments), most or all of them presumably in those minor municipalities. Since annual consumption in these minor centers is unlikely to have averaged more than 15 cubic meters per capita (judging from the data for Chieti, Lodi, Massa, Rovigo, and Viterbo in 1911 in the *Annuario città 1913-14*, pp. 230-233), neglected output is unlikely to have reached 0.5% of the reported quantity, and may have been under 0.1% of it. The later data in the *Rivista mineraria*, at least, would thus appear to be substantially comprehensive.

Value added is estimated directly from the outputs, value, and input consumption data reported by the Corpo delle miniere.

J03.02 Output: gas

The gas production series (Table J.02, col. 1; *Sommario*, p. 133) is here reconstructed in some detail. In 1891-1913, the characteristic evidence of a gap in the information base is a repetition of (district or province) figures reported in earlier years; these repeated figures are here replaced by (geometric) interpolations of the neighboring independent observations. As it turns out, these corrections are sometimes important for individual districts, but rarely amount to more than 1 or 2% in the aggregate (cols. 1 and 13). The 1891-1913 estimates are extrapolated back to 1861 with the aid of the 1865 datum and a few partial figures (that warrant separate estimates for the Caltanissetta, Milano, Roma, and Torino districts); the extrapolations assume constant growth rates between (and beyond, to 1861) the available observations (in preference to constant absolute increments, which would have produced a much greater discontinuity between 1861-90 and 1891-1913).

The detailed estimates are obtained as follows. The Bologna district figures in col. 2 include the data for 1891, 1895, and 1902, and interpolated (in lieu of repeated) values in 1892-94 and 1896-1901. The 1891 datum is presented as an average for 1887-91 (*Rivista mineraria 1891*, p. 31); it is here retained as an estimate for 1891, as the similar averages in the *Notizie_minerarie*, pp. 26 ff., were in fact very close to the latest annual data available at the time (e.g., *Notizie minerarie*, pp. 260-268).

The Caltanissetta district figures in Table J.02, col. 3 include the data for 1865, 1884, 1891, 1895, 1899, and 1901-02, and interpolated (extrapolated) figures in other years; those for 1892-94, 1896-98, and 1900 replace the repeated figures in the sources.

The correction to the Firenze district figures is somewhat more complex. In the first place, the district is here redefined to have from 1891 the boundaries it actually had from 1893; the present 1891 and 1892 figures thus exclude the gas obtained in Lucca and Massa-Carrara (1.00 million cubic meters in 1891, repeated in 1892). Secondly, the province of Firenze reported new levels of output in 1891, 1895, 1896, and 1902 (5.3, 6.0, 6.5, and 6.4 million cubic meters, respectively); the other provinces (Livorno, Pisa, Siena) reported new levels of output in 1891 and 1902 only (4.9 and 4.0 million cubic meters, respectively). The 1891-1902 estimates (Table J.02, col. 4) are accordingly the sum of two separate time series: one for Firenze province, incorporating the four available benchmarks and the appropriate interpolated values for 1892-94 and 1897-1901; and another for the rest of the district, incorporating the two available benchmarks and the appropriate interpolated values for 1892-1901. The 1903-05 figures are retained as reported, but the 1906 and 1907 estimates incorporate partial corrections. In 1907, Firenze province is allowed 7.0 million cubic meters in lieu of 6.5 (as in 1906), against 7.5 million cubic meters in 1908; and in 1906 and 1907, Pisa province is allowed 1.4 and 1.5 million cubic meters, respectively, in lieu of 1.3 (as in 1905), against 1.6 million cubic meters in 1908. Other repeated figures (Livorno in 1905, Siena in 1907) are not corrected, as the alteration would be trivial.

The Genova (later Carrara) district figures for 1891-95 (col. 5) transcribe the data, with two modifications. The first is an increase of 1.0 million cubic meters in 1891 and 1892, to allow for Lucca and Massa-Carrara; the second is a decrease of .2 million cubic meters in 1893, as the figure reported for Porto Maurizio (1.4 million cubic meters, as in 1892, against 1.0 million in 1894) is replaced by an interpolation of those for 1892 and 1894. The other provinces' output data for 1892 and 1893 appear to repeat those for 1891, but the net error appears to be negligible.

The Iglesias district data repeat the 1891 figure (.9 million cubic meters) through 1893; but the 1894 figure (1.0 million cubic meters) is barely higher. The present estimates (col. 6) assume that that level was actually reached in 1893; the 1891-92 and 1894-95 figures are unchanged.

The Milano district figures (col. 7) incorporate the data for 1891, 1893, and 1895. The 1892 value is interpolated; the 1894 estimate is the reported total increased by .1 million cubic meters, to reflect the interpolation of the 1893 and 1895 observations from Parma and Piacenza (a combined 1.5 and 1.7 million cubic meters, respectively). In earlier years, the series includes the 1865 benchmark obtained as the sum of the *Statistica mineraria* figures for Lombardy, Parma, and Piacenza, and the 1887 observations reported in the *Rivista mineraria*; the 1861-64, 1866-86, and 1888-90 figures are interpolated (extrapolated).

The Napoli district figures (Table J.02, col. 8) include the data for 1891 and 1895, and interpolated (in lieu of repeated) values in 1892-94. The district figure for 1896 is repeated in 1897, and the Foggia province figure is repeated in 1905; these are not recalculated, as the corresponding correction would be negligible.

The Roma district figures (col. 9) include the data for 1891 and 1895, and interpolated (in lieu of repeated) values in 1892-94. Later figures are not corrected: the 1897 Perugia figure is repeated in 1898, but the corresponding error is negligible. The earlier figures are estimated on the assumption of constant growth from 1861 through 1865 to the 1887 benchmark, and again between 1887 and 1891. The 1865 figure includes the .1 million cubic meters indicated by the *Statistica mineraria* (for the province of Chieti) plus an estimated 2.2 million for the province of Rome; this figure allows the city of Rome 10 cubic meters in 1865 per person in 1871 (*Censimento 1881, Relazione generale*, p. 87), a figure similar to those obtained for Naples and Palermo.

The Torino district figures for 1861-86 assume constant growth through the 1865 benchmark (the *Statistica mineraria* figure for Piedmont) to 1887; the 1887-95 figures are taken as reported in the *Rivista mineraria* (col. 10).

The Vicenza district figures (Table J.02, col. 11) include the data for 1891 and 1895, and interpolated (in lieu of repeated) values in 1892-94. Some partial figures are also repeated in later years (Ferrara and Venezia: 1891, in 1895 and 1896; Ferrara, Rovigo, Venezia, and Verona: 1897, in 1898); but the concomitant error is negligible.

The figures in col. 12 are the complement to those in cols. 2 – 11. In 1861-90, these figures are estimates for all districts except Caltanissetta, Milano, Roma, and Torino; they assume constant growth from 1861 through the 1865 benchmark (16.6 million cubic meters, obtained as the total reported in col. 1 plus the 2.2 million cubic meters allowed for the province of Rome, less the corresponding figures in cols. 3, 7, 9, and 10) to 1891 (when the corresponding output was 61.4 million cubic meters, obtained as the sum of cols. 2, 4 – 6, 8, and 11). In 1896-1908, the figures in col. 12 are the aggregate data (col. 1) less the amounts reported for Bologna until 1902, Caltanissetta until 1902, and Firenze.

The estimated aggregate output of illuminating gas is presented in col. 13. It is equal to col. 1 in 1891 and 1909-13, and to the sum of cols. 2 – 12 in other years.

J03.03 Output: coke and tar

The aggregate gas coke and gas tar output data currently reported by the Corpo delle miniere (sometimes only in the comparison of output and international trade) are transcribed in Table J.03, cols. 1 – 2. Both these series appear to refer to the gross output of gas by-products, inclusive of tar subsequently distilled, and of the coke burnt as fuel within the gas works. There are some relatively explicit textual indications to this effect (e.g., *Statistica mineraria*, pp. 48-51; *Rivista mineraria 1891*, p. 279, *1904*, pp. XXXI, LXIII, *1908*, pp. XXXVII, LXIX, 61); and these are largely confirmed, in the case of coke, by the ratio of reported output to reported input (Table J.03, col. 3; the variations in this ratio are within the range appropriate to different types of coal: Martin, 1918b, vol. 1, p. 6; *Rivista mineraria 1891*, p. 32). This gas coke series is similar to that in the *Sommario*, p. 133, with only minor unexplained discrepancies in 1893 and 1894 (present also in the *Rivista mineraria 1899*, p. L.XXV), and corrections for 1900 (when the *Sommario* figure includes metallurgical coke) and 1911 (when the *Sommario* repeats the typographical error in the *Rivista mineraria 1911*, p. LVI; compare p. LII). The tar series is instead quite different from that in the *Sommario*, p. 133: the latter includes the tar (and, in 1898-99, the pitch) obtained in the chemical industry, and excludes the tar consumed in the distilleries in 1904-10 (e.g., *Rivista mineraria 1904*, p. XXXIII).

The gas coke and gas tar data are of course of a piece with the illuminating gas data discussed above; and they manifest similar omissions and repetitions. Rather than repeat for coke and tar the detailed reconstruction that was carried out for gas (particularly since the by-products data are marginally poorer: e.g., *Rivista mineraria 1887*, p. 340), however, it seems expedient to estimate the aggregate correction to the coke and tar data directly from the aggregate corrections calculated for the gas figures. In 1865 and 1891-1913, then, the present gas coke and gas tar estimates (Table J.03, cols. 4 – 5) are obtained as the product of the corresponding data (Table J.03, cols. 1 – 2) and the year-specific relative correction to the gas data (Table J.02, col. 13 divided by col. 1). In the same vein, the gas coke and gas tar estimates for 1861-64 and 1866-90 are interpolated on the basis of the gas estimates (Table J.02, col. 13): in 1861-64, the gas estimates are multiplied by the coke/gas and tar/gas ratios that obtained in 1865; in 1866-90, the gas estimates are multiplied by year-specific coke/gas and tar/gas ratios obtained by geometrically interpolating the corresponding ratios for 1865 and 1891 (Table J.03, cols. 4 and 5 divided by Table J.02, col. 13).

J03.04 Value added

In 1911, the reported quantities of illuminating gas, coke, and tar were worth a total 53.6 million lire (apparently net of tax: e.g., *Rivista mineraria 1909*, p. 18), 28.9 million lire, and 1.7 million lire, respectively; recoverable ammonia is estimated to have been worth another 2.3 million lire (11 tons of ammonia, equivalent to 44 tons of ammonium sulfate, per million cubic meters of gas, at a unit value of 600 lire; see above, sections D12.06 and D12.07).

The corresponding inputs include the coal distilled, fuel to distil the coal, and energy for the industry's reported 4,115 horsepower. In 1911, 1,287,100 tons of coal were distilled (along with 200 tons of oil, which are here neglected; *Rivista mineraria 1911*, p. LIX and Table J.03, col. 3); these are attributed an average unit value of 32.4 lire, estimated as the price of gas coal delivered in Genoa (26.5 lire per ton, according to Cianci, 1933), plus an average 5.9 lire per ton for transportation costs to inland centers. The latter allowance is equal to the average value of the coal distilled in 1908 (excluding the Bologna and Firenze districts, which accounted for 11% of the total: *Rivista mineraria 1908*, e.g., pp. XXXVII, 18, 61, 124) less that year's Genoa price of gas coal quoted by Cianci (1933), or 30.8 less 24.9 lire per ton, respectively; it is 20% below the comparable allowance for steam coal (see above, section A3.4), probably reflecting the relative distribution of Italy's cities and industry (the former being on average much closer to the sea) and possible scale economies in the gas-works' coal purchases (train-load deliveries and the like). On this basis, the industry's prime raw material is estimated to have cost an aggregate 41.7 million lire.

The gas works normally burnt part of their own coke output as fuel to distil the coal. A figure of .13 to .14 tons of coke per ton of coal seems appropriate for 1911 (*Enciclopedia italiana*, vol. 16, p. 416); since coke production equaled .62 tons per ton of coal, coke consumption is here estimated at 22% of coke production, for a total value of 6.4 million lire. This estimate makes no use of the considerably higher coke consumption-to-output ratio (35%) quoted by the Caltanissetta district report as late as 1909; but that district produced only 5% of total gas output, and its gas prices were then nearly 40% above the national average (to which they had substantially fallen by 1911: *Rivista mineraria 1905*, p. 58, *1909*, pp. XXXV, 59, *1911*, pp. XLVI, LII).

All the industry's reported 4,115 horsepower ran on purchased fuel or electricity; allowing annual costs of 80 lire per horsepower (for about 2,000 hours per year, on average), power costs are estimated at .3 million lire.

Neglecting minor items (recoverable cyanogen, lime to purify the gas, and so on), the above estimates yield an aggregate sales value of 86.5 million lire and an aggregate raw materials and fuel cost of 48.4 million lire, for a value added of 38.1 million lire (44.0% of value). Unit values added are estimated in proportion to unit values, except that recoverable ammonia is assumed to move with gas production. Value added in gas and recoverable ammonia together is thus estimated at 24.62 million lire, or 71,200 lire per million cubic meters of gas; value added in coke and tar, at 12.73 and .75 million lire (16,060 and 13,660 lire per thousand tons, respectively).

This value added of 38.1 million lire is here distributed among primary inputs as follows. The *Rivista mineraria* reports 5,848 blue-collar workers, all but six of them adult males; these are attributed a daily wage of 3.5 lire for 300 days a year, for a total wage bill of 6.1 million lire. Allowing 23 white-collar workers per 100 operatives, as suggested by the *Censimento industriale* data for category 8.21, and an average annual salary of 2,000 lire, the total salary bill is estimated at 2.7 million lire. These figures leave a residual of 29.3 million lire for capital costs, or about 7,100 lire per horsepower.

J04. Water

J04.01 Introduction

The water-supply industry is here defined to include the public provision of water to household and non-agricultural business users; the public provision of water for agricultural irrigation is considered part of agriculture, and the private provision of water by business users is considered part of the consuming industry. As noted in section J01.01 above, this definition is somewhat narrower than that of the 1911 censuses (which would appear to include the operation of irrigation systems in category 8.21); but it is consistent with those of other industries (which include their in-house generation of water power), analogous to those of the other utilities (which similarly exclude the private provision of their characteristic product), and essentially identical to its counterpart in the *ISIC* (category 4200).

Information on Italy's water-supply industry may be found in a variety of publications. These include three national surveys of the industry: the *Acque potabili 1866*, the *Inchiesta igienica 1886*, and the *Acque potabili 1903*. The first survey in fact covers only 19 provinces, and normally identifies water supplies only as abundant or scarce; the second seems geographically comprehensive, but also normally identifies water supplies only as sufficient or insufficient. Only a handful of local water-consumption figures appear to be available in these two sources together (*Acque potabili 1866*, p. XXXIII, *Inchiesta igienica 1886*, p. XLIV). The *Acque potabili 1903* is an altogether richer source: it includes a brief general report reviewing the results of the current survey and its predecessors (including an unpublished one of 1899), and a detailed list of Italy's aqueducts, with information on their date of construction, length, and yield (number of people served, and daily water supply per person), in vol. 1; summary information on public wells and cisterns, distributed by type, location, and municipality, in vol. 2; and data on municipal expenditure from 1889 to 1903 for water-supply installations, again distributed by municipality, in vol. 3. Information on the water works of various cities and towns is also available in the *Notizie città 1891*, and, more abundantly, in the *Annuario città*. The 1906 to 1913-14 editions of the latter include data on the physical characteristics, yields, capital costs, personnel, and incomes and expenditures of the water works of a few dozen cities and towns; the 1934 edition instead includes a broad survey of the works of over two hundred cities and towns, with information on their aqueducts' date of construction and yield. Information on the local works is also often available in the statistical annuals of the major cities (e.g., the *Annuario Firenze* and *Statistica Milano*); and balance-sheet data for incorporated water-supply companies were included in the *Notizie S.p.A.*.

Production is here represented by three time series covering, respectively, the Apulian aqueduct, other aqueducts, and local distribution networks. The Apulian aqueduct, though still far from completion in 1913, was already much the largest single such project in Italy; in the absence of better indicators, this part of the industry is indexed by cumulative real investment, estimated by deflating the increments in the construction expenditure reported by the *Notizie S.p.A.*. The output of the other aqueducts is instead indexed by their aggregate equivalent ton-kilometers per day. The latter are calculated, as the square root of the tons of water delivered per day (to allow for economies of scale) times the length of the aqueduct, from the aqueduct-specific data in the *Acque potabili 1903*, extended to 1913 with the aid of the broad sample in the *Annuario città 1934*. The output of the local distribution networks, finally, is indexed simply by their total length (including an allowance for local wells and cisterns). The latter is estimated from a variety of sources, including the local statistical annuals of various major cities, the *Annuario città* and *Notizie città 1891*, and the *Acque potabili 1903*.

Value added in 1911 is difficult to estimate: aggregate input-employment data are not available, and the measured revenues and (capital) costs of an industry such as this are largely arbitrary. In the absence of more direct evidence, the present estimates are obtained by estimating l911-price capital stock figures analogous to those obtained for the Apulian aqueduct for the other aqueducts and the local distribution networks as well, converting these to annual interest and amortization costs, and inflating these to allow for wage and salary costs.

J04.02 Output: aqueducts

The Apulian aqueduct was an exceptionally large project, designed to serve an entire region with some 1,600 kilometers of main and branch lines. Though built largely at public expense, it remained in the hands of the original concessionaire from its inception in 1906 through 1913 (*Opere pubbliche*, pp. 106-108). The *Notizie S.p.A. 1912*, p. 715, *1918*, p. 1397 reports some annual data from this company's balance sheet; these include an apparent cumulation of construction expenditure (which grows from 2.1 million lire in 1906 to 98.6 million lire in 1913), and, separately, an item labeled installation charges (which grows from .5 million lire in 1906 to 1.4 million lire in 1908, and then declines, presumably as a result of depreciation, to .9 million lire in 1913). Current investment expenditure is here estimated as the sum of the non-negative increments in these two series; the resulting figures are transcribed in Table J.04, col. 1. These estimates are then deflated by the construction cost index (for public works other than buildings) in Table K.06, col. 12, to obtain estimates of investment at 1911 prices; and the latter are then cumulated into the estimates of the capital stock at constant prices transcribed in Table J.04, col. 2. Since the desired stock figure is the average over the year rather than that at the end of the year, the present capital-stock figure for any year includes the entire deflated investment through the previous year, and half that of the current year.

The other aqueducts included some relatively substantial ones, serving major centers with works up to a few dozen kilometers in length; but most were strictly local works carrying small quantities of water over a few kilometers or even less. The present estimates of their output (Table J.05, col. 5) are obtained by separately estimating the annual output increments attributable to major and minor aqueducts through 1903 from the detailed, comprehensive listing in the *Acque potabili 1903*, vol. 1 (cols. 1 and 3), cumulating the result, and extending it to 1913 on the basis of a parallel cumulation of annual output increments calculated from the broad sample in the *Annuario città 1934* (col. 4).

Table J.05, col. 1 transcribes the estimates of the output increments attributable to the completion of major aqueducts, defining the latter as those listed in the *Acque potabili 1903*, vol. 1 as serving at least 10,000 people or being at least 10 kilometers long (each, or on average if the quoted figures refer to more than one aqueduct). Where the source refers the entire population of a municipality to a single aqueduct, even though more than one aqueduct was in use, that population is here taken to refer to all the aqueducts in use combined (see for example Spinazzola in the Barletta district of the province of Bari, or Barrafranca and Valguarnera Caropepe in the Piazza Armerina district of the province of Caltanissetta). The source appears to list 278 such aqueducts, distributed over the following provinces and districts: Alessandria: Acqui, Asti, and Novi Ligure (2); Ancona: Ancona (2); L'Aquila: L'Aquila (2, allowing 1 for Paganica), Avezzano, and Sulmona; Arezzo: Arezzo (the first for Arezzo); Ascoli Piceno: Ascoli Piceno (3) and Fermo (2); Avellino: Avellino (2); Benevento: Benevento and Cerreto Sannita; Bergamo: Bergamo (2) and Treviglio; Bologna: Bologna and Imola; Brescia: Brescia; Cagliari: Cagliari, Iglesias, and Oristano (2); Caltanissetta: Caltanissetta (4), Piazza Armerina (3), and Terranova (l); Campobasso: Campobasso; Caserta: Caserta (5), Nola (4), and Sora (2); Catania: Acireale (3), Caltagirone (4), Catania (6), and Nicosia (1); Catanzaro: Catanzaro and Nicastro; Chieti: Chieti and Lanciano (but not the one in Vasto, since its inordinate reported length seems to be a misprint); Como: Como and Varese; Cosenza: Cosenza (2) and Rossano; Cuneo: Alba, Cuneo, Mondovì, and Saluzzo; Ferrara: Ferrara; Firenze: Firenze (5) and

Pistoia; Foggia: Bovino; Forlì: Cesena and Rimini; Genova: Albenga, Genova (7), Savona, and La Spezia (5); Girgenti: Bivona (2), Girgenti (5), and Sciacca (2); Grosseto: Grosseto; Lecce: Brindisi and Taranto; Livorno: Livorno; Lucca: Lucca (9); Macerata: Macerata (4); Massa e Carrara: Massa e Carrara; Messina: Castroreale, Messina, Mistretta, and Patti; Milano: Gallarate, Lodi, and Milano; Napoli: Casoria (6), Castellamare di Stabia (2), Napoli (6), and Pozzuoli (2); Novara: Biella and Novara; Padova: Padova; Palermo: Cefalù (2), Corleone (2), Palermo (7), and Termini Imerese (3); Parma: Borgo San Donnino (2) and Parma (2); Perugia: Perugia, Rieti (2), and Terni (3); Pesaro e Urbino: Pesaro (6) and Urbino; Piacenza: Piacenza; Pisa: Pisa; Porto Maurizio: Porto Maurizio (2) and San Remo (2): Potenza: Matera, Melfi (2) and Potenza (2); Ravenna: Faenza; Reggio Calabria: Gerace (2), Palmi, and Reggio Calabria (4); Reggio Emilia: Reggio Emilia; Roma: Civitavecchia (2), Frosinone (5), Roma (10), Velletri (5), and Viterbo; Salerno: Salerno (2); Sassari: Ozieri (2), Sassari, and Tempio Pausania; Siena: Montepulciano (4) and Siena; Siracusa: Modica (6), Noto, and Siracusa (4); Teramo: Teramo; Torino: Ivrea and Torino (3); Trapani: Alcamo (2), Mazzara del Vallo (3), and Trapani (3); Treviso: Montebelluna (2); Udine: Palmanova (2), and Udine (3); Venezia: Chioggia and Venezia; Verona: Verona (2); Vicenza: Bassano and Vicenza.

Output is measured in equivalent ton-kilometers per day, defined as the square root of the actual tons of water delivered per day, times the length of the aqueduct in kilometers. In general, the tons of water delivered per day are calculated as the product of the reported quantity of water supplied per person per day (converted from liters to tons) and the reported number of people served. Where the quantity of water supplied per person per day is said to be insufficient, unknown, or sufficient, it is assumed to equal 15, 40, and 50 liters per person per day, respectively (a comparison of the reported number of municipalities with sufficient and insufficient water in the *Acque potabili 1903*, vol. 1, pp. 469 ff. with the aqueduct-specific data in pp. 1-465 suggests that the dividing line between sufficiency and insufficiency varied, perhaps in relation to the abundance of alternative sources: e.g., it seems to have been near 10 liters per person per day in the province of Alessandria, and between 20 and 30 in that of Sassari; compare *Acque potabili 1903*, vol. 2, pp. 514-515). Exceptionally, the Scillato aqueduct serving the city of Palermo is attributed 43,200 tons per day (from the *Notizie S.p.A. 1918*, p. 1398), while the Boccadifalco aqueduct also serving the city of Palermo and the aqueduct serving Rogliano (in the district and province of Cosenza) are both attributed 100 tons per day. Where the length of the aqueduct (or main branch serving a particular municipality) is unknown, it is assumed to equal 5 kilometers; exceptionally, each of the 5 aqueducts serving the city of La Spezia in the province of Genova is assumed to be 3 kilometers long (mid-way between the two reported lengths), and each of the 5 components of the single aqueduct serving the city of Milano is assumed to be 5 kilometers long. Where a single water-quantity or aqueduct-length figure refers to more than one aqueduct, it is evenly distributed over all the aqueducts to which it refers; exceptionally, however, the 3 minor aqueducts serving the city of Avellino are all assumed negligible. The output figures so obtained are attributed, as the current increment in total output, to the reported year of construction; exceptionally, the De Ferrari-Galliera aqueduct serving the city of Genova is attributed to 1884 rather than to 1874, as reported (e.g., *Notizie S.p.A. 1918*, p. 1399; *Notizie città 1891*, p. 133), the 2 aqueducts (actually main branches off the Genoese aqueducts) serving San Pier d'Arena in the district and province of Genova are attributed to 1854 and 1884, and the 5 aqueducts serving the city of La Spezia in the province of Genova dated 1865-1888 are attributed to 1865, 1871, 1877, 1883, and 1888, respectively. Where two dates are reported for a single aqueduct (the first aqueduct serving the city of Arezzo, and the second aqueduct serving the city of Udine), current output growth is calculated on the basis of half the quantity of water, and the full aqueduct length, at each of those dates.

The figures for the aqueducts serving the city of Rome are obtained, exceptionally, as follows. The output of the three ancient aqueducts (23,427 equivalent ton-kilometers per day) is calculated from the lengths and yields quoted in the *Annuario Roma 1913*, pp. 44-45. The fourth aqueduct, the Marcian, was actually built up by components (Società dell'Acqua Pia Antica Marcia, 1941). The first masonry aqueduct from the sources to Tivoli and the first cast-iron conduit from Tivoli to Roma, each about 27 kilometers long, opened in 1870. Three further cast-iron conduits, substantially identical to the first, were built in 1880, 1887, and 1907; and a second masonry aqueduct parallel to the first, but with a greater capacity (2,500, instead of 1,500, liters per second), was built in 1890. The *Annuario Roma 1913*, pp. 45-46, suggests that the capacity of each cast-iron conduit was 40,000 tons per day, and that the yield of the masonry aqueducts was about 240,000 tons per day. Assuming yields equal to capacity in the case of the cast-iron conduits, and proportional to capacity in that of the masonry aqueducts, the Marcian aqueduct is here attributed 13,500 equivalent ton-kilometers per day in 1870, 5,400 p.a. in 1880 and 1887 (and 1907), and 10,457 in 1890.

The figures in Table J.05, col. 1 cover 276 aqueducts listed in the source (the further two, in the provinces of Lucca and Sassari, are ignored: they are dated 1904, aand the *Acque potabili 1903* was in principle comprehensive only through 1903). Of these, 270 are attributed to specific years (or defined in the source as "ancient"). The 6 aqueducts that remain undated are those serving Avezzano in the province of L'Aquila, Faicchio in the district of Cerreto Sannita, province of Benevento, Menfi in the district of Sciacca, province of Girgenti, Brindisi in the province of Lecce, Cittanova in the district of Palmi, province of Reggio Calabria, and San Casciano in the district of Montepulciano, province of Siena; together, they account for 842 equivalent ton-kilometers per day, or just 0.4% of the estimated 198,830 equivalent ton-kilometers per day produced by the 278 major aqueducts listed in the *Acque potabili* 1903. On the presumption that the date of construction was unknown because it was lost in the relatively distant past, these too are here considered already present in 1860.

The annual output increments attributable to the completion of the other aqueducts are estimated simply from the number of such aqueducts completed each year. That number is subject to a margin of uncertainty; the figures here trascribed in Table J.05, col. 2 are obtained as follows. Where for a given aqueduct the source cites two consecutive years, it is here attributed to the second; where the source cites non-consecutive years, the aqueduct is attributed to both, as if at the later date the original system had been doubled. Where for a group of aqueducts the source indicates various dates, but fewer in number than the aqueducts, these are distributed over the indicated dates; where the source cites only a range of years, the aqueducts are allocated at regular intervals over that range; and where the number of aqueducts is not indicated, it is assumed equal to the number of indicated dates. Local branches of other aqueducts are considered separate aqueducts. Most significantly, and as for the major aqueducts, the undated aqueducts are considered already present in 1860; the only exception refers to the undated branches of the Genoese aqueducts, attributed to 1854 if part of the Nicolay and to 1884 if part of the De Ferrari-Galliera. With these conventions, a total of 5,479 aqueducts are allocated to the pre-1861 period or to the years 1861-1903; of these, no fewer than 1,158 are undated (and attributed to 1860 and earlier), 911 dated before 1861, and 3,410 dated between 1861 and 1903 (a further 7, dated 1904 or 1905, are here ignored).

The average output of the minor aqueducts is estimated from a sample of 219 individual aqueducts; these are those listed on every tenth page of vol. 1 starting with p. 6, for which the source reports all three bits of information (length, quantity of water supplied per person, number of people served) needed to calculate output in equivalent ton-kilometers per day. This sample yields an average of 22.326 equivalent ton-kilometers per day per aqueduct; while the year-specific average is of course quite variable, it displays no discernible trend. The estimated annual output increments in Table J.05, col. 3 are obtained as the product of the number of new acqueducts in col. 2 and this estimate of output per aqueduct.

A broad sample of urban aqueducts, including over 700 built before 1914, is documented in the *Annuario città 1934* (pp. 476 ff.). Table J.05, col. 4 transcribes the estimates of the annual yield increments attributable to the completion of the aqueducts in that sample, excluding those identified as part of the Apulian aqueduct, those outside Italy's borders of 1913, those for which no construction date is reported, and of course those built after 1913. Yield is measured in equivalent liters per second, defined as the square root of the liters per second actually delivered; in the absence of aqueduct-length figures, no attempt is made to convert yield measures into output measures more directly comparable to the figures in col. 1.

Yield is here calculated from the figures (or the mid-point of the range of figures) reported as the normal quantity delivered, converting the ounces reported for the aqueduct serving Viterbo at the rate of 20,000 liters per day per ounce (*Annuario città 1913-14*, p. 242). When these data are missing or (as in the case of the aqueduct serving Acireale) incomplete, yield is estimated from an allowance equal to 20 liters per second; exceptionally, that allowance is reduced to 2 liters per second in the case of the 13 aqueducts serving the outlying wards of Pescia. Where the quantity delivered by a single aqueduct is reported in several components, their square roots are taken before aggregating; similarly, when a single quantity figure refers to more than one aqueduct (as for the pairs serving Caltanissetta, Perugia, and Senigallia, and an estimated three serving Rieti), it is divided into the appropriate number of equal parts before the taking of square roots. The yield figures so obtained are attributed, as the current increment in total yield, to the reported year of construction. If the source attributes construction to a range of years, it is here attributed to the terminal year of the reported range; the aqueducts serving Firenze, Milano, Rimini, Cortona, Mondovi, and Spoleto, attributed to broad ranges of years ending after 1913, are accordingly omitted from the present sample. An exception of sorts is made in the case of Ragusa: since the reported range there refers to two aqueducts, these are attributed to the first and last year of the indicated range, respectively. If two or more specific dates refer equally to a particular quantity figure, the latter is divided among those years (again prior to the taking of square roots); on the other hand, the dates of mere expansions or renovations are neglected. Exceptionally, the quantity delivered by all 5 aqueducts serving Verona is divided between 1888 and 1929; and the aqueducts serving Roma are attributed yields derived from the quantity figures underlying the estimates in col. 3 above (for the three ancient aqueducts, 833, 255, and 660 liters per second; for the Marcian aqueduct, 1,042 liters per second in 1870 and 1,736 in 1890 for the masonry aqueducts, and 463 liters per second annually in 1870, 1880, 1887, and 1907 for the cast-iron conduits).

The figures in col. 4 are the sums of the specific yield estimates attributed to each year. Allowing for the minor discrepancies between the dates reported for specific aqueducts in the *Annuario città 1934* and the *Acque potabili 1903* (the former attributing the Serino aqueduct serving Napoli to 1884, for example, the latter to 1885), from 1861 to 1903 the time path of col. 4 is gratifyingly similar to that of cols. 1 and 3 together; if it is regressed on these, both are statistically significant, and their coefficients are again similar.

The present estimates of aqueduct output in 1861-1913 transcribed in col. 5 are obtained by cumulating the sum of cols. 1 and 3 on the one hand, and col. 4 on the other, to obtain year-end estimates of output (1860-1903) and yield (1860-1913); extending those output estimates to end-1913 in proportion to the yield estimates (using their ratio at the end of 1903, or 321.153/1132.5); and shifting the resulting figures six months backwards, to obtain mid-year estimates.

Overall, these estimates of aqueduct output are much like the estimates of electric power output, in that the time series reflect the construction dates of installations surveyed at a given point in time. Like these, they are heir to opposing gross biases, as they generally neglect both the disappearance of aqueducts that were abandoned or rebuilt, and the possible enlargement over time of the works appearing in the available survey (*Acque potabili 1903*, vol. 1, p. XXX); their net bias, at least, should be relatively small.

J04.03 Output: local works

The local water-distribution networks are considered in Table J.06. Their aggregate length (col. 10) is estimated in three major parts, corresponding to the networks of the eleven largest cities (col. 4), the other networks fed by aqueducts serving 10,000 people or more in 1903 (col. 8), and the networks fed by other aqueducts (col. 9), respectively, to which is added an allowance for the other local works (public wells and cisterns).

The first major component of col. 10, transcribed in col. 4, covers the local distribution networks of the eleven largest cities (all with over 149,000 inhabitants in 1901, against less than 100,000 for the next largest: *Censimento 1901*, vol. 5, p. 63). The length of each of these networks is estimated directly, often from scattered bits of evidence. The Firenze city net (col. 1) is taken as reported in the *Relazione Firenze* (e.g., *1888*, p. 211, *1895*, Alleg. 68, *1900*, Alleg. 44) for 1883-88, 1890, and 1894-1900, in the *Notizie città 1891*, p. 150, for 1891, and in the *Annuario Firenze* (e.g., *1907*, p. 241, *1913*, p. 213) for 1902-13. The figures for 1901 and 1903 are calculated from that for 1902 and the reported increments in 1902 and 1903 (*Annuario Firenze 1903*, pp. 192-193, *1904*, p. 146); those for 1881 and 1882 are calculated, in the face of some ambiguity in the sources, from that for 1883 and the reported increments in 1882 and 1883 (*Relazione Firenze 1882-83*, p. 327, *1884*, p. 195). Those for 1889 and 1892-93 are linearly interpolated; and those for 1861-80 are estimated directly, in the absence of usable evidence (the date of the aqueduct's construction, in particular, is irrelevant, since the latter was added to an existing network supplied from local sources: *Risanamenti urbani*, pp. 147-148). The Milano city net (col. 2) is a simple cumulation of the annual increments reported in the *Statistica Milano 1913*, p. 500. The Roma city net (col. 3) is estimated, from 1861 to 1891, as the sum of a constant allowance of 71 kilometers for the local net served by the three old aqueducts (*Annuario Roma 1913*, p. 48), plus the length of the local net served by the fourth aqueduct reported in the *Notizie città 1891*, p. 18. In 1904, 1906, 1908, and 1911, it is taken as reported in the *Annuario città* (*1906*, p. 83, *1907-08*, p. 73, *1909-10*, p. 115, *1913-14*, p. 229); and in other years, it is obtained by linear interpolation or extrapolation.

Col. 4, in turn, is the sum of cols. 1 – 3 and of separate allowances for the city nets of Bologna, Catania, Genova, Messina, Napoli, Palermo, Torino, and Venezia. The Bologna city net is assumed negligible through 1880, and then to have grown linearly from 25 kilometers in 1881 to 39 kilometers in 1905 (*Risanamenti urbani*, p. 61); it is then assumed to have grown linearly from 62 kilometers in 1906 to 65 kilometers in 1908 and 80 kilometers in 1911 (*Annuario città*, e.g., *1909-10*, p. 115), and, extrapolating, to 90 kilometers in 1913. The Catania city net is first estimated to equal 54 kilometers in 1904, or 1.2 times the corresponding figure for Messina (*Annuario città 1906*, p. 83). Allowing for the number of people served by its aqueducts and the dates at which these were completed, that net is here estimated to have equaled 22 kilometers in 1861-86, and then to have increased by 6 kilometers p. a. in 1887-91, and one kilometer p. a. in 1896-97 and 1908-09, to 56 kilometers in 1910-13 (*Acque potabili 1903*, vol. 1, pp. 124-125, *Annuario città 1934*, pp. 476-477). The Genova city net is taken to have equaled 166 kilometers in 1904 and 1906, and 170 kilometers in 1911 (*Annuario città*, e.g., *1907-08*, p. 72); it is estimated by linear interpolation in the intervening years, and then by linear extrapolation to 172 kilometers in 1913. Allowing for the dates at which its aqueducts were constructed, that net is assumed to have grown linearly by 2 kilometers p. a. from 65 kilometers in 1861 to 109 kilometers in 1883, then by 5 kilometers p. a. to 134 kilometers in 1888, and then again by 2 kilometers p. a. to 166 kilometers in 1904. The Messina city net is taken to have equaled 45 kilometers in 1904, 52 kilometers in 1906, and 65 kilometers in 1911 (*Annuario città*, e.g., *1907-08*, p. 73); it is estimated by linear interpolation in the intervening years, and then by linear extrapolation to 70 kilometers in 1913. In the absence of clear evidence on earlier growth (*Acque potabili 1903*, vol. 1, pp. 244-245; *Risanamenti urbani*, p. 228), that net is simply assumed to have grown by 3 kilometers p. a. from 1890 to 1904. The Napoli city net is assumed negligible through 1884, and then estimated to have grown in proportion to the number of consumers by 31, 37, 17, 29, 63, 15, and 7 kilometers in the seven following years to the reported figure of 199 kilometers in 1891 (*Notizie città 1891*, p. 68). It is thence assumed to have grown linearly to 223 kilometers in 1904, 226 kilometers in 1906, 231 kilometers in 1908, and 239 kilometers in 1911 (*Annuario città*, e.g., *1906*, p. 84), and, extrapolating, to 244 kilometers in 1913. The Palermo city net is taken to have equaled 132 kilometers in 1905 (*Risanamenti urbani*, p. 319). Allowing for the initial construction of fountains in 1885-86 and of the major aqueduct in 1895 (*Acque potabili 1903*, p. 282, *Risanamenti urbani*, p. 319), that net is assumed negligible through 1884, and then to have grown by 4 kilometers in 1885, 5 kilometers in 1886, 13 kilometers p.a. in 1895-1903, and 3 kilometers p. a. in 1904-13. The Torino city net is taken to have equaled 235 kilometers in 1904, 249 kilometers in 1906, and 282 kilometers in 1911 (*Annuario città*, e.g., *1906*, p. 84); it is estimated by linear interpolation in the intervening years, and then by linear extrapolation to 295 kilometers in 1913. Allowing for the completion of the second aqueduct in 1896 (*Acque potabili 1903*, vol. 1, p. 420), that net is assumed to have equaled 20 kilometers from 1861 to 1890, and then to have grown by 10 kilometers p. a. to 70 kilometers in 1895, then by 25 kilometers p. a. to 195 kilometers in 1900, and then again by 10 kilometers p. a., to 235 kilometers in 1904. The Venezia city net, finally, is taken to have equaled 60 kilometers in 1886, 100 kilometers (half the reported figure) in 1904, 127 kilometers in 1906, and 170 kilometers in 1908 and 1911 (*Rendiconto Venezia 1883-86*, p. 481, *Annuario città*, e.g., *1906*, p. 84). It is estimated by linear interpolation in the intervening years, and assumed constant after 1911; in view of the opening of the aqueduct in 1884 (*Acque potabili 1903*, vol. 1, p. 448), it is assumed negligible through 1883, and then to have grown by 20 kilometers p. a. to 60 kilometers in 1886.

The second major group of local water-distribution networks is that served by the other aqueducts listed in the *Acque potabili 1903* as serving 10,000 people or more (corresponding to the major aqueducts covered by Table J.05, col. 1, excluding those serving the 11 major cities and those over 10 kilometers long but serving fewer than l0,000 people). Cols. 5 and 6 transcribe the reported number of people served (in 1903) by those aqueducts, distributed by the year the aqueduct was built, and adopting the same dating conventions (including the re-dating of the De Ferrari-Galliera aqueduct) as in the construction of Table J.05, col. 1 above. Col. 5 counts the population served where the source provides direct evidence of distribution to private houses (by indicating its price, or that it was available, or that output was metered); col. 6 counts the population served where the source provides no such evidence, and suggests instead that distribution was by public fountains alone. At times, the population figure cited by the source is simply the 1901 census total for the city in question (e.g., Iglesias in the province of Cagliari); the small attendant error is here ignored.

The estimated length of the corresponding local networks are presented in col. 8; from 1861 to 1903, they are obtained as follows. First, cols. 5 and 6 are cumulated. On the assumption that the public fountains were installed with the aqueduct, while the construction of the initial private distribution network was spread out over five years, the cumulation of col. 5 first distributes each year's figure so that 40% of it remains attributed to that year, and 15% of it is attributed to each of the four succeeding years; the cumulation of col. 6 is instead perfectly ordinary. Second, on the further assumption that the networks expanded with the growth of the population they served, these cumulated values (of the population served in 1903) are discounted by 1.00444 (the growth rate of the population in nucleated settlements, excluding the 11 largest cities, calculated from the early-1901 and end-1871 figures for that population reported by the *Censimento 1901*, vol. 5, pp. 62-63, *1871*, vol. 1, pp. XXIV-XXV) raised to a power equal to 1903 minus the current date. Third, these discounted cumulations of col. 5 and 6 are weighted by estimates of the corresponding per-capita network length, and summed.

The per-capita network-length estimates are derived from the sample of distribution-net and population figures for 1904 in the *Annuario città 1906*, pp. 83-84. The six towns in the latter sample with the shortest distribution net per person (Alcamo, Campobasso, Prato, Reggio Calabria, Salerno, and Taranto) totaled just 14.3 centimeters of local net per person, against 85.1 centimeters for the 29 other cities and towns in the sample (excluding the 11 major cities covered by col. 10, those that did not report both population and the length of the net, and also Bergamo, Chioggia, Cuneo, Reggio Emilia, San Remo, and Trapani, since their lower network-length figures in later editions of the *Annuario città* suggest that the initial magnitudes were in error). Allowing for the fact that some of the towns counted here in col. 6 actually had a sizeable local distribution network per person, perhaps because they actually did pipe water into private houses despite the lack of evidence to that effect (e.g., Cesena and Lucca: compare *Acque potabili 1903*, vol. 1, pp. 196-197, 222-223 and *Annuario città 1906*, p. 83), the total length of the local distribution networks is here estimated by allowing 85 centimeters per person counted in col. 5 and 20 centimeters per person counted in col. 6.

In 1904-13, col. 8 is estimated with the aid of the sample network lengths for 1904, 1906, 1908, and 1911 in the *Annuario città* (e.g., *1906*, pp. 83-84). Table J.07 transcribes the information in that sample, excluding the major cities covered by cols. 4 above, the earlier reported network lengths that are higher than later ones (and thus presumably erroneous), and the towns for which only a single year's figure is reported (or not excluded); missing intermediate observations are instead estimated by linear interpolation and added to the sample. Summing over the network-length figures that are available in both 1904 and 1906, one obtains totals equal to 639.9 kilometers in 1904 and 689.1 in 1906, for an annual increase of 3.77%. The analogous totals for the subsequent pair of years equal 703.1 kilometers in 1906 and 832.5 in 1908, for an annual increase of 8.81% in two years. Those for the final pair of years equal 867.5 kilometers in 1908 and 1,157.7 kilometers in 1911, for an annual increase of 10.10%; much of it is due to the large increase in the city of Ferrara (confirmed by the *Annuario Ferrara 1909*, p. 113, *1913*, p. 161), and excluding Ferrara the sample annual growth rate falls to 6.64%. The present estimates in Table J.06, col. 8 for 1904-13 are obtained by extrapolating the estimate for 1903 with annual percentage increases equal to 3.77 in 1904-06, 8.81 in 1907-08, and 7.79, as a compromise estimate (the average of 10.10 and, with a double weight, 6.64), in 1909-13. In general, this extrapolation of col. 8 beyond 1903 displays a relatively smooth acceleration from the growth rates that prevailed in the immediately preceding years to rates comparable to those that prevailed in the late 1880s; since the strong cycle in public works peaked in the late 1880s and again on the eve of the World War, this result is in itself a very reasonable one.

The third major group of local water-distribution networks is that served by the other aqueducts listed in the *Acque potabili 1903* as serving fewer than 10,000 people (corresponding to the minor aqueducts in Table J.05, col. 2, excluding those serving the 11 major cities, and including the other aqueducts over 10 kilometers long but serving fewer than 10,000 people). The estimated length of the corresponding local networks are presented in col. 9; from 1861 to 1903, they too are obtained as the sum of two components, as follows.

Col. 7 transcribes the reported number of people served by those aqueducts where the source provides direct evidence of distribution to private houses (as in the case of col. 5). It adopts the same conventions in the case of multiple dating and the like as cols. 5 and 6, while attributing the Genoese aqueducts to 1854 (Nicolay) and 1884 (De Ferrari-Galliera), respectively. Here too, the reported population of a municipality is distributed over the various aqueducts in use in the cases where the source would attribute it entirely to a single one; in addition, where part of the municipality's population is attributed to one aqueduct and no population figures are given for the other aqueducts, the latter are assumed to share the residual (thus, for example, the second aqueduct serving the city of Campobasso is assumed to serve some 2,800 people: *Acque potabili 1903*, vol. 1, pp. 104-105). Exceptionally, the population listed under numbers 2 through 8 of the Spoleto district, province of Perugia, and in numbers 6 through 10 of the Salerno district, province of Salerno, are excluded from col. 13; in both these cases, the indication of distribution to private houses "as above" is assumed to be in error (*Acque potabili 1903*, vol. 1, pp. 305-306, 370-371).

These estimates in col. 7 are then transformed exactly like those in col. 5: the entries for each year are distributed over that year (40%) and the four succeeding years (15% each); the resulting figures are then cumulated, and discounted by 1.00444 raised to a power equal to 1903 minus the current date. The resulting estimates of the population actually served are then multiplied by 85 centimeters. per capita; the network-length figures so obtained are the first component of col. 9.

The other component of col. 9 covers the local networks associated with the residual aqueducts: the other aqueducts listed in the *Acque potabili 1903* as serving fewer than 10,000 people without, as far as can be told, distribution to private houses. For the sake of simplicity, the distribution of the minor aqueducts in Table J.05, col. 2 is here accepted as representative of that residual group; it covers almost 5,500 aqueducts, and for present purposes fails to include no more than a few dozen over 10 kilometers long, and to exclude no more than a few hundred apparently with pipes to private houses. That series is here treated analogously to col. 6 above: it is straightforwardly cumulated, discounted by 1.00444 raised to a power equal to 1903 minus the current date, and multiplied by .212 kilometers of local net per (cumulated, discounted) per aqueduct.

This last estimate is obtained as follows. The *Acque potabili 1903*, vol. 1, p. 514, lists a total of 12,988,100 people served by aqueducts. Deducting the 2,757,800 people served by aqueducts in the 11 major cities, and the 4,419,600 covered by cols. 5, 6, and 7, one obtains a residual equal to 5,810,700 people; again allowing 20 centimeters per capita, the corresponding network length is estimated at 1,162 kilometers, or .212 kilometers for each of the 5,479 aqueducts in Table J.05, col. 2.

In 1904-13, finally, the present estimates in col. 9 are simply the corresponding figure for 1903, extrapolated with the aid of the estimates in col. 8. Both series grow faster after the early 1880s than before, and both, plausibly, accelerated further after 1903; from 1861 to 1903, however, col. 8 grew consistently faster than col. 9. Allowing for the relative difference in their long-term growth rates, from 1904 to 1913 the estimates in col. 9 are constructed using growth rates equal to 80% of those estimated for col. 8, or 3.02% p. a. in 1904-06, 7.05 in 1907-08, and 6.23 in 1909-13.

The estimates of the aggregate length of the local distribution networks in col. 10 are obtained as the sum of the partial estimates in cols. 4, 8, and 9, with the addition of a further allowance for other local works serving the public. The latter are covered by the *Acque potabili 1903*, vol. 2, which lists a total of 4,868 shallow wells within the built-up area of 2,139 municipalities (out of a total of 2,737 municipalities reporting shallow wells), 1,157 shallow wells outside built-up areas, 2,930 deep wells, 1,139 cisterns within the built-up area of 504 municipalities (out of a total of 553 municipalities reporting cisterns), and 291 cisterns outside built-up areas (pp. 750-751). Scaling up the reported numbers of shallow wells and cisterns within the built-up areas in proportion to the ratio of the total number of municipalities reporting wells or cisterns to the number covered by the data, these figures yield estimated totals of 7,386 shallow wells, 2,930 deep wells, and 1,541 cisterns in 1903. For the sake of simplicity, each of these is here considered equivalent to 25 meters of local distribution network, without further distinctions (noting the relative depths and diameters reported for deep and shallow wells in the *Enciclopedia italiana*, vol. 28, pp. 135-136, and also the cost of individual shallow and deep wells reported through the *Acque potabili 1903*, vol. 3, e.g., pp. 2, 110, in relation to the unit costs of local distribution networks noted below); the resulting total equals 296 kilometers of local distribution network in 1903. In the absence of evidence on the dates at which these local works were constructed, the present aggregate estimate for 1903 is extended to 1861-1913 on the assumption of growth at 0.566% p. a., so as to maintain a constant stock per person in nucleated settlements (from the data in Table K.57, cols. 2, 4, and 10); since a number of such works were built in 1889-1903 (*Acque potabili 1903*, vol. 3, pp. 370-371), while others were no doubt displaced by newly built aqueducts and local distribution nets, this assumption may be considered a prudent one. Given the rapid growth of the local distribution nets covered by cols. 4, 8, and 9, the share of col. 10 attributable to this allowance for other local works declines from 18.9% in 1861 to 3.1% in 1913.

J04.04 Value added

Value added in 1911 is here tentatively estimated by calculating approximate capital-stock figures at 1911 prices, analogous to those calculated above for the Apulian aqueduct, for the other aqueducts and the local distribution networks too; converting all these to estimates of annual capital costs; and then inflating them to allow for personnel costs.

Aqueduct capital costs at 1911 prices are estimated from the cost figures for the Apulian aqueduct included in the relevant legislation (*legge 21 luglio 1911, n. 835*). Overall, the main conduit from Caposele to the derivation for Fasano was attributed a cost of 60.6 million lire for 216 kilometers, for an average of 280 lire per meter. The unit costs of this main conduit, divided into six successive segments of declining capacity, decline from 165 lire per meter to 80 lire per meter in the open air, and from 520-700 lire per meter to 80-220 lire per meter in tunnels. Attributing these six segments unit weights equal to .30, .10, .10, .20, .15, and .15, in rough proportion to their share of the main conduit's total length (from the map in the *Enciclopedia italiana*, vol. 1, pp. 408-409), one obtains an average cost, for the section in the open air, of 122 lire per meter; the actual average cost, at 280 lire per meter, was some 2.3 times this amount. The normal yield of these six segments, in cubic meters per second, is reported in art. 12 of the specifications attached to the *regio decreto 17 novembre 1904, n. 619*. Converting these six yields into equivalent tons per day (i.e., multiplying the reported number of cubic meters per second by 86,400 to obtain tons per day, and taking the square root of the result), and dividing the result into 2,300 times the open-air cost per meter, one obtains six estimates of actual average capital costs per equivalent ton-kilometer per day; these average approximately 600 lire, for an estimated total capital cost in 1911 of 233.4 million lire for the aqueducts covered by Table J.05, col. 5 (ignoring the difference between capacity reported directly as volume per unit time, and capacity calculated as the product of volume per person served and number of persons served; the corresponding data for Bari, Messina, Milano, Napoli, Padova, Alessandria, Ancona, Foggia, Pavia, Perugia, and Piacenza in the *Annuario città 1934*, pp. 476-490 suggest that these alternative measures could be quite different in specific cases, but that their average ratio was close to unity).

The *legge 21 luglio 1911, n. 835* also reports the aggregate cost and length of four local distribution networks, which yield average costs ranging from 20,000 to 26,600 lire per kilometer. These suggest an average of about 23,000 lire per kilometer, or about 208.6 million lire for the approximately 9,070 kilometers covered by Table J.06, col. 10. This estimate too is something of a compromise figure: the aggregate capital cost figures for such major cities as Brescia, Firenze, and Milano in the *Annuario città 1911-12*, p. 149 and the corresponding network-length figures in Tables J.06 and J.07 suggest rather higher average cost figures, at least in the large cities; but rather lower figures are suggested by the incremental cost of extensions to the networks in 1910-12 reported in the local publications of those same cities (e.g., *Statistica Brescia 1913*, p. 217, *Annuario Firenze 1910*, p. 256; these marginal costs may of course reflect a lower-than-average current provision of complementary equipment and installations).

Annual capital costs are estimated at 7% of the corresponding stock figure, calculated as 4% interest and 3% depreciation, as suggested by the interest rate and depreciation period data in the *Annuario città 1911-12*, p. 149 (one notes also the capital-cost figure for Torino, and the corresponding interest and depreciation charges in the *Annuario città 1913-14*, p. 185; while other cities' figures yield lower ratios of annual capital charges to total capital costs, these presumably reflect their relatively lesser reliance on borrowed funds). Annual personnel costs, in turn, are assumed to equal 15% of capital costs in the case of the Apulian aqueduct, 25% of capital costs in that of other aqueducts, and 35% of capital costs in that of local distribution networks. These estimates are based on the 1911 personnel costs of the water works of Firenze and Milano reported in the *Annuario città 1913-14*, p. 185, and the corresponding capital charges calculated by applying the above standard rates to their aqueducts' equivalent ton-kilometers per day (calculated from the *Acque potabili 1903*, vol. 1, as for Table J.05, col. 1) and their network-length figures (in Table J.06, cols. 1 – 2); both cities yield a ratio of personnel to capital costs very close to .30, which is incidentally the ratio obtained for the roughly comparable gas industry in section J03.04 above. The specific figures applied here assume that the ratio of labor to capital costs was somewhat lower for aqueducts than for local distribution networks, with their presumably greater administration, supervision, and maintenance needs; a specially low ratio is applied to the Apulian aqueduct, which was still under construction. The resulting estimates of value added in 1911 equal 8.05% of the capital-stock figures in Table J.04, col. 2 in the case of the Apulian aqueduct, or 3.49 million lire in all; 8.75% of the above capital-stock estimate in the case of the other aqueducts, equivalent to 52,500 lire per thousand equivalent ton-kilometers per day in Table J.05, col. 5, or 20.42 million lire in all; and 9.45% of the above capital-stock estimate in the case of the local distribution networks, equivalent to 2.1735 million lire per thousand kilometers in col. 10, or 19.71 million lire in all. Together, these estimates sum to a total value added of 43.6 million lire in 1911; of these, 9.7 million lire are attributed to wages and salaries.

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Table J.01
Estimated Output of Commercial Electric Energy, 1861-1913

	(1) Reported consumption[a] (million kWh)	(2)	(3) Reported capacity introduced (thousand kW)	(4)	(5)	(6)
			Commercial plants[b]	Sample power stations		
Year	Taxed 1896-1914	Total 1896-1914	1895-1908	Thermal 1883-1908	Hydraulic 1883-1908	Both 1883-1908
1880						
1881						
1882						
1883				1.4	.0	.0
1884				.0	.0	.0
1885				.0	.1	.0
1886				1.4	.0	.0
1887				.1	.2	.1
1888				.5	.1	.0
1889				.0	.2	.6
1890				1.0	.1	.2
1891				3.7	.0	.1
1892				.8	1.4	.1
1893				.6	.8	1.0
1894				.0	.9	.1
1895			22.0	.5	1.3	.3
1896	10		2.4	.4	1.8	.1
1897	16		11.5	3.9	3.2	.4
1898	19		19.6	5.2	13.1	.6
1899	22		11.4	5.0	4.6	.1
1900	27		7.8	1.0	6.8	.5
1901	32		24.3	9.9	12.4	3.0
1902	38		11.8	.7	11.9	.6
1903	45		28.9	1.3	11.7	.3
1904	53		38.2	5.7	21.7	5.1
1905	62		17.1	7.1	6.8	1.4
1906	74		44.7	12.3	23.0	4.9
1907	87		48.6	8.6	37.8	.7
1908	101		46.9	8.5	35.0	.7
1909	116	1,098				
1910	131	1,285				
1911	146	1,471				
1912	165	1,787				
1913	183	1,968				
1914	197	2,312				

Table J.01 (continued)

Year	(7) Estimated commercial capacity and output: Capacity[c] (thousand kW) Thermal 1861-1913	(8) Capacity[c] (thousand kW) Hydraulic 1861-1913	(9) Output[d] (million kWh) Thermal 1861-1913	(10) Output[d] (million kWh) Hydraulic 1861-1913
1880	.0	.0	.0	.0
1881	.0	.0	.0	.0
1882	.0	.0	.0	.0
1883	.4	.0	.1	.0
1884	.6	.0	.3	.0
1885	.8	.1	.5	.1
1886	3.1	.1	1.3	.2
1887	3.6	.3	2.2	.4
1888	4.6	.4	2.7	.7
1889	5.3	.8	3.2	1.3
1890	7.2	.9	4.0	1.9
1891	12.7	1.0	6.4	2.1
1892	13.9	2.2	8.4	3.6
1893	15.6	3.2	9.2	6.1
1894	15.6	4.0	9.7	8.3
1895	16.6	5.2	9.9	10.7
1896	17.1	7.1	10.2	14.4
1897	23.4	12.3	12.1	23.1
1898	29.1	26.2	15.5	46.4
1899	35.0	31.7	18.7	70.6
1900	36.2	38.3	20.6	86.4
1901	47.1	51.7	23.8	112.5
1902	48.0	62.6	26.9	144.6
1903	51.2	88.3	27.7	193.3
1904	60.9	116.8	31.0	266.0
1905	69.6	125.2	35.7	317.7
1906	86.0	153.5	42.1	370.5
1907	95.2	192.9	48.5	466.3
1908	104.6	230.4	52.8	577.0
1909	114.5	266.6	57.3	685.9
1910	123.8	305.0	61.6	798.6
1911	137.7	364.9	66.8	947.7
1912	145.7	404.4	71.7	1,101.7
1913	159.5	463.5	76.3	1,258.4

[a]by fiscal year, to June 30 of the indicated year.

[b]in 1895, counts all those extant at then end of 1898 introduced before 1896.

[c]at year-end.

[d]output equaled zero before 1880.

Sources: cols. 1 - 2: *Imposte di fabbricazione*.

cols. 3 - 6: *Statistica elettrica*.

cols. 7 - 10: see text.

Table J.02
Estimated Output of Illuminating Gas, 1861-1913
(million cubic meters)

Year	(1) Reported aggregate output 1861-1913	(2) Estimated Bologna district output 1891-1902	(3) Estimated Caltanissetta district output 1861-1902	(4) Estimated Firenze district output 1891-1908	(5) Estimated Genova district output 1891-1895	(6) Estimated Iglesias district output 1891-1895
1861			1.6			
1862			1.7			
1863			1.8			
1864			2.0			
1865	30.2		2.1			
1866			2.2			
1867			2.4			
1868			2.5			
1869			2.7			
1870			2.9			
1871			3.1			
1872			3.3			
1873			3.5			
1874			3.7			
1875			4.0			
1876			4.3			
1877			4.5			
1878			4.8			
1879			5.2			
1880			5.5			
1881			5.9			
1882			6.2			
1883			6.7			
1884			7.1			
1885			7.2			
1886			7.3			
1887			7.4			
1888			7.5			
1889			7.7			
1890			7.8			
1891	138.6	6.2	7.9	10.2	14.8	.9
1892	141.6	6.5	8.4	10.3	15.3	.9
1893	154.9	6.9	9.0	10.3	15.1	1.0
1894	149.0	7.2	9.6	10.4	15.0	1.0
1895	163.8	7.6	10.3	10.6	16.0	1.1
1896	174.2	8.2	10.2	11.0		
1897	179.2	8.8	10.1	10.9		
1898	192.8	9.5	10.1	10.8		
1899	195.4	10.2	10.0	10.6		
1900	194.0	11.0	10.1	10.6		
1901	198.6	11.9	10.2	10.5		
1902	210.5	12.8	10.2	10.4		
1903	231.4			10.2		
1904	244.8			10.7		
1905	256.8			10.8		
1906	272.3			10.6		
1907	291.2			11.2		
1908	307.5			12.8		
1909	318.2					
1910	327.8					
1911	345.8					
1912	350.4					
1913	358.2					
1914						

Table J.02 (continued)

Year	(7) Estimated Milano district output 1861-1895	(8) Estimated Napoli district output 1891-1895	(9) Estimated Roma district output 1861-1895	(10) Estimated Torino district output 1861-1895	(11) Estimated Vicenza district output 1891-1895	(12) Estimated residual output 1861-1908
1861	3.5		1.6	5.6		13.6
1862	3.8		1.8	5.9		14.3
1863	4.0		1.9	6.2		15.0
1864	4.3		2.1	6.5		15.8
1865	4.6		2.3	6.8		16.6
1866	4.9		2.5	7.1		17.5
1867	5.3		2.8	7.5		18.4
1868	5.6		3.0	7.9		19.3
1869	6.0		3.3	8.3		20.3
1870	6.4		3.6	8.7		21.3
1871	6.9		3.9	9.2		22.4
1872	7.3		4.3	9.7		23.6
1873	7.8		4.7	10.2		24.8
1874	8.4		5.2	10.7		26.1
1875	9.0		5.6	11.2		27.5
1876	9.6		6.2	11.8		28.9
1877	10.3		6.7	12.4		30.4
1878	11.0		7.4	13.1		31.9
1879	11.7		8.1	13.7		33.6
1880	12.5		8.8	14.4		35.3
1881	13.4		9.6	15.2		37.1
1882	14.3		10.5	16.0		39.0
1883	15.3		11.5	16.8		41.1
1884	16.4		12.6	17.6		43.2
1885	17.5		13.8	18.5		45.4
1886	18.7		15.1	19.5		47.7
1887	20.0		16.5	20.5		50.2
1888	22.3		16.2	21.8		52.8
1889	24.8		15.9	23.1		55.5
1890	27.6		15.6	24.3		58.4
1891	30.7	17.4	15.3	23.2	11.9	
1892	33.8	17.7	15.1	25.7	11.9	
1893	37.2	18.0	14.9	32.5	12.0	
1894	37.9	18.3	14.8	26.3	12.0	
1895	41.7	18.6	14.6	30.8	12.1	
1896						144.9
1897						149.9
1898						163.5
1899						166.4
1900						165.0
1901						169.4
1902						177.1
1903						221.2
1904						234.1
1905						246.0
1906						261.8
1907						280.7
1908						294.7
1909						
1910						
1911						
1912						
1913						
1914						

Table J.02 (continued)

Year	(13) Estimated aggregate output 1861-1913	(14) Reported taxed consumption[a] 1896-1914[c]	(15) Reported aggregate consumption[b] 1909-1914[c]
1861	25.9		
1862	27.5		
1863	28.9		
1864	30.7		
1865	32.4		
1866	34.2		
1867	36.4		
1868	38.3		
1869	40.6		
1870	42.9		
1871	45.5		
1872	48.2		
1873	51.0		
1874	54.1		
1875	57.3		
1876	60.8		
1877	64.3		
1878	68.2		
1879	72.3		
1880	76.5		
1881	81.2		
1882	86.0		
1883	91.4		
1884	96.9		
1885	102.4		
1886	108.3		
1887	114.6		
1888	120.6		
1889	127.0		
1890	133.7		
1891	138.6		
1892	145.6		
1893	156.9		
1894	152.5		
1895	163.4		
1896	174.3	74.6[c]	
1897	179.7	112.3	
1898	193.9	116.6	
1899	197.2	125.0	
1900	196.7	132.8	
1901	202.0	137.9	
1902	210.5	144.6	
1903	231.4	155.8	
1904	244.8	166.9	
1905	256.8	173.8	
1906	272.4	189.5	
1907	291.9	204.9	
1908	307.5	220.4	
1909	318.2	232.6	287.3
1910	327.8	243.1	299.3
1911	345.8	260.8	364.9
1912	350.4	266.2	378.6
1913	358.2	280.5	383.0
1914		282.5	391.1

Table J.02 (continued)

[a]consumption, including that from private works, was taxed from Nov. 1, 1895.

[b]includes that from private works.

[c]fiscal years, to June 30 of the indicated year.

Sources: col. (1): *Statistica mineraria*, *Rivista mineraria*.

cols. (2)-(13): see text.

cols. (14)-(15): *Imposte di fabbricazione*.

Table J.03
Estimated Output of Gas Coke and Tar in Commercial Gas Works, 1861-1913
(thousand tons)

Year	(1) Reported output of gas coke 1861-1913	(2) Reported output of gas tar 1861-1913	(3) Reported coal distilled 1861-1913	(4) Estimated output of gas coke 1861-1913	(5) Estimated output of gas tar 1861-1913
1861				58.0	6.0
1862				61.6	6.4
1863				64.8	6.7
1864				68.8	7.1
1865	67.7	7.0	133.8	72.6	7.5
1866				77.0	7.8
1867				82.3	8.2
1868				87.1	8.5
1869				92.7	8.9
1870				98.4	9.3
1871				104.9	9.8
1872				111.7	10.2
1873				118.7	10.7
1874				126.5	11.2
1875				134.7	11.7
1876				143.6	12.2
1877				152.6	12.8
1878				162.6	13.4
1879				173.2	14.0
1880				184.1	14.7
1881				196.4	15.4
1882				209.0	16.1
1883				223.2	16.9
1884				237.7	17.6
1885				252.4	18.4
1886				268.3	19.2
1887				285.2	20.1
1888				301.6	20.9
1889				319.1	21.7
1890				337.6	22.6
1891	351.6	23.1	557.7	351.6	23.1
1892	355.6	23.5		365.6	24.2
1893	395.3	25.0		400.4	25.3
1894	371.4	26.0		380.1	26.6
1895	394.0	26.4	613.2	392.8	26.3
1896	426.9	27.9	642.3	427.1	27.9
1897	430.6	25.6	649.1	431.8	25.7
1898	469.2	27.7	672.3	471.9	27.9
1899	486.0	29.4	725.9	490.5	29.7
1900	472.2	31.1	709.3	478.8	31.5
1901	490.8	34.9	732.7	499.2	35.5
1902	498.8	36.4	804.5	498.8	36.4
1903	533.6	39.7	855.3	533.6	39.7
1904	577.3	39.3	895.3	577.3	39.3
1905	592.0	41.2	910.5	592.0	41.2
1906	634.7	45.6	925.4	634.9	45.6
1907	682.7	48.3	987.9	684.3	48.4
1908	708.8	51.1	1,059.3	708.8	51.1
1909	749.0	53.0	1,106.2	749.0	53.0
1910	764.0	53.5	1,149.9	764.0	53.5
1911	792.6	54.9	1,287.1	792.6	54.9
1912	786.2	57.3		786.2	57.3
1913	837.9	58.8		837.9	58.8

Sources: cols. (1)-(3): *Statistica mineraria*, *Rivista mineraria*.
cols. (4)-(5): see text.

Table J.04
Estimated Output of the Water-Supply Industry, 1861-1913:
Apulian Aqueduct

Year	(1) Estimated current-price investment (million lire) 1905-1913	(2) Estimated 1911-price capital stock at mid-year (million lire) 1905-1913
1905	.0	.0
1906	2.7	1.6
1907	4.1	5.5
1908	6.9	11.5
1909	6.4	18.5
1910	12.2	28.0
1911	18.6	43.4
1912	26.7	65.7
1913	22.4	89.3

Sources: col. 1: *Notizie S.p.A.*

col. 2: see text.

Table J.05
Estimated Output of the Water-Supply Industry, 1861-1913:
Other Aqueducts

Year	(1) Major[a]: estimated output increase[b] (thousand equivalent ton-kms/day)[c] 1860-1903	(2) Minor[a]: number, distributed by year of construction[d] 1860-1903	(3) Minor[a]: estimated output increase[b] (thousand equivalent ton-kms/day)[c] 1860-1913	(4) Urban: estimated yield increase[b] (equivalent liters/second)[e] 1861-1913	(5) Estimated output (thousand equivalent ton-kms/day)[c] 1861-1913
1860	38.522	2,069	46.192	185.9	
1861	.000	14	.313	.0	85
1862	.000	15	.335	.0	85
1863	.000	16	.357	.0	86
1864	.000	22	.491	.0	86
1865	.374	39	.871	.0	87
1866	.386	33	.737	4.5	88
1867	1.337	25	.558	.0	90
1868	.361	27	.603	.0	91
1869	.735	21	.469	.0	92
1870	13.731	64	1.429	65.2	100
1871	.346	25	.558	.0	108
1872	.361	25	.558	10.2	109
1873	.043	29	.647	.0	110
1874	.266	33	.737	6.5	111
1875	.000	35	.781	2.1	112
1876	.322	24	.536	.0	113
1877	.410	28	.625	.0	113
1878	.420	45	1.005	.0	115
1879	.203	38	.848	.0	116
1880	5.519	69	1.540	21.5	120
1881	2.305	43	.960	31.5	125
1882	3.667	67	1.496	51.6	129
1883	.588	69	1.540	11.1	133
1884	7.828	91	2.032	82.5	139
1885	30.248	88	1.965	45.5	160
1886	7.481	109	2.434	22.1	181
1887	9.173	102	2.277	49.2	192
1888	.851	102	2.277	59.2	199
1889	4.252	116	2.590	77.1	204

Table J.05 (continued)

	(1)	(2)	(3)	(4)	(5)
1890	18.665	117	2.612	81.0	218
1891	2.044	127	2.835	10.3	231
1892	2.246	115	2.567	18.7	236
1893	.561	146	3.260	25.1	240
1894	4.741	148	3.304	24.0	246
1895	17.399	136	3.036	66.2	261
1896	4.000	123	2.746	34.3	274
1897	4.365	134	2.992	36.8	281
1898	2.315	202	4.510	18.8	288
1899	3.198	135	3.014	19.8	295
1900	2.045	137	3.059	34.5	300
1901	1.328	142	3.170	12.4	305
1902	2.499	129	2.880	23.6	310
1903	3.725	205	4.577	1.3	317
1904				8.8	318
1905				42.8	326
1906				58.0	340
1907				28.9	352
1908				51.1	363
1909				16.8	373
1910				22.1	378
1911				21.5	384
1912				75.6	398
1913				24.7	412

Table J.05 (continued)

[a]major aqueducts are those serving 10,000 people or more in 1903, or 10 or more kilometers long; all others are minor.

[b]in 1860, the reported figure is estimated total output (or yield) at the end of the year.

[c]equivalent ton-kilometers/day equal the product of kilometers and the square root of tons/day.

[d]in 1860, the reported figure is the estimated total number extant at the end of the year.

[e]equivalent liters/second equal the square root of liters/second.

Sources: cols. 1 - 2: *Acque potabili 1903*.

cols. 3, 5: see text.

col. 4: *Annuario città*.

Table J.06
Estimated Output of the Water-Supply Industry, 1861-1913:
Local Distribution Networks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Estimated length of the local distribution networks of the eleven largest cities (kilometers)				Population elsewhere served by aqueducts in 1903 (thousands): distribution by year of aqueduct construction[e]		
					By aqueducts serving 10,000 people or more		By other aqueducts
	Firenze	Milano	Roma	Total	Apparently piping into private houses	Apparently not piping into private houses	apparently piping into private houses
Year	1861-1913	1861-1913	1861-1913	1861-1913	1856-1903	1856-1903	1856-1903
1856					398.8	170.8	147.5
1857					19.0	.0	2.8
1858					.0	.0	.0
1859					.0	26.0	.0
1860					.0	14.0	.0
1861	20	0	71	198	.0	.0	.0
1862	20	0	71	200	.0	.0	.5
1863	20	0	71	202	.0	.0	2.2
1864	20	0	71	204	.0	.0	9.7
1865	20	0	71	206	35.0	.0	16.1
1866	20	0	71	208	.0	24.0	10.8
1867	20	0	71	210	54.2	12.7	3.1
1868	20	0	71	212	.0	35.1	5.7
1869	20	0	71	214	.0	30.0	6.4
1870	20	0	71	216	.0	71.2	8.9
1871	20	0	86	233	29.2	11.3	5.1
1872	20	0	95	244	43.0	46.9	.0
1873	20	0	109	260	.0	32.2	8.6
1874	20	0	118	271	.0	.0	11.2
1875	20	0	120	275	.0	.0	7.6
1876	25	0	124	286	.0	16.4	.0
1877	30	0	131	300	23.4	.0	.0
1878	35	0	134	310	19.4	16.5	5.4
1879	40	0	141	324	28.7	.0	7.2
1880	45	0	146	336	18.0	.0	10.6
1881	50	0	154	376	45.0	.0	5.6
1882	54	0	161	390	98.3	.0	18.2
1883	58	0	166	401	48.9	.0	15.7
1884	63	0	175	441	56.7	.0	54.9

Table J.06 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1885	70	0	194	527	98.2	.0	31.0
1886	75	0	212	618	162.3	.0	46.0
1887	79	0	253	693	93.8	68.9	17.4
1888	82	0	282	768	36.4	66.1	26.5
1889	88	9	289	865	102.8	48.7	26.4
1890	95	14	292	908	157.4	26.3	32.1
1891	96	20	295	949	93.0	.0	35.6
1892	101	33	301	992	46.0	25.9	54.8
1893	106	42	307	1,033	28.0	10.7	36.3
1894	111	57	312	1,078	114.1	20.0	59.7
1895	114	69	318	1,130	70.0	.0	42.6
1896	115	83	324	1,200	64.1	.0	66.3
1897	116	97	330	1,269	39.7	25.7	26.6
1898	120	111	335	1,341	100.3	12.0	66.3
1899	122	124	341	1,409	51.6	14.2	23.1
1900	126	134	347	1,477	24.7	10.7	48.3
1901	130	142	353	1,527	83.3	40.1	51.7
1902	132	152	358	1,577	47.3	.0	55.0
1903	134	160	364	1,626	31.9	10.7	60.5
1904	136	168	370	1,664			
1905	138	178	375	1,712			
1906	140	196	380	1,787			
1907	144	214	390	1,860			
1908	150	235	400	1,934			
1909	156	257	408	1,992			
1910	160	279	415	2,044			
1911	163	305	423	2,103			
1912	168	337	430	2,169			
1913	175	360	438	2,226			

Table J.06 (continued)

Year	(8) Estimated length of other local distribution networks (kilometers): Fed by aqueducts serving 10,000 people or more in 1903 1861-1913	(9) Fed by other aqueducts 1861-1913	(10) Estimated length of the local distribution networks[f] (thousand kilometers) 1861-1913
1856			
1857			
1858			
1859			
1860			
1861	330	473	1.24
1862	331	478	1.24
1863	333	483	1.25
1864	334	492	1.27
1865	346	507	1.30
1866	355	522	1.33
1867	378	534	1.36
1868	396	547	1.40
1869	413	559	1.43
1870	433	579	1.47
1871	451	590	1.52
1872	477	600	1.57
1873	493	613	1.62
1874	503	628	1.65
1875	514	642	1.68
1876	524	653	1.72
1877	533	664	1.75
1878	547	679	1.79
1879	563	693	1.84
1880	580	714	1.89
1881	606	730	1.97
1882	652	755	2.06
1883	693	782	2.14
1884	738	826	2.17

Table J.06 (continued)

	(8)	(9)	(10)
1885	802	868	2.46
1886	892	922	2.70
1887	982	969	2.91
1888	1,059	1,020	3.12
1889	1,153	1,070	3.36
1890	1,261	1,123	3.57
1891	1,344	1,177	3.75
1892	1,417	1,238	3.93
1893	1,483	1,303	4.10
1894	1,571	1,378	4.31
1895	1,635	1,449	4.50
1896	1,695	1,526	4.71
1897	1,755	1,595	4.91
1898	1,835	1,690	5.15
1899	1,897	1,759	5.35
1900	1,948	1,835	5.55
1901	2,020	1,911	5.75
1902	2,078	1,989	5.94
1903	2,127	2,085	6.13
1904	2,207	2,148	6.32
1905	2,290	2,213	6.51
1906	2,377	2,280	6.75
1907	2,586	2,440	7.19
1908	2,814	2,612	7.66
1909	3,033	2,775	8.11
1910	3,269	2,948	8.57
1911	3,524	3,132	9.07
1912	3,799	3,327	9.61
1913	4,095	3,534	10.17

Table J.06 (continued)

[e]In 1856, the reported figure is the cumulation of the estimated number constructed prior to 1857.

[f]includes an allowance for wells and cisterns.

Sources: cols. 1, 3 - 4, 8 - 10: see text.

col. 2: *Statistica Milano*.

cols. 5 - 6: *Acque potabili*.

Table J.07
Reported Length of Local Water-Distribution Networks, 1904-1911
(kilometers)

	(1) 1904	(2) 1906	(3) 1908	(4) 1911
Ancona	48.3	57.5	68.0	75.0
Arezzo	5.0	13.2	13.2	
Asti	13.0	14.1	14.5	14.5
Bergamo			43.0	60.0
Brescia	32.0	35.0	38.8	49.2
Busto Arsizio		12.0	18.0	
Cagliari	25.0	25.0	25.0	30.0
Caltagirone		8.5	*8.7*	9.0
Caltanissetta		18.5	*18.8*	19.2
Castellammare di Stabia	12.3	12.3		
Catanzaro	15.0	*15.0*	*15.0*	15.0
Cesena	8.0	8.0	8.0	8.0
Chieti		4.2	*7.7*	13.0
Chioggia		5.8	6.5	
Civitavecchia	4.0	*8.9*	13.8	15.0
Cosenza	10.0	10.0	10.0	10.0
Cuneo		20.0	21.0	22.0
Faenza	9.0	9.8	9.9	10.6
Ferrara	42.0	50.0	53.0	170.0
Forlì	12.8	*14.6*	*16.3*	19.0
Grosseto	12.5	12.5	12.5	58.0
Lecco			11.3	13.5
Livorno	30.0	36.0	36.0	
Lucca	11.9	12.6	*12.9*	13.4
Mantova		3.0	*13.2*	28.5
Marsala		15.0	15.5	25.5
Padova	118.0	118.0	128.2	128.2
Perugia	13.5	13.5	39.0	40.0
Pesaro		5.1	5.1	5.1
Potenza	34.0	35.0		
Prato	1.6	1.6		
Ragusa		6.8	41.0	
Reggio Calabria	8.2	*11.0*	*13.8*	18.0
Salerno	4.0	4.0		
San Pier d'Arena			30.4	31.5
Sassari			11.0	11.0
Savona	40.8	41.8	44.5	48.3
Sestri Ponente		10.4	10.4	
Siena			17.4	22.0
Spezia			22.0	22.0
Spoleto		12.3	12.3	12.3
Udine	82.0	82.7		
Verona	47.0	47.0	53.9	53.9
Vicenza			25.0	59.0
Viterbo		28.0	28.0	28.0

[a]the figures in italics are interpolated.

Source: *Annuario città*.

Summary Table J.1
The utilities industries: elementary production series, 1861-1913

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Electricity		Gas			Water		
	Thermal power (million kWh)	Hydraulic power (million kWh)	Gas (million cubic meters)	Gas by-products: Coke (thousand tons)	Gas by-products: Tar (thousand tons)	Apulian aqueduct (million 1911 lire)	Other aqueducts (equiv. t-kms/day)	Local nets (thousand kms)
code:	ja01	ja02	jb01	jb02	jb03	jc01	jc02	jc03
source:	j01c09	j01c10	j02c13	j03c04	j03c05	j04c02	j05c05	j06c10
note:	(a)	(a)	(b)	(b)	(b)	(c)	(d)	(e)
1861	.0	.0	25.9	58.0	6.0	.0	85	1.24
1862	.0	.0	27.5	61.6	6.4	.0	85	1.24
1863	.0	.0	28.9	64.8	6.7	.0	86	1.25
1864	.0	.0	30.7	68.8	7.1	.0	86	1.27
1865	.0	.0	32.4	72.6	7.5	.0	87	1.30
1866	.0	.0	34.2	77.0	7.8	.0	88	1.33
1867	.0	.0	36.4	82.3	8.2	.0	90	1.36
1868	.0	.0	38.3	87.1	8.5	.0	91	1.40
1869	.0	.0	40.6	92.7	8.9	.0	92	1.43
1870	.0	.0	42.9	98.4	9.3	.0	100	1.47
1871	.0	.0	45.5	104.9	9.8	.0	108	1.52
1872	.0	.0	48.2	111.7	10.2	.0	109	1.57
1873	.0	.0	51.0	118.7	10.7	.0	110	1.62
1874	.0	.0	54.1	126.5	11.2	.0	111	1.65
1875	.0	.0	57.3	134.7	11.7	.0	112	1.68
1876	.0	.0	60.8	143.6	12.2	.0	113	1.72
1877	.0	.0	64.3	152.6	12.8	.0	113	1.75
1878	.0	.0	68.2	162.6	13.4	.0	115	1.79
1879	.0	.0	72.3	173.2	14.0	.0	116	1.84
1880	.0	.0	76.5	184.1	14.7	.0	120	1.89
1881	.0	.0	81.2	196.4	15.4	.0	125	1.97
1882	.0	.0	86.0	209.0	16.1	.0	129	2.06
1883	.1	.0	91.4	223.2	16.9	.0	133	2.14
1884	.3	.0	96.9	237.7	17.6	.0	139	2.17
1885	.5	.1	102.4	252.4	18.4	.0	160	2.46
1886	1.3	.2	108.3	268.3	19.2	.0	181	2.70
1887	2.2	.4	114.6	285.2	20.1	.0	192	2.91
1888	2.7	.7	120.6	301.6	20.9	.0	199	3.12
1889	3.2	1.3	127.0	319.1	21.7	.0	204	3.36
1890	4.0	1.9	133.7	337.6	22.6	.0	218	3.57
1891	6.4	2.1	138.6	351.6	23.1	.0	231	3.75
1892	8.4	3.6	145.6	365.6	24.2	.0	236	3.93
1893	9.2	6.1	156.9	400.4	25.3	.0	240	4.10
1894	9.7	8.3	152.5	380.1	26.6	.0	246	4.31
1895	9.9	10.7	163.4	392.8	26.3	.0	261	4.50
1896	10.2	14.4	174.3	427.1	27.9	.0	274	4.71
1897	12.1	23.1	179.7	431.8	25.7	.0	281	4.91
1898	15.5	46.4	193.9	471.9	27.9	.0	288	5.15
1899	18.7	70.6	197.2	490.5	29.7	.0	295	5.35
1900	20.6	86.4	196.7	478.8	31.5	.0	300	5.55
1901	23.8	112.5	202.0	499.2	35.5	.0	305	5.75
1902	26.9	144.6	210.5	498.8	36.4	.0	310	5.94
1903	27.7	193.3	231.4	533.6	39.7	.0	317	6.13
1904	31.0	266.0	244.8	577.3	39.3	.0	322	6.32
1905	35.7	317.7	256.8	592.0	41.2	.0	330	6.51
1906	42.1	370.5	272.4	634.9	45.6	1.6	344	6.75
1907	48.5	466.3	291.9	684.3	48.4	5.5	356	7.19
1908	52.8	577.0	307.5	708.8	51.1	11.5	368	7.66
1909	57.3	685.9	318.2	749.0	53.0	18.5	377	8.11
1910	61.6	798.6	327.8	764.0	53.5	28.0	383	8.57
1911	66.8	947.7	345.8	792.6	54.9	43.4	389	9.07
1912	71.7	1,101.7	350.4	786.2	57.3	65.7	403	9.61
1913	76.3	1,258.4	358.2	837.9	58.8	89.3	417	10.17

Summary Table J.1 (continued)

NOTES

(a) The production of electricity is estimated in the main from evidence on the growth of generating capacity, and on its utilization. The present series cover only the power generated by the electric utilities, i.e., for sale to third parties.

(b) The production of gas and gas by-products is estimated from direct evidence of production; until ca. 1890 the data are very scarce, and the estimates rely heavily on interpolation.

(c) The real product of the Apulian aqueduct is measured by the capital stock at 1911 prices; it is estimated by deflating and cumulating the reported expenditure on the aqueduct's construction.

(d) The product of the other aqueducts is estimated from detailed evidence on their capacity, length, and date of construction. To allow for economies of scale their equivalent product is measured as their length (in kilometers) times the square root of their capacity (in tons per day).

(e) The product of the local distribution nets is measured by their length. The present series is derived in part from sporadic direct evidence for the major cities, and in part from the evidence on the construction of the corresponding aqueducts. It includes an allowance for wells and cisterns.

Summary Table J.2
The utilities industries: value added in 1911

1. By product

(1) series code	(2) Physical series: product	(3) Value added per unit	(4) Total value added: million lire	(5) Total value added: series code
Electricity				
ja01	thermal power	.1624 lire/kWh	10.85	ja01v
ja02	hydraulic power	.1014 lire/kWh	96.10	ja02v
Gas				
jb01	gas	.0712 lire/cu. m.	24.62	jb01v
jb02	coke	16.060 lire/ton	12.73	jb02v
jb03	tar	13.660 lire/ton	.75	jb03v
Water				
jc01	Apulian aqueduct	80,500 lire/million lire	3.49	jc01v
jc02	other aqueducts	52,500 lire/equiv. t-kms/day	20.58	jc02v
jc03	local nets	2,173.5 lire/km	19.71	jc03v

2. By industry

(1) Code	(2) Industry	(3) Value added (million lire)	(4) Component series
jav	electricity	106.9	ja01v--ja02v
jbv	gas	38.1	jb01v--jb03v
jcv	water	43.6	jc01v--jc03v

3. By industry group

(1) Code	(2) Industry	(3) Value added (million lire)	(4) Component series
jv	utilities	188.7	jav--jcv

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 J.3
The utilities industries: value added at 1911 prices, 1861-1913
(million lire)

	(1)	(2)	(3)	(4)
	Electricity	Gas	Water	Utilities
code:	jav	jbv	jcv	jv
1861	.000	2.858	7.158	10.015
1862	.000	3.035	7.158	10.192
1863	.000	3.190	7.232	10.422
1864	.000	3.388	7.275	10.663
1865	.000	3.575	7.393	10.968
1866	.000	3.778	7.511	11.289
1867	.000	4.025	7.681	11.706
1868	.000	4.242	7.820	12.062
1869	.000	4.501	7.938	12.439
1870	.000	4.762	8.445	13.207
1871	.000	5.058	8.974	14.032
1872	.000	5.365	9.135	14.500
1873	.000	5.684	9.296	14.980
1874	.000	6.037	9.414	15.450
1875	.000	6.403	9.531	15.934
1876	.000	6.802	9.671	16.473
1877	.000	7.204	9.736	16.940
1878	.000	7.650	9.928	17.578
1879	.000	8.121	10.089	18.210
1880	.000	8.604	10.408	19.012
1881	.000	9.146	10.844	19.990
1882	.000	9.700	11.250	20.950
1883	.016	10.323	11.634	21.973
1884	.049	10.957	12.231	23.237
1885	.091	11.596	13.747	25.434
1886	.231	12.282	15.371	27.884
1887	.398	13.014	16.405	29.817
1888	.509	13.716	17.229	31.454
1889	.652	14.464	18.013	33.128
1890	.842	15.250	19.204	35.297
1891	1.252	15.831	20.278	37.361
1892	1.729	16.569	20.932	39.230
1893	2.113	17.947	21.511	41.571
1894	2.417	17.326	22.283	42.025
1895	2.693	18.302	23.483	44.478
1896	3.117	19.651	24.622	47.389
1897	4.307	20.080	25.424	49.812
1898	7.222	21.766	26.314	55.301
1899	10.196	22.324	27.116	59.635
1900	12.106	22.125	27.813	62.044
1901	15.273	22.884	28.510	66.667
1902	19.031	23.496	29.186	71.712
1903	24.099	25.588	29.966	79.653
1904	32.007	27.238	30.642	89.886
1905	38.012	28.354	31.474	97.841
1906	44.406	30.214	32.860	107.480
1907	55.159	32.434	34.760	122.354
1908	67.083	33.975	36.895	137.953
1909	78.856	35.409	38.909	153.173
1910	90.982	36.340	40.988	168.310
1911	106.945	38.100	43.630	188.675
1912	123.356	38.358	47.334	209.048
1913	139.993	39.764	51.186	230.942