

# Collegio Carlo Alberto



## Italian Industrial Production, 1861-1913: A Statistical Reconstruction A. Introduction

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Stefano Fenoaltea

**ITALIAN INDUSTRIAL PRODUCTION, 1861-1913:**

**A STATISTICAL RECONSTRUCTION**

**A. INTRODUCTION**

2015

# ITALIAN INDUSTRIAL PRODUCTION, 1861-1913:

## A STATISTICAL RECONSTRUCTION

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## READER'S GUIDE

### The nature of the present work

This work is a statistical reconstruction of Italy's industrial production from 1861 to 1913. "Production" is an ambiguous word, used to refer both to what industry *does* -- to the process, the transformation of raw materials into output -- and to what industry *makes*, that is, to output itself. As a rule, output is here measured in physical units: each product in its own unit, e.g., "tons of pig iron." The process is measured, in a common monetary unit, by the value it adds to the material (far greater, for example, if machines are made from metal rather than merely assembled from imported parts), somehow deflated to obtain a measure of "real" value added over time. Here, the elementary "real" value added series are calculated, imperfectly but economically, as physical output weighted by value added per unit at constant (1911) prices. In some cases, typically when the physical output is ill-defined, the disaggregated series are expressed directly in 1911-price value added units.

The disaggregated constant-price value added series cover, in principle, all industrial production; the aggregate "real" product of any specific industry or group of industries is thus simply the sum of the appropriate sub-set of product-specific series, without further weighting. This in turn implies that the transfer of an activity from one subset to another -- that is, a change in the industrial classification -- does not alter the higher-level aggregates, as it would if missing series were represented by others in the same subset.

The classification used to organize the present material is essentially, at the higher levels, the now old (1971) *ISIC*, the International Standard Industrial Classification of the United Nations. Some normally minor modifications, indicated in passing, reflect Italian practice or the Italian sources; some presume to anticipate future revisions to the national accounts. Within industries and industry groups, the disaggregation by product reflects the constraints imposed by the source material; it is extensive where the sources are rich, and correspondingly limited where they are not. In general, the disaggregation of the present elementary series readily allows their recombination to fit alternative classifications.

Specialists know, and the non-specialist may wish to keep in mind, that the figures presented here are derived from imperfect sources, sensitive to the author's evaluations, and susceptible to almost endless refinement. The present estimates are surely better than their predecessors; still better estimates can be generated by further research.

The process of improvement varies with the nature of the evidence, which runs between two polar cases. In the one, the sources report -- *apparently* report -- the production in question; improvement comes from a better understanding of the process that generated the historical data, of what the sources actually document, in short from approaching the historical evidence as a historian. Some historical series are here accepted as published, some rejected as altogether spurious; most are retained with more or less extensive revisions to correct for changes in the object's definition, in geographic coverage, and the like.

At the other and more common extreme, the familiar sources contain no production data whatsoever. The most significant improvement comes here from reconstructing those time series at all, instead of assuming that undocumented production is adequately represented by documented production. In a number of cases, research turned up relatively direct evidence of production that had simply been overlooked; more such evidence may still lie buried. Again, some undocumented production can be estimated quite straightforwardly, by extension from the documented production of a previous or subsequent stage of production, allowing for international trade. This familiar procedure exploits the (amateur) production engineer's

knowledge of the industry's technological structure, of its products and processes, of the relevant input-output coefficients.

The most challenging estimates are of course those for the industries that are not documented by evidence either direct or, if indirect, at least nearly direct. In such cases, the shape of the object at hand is teased out by examining the shadows it casts when illuminated from various points of light; it is diagnosed, to change the metaphor, from the observable symptoms. Formally, the problem is that of identifying a system of equations that links the unknown to the known; substantively, that of identifying a time path that is consistent with those of other variables, for related markets, given the predictable behavior of constrained decision-makers. It is here that the economist comes into his own.

The present work consists of a general introduction describing the main available sources and the methodological approach, and a series of sections devoted to industry's various major sectors. Each of these sections contains its own introduction -- to the relevant sector, the useful sources, and the resulting estimates -- and a detailed description of the derivation of the present time series and 1911-price value added estimates. This description allows the reproduction of the present estimates directly from the cited source material, and thus of their verification; and it paves the way for their improvement.

For the user's convenience each section also includes a final group of summary tables that present with no more than brief notes the full set of disaggregated production series -- normally the product-specific physical output series -- and the corresponding value added estimates at 1911 prices, as well as the 1911-price value added series for the successively higher-level aggregates obtained from these basic building blocks.

Each elementary series reproduced in these tables is labeled with its source in the preceding material: for example, the indication *h06c01* attached to "clean domestic virgin wool" identifies that series as the one presented in Table H.06, col. 1, and discussed in the accompanying text (in section *H. The textile, apparel, and leather industries*, as specified in the section table of contents). Each physical output series is also labeled with a code that identifies its major sector, industry group, industry, and sequence number. For example, the code *hab01* attached to that same physical output of clean domestic virgin wool identifies that series as pertaining to the textiles, apparel, and leather sector (*h*), within that sector to the first industry group (textiles: *a*), and within that group to the second industry (wool: *b*). Of the physical output series for the wool industry, "clean domestic virgin wool" is the first (*01*).

The corresponding elementary 1911-price value added series are labeled with the same code, with the extension *v*: for example, the 1911-price value added series referred to the production of clean domestic virgin wool is identified as *hab01v*. Higher-level 1911-price value added series use the same codes, suitably abbreviated: for example, *habv* identifies the series for the entire wool industry, *hav* that for all textiles, and *hv* for the entire textiles, apparel, and leather sector.

## **The limits of the present work**

This work has absorbed the larger part of the author's working life. *Ars longa, vita brevis*: in its present form it suffers from three deep limits.

The first is conceptual. The present "real value added" series are simply physical series, weighted by unit value added at 1911 prices: that is the best that can be done with the estimates so far compiled. As explained in the general introduction (chapter A04) a proper measure of real value added requires the deflation of current-price value added series by a common price index; and that means that the present physical product series should in principle be weighted by

estimates of unit value added calculated at each year's prices, and not, as at present, at the prices of 1911 alone. The compilation of such estimates is tedious but not difficult; priority has here been given to the altogether more challenging reconstruction of the physical series, where the return to the author's accumulated expertise seems altogether higher.

The second is eminently practical. Expertise accumulates slowly, even sources worked on for decades unexpectedly reveal new secrets; thus the demographic census of 1911, for example, some peculiarities of which were brought to light only by recent work on the sub-national data. A final pass through the entire material, to revise the earlier work in light of all the author subsequently learned (or should have learned), would no doubt have been desirable; it was eschewed because of two very real risks. The more obvious is that the author would not live to see it through. The more daunting stems from the magnitude of the work itself, the sad fact that the author's mind cannot comprehend it, at once, in its entirety. Some estimates for particular sectors feed into those for other sectors, at times in complex ways; a late correction in one section might well require a chain of subsequent revisions in other sections, and the chances are high that something would simply be overlooked, destroying the estimates' logical consistency and replicability. Technology continues to improve, but if a product is to be obtained at all the design must at some point be frozen; and so it has been here, industry after industry.

A further, not insignificant consideration is that the present reconstruction of national industrial production serves as the underpinning for the estimates of regional production compiled by the present author and Carlo Ciccarelli. Those for the extractive, non-metallic mineral products, chemical, metalmaking, engineering, utilities, and construction industries have already been published (Ciccarelli and Fenoaltea, 2009, 2014); the corresponding parts of the present work to which they refer needs remain as they were.

The third and most significant limit is *in ipsis rebus*. Measurement is not a science, it is an art, a craft: the time series presented here are not "data," not "the facts," but constructs derived from data in the sources that are themselves constructs. They convey not what actually occurred, but the author's sense of what not implausibly occurred, as he could read the evidence, through a glass, darkly.

## REFERENCES

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Ciccarelli, Carlo, and Stefano Fenoaltea (2014). *La produzione industriale delle regioni d'Italia, 1861-1913: una ricostruzione quantitativa. 2. Le industrie estrattivo-manifatturiere* (Roma: Banca d'Italia).

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

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The author alone, of course, is responsible for the material presented here.



**ITALIAN INDUSTRIAL PRODUCTION, 1861-1913:  
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**A. INTRODUCTION**

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## A. INTRODUCTION

### A01. The output and value added estimates

#### *A01.01 On method*

Alexander Gerschenkron published, decades ago, a full description of the sources and methods underlying his index of Italian industrial production from 1881 to 1913 (Gerschenkron, 1962). That description set a standard -- of verifiable, replicable scholarship -- to which this work adheres.

In appraising his own index Gerschenkron wrote that “[it] is probably capable of being improved by further study. But such improvements would be spotty.” A few series might be added, different weights could be used; but “the main features of the present index would remain unchanged and so would its shortcomings” (Gerschenkron, 1962, p. 412).

Not so, and not just or even primarily because further research has multiplied the number of elementary series over tenfold. The main shortcomings of his index are a matter of method, his method, the standard method that still underpins, in the main, the world-wide corpus of historical production series (Fenoaltea, 2010).

The standard procedure is simply to transcribe the relevant time series from official publications: “data-gathering” is considered essentially mindless work, readily delegated to graduate assistants. But the official measurement of the economy is a practice, and requires skills and organizations, that developed over time; the numbers in the historical sources must be evaluated in the light of the process that generated them, of their congruence with other evidence, in short with the mind-set of a professional historian. The sources are in fact littered with numbers that cannot be taken, as they have been and sadly continue to be (Fenoaltea, 2014b), at face value: the most significant, earliest improvements to Gerschenkron’s index -- and the parallel reappraisal of the official historical accounts (the *Reddito nazionale*) published by Istat, the Istituto centrale di statistica, in 1957 -- stemmed not from the inclusion of data that had not been used, but from the selective exclusion of data that had been used, with no concern for their defects (notably the figures on grain production, which dominate the calculated product of all agriculture on the one hand, and of the foodstuffs industry on the other: Fenoaltea, 1967, 1969, 1972). In this work, the sources are approached with due diffidence: the production series they contain are vetted, typically amended, at times rejected outright.

The standard procedure is to be content with indices of the aggregate product of an entire industry group, using for example the production of sulfuric acid to track the product of the chemical industry, or the consumption of iron and steel, net of rails, to track that of the engineering industry (Gerschenkron, 1962; Felice and Carreras, 2012). In this work, where the sources allow, production is extensively disaggregated. The technical payoff is that the elementary series are more nearly homogeneous, and that the aggregates capture composition effects; the historical payoff can vary from the mere enrichment of our knowledge to a dramatic recharacterization of a major industry, which turns out to have been quite other than we thought (Fenoaltea, 2014a).

The standard procedure is to use the available components of an aggregate to represent the whole, as if that were inevitable (Feinstein, 1972, p. 207): the undocumented components are implicitly assumed to move just like the documented ones. The practice is patently defective, in form and substance. As a matter of form, it injects a random element, for it ties the path imputed to the various undocumented industries to the industrial classification one happens to use. The production of sulfuric acid and of rubber, say, are documented, other chemicals are not; the latter will be represented by sulfuric acid and rubber together if rubber-processing is

considered part of the chemical industry, and by sulfuric acid alone if it is not. As a matter of substance the procedure is simply wrong-headed, for the undocumented industries were often independent of the documented ones of the same group, if not their direct rivals. Within the extractive-industries group, for example, documented mining produced high-grade ores for the metalmaking and chemical industries in Italy and abroad, undocumented quarrying mostly low-grade materials for the construction industry in Italy; within the textile group, documented, factory-processed cotton progressively displaced undocumented, hand-processed hemp. In this work, all production is estimated directly, from whatever evidence can be brought to bear; and if some estimates remain guesses, they are at least the product of reflection rather than of a mindless algorithm. Because the coverage of the present series is thus exhaustive, changing the industrial classification here involves only a regrouping of the elementary series, with no effect at all on the path attributed to individual (“undocumented”) industries, or to industry as a whole.

The standard procedure is to aim for “double-deflated” Fabricant-Geary “real” measures of value added; but the latter too leave much to be desired. For the reasons expounded now long ago (Fenoaltea, 1976) and recalled below, the only proper measure of “real value added” is a deflation of every industry’s value added at current prices by a *common* price index. That further step is not taken here: if the traditional measures are considered first-generation estimates, those produced here are second-generation estimates, and proper measures of real value added await a third generation.

#### ***A01.02 The present estimates***

The present is a quantitative reconstruction of Italy’s industrial production from 1861 to 1913. Industry is here defined to include the production of goods for the market without regard to the size of the enterprise or the physical organization of production; Italy, by the borders reached in 1871 and maintained through the First World War.

The work normally develops, in the first instance, two related sets of estimates. One comprises the annual series tracing each industry’s physical output: these are estimates what industry *made*, year after year. The other comprises the estimates of value added at factor cost, at 1911 prices, associated with each specific unit of output: the direct estimates of the process -- of what industry *did*, of what industry *was* -- are thus obtained only for 1911 (a year for which evidence is uniquely abundant, and late enough to obviate the need to estimate the cost of production of goods that had yet to be invented). The corresponding product-specific annual production series are then derived simply by multiplying each physical output series through by the corresponding 1911-price unit value added. In a minority of cases the elementary production series are presented directly in 1911-price units of value added, typically when the corresponding physical output is ill defined (as in the case for example of maintenance activity, or public works); these are obtained either by extrapolating an estimate of aggregate value added in 1911 with a suitable physical index (e.g., of the stock maintained), or by deflating and rescaling, by the ratio of value added to value, current expenditure data (e.g., for public works). In either case, the present “real” product series are at bottom physical series, combined (with value added weights) at 1911 prices.

Physical output is normally measured in customary units, typically of weight, and extensively disaggregated to limit the heterogeneity of the measured units, that is, the (neglected) variation in (1911-price) value added per measured unit of product. In some cases heterogeneity can be avoided without disaggregation, by appropriately choosing the dimension of measurement; signal examples here are the measurement of cotton goods produced not by weight but by the length of the yarn spun and woven, or the aggregation of large and small aqueducts using the square root of their yield to capture economies of scale.

Because the disaggregated 1911-price value added series estimated here cover *all*

industrial production, in homogeneous units, they can be directly aggregated into time series for particular industries, and groups of industries -- defined as one may wish -- without further weighting. The present division among industry groups is somewhat *sui generis*, reflecting the nature of the sources; but the major aggregates correspond very closely to the major industry groups and divisions of the International Standard Industrial Classification (*ISIC*).

The present estimates cannot be considered definitive. The basic estimates of annual physical product, and of value added in 1911, can be improved by the use of additional evidence, by the removal of simple error, and so on: the point is general, and trite. The present real value added series are instead interim series in an altogether more immediate sense. They are what can be obtained from the basic estimates so far compiled, and are accordingly justified, if at all, only by their minimal data requirements. As just noted, proper estimates require the deflation of current-price value added series by a common price index; and that requires estimates of product-specific current-price unit value added not just for 1911, but for every year from 1861 to 1913. Their calculation is tedious but not particularly challenging; it is left for the future, not necessarily the author's own.

## **A02. The output series: sources and methods**

### ***A02.01 Preliminary: industry's output***

The output series compiled here are at times simply transcribed from the sources; as a rule, however, they are new estimates derived through more or less complex transformations of the available historical statistics. A variety of methodological problems and statistical sources are particular to individual industries, and will be discussed in the appropriate context below; but others are of sufficiently general relevance to warrant consideration in this introduction.

Following the usual conventions, output will here be considered “industrial” only if it consists of (inanimate) goods produced to be sold in their own right, either as such, or after further processing within a vertically integrated firm. So defined, industrial output will include, for example, food cooked by a canning or packing firm; it will exclude food cooked for domestic meals (output not sold) and for restaurant meals (output whose sale is incidental to that of a service).

This criterion was adopted at the very start of this project, when it seemed altogether obvious; but it was a child of its times, when we thought that reliance on the market was the mark of progress. We have since come to recognize that the market, hierarchies, and families are substitute institutions, each with its own advantages and disadvantages in the organization of production, each therefore “efficient” in particular roles in particular technological and cultural contexts (Pollak, 1985); but that recognition came too late to modify what was by then a cornerstone of an already substantial structure. That this criterion is consistent with the current national accounts is no justification, it underscores rather the deep flaws of those accounts, of their failure to measure performance and well-being; but that topic cannot be pursued here.

On the other hand, output that meets the above criterion will be considered industrial without regard to the scale or setting of production. Many would argue that only (“modern”) large-scale factory industry matters for capitalist development; but the belief that progress is tied to increasing scale now seems an outdated, nineteenth-century view, undermined on the theoretical level by the analysis of transactions costs, on the empirical by the enduring importance of small firms even in advanced industrial economies, the success of industrial districts, the revival (not least by the Benetton firm) of the putting-out system that predated the “industrial revolution.” The physical setting as such seems similarly unimportant: while production (for the market) “in the home” is obviously small-scale, production “in a (separate) workshop” but on a similar scale does not appear meaningfully different. As in most current official publications, then, industrial output will be taken to include all goods produced for the (goods) market, without further restriction (see *SNA*, p. 234, and *ISIC*, pp. 7-8; contrast *INIP*, p. 10).

A practical problem concerns the measurement of intermediate outputs in gross or net terms. The hat industry, for example, processes animal fibers into felts, and felts into hats; the measured production of felts can be gross, or net, of those transformed into hats. If the production of felts is measured in gross terms, the value added attached to hat production is that of the transformation of felts into hats; if the production of felts is instead measured in net terms, and thus tracks only the output sold out of the hat industry (to households, other industries, or for export), the value added attached to hat production must cover the full transformation from fiber to felt and thence into hats. A gross measure of the output of intermediate goods (felt) is in principle superior, as it allows for changes in the input/output ratio (felt per hat). Often, however, changes in the input/output ratio are negligible (or simply neglected, in the absence of evidence); the two measures are then equivalent (in the sense that the sum of the two value added series remains the same, so long as the output and unit value added estimates are mutually consistent), and the choice between them is arbitrary. The present

series are normally in gross terms; the occasional exceptions are noted in passing.

### ***A02.02 The secondary sources***

The secondary sources closest to the present endeavor are no doubt such earlier quantitative reconstructions as Dessirier (1928), Tagliacarne (1947), Golzio (1951), Barberi (1961), Gerschenkron (1962), Vitali (1969a, 1969b), and of course the official *Reddito nazionale*. Gerschenkron in particular paved the way for future research with a uniquely thorough description of his sources and methods: it is from his work that the present effort is directly derived.

Other particularly valuable secondary sources are those broad compilations of statistical data documenting not only industrial production but a host of other phenomena that can also be used, *faute de mieux*, as evidence on output. The handiest such compendium of time series on everything from the weather to population, production, commerce, and prices is Istat's 1958 abstract of historical statistics, the *Sommario*. Some of these time series, for instance of agricultural production, national income, or food availabilities, are very recent estimates, and thus strictly speaking not historical data at all; but most simply reproduce a selection of statistics from the historical sources of the time. These are indeed data, but stripped of the information that allows their evaluation and proper reconstruction; the annotation is sparse, and even the bibliographic indications are usually general rather than specific.

The other notable statistical compilations, altogether less handy but more informative than the *Sommario*, are the periodical statistical abstracts, the first of which were produced on private initiative (e.g., Correnti and Maestri, 1864). The official *Annuario* was published by Istat's predecessor, Dirstat (the Direzione generale della statistica, or, over the years, some minor variation thereof) at intervals from 1878, and annually from 1911. Each edition reproduced a broad selection of current statistics on a range of topics as inclusive as that of the *Sommario*, but with an abundance of data, notes and references the latter cannot match. The *Annuario* also typically includes retrospective information. The most generous editions in this respect are those from 1878 to 1884 and from 1900 to 1905-07; a five-year scope was standard from 1911, and a selected sample of economic time series starting in 1881 was appended to the *Annuario 1913* and *1914*. For present purposes, the *Annuario* is sometimes a sufficient source of data; but it serves most usefully as an excellent stepping-stone to the even more abundant documentation in the primary published sources.

An essential guide to the latter is to be found in Istat's detailed survey of statistical measurement in Italy, the *Rilevazioni statistiche*. Though devoid of statistics, this vast work provides indispensable perspective on what may be called the original accumulation of statistical capital, and, by implication, on later derivatives of those figures. Only little of the expertise represented by these volumes appears to have been put to use by Istat itself: next to the *Rilevazioni statistiche*, the *Sommario* and *Reddito nazionale* appear oddly unreliable.

### ***A02.03 The reports of the Corpo delle Miniere***

Only the State had the resources or the authority to collect comprehensive production statistics on an ongoing basis; but in the period before the first World War no specialized statistical institute was so mandated, and what output statistics do exist were generally obtained by official bodies with a variety of other interests in mind. The Corpo delle miniere of the Ministero di Agricoltura, industria, e commercio -- concerned primarily with the supervision of the mining industry, largely leased to private concessionaires -- was thus also charged with the compilation of production statistics on mines and a growing spectrum of related industries; and since it was the only public body so charged on any considerable scale, its collected reports (the *Rivista mineraria* and predecessor publications) are overwhelmingly the richest single source of

direct information on industrial production at the time.

This statistical base was produced by a bureaucracy that was, by present-day standards, surprisingly small. Information was collected, at the local level, by ten district offices (*Uffici distrettuali*); in the early twentieth century these were located in Bologna, Caltanissetta, Carrara, Firenze, Iglesias, Milano, Napoli, Roma, Torino, and Vicenza. Each of these encompassed a number of *province* (rather small administrative units -- there were 69 such in 1913 -- known by the name of the principal city), each of which in turn comprised a number of *comuni* (municipalities, also known by the name of their principal urban center); the sixteen larger regions with their own names -- Piedmont, Liguria, etc., then called *compartimenti* -- were not relevant as such to the mining districts.

The district-level data were collated into national figures by the central *ispettori*. Even at the end of the period at hand, the professional staff (*ingegneri, ispettori*) involved in the process were at most two dozen individuals, aided by a technical staff (*aiutanti*) numbering not quite again as many (*Rivista mineraria 1913*, p. CLXXXVI). In fact, since the district reports were the responsibility of the heads of the district offices and the national report was that of one of the *ispettori* in Rome, the published figures -- which comprise the bulk of the direct evidence on the industrial production of a nation of (in 1913) some thirty-five million people -- are in essence a record of the perception of eleven men. Their expertise and sources of information were of course of a high order; but they did not always make the effort to update their information, and their perception was at times distorted in transmission. Since the published material provides a good deal of evidence on the output figures' derivation, significance, and credibility, the published national totals can often be improved.

Abundant data on the 1860s and 1870s were first published by the Corpo delle miniere not in current serials but in two special publications. The earlier of these was articulated in two volumes, the 1868 *Statistica mineraria* and *Relazioni minerarie*. These volumes cover not only mining but other extractive industries, mineralworking, kilns, and metalmaking; the data in the *Statistica mineraria* refer to various years between 1861 and 1866, and naturally exclude the residual Papal states incorporated into the Kingdom only in 1870. The cross-section information is particularly rich: it documents not only output and sales but factor employment (wage laborers, wages, days worked; horsepower) and sometimes raw materials consumption as well, all disaggregated to the province level. The tables are generously annotated, and the special reports on various individual industries are also very informative, to the point of occasionally including disaggregated output, sales, and employment series.

The later special publication of the Corpo delle miniere was the 1881 *Notizie minerarie*, which covers much the same activity as the preceding volumes, with the addition, moreover, of the chemical industry. Beyond the data in the special surveys of individual industries, the *Notizie minerarie* includes three separate bodies of extremely useful statistical information. One is a comprehensive industry-by-industry review of 1875-79 average annual aggregate output, sales, and employment; these figures are not disaggregated at all, but they are accompanied by very copious indications on the location, techniques, and destination of production. Another is a detailed cross-section report of mining output, sales, and employment in 1878; the data are disaggregated, by product, to the individual *comune*, and are again generously annotated. For present purposes, however, the most important data set is the third, which comprises 1860-79 time series on output, sales, and employment, disaggregated down to the ten mining districts, for all mine products and one or two others. These series were produced with the clear purpose of revising, as necessary, previously published data (*Notizie minerarie*, p. 275); they are particularly valuable, not because they are not imperfect, but because their imperfections are generally manifest. As each series as a whole was apparently produced by one mind and at one time, rather than by the slow accretion of information over the



years, the risk of heterogeneity unknown even to the compiler is particularly low; and there are ample notes to communicate to the reader the compiler's own knowledge of the imperfections of the series. While the great detail of the *Statistica mineraria* keeps the earlier volume from being altogether superseded, then, the *Notizie minerarie* remains the principal source for the whole of the twenty-year period it covers.

The uninterrupted sequence of periodic reports by the Corpo delle miniere began in 1870, with very thin trimestral (1870-73) and then semestral (1874-76) pieces on the *Servizio delle miniere* in the *Annali A.I.C.*; the informative annual issues of the *Rivista mineraria* date from 1877. The scope of these annuals broadened with time, and by the early years of the twentieth century they included sections on all extractive industries, mineralworking and metalmaking, kilns, and chemicals, with statistics on output quantities and values, blue-collar workers (*operai*) employed, installed horsepower (apparently unduplicated, as evidenced by the attribution of little more than water power to electrochemical firms, e.g., *Rivista mineraria* 1909, p. 393, 1911, p. XCVI; the footnote on this last page is misleading, as the electric motors counted in lieu of the corresponding prime movers seem to be only those consuming purchased electricity), and sometimes raw materials consumed as well.

After the very first few issues, the format of the *Rivista mineraria* settled into the pattern it retained throughout the relevant period. The first part of the issue, paginated in roman numerals, contains the national report issued by the central *Ispettorato*; the production statistics are reported even there with a more or less extensive geographical breakdown, and particularly heterodox figures are typically annotated. The statistical section includes, *inter alia*, a table comparing domestic production to international trade flows; at times, this table includes output information even beyond that to be found in the tables devoted specifically to production. Beyond these statistics, the national report includes an often independently informative chronicle of the major developments over the past year; and the national report is generally rounded out by an appendix on the Corpo delle miniere itself which includes personnel lists by rank and seniority, information on postings, personnel changes in the past year, etc. The second part of the issue, paginated in arabic numerals, is instead devoted to the district reports, prefaced by a table listing the mining districts and specifying the provinces included in each one. Each district report includes a statistical section and a chronicle, thus repeating the pattern of the national report (minus of course the international comparisons); together, they are, at least through 1909, a far richer source than the national report, as their geographic disaggregation is more extensive, and special attention is paid to industries of particular local importance. From 1910, presumably in an effort to limit the bulk and cost of each issue, the published district reports no longer reproduced those received by the *Ispettorato* in their entirety (as they apparently did in previous years). The result of this abridgment was not just to eliminate the previously extensive duplication of statistical information between the national and district reports: a good deal of local information was lost altogether, and for a variety of items the latest pre-war figure is that in the 1909 issue.

The *Rivista mineraria* is generally devoid of time series, with two sets of exceptions: one includes the occasional tables on particular industries, typically found in the district chronicles, and correspondingly local in scope; the other comprises the national output, unit value, sales, and employment series from 1860 to 1897, and then again to 1899, in those years' issues. The latter series, which appear to have been the direct source for more recent compilations, cover mining, mineralworking, metalmaking, and chemicals (from 1893); the statistics simply repeat the national figures in the *Notizie minerarie* (through 1880) and the current *Rivista mineraria* from 1881, with no effort to amend or improve them. Even the notes to the time series reproduce only part of those, often themselves inadequate, in their own sources, with the obvious result of making the series appear a good deal less defective than they

are in actual fact.

The defects of the national output series obtained by transcribing the output figures in successive national reports are manifold, and a variety of types of distortions can be identified and largely corrected. In the face of entrepreneurial reluctance to provide information (e.g., *Rivista mineraria* 1885, p. 195, 1895, p. 223), these basic data are often educated guesses based on the inspectors' knowledge of the productive potential of local industry, market conditions, etc. But activities at the margin of the inspectors' interests were not kept under continuous scrutiny: the output of quarry and kiln products, in particular, was systematically measured only in 1890 and 1901, and the "current" figures published from 1902 remained, in the main, those collected in 1901. The historian, however, has the advantage of knowing what the inspectors themselves discovered when they next went into the field and updated their information, as well as a good deal of ancillary data the compilers of the output figures may have lacked altogether; and with this information even the original disaggregated output data can at times be corrected.

Most often, however, these disaggregated data are not so much corrected as transformed into less heterogeneous components of a cross-section or time series. Part of the existing heterogeneity appears to stem from the relatively common habit of measuring output as sold, rather than at a well-defined stage of production; as production is often not just value-adding but weight-reducing, even the physical output measures are subject to correction. The greater heterogeneity, however, appears to stem from a lack of coordination that is frankly remarkable in view of the small number of individuals involved: even when each disaggregated figure refers to the output of (throughput at) a well-defined point of the production process, different reporters often selected different reference points. Different goods are thus very often attributed the same label, and the same good at times appears under different ones. In such cases the aggregates are heterogeneous, and the aggregate series would be distorted even if their single component series were not (unless of course they all moved in unison); but as particular individuals sometimes altered their practice, or as bureaucratic reshufflings redistributed responsibility for the reports, even the disaggregated series can be quite heterogeneous over time. For present purposes, furthermore, this heterogeneity of the output data as output data is not the only relevant one: as the output series double as indices of real value added, they are here to be considered heterogeneous not only if they aggregate different goods, but also (for the reasons and with the qualifications noted below) if they aggregate identical goods produced by different techniques.

Beyond the defects they may inherit from the weakness or heterogeneity of the local data in the district reports, the aggregate series suffer from the simplicity with which these components were combined into national estimates. The latter are almost invariably simple summations of the local figures, with no attempt to allow for their heterogeneity or even for the possible incompleteness of their geographical coverage. Some production, at the limit, was monitored only in particular mining districts, not because they were the only producers, but because of particular local interest in the industry: for instance, processing activity which was ignored in most of the country might instead be recorded in the area where the extraction of the materials was itself particularly important. These figures, presented as it were on local initiative and with no claim to represent national output, nonetheless often reappear in the national reports elevated to the status of national estimates. Moreover, comprehensive reports from the local level were not always forthcoming even in the presence of a central directive to measure an industry's output; the less central an industry to the interests of the *Corpo delle miniere*, once again, the less one can be sure of that the figures are actually comprehensive. Movements in the aggregate series are thus at times utterly spurious, and reflect no more than changes in the area to which the output figures refer. On the other hand, there is no *systematic* change in the series' coverage: in particular, whereas current national data, in any source, almost invariably refer to

the area within current political boundaries, the time series in the *Notizie minerarie* reconstruct output since 1860 within Italy's borders of 1880, and are thus unaffected by the political changes of 1866 and 1870.

In sum, while the output information collected by the Corpo delle miniere is, as a whole, as good as any one can hope to find, the aggregate figures they published, and even more the time series these figures generate, are relatively weak. Improved series can thus often be obtained by taking the published figures apart into their components, recalculating these on a more homogeneous (and, if need be, more comprehensive) basis, and then reaggregating into a new set of national estimates. Only part of the defects in the original series are pointed out by notes in the sources: many are suggested by a time series' relatively implausible behavior, and the rest are discovered by analogy, as one expects similar situations to produce similar results. The at times considerable ambiguity of the published figures can often be reduced by examining other evidence internal to the reports of the Corpo delle miniere, including such information as the value and employment statistics that accompany the output data, the narrative in the verbal chronicles (particularly useful as an indicator of production processes), and perhaps the way the presumptive creator of the ambiguous figure in question solved analogous problems of measuring and reporting output.

External evidence from other sources (about which more below) can also often usefully be brought to bear: one can thus check the compatibility of the apparent significance of the figures of the Corpo delle miniere with data on international trade flows, with other available value or employment statistics, or with general information on the technology and relative factor costs of the time (and, for instance, the industrial location pattern which these would suggest). At times, the evidence is abundant and compatible, and one can have considerable faith in one's best guess as to the actual significance of those published output figures; at other times, the evidence is scanty or contradictory, and one's best guess remains very tentative indeed.

#### ***A02.04 The production-tax reports of the Ministero delle finanze and other primary sources of output data***

The reports of the Corpo delle miniere are the only substantial manifestation of sustained public concern with industrial production *per se*; the second richest set of industrial production statistics, like so much other information on every aspect of economic life, is instead a by-product of fiscal intervention, and was published accordingly by the Ministero delle finanze (or a subdivision thereof). An important set of output statistics was thus generated by the collection of production taxes. In the early years, such taxes were relatively few, and the relevant data occupied no more than a special section of the *Annuario finanze*; later, their number was much increased, and copious real and financial data were presented by the Direzione generale delle gabelle in a special serial, the *Imposte di fabbricazione*. The annual output figures refer to fiscal years, which coincided with calendar years only through 1883, and then (after a special *esercizio* covering the first six months of 1884) ran from July 1 through the following June. Reports were fortunately published two or more times a year; and while the sub-annual issues have survived less readily than the annual ones, calendar-year figures can generally be reconstructed, as needed, from the semestral reports.

The *Imposte di fabbricazione* are the only direct source of output data on a number of goods (mainly minor foodstuffs), and these have accordingly been widely reprinted; but in view of their peculiar nature, they must be evaluated with a good deal of circumspection. As measures of actual production, the figures can be very weak, for a variety of reasons (Einaudi, 1914, pp. 372 ff.). The most obvious problem is that the output figures report the effective tax base, i.e., taxed output, to the exclusion of possibly large amounts of clandestine, untaxed output. The tax collectors may of course have had the knowledge to produce fairly sturdy

estimates of actual output; but such estimates were not included in these fiscal reports. Secondly, even taxed output was by no means always directly measured. At times, the tax and the corresponding “output” were set by negotiation with each producer: production was then not measured at all, and the published figures are no doubt underestimates. At other times, “output” was calculated, by means of a conventional formula, from the flow of some intermediate product or factor service which was alone actually measured. The difficulty here is rooted not just in the indirectness of the output measure, but in the use to which this indirectness was put: the evidence is that the input-output coefficient in the formula may have been purposely overstated so as to reduce the actual tax per unit of output below the ostensible level specified in the law (thus providing a net increase in tariff protection, as imports were subject to a compensatory tax at the full legal rate). Here too, then, as in the case of tax evasion or contracted payment, the result was to build a downward bias into the output figures.

The reported time series are similarly weak as indices of production movements, as there is no reason to expect relative biases to remain constant. Whatever the method by which taxable output was measured, the extent of tax evasion would vary with the intensity of administrative efforts to assure compliance on the one hand, and with the prospective benefits from successful evasion (i.e., with the effective tax rate) on the other. In the case of indirect measurement, the bias of the “output” figure would vary with changes in technique, whether due to technical progress or simply to adaptation to the tax formula itself; but by far the largest spurious changes in reported output are attributable to changes in the method by which taxable output was measured in the first place. These last changes, at least, are easy enough to identify, as the methods of administration were typically specified, like the tax rates themselves, in the enabling legislation, duly reprinted in the collected *Leggi e decreti*. The other influences on the figures’ bias, however, are far more difficult to assess, particularly since after a change in the incentive structure a new equilibrium would be reached only with some non-negligible lags attributable to learning processes, the usual short-run barriers to plant and equipment change or entry and exit (between the legal and the clandestine industries), etc. In general, therefore, the data in the *Imposte di fabbricazione* are to be used very carefully indeed.

The production reports of the Corpo delle miniere and the production-tax reports of the Ministero delle finanze are the only primary published sources of national output statistics that encompass a relatively broad range of industries over a significant number of years; indeed, partial and imperfect as they are, they nearly exhaust the primary output data base altogether. There are, to be sure, other sources of periodic output information, that cover individual industries: for instance, the annual reports of such public monopolies as the salt or tobacco industries, or the reports on merchant shipbuilding appended to the annual ministerial reports on merchant shipping or the merchant marine. In the appropriate specific contexts, as shall be evident below, such narrow sources are of course most useful; but they are very few and far between. For industries working vegetable or animal raw materials, or processing mineral products beyond the initial few stages, statistical coverage is the rare exception rather than the rule. Between the Unification and the First World War, broad sectors of Italian industry remained beyond the purview of any ongoing statistical report; and the primary output data set suffers at least as much from its gross incompleteness as it does from the uncertain definition of the figures that do exist.

#### ***A02.05 The sources of ancillary evidence***

Because the output data are thus limited and imperfect, the desired production figures are often obtained by exploiting indirect evidence.

The most widely useful bodies of indirect evidence fall into three sets. The first consists of the labor force figures in the censuses, and the factor-employment figures in the early

industrial surveys and the industrial census of 1911. Since these data are particularly useful as evidence of factor use and value added, they are discussed below (section A03.02); they enter the output estimates only as data of last resort, as in the absence of any other information the path of production is built up from the handful of census-based labor force figures (with some correction for productivity growth), and a benchmark physical output figure is itself estimated as the ratio of aggregate value added to value added per unit.

The second set consists of the data generated by the State's concern with international trade. Detailed import and export figures appear in the *Movimento commerciale*, published each (calendar) year by the Direzione generale delle gabelle of the Ministero delle finanze, and continuing a Piedmontese serial dating from 1851. These volumes report international trade by country, transport mode (land or sea), *commercio speciale* and *generale* (the former excluding, the latter including, reexported imports; as transit was almost universally completed within the calendar year, net imports are usually the same on both definitions), and of course type of good; these last categories, in excess of six hundred in 1861, become even narrower and more numerous over time, as the most favored nation clause was circumvented by narrowing specifications in the tariff legislation. Some ambiguity is caused by border changes, as the Kingdom of Italy was born in 1861, and incorporated Venetia in 1866 and Latium in 1870. The *Movimento commerciale 1861* noted the uncertain coverage of the parts of the new Kingdom that suffered administrative discontinuity (p. IX); the *Movimento commerciale 1866* separately reported the trade of the newly-acquired Venetian provinces over the last two months of the year (pp. VII, 461 ff.). The *Movimento commerciale 1870* and *1871* are instead bereft of useful commentary; the figures for 1870 that treat "Rome" as a foreign country cover most of the year, but the subsequent trade through Latium may or may not have been included in that of the Kingdom before the year ran out (*regi decreti 13 ottobre 1870, n. 5920 and 11 dicembre 1870, n. 6128*).

The *Movimento commerciale* usually reports trade in both physical and value terms, though the physical measure may be lacking in the case of extremely heterogeneous groupings. From 1871, each issue contains a disaggregated five-year comparison; but the usefulness of these retrospective figures is limited by a surprising tendency to err by factors of ten if and when the physical unit of measurement changed (e.g., from tons to quintals) within the relevant period. Beyond that, the only systematic defect of the figures turns on the somewhat erratic handling of temporary imports (in the technical sense of goods imported duty-free to be processed and reexported), often but not always counted both as *commercio speciale* and as *commercio generale*; a useful retrospective appears in the *Annali commercio 1913-1914*, pp. 397-405. Smuggling, of course, may have been something of a problem, but most probably not a severe one for most (low-duty) goods; and given the unique degree of administrative continuity in the collection of these data, they no doubt rank with the best available historical statistics (without, for all that, being always above reproach; see for instance *Notizie minerarie*, pp. 276-277).

Imports of raw materials and exports of industrial products are direct indicators of production, albeit typically only partial ones, as domestic raw material supplies or domestic consumption cannot normally be neglected. The trade figures also serve at times to evaluate independent output data (as in the notorious case of the official silk production figures, which consistently fell short of net exports); more significantly, as detailed in the next section below, they serve as building blocks in the calculation of separate series for goods at successive stages of production.

Two other trade-related publications are also very useful. The prices used to evaluate imports and exports were set each year by a committee of experts, the Commissione centrale dei valori per le dogane. The latter's proceedings, the *Atti C.C.V.D.*, appear from 1879 in the

*Annali I. e C.*, and then in the *Annali commercio*; the last pre-war issues often contain much evidence on the production, location, technology, and cost structure of specific industries. Similar information, often with a notable retrospective component, also appears in the rich series of industry-specific monographs produced around the time of the World War, and in view of the prospective revision of the tariff, under the auspices of the Comitato nazionale per le tariffe doganali e i trattati di commercio (e.g., *Notizie metallurgiche*).

The final broad set of statistics that shed light on production are the consumption statistics generated by the *dazio consumo*, i.e., the local consumption taxes on such staples as food and drink, fodder, fuel, construction materials, and the like (*Enciclopedia italiana*, vol. 12, pp. 426-427; Pavese, 1979, pp. 141-157). The relevant legislation (esp. *legge 3 luglio 1864, n. 1827, legge 15 aprile 1897, n. 161, and legge 7 maggio 1908, n. 248*) contemplated two basic systems: in the larger population centers, the tax was normally collected as the goods passed through the municipal customs barrier (traditionally, the city walls) into the so-called “closed township” (*comune chiuso*); in other areas, declared “open” (*comune aperto*), the tax was levied on retail (petty) sales. The statistical by-product of “open-area” taxation was relatively slight, as few goods were subject to tax, large sales (even to final consumers) were exempt, and retailers typically negotiated a quit payment with the tax office; the consumption of closed areas, in contrast, was relatively reliably documented by the tax collector. The available data cover only a small part of total consumption, because only part of the population (about one quarter of the total, around the turn of the century: Lacava, 1901, p. 872) lived behind municipal customs barriers; because not all consumption tax accounts disaggregated by type of good (particularly when and where the consumption tax was farmed); and because the published record is scanty, while the possibly rich archival one has only just begun to be exploited. The currently available sample is restricted to a few medium to large cities in central and northern Italy; but for all their limitations, these figures do provide some evidence of consumption movements which can at times be useful.

#### ***A02.06 Coping with missing data***

Production figures are more often absent than present: the need to reconstruct the path of undocumented production is correspondingly pervasive.

At times, all that is missing is part of a series. In such cases, the interpolation or extrapolation is guided by a presumption of continuity (*natura non facit saltum*): deviations from the norm are considered unlikely, if only because random increments and decrements are equiprobable; and larger changes are disproportionately less credible than smaller ones. At times, that presumption is applied directly to production, and the missing values of a time series are interpolated by assuming constant growth between the available figures. This constant growth may be absolute or relative: the choice may depend on substantive considerations (for example, a reservoir filling with rainwater suggests equal absolute increments; a growing population, equal relative ones), or even on purely formal ones (for example, ratios are better interpolated geometrically, as  $x/y$  and  $y/x$  would otherwise yield different estimates). At other times, it is applied rather to the determinants of production. If there is for example a large decline in production accompanied by a significant decline in the product’s price, it is reasonable to impose continuity on the supply function rather than the quantity supplied, and distribute the decline in production over the years as suggested by the path of the product price.

More often, entire output series are missing. Many can easily be derived from other output series, as the production of any particular good documents the consumption of its raw material, and, if it is not itself a final good, the production of the raw material transformed by the succeeding stage of production. This extrapolation across the production sequence is based on input-output coefficients and the material-balance identity. The former are readily obtainable

in technical manuals, encyclopedias, and the like, and at least in the case of the principal raw material they are normally quite stable over time. The latter recalls that the total amount of a good available to the domestic economy in a given period is the total somehow disposed of: the sum of current domestic production ( $Q$ ), imports ( $M$ ), and the initial stock ( $S$ ) must equal the sum of current domestic use (as raw material for the succeeding stage of production,  $R$ , or for other consumption,  $C$ ), exports ( $X$ ), wastage ( $W$ ), and the terminal stock ( $S$  plus the increment  $I$ ).

Together, the material-balance identity and the input-output coefficients link the outputs at successive stages of production in vertically disaggregated industries. Letting the subscripts  $a, b, c...$  identify successive stages of production, and denoting the technical coefficient ( $Q_b/R_b$ ) by  $i_b$ , ( $Q_c/R_c$ ) by  $i_c$ , etc., these relations yield the system

$$\begin{aligned} R_b &= Q_a + (M_a - X_a) - (C_a + W_a + I_a) \\ Q_b &= i_b R_b \\ R_c &= Q_b + (M_b - X_b) - (C_b + W_b + I_b) \\ Q_c &= i_c R_c \\ &\dots \end{aligned}$$

A significant proportion of the wholly new output series produced here are obtained from these equations. Given the production coefficients and the international trade flows, and simply neglecting, as a rule, wastage, changes in inventories, and the other consumption of semi-finished goods, a single known output series allows the solution of the system for the output at all preceding and succeeding stages of production.

In practice, therefore, the calculated paths of output at successive stages of the production process differ essentially, and meaningfully, to the extent that they are driven apart by changes in the pattern of international trade (specifically, in the ratios of net imports to output). Of practical necessity, moreover, the many successive transformations that turn an unprocessed raw material into a final good are collapsed into no more than a very few broad stages of production. The natural boundaries of these are of course the (intermediate) goods that are most readily exchanged between firms and nations; but goods processed to a different degree are also traded, and these are simply distributed among the closest norms (i.e., misclassified, though the errors so introduced will tend to cancel). Further to simplify matters, the output estimates related through the above equations are also normally considered simultaneous: the present figures typically neglect processing time as well as inventory changes, though exceptions are of course made where production is particularly time-consuming (e.g., the production of complex machinery).

All this is a staple of the literature, and the time paths of cotton yarn and cotton cloth, for example, were thus separately estimated already in the *Reddito nazionale* (p. 82). But the literature is curious. As noted, the product of the engineering industry is also readily extrapolated, across sectors, from the consumption of metal; but at other times accounting trumps technology, and as recalled above the product of the quarrying industry is implicitly extrapolated from that of the documented component of the same sector (the mining industry) rather than explicitly from that of the different sector that consumes its products (the construction industry).

The present estimates resolutely apply the above algorithm wherever possible, across sectors as readily as within them. In fact, they extend it: in the absence of output data at any point of the production process the least unpromising basis for the output estimates is the likely path of final consumption, given that of related goods and changes in relative prices, and the above system of equations is then solved from final consumption back to the basic raw material.

When output data are available only at occasional benchmarks the problem of

interpolation over time and extrapolation across variables must be faced together. Simplified, the above equations reduce to

$$\begin{aligned} R_b &= Q_a + (M_a - X_a) \\ Q_b &= i_b R_b \\ &\dots \end{aligned}$$

Assume that they can be solved for the years  $t$  and  $(t + n + 1)$ , and that over the  $n$  years to be interpolated  $(M_a - X_a)$  displays a sharp cycle. The minimum-change growth path cannot then be attributed to both  $Q_a$  and  $Q_b$ , for these would be inconsistent; the smooth interpolation of  $Q_a$  as a simple trend logically transfers the entire cycle to  $Q_b$ , and vice versa. In such circumstances, the guiding rule is to estimate the related paths together, including that of final consumption, so distributing the cyclical variation among the time series as to minimize the total implausibility of the estimated set in the light of the likely elasticity and volatility of the supply curves on the one hand and of the final demand curve on the other. The procedure is not entirely arbitrary, but the final estimates are very much a judgment call.

This extrapolation across stages of production is in fact something of a favorite special case. More generally, if the path of  $x$  is known that attributed to  $y$  determines that attributed to  $x/y$ , and vice versa. The lower the ratio of the variation in  $x/y$  to the equiprobable variation in  $y$ , the closer the best estimates will be to those obtained by minimizing the variation of  $x/y$  alone and calculating  $y$  as  $x/(x/y)$ ; at the limit,  $x$  is an index of  $y$ , and the latter is simply calculated from a related current variable in the fashion just described. At the other limit, of course,  $x$  and  $y$  are independent, and  $x/y$  is without interest; but very often one's expectations are well between these limits, and the estimates for the missing elements of a time series will reproduce the movements of the available related series in a definite but muted way (compare Friedman, 1962; also Friedman and Schwartz, 1970, pp. 314-333). The selection of the actual algorithm is again a judgment call; from case to case  $y$  may be derived from  $x$  using regression coefficients, or on the assumption that the  $x$ -elasticity of  $y$  is less than unity, or even by first calculating  $y$  in strict proportion to  $x$ , and then smoothing the resulting  $y$  series.

The poorer the sources, the less directly they reveal the time path of output, the more the estimated time series reflect their author's choices and perceptions; and in extreme cases the time series must be reconstructed in the absence of any direct evidence at all. In the abstract, the problem is that of locating a point in Cartesian space by identifying constraints that rule out successive portions of that space. Concretely, each case is unique; the solution depends very much on the clues one is capable of detecting, on the logical structure one can erect to bring them to bear. At times their relevant implications are surprisingly distant: as noted below, for example, the tightest constraint on the share of maintenance in the engineering industry's value added in 1911 was found in the implied ratio of metal consumption per worker in new production to that in maintenance in 1871. The present estimates are the product of much perspiration, and what inspiration the author could command; much has been done, far more, surely, was never so much as imagined, and remains to be done.



### A03. The value added estimates: sources and methods

#### A03.01 Preliminary: industry's value added

Unlike output, value added is a measure of the process of production, of the transformation of materials, of industry's activity. Form follows function: to allow comparisons and aggregation across industrial boundaries all production is counted in a meaningful common unit (*value added*), once and only once (*value added*). The concept was evolved, not without difficulty, over a century ago, and the parallel need to render value units comparable over time was also duly noted (United States Census Office, 1860; 1870, pp. 377-381; 1880, pp. x, xxiv; 1890, pp. 28-29; 1900, pp. cxxxviii-cxlii; *U.S. 13<sup>th</sup> Census VIII*, pp. 22-26). Intertemporal homogeneity -- "real" value added -- will be considered separately below (chapter A04); the present concern is with the measurement of production at any point in time, at current prices.

The value added measure of production is in principle, and by construction, net and homogeneous. In practice, of course, value added measures will reflect a number of relatively arbitrary definitions: of industrial and non-industrial production; of individual industries; and, not least, of value itself (Fenoaltea, 1976, here broadly summarized).

Value will here be that given by the market-place: though fundamentally arbitrary, and possibly repugnant in its implicit acceptance of the prevailing distribution of wealth, this choice is at least utterly conventional. In the presence of market imperfections, on the other hand, market values are themselves ambiguous; and while most such imperfections and ambiguities may be small enough to be ignored, two at least are here of sufficient empirical significance to warrant explicit consideration. The first is that created by what may be a multiplicity of markets for a single good; the archetype here is labor, and the problem will be discussed in that specific context below (section A03.04). The second is that created by production taxes, monopoly power, or disequilibrium; and this can be considered forthwith.

Let output  $Q$  be obtained by combining labor services  $L$ , capital-goods' services  $K$ , and raw materials  $R$ ; and let the unit prices (to the purchaser) of these goods and services be, respectively,  $p$ ,  $w$ ,  $r$ , and  $z$ . Assuming for the moment an absence of public intervention, we note that in competitive equilibrium ( $pQ - zR$ ) equals ( $wL + rK$ ), so value added can indifferently be measured by either one. This is true not only in the long run but in the short run as well: even though  $K$  is fixed to the industry as a whole, entrepreneurs can bid for the use of existing capacity; and since  $r$  adjusts to clear that market, the equality of ( $pQ - zR$ ) and ( $wL + rK$ ) is maintained, and there are no "short-run profits." Our textbooks claim otherwise, but their "short-run profits" are in fact  $K$  times the difference between current  $r$  and the historical  $r$  that determines "fixed" costs. Since existing firms can lease capacity to and from each other the (current, opportunity) cost of capacity is not fixed even if no new firms can enter the industry, even if the stock of equipment cannot be expanded; "short-run profits" accrue not to the industrial producer who *uses* capacity but to the (conceptually distinct) speculator who *owns* it.

On the other hand, ( $pQ - zR$ ) and ( $wL + rK$ ) can obviously differ by a (positive or negative) surplus  $S$ : a rent attributable to a legal monopoly, for instance, or a speculative loss from over-optimistic production in anticipation of future orders. The current rule is to include that surplus in value added, on the grounds that "production ... refers not to activity as such but to the results of activity" (*INIP*, pp. 5-6; see also Fabricant, 1940, p. 26, *SNA*, pp. 67 ff., Hill, 1971, pp. 12-14, Arrow, 1974, p. 4). The "result of activity" here refers to the transformation of the material  $R$  into the output  $Q$ , and not to the latter as such; but since the market values activities by their results it is hard to see how the value of the results of activity ( $pQ - zR$ ) can differ from the value of activity itself ( $wL + rK$ ) so long as these are consistently defined. This suggests that the surplus  $S$  is the value of a neglected activity distinct from the purely productive

activity represented by  $L$  or  $K$ ; and the distinction seems valid, since we can readily imagine that the monopolist or the speculator are independent enterprises that subcontract production to firms that engage *solely* in productive activity. In such a case, the value of productive activity ( $wL + rK$ ) clearly coincides with the value of its results ( $p'Q - zR$ ), where  $p'$  is the price paid by the monopolist or speculator to the pure producer (assuming competitive bidding); and the value  $S$  of the restrictive or speculative activity is similarly equal to the value of its results ( $pQ - p'Q$ ). Seen in this light, the relevant question is not so much “should we measure the value of activity or that of its results?” as “which activities and results do we consider industrial?”; and the ambiguity of value and value added in the presence of a non-zero surplus reduces to the ambiguity of industrial production itself.

While the resolution of this ambiguity is again fundamentally arbitrary, it does seem natural to identify industry with production strictly defined. Given this preference, value added will here be considered as equivalent to the value of (the results of) purely productive activity  $L$  and  $K$ . Since the assumption of competitive pricing is usually tenable (and since any evidence of speculative production ahead of demand is usually lacking), value added in the absence of production taxes will usually be considered equivalent to both ( $pQ - zR$ ) and ( $wL + rK$ ). In those exceptional instances where (monopoly) surplus appears to be significant, the firm will be treated as an integrated enterprise straddling industrial and non-industrial pursuits; and the value of the former can be measured as ( $wL + rK$ ) or ( $pQ - zR - S$ ). On the same logic, production taxes  $T$  can be taken to measure the market value of public monopolization; so they too will be excluded from industrial value added. On these definitions, it may be noted, *industrial* value added is necessarily positive. Non-industrial value added can instead be negative: “bad” speculation is “value subtracting” rather than “value adding,” and production subsidies are of course negative taxes. If we define industry broadly enough to include  $S$  and  $T$  as well as pure production, the corresponding value added ( $pQ - zR$ ) = ( $wL + rK + S + T$ ) can also be zero or negative.

These restrictions on what is here meant by “industry” are naturally additional to those described in section A02.01 above: in summary, industry here reduces to the productive activity of industrial enterprises, to the exclusion both of non-productive activity (monopolization, speculation, etc., even if by industrial firms), as described here, and of other productive activity (e.g., home cooking), as described there. The net value of industrial production is the market value of that activity and of its results; except for the omission of occasional monopoly surplus, the resulting aggregate corresponds to the ordinary measure of industrial value added at factor cost.

The distribution of that aggregate among individual industries is also problematic, since a single establishment often spans activities characteristic of different industries. Current practice is to attribute all the activities of such establishments to the industry that includes their principal endeavor (*ISIC*, pp. 7, 27 ff.), with the clearly undesirable result that the pattern of measured production will vary with the mere redistribution of given activities among different firms. It would be altogether preferable to define the boundaries between industries, and to classify production, strictly on the basis of technical processes (the nature of activity and of its results); and this is in essence the principle adopted here, albeit with two sorts of exceptions. In the first place, many subsidiary activities will simply be ignored, because they are so minor that their exact attribution would have only a trivial effect on the present crude estimates of value added. In the second place, the often significant value added in the production of power by the firms that use it will be attributed not to the power industry but to the user industry, as is commonly done, simply because a consistent revision would here be empirically difficult (value added in the production of electricity will in fact be estimated where it is particularly significant, precisely to facilitate its attribution to the electric power industry instead; but a consistent

definition of industrial categories would require the attribution to the power industry of *all* energy conversion, including that by prime movers, and the necessary recalculation of goods-specific values added would be both pervasive and uncertain).

In the present study, finally, the disaggregation of value added into various industries is also informed by the need to let a relatively small number of output series represent the time path of industry as a whole (above, section A02.06). For example, the full transformation of a good from basic raw material to finished product may be represented by not more than, say,  $Q_a$ ,  $Q_b$ , and  $Q_c$ ; and the value added in the full transformation will have to be distributed among three corresponding industries each of which will in fact include a number of successive transformations (stages of production). Given this constraint, the boundaries between these industries will naturally be chosen so as to limit the resulting distortions: the first industry will ideally be taken to include all the intermediate flows that move more like  $Q_a$  than  $Q_b$ , the second all those that move more like  $Q_b$  than  $Q_a$  or  $Q_c$ , and so on; and the values added specific to each industry will be calculated accordingly.

### ***A03.02 The evidence on factor use***

Value added can thus be estimated both as the value of activity, on the basis of factor use, or as the value of the results of activity, on the basis of output and purchased materials. Both these approaches are utilized here.

The most significant evidence on factor use is that provided by the *Censimento industriale* and the *Censimento demografico*, taken together on June 10, 1911. In earlier years, the evidence on factor use is limited to that in the censuses of population on the one hand, and in partial industrial surveys on the other. The *Censimento 1861*, *1871*, and *1881* refer to the 31st of December, and the *Censimento 1901* to the 10th of February; the census of 1891 was omitted, apparently as an economy measure, and the omission is damaging.

The demographic censuses provide data on the professional distribution of the labor force, which improve over time. The *Censimento 1861* reported only the totals for all “manufacturing” (vol. 3, pp. 1-75), plus the breakdown for a handful of artisanal activities (parte I, pp. 89-95); the *Censimento 1871* (vol. 3), *1881* (vol. 3), and *1901* (vol. 4) provided detailed breakdowns, but in the *Censimento 1871* the labor force associated with particular products does not always separate the manufacturing component from the commercial. As the census bureau well knew (e.g., *Censimento 1901*, vol. 5, pp. LXXIV ff., LXXXIV ff.), it is in the nature of such figures to underrepresent some activity, for instance in industries processing perishable products immediately after the harvest; but their overall bias is clearly upward, as many who list a profession may be unemployed, retired, or only sporadically active. The early censuses are particularly weak on this last count: as has often been noted, many housewives who did a little spinning or weaving were counted as textile workers, thus grossly inflating ostensible industrial employment, consistently in Calabria and, in 1881, in much of the South (Vitali, 1970, pp. 31-43; Fenoaltea, 2014b, p. 7). In an effort to limit such distortions, the 1901 census collected information on subsidiary occupations, domestic industry (by dependent workers), and unemployment (of manual laborers and the like). Relatively small numbers were recorded (some 460,000 subsidiary occupations, 118,000 domestic dependent workers, and under 230,000 unemployed, against a labor force of 12.84 million: *Censimento 1901*, vol. 4, pp. 169, 189, 297, vol. 5, pp. XCIV, CXII-CXIII, CXVI-CXIX, 153, 158 ff., 211); such figures do not seem to have been particularly reliable, and their counterparts do not appear in the 1911 census (*Censimento demografico*, vol. 7, p. 8). While clearly an improvement over its predecessors, then, even the 1901 census is a mediocre guide to actual labor use; neither of course does any demographic census contain any information, however indirect, on cooperating factors of production.

The early industrial surveys are equally unsatisfactory, albeit for quite opposite reasons: although they list blue-collar workers actually employed and generally include at least horsepower figures as a measure of capital, they are usually very incomplete. A first such survey of “some industries,” the *Notizie industriali*, was published by the Ministero di agricoltura, industria, e commercio in 1878; it was soon followed by a companion piece, Ellena (1880). From 1885, Dirstat’s *Annali* (series IV) published a series of industrial surveys. Most were devoted to the various provinces (e.g., *Notizie Firenze*; those for the Piedmontese and Lombard provinces were then collected, updated, and separately published, e.g., *Notizie Piemonte*); five were studies of individual industries (milling, paper, cotton, silk, and wool; e.g., *Notizie cotone*). The collected material was then updated to 1903 and published by Dirstat as the *Riassunto industriale*. This compilation relied as far as possible on the ongoing reports of other branches of the civil service; it does not therefore provide an independent check of the official time series, but tends instead to repeat their errors. As to the rest, the prime sources of data were the local chambers of commerce, and, advertently or not, large numbers of small shops appear to have been overlooked (*Rilevazioni statistiche*, vol. 5, pp. 611 ff.; *Censimento industriale*, vol. 5, p. 27).

The 1911 censuses contain far more information, and warrant estimating value added, at least initially, in that year in preference to any other. The *Censimento industriale* is of course a major source of data on industrial employment, power in use, and more; but it too is far from complete, as it covers neither one-man shops nor domestic industry. Information on such activity was to be collected on the standard demographic form sent to each head of household, while special questionnaires were sent only to separate workshops with at least one employee; in the event, the relevant responses to the former proved unusable, and as the *Censimento industriale* clearly indicates (vol. 5, p. 25) it tabulated only the information collected on the latter. As far as one can tell, moreover, “domestic” industry appears to have been bureaucratically defined as that taking place at the proprietor’s residential address, with the result that the census occasionally missed even relatively large concerns (such as the Pirelli rubber works in Milano: below, section D01.02). In addition, 1,157 *comuni* out of 8,323 (14%) were missed altogether; but these held only 4.3% of the total population (*Censimento industriale*, vol. 5, pp. 27-28), and their share of industry was no doubt small enough to be neglected.

The detailed data produced by the *Censimento industriale* appeared in volumes 2, 3, and 4, covering respectively shops with one to ten employees, shops with more than ten employees, and both the preceding; inactive shops that had been active in the preceding twelve months were included in the count (see vol. 1, p. 3). The published information includes a breakdown of employment (on June 10) by rank, sex, and age, of both electric and non-electric power in use (on average, in June) by source, and of shops by the duration of their work year. These figures are presented for 257 categories, to wit industry as a whole, its eight component *categorie* (seven defined in their own right, plus one for concerns straddling two or more of those seven), their 41 component *classi* (31 defined in their own right, 10 by the others they straddle), and 207 component *sotto-classi* (179 defined in their own right, 28 by the others they straddle). Since the census office kept 1. for agriculture, the seven independent *categorie* are 2. extractive industries, 3. industries working animal and vegetable products (except textiles), 4. industries making or working metals, 5. industries making or working clay, glass, and stone (including construction), 6. textile industries, 7. chemical industries, and 8. “industries catering to collective needs” (publishing and utilities). The specification is narrowed by adding digits on the right: e.g., *classe* 3.3 refers to cereal processing, and *sotto-classe* 3.35 to bread bakeries.

Categories grouping establishments that straddle other categories are denoted by an omega ( $\omega$ ) in the appropriate position: e.g., 3.3 $\omega$  groups shops engaged in different kinds of

cereal processing, 3.ω groups shops working different (non-textile) agricultural goods, and ω. groups shops whose activities overlap two or more *categorie*; digits to the right of the omega appear to be arbitrary. As noted, almost all shops use heat or power, and most generate at least some of what they use themselves directly from fuel or prime movers; but precisely because energy production is thus ubiquitous such shops were *not* classified as if they straddled their primary activity and energy production (*classe* 8.2).

A detailed list of the industries covered by each category appears in the *Censimento industriale*, vol. 2, pp. 11-35; with the suppression of the straddle categories and some further regrouping to conform to modern practice, this industrial classification is retained as the basis for the present estimates.

The *Censimento demografico*, in turn, includes a breakdown of the population over 10 years of age by (principal) profession, rank, sex, and age (vols. 4 and 5; the national totals by profession, rank, and sex were reproduced in the *Annuario 1914*, pp. 40 ff.). The classification of the industrial professions is identical to that of industries in the *Censimento industriale*, except that construction work is disaggregated by job type rather than by product; and the categories that straddle others are naturally absent, save for a totally unspecified residual of just one-tenth of one percent of the labor force. Within each profession, the ranks are expanded, as appropriate, to include independent artisans (among owners and managers, or in a separate category), and the *operai* (blue-collar workers) include those in domestic (and “domestic”) activity as well as in shops; since 1911 came near the end of the pre-war boom the large difference in the aggregate numbers reported by the *Censimento demografico* (4.4 million industrial workers) and the *Censimento industriale* (2.3 million workers) appears to reflect primarily the more complete coverage of actual employment by the former source, and only secondarily its already noted tendency to overstate actual employment.

But the *Censimento demografico* is not without its problems. The independent employment data provided by the Corpo delle miniere clearly show that where production was vertically integrated the census labor force figures are distorted in favor of the last stage of production and against the earlier ones, as if workers reported the final product of their employer (e.g., chemical fertilizer) rather than the immediate product of their own activity (e.g., the acid then used in fertilizer production). Again, the labor force figures underestimate the numbers engaged in temporary activities: obviously, as noted, in the processing of perishables after the harvest. But the problem runs deeper than that: the subnational figures reveal that the census also tends to undercount the labor force in activities faced with supernormal demand, presumably as the (unskilled) workers they hired away from other sectors reported their customary occupation on their census form (Fenoaltea, 2014b). More subtly still, the subnational figures alone reveal the extent to which the reported figures are affected by seasonal migration, and thus by the change in the census date from mid-winter to June (Cicarelli and Fenoaltea, 2013).

Given the partial nature of the *Censimento industriale*, the labor-force data in the *Censimento demografico* are used here, suitably adjusted, as the primary evidence of aggregate employment. But not all their defects were discovered in good time. In particular, the relevant work on the subnational data came far too late to inform the estimates for the construction industry, and those derived therefrom; in section K10.03 below, specifically, the apparent decline in the agricultural population from 1901 to 1911 is not attributed, as or to the extent it should have been, to seasonal migration.

### ***A03.03 Estimating the value of activity***

Census-based estimates of value added in 1911 here serve normally as base-line figures where output is not documented, and where output is documented to verify that the sum of the

product-specific value added estimates satisfactorily covers all production. These estimates are typically obtained by separately estimating labor costs and capital costs. Labor costs are obtained relatively directly from census-based estimates of aggregate employment, and complementary estimates of average wages and salaries; capital costs are obtained in a variety of ways, depending on the available information.

The employment estimates begin from the figures in the *Censimento industriale*. The employment (and horsepower-in-use) data reported therein are first of all revised, as may be necessary, to allocate those in the categories that straddle different industries. For the reasons noted in section A03.01 above, the contents of those categories are here distributed over their independent component industries, rather than attributed *in toto* to one of them as in the *ISIC*. The required estimate of each industry's share of a suppressed category's employment is sometimes based simply on the agnostic assumption of equal participation; but more refined estimates can at times be obtained from the factor proportions in the independent categories (when these are sufficiently different to define the possible weights attached to any given combination of the two) or from the labor force figures in the *Censimento demografico* (when the labor force in the independent categories is close to the reported employment for the independent and straddle categories together) or even from independent evidence (such as the employment data in the *Rivista mineraria*).

The revised activity-specific estimates of actual employment at the census date in the shops covered by the *Censimento industriale* are then compared to the corresponding labor force figures in the *Censimento demografico*; the final estimate of actual employment is normally based on an allocation of the discrepancy between the two on the one hand to unemployment (as suggested by recent production movements), and on the other to domestic and artisanal employment. In the exceptional case of sharply seasonal industries processing perishable agricultural goods, this procedure fails altogether: as noted above, the *Censimento demografico* tends to overlook the relevant labor force, which is normally borrowed from other activities, and the actual employment at the census date registered by the *Censimento industriale* has little bearing on the actual input of labor over the year.

The desired estimate of the aggregate value of labor services in the census year is normally obtained from the census-based estimate of employment in June (workers) with the aid of estimates of the average work year (days per worker) and the average wage (lire per day), distinguishing between wages and salaries. The average work year is normally taken to consist of 300 work days; but the census breakdown of shops by the length of their annual suspension of activity often suggests sufficient seasonality to warrant departing from this norm. In the majority of such cases, the industry can be considered close to its normal level of activity at the census date, and the work year needs only to be shortened to allow for a seasonal suspension. In other cases, however, the census date falls in the slack season; the estimated short working year is then applied to an estimate of peak-period employment, itself obtained with much uncertainty from evidence of seasonality and off-peak employment. In such cases, of course, the estimated number of annual man-days per employee at the census date can easily exceed the 300-day norm.

The choice of an average wage is heir to difficulties of a different order. The evidence on wages is of course highly imperfect, but there is enough to bring out noticeable differences by industry, sex, age, status, and geographic location; some of these differences may be considered relevant (differences in perceived value), and others irrelevant (distortions due to market imperfections, discrimination, and so on). With the inevitable misgivings that any rule entails, the present work recognizes wage differences by industry, sex, age, and status, on the presumption that these reflected, in the main, "true" differences in the human capital or physical effort provided by different workers. On the other hand, all labor is valued at standard wages,

essentially those prevalent in northern Italy, on the grounds that geographical differences reflect differences in living costs (altogether more than differences in real wages that persist because of moving costs) which make even contemporary money values heterogeneous (and thus require the substitution of “real” measures, as discussed below).

In practice, evidence on the daily wages of blue-collar workers will be drawn from the relevant sections of the *Annuario* (1911, pp. 218 ff., 1912, pp. 225 ff., 1913, pp. 266 ff.); since these do not indicate relative frequencies but only the range for a variety of different classes of worker, a “typical” industry-specific wage for an adult male worker (and the corresponding discount for women and children) will be gauged by informal inspection. The income of white-collar employees, executives and managers is instead estimated from the annual remunerations of government employees reported in the *Sommario* (pp. 204-205), which suggest an average of perhaps 2,000 lire p.a. for such personnel, at least in relatively large-scale industry; in the case of small shops, typically including those missed by the *Censimento industriale*, the owner-managers were little more than independent workers, and they too are attributed a blue-collar wage.

The calculation of capital costs is altogether less straightforward. As noted, the *Censimento industriale* reports only unduplicated horsepower in use, and the *Rivista mineraria* only unduplicated installed horsepower; capital costs are thus variously extrapolated from horsepower (including the power attributed to the shops the industrial census missed), physical production, employment, or labor costs, on the basis of an estimate of the appropriate ratio obtained from some ancillary source. The best of these are of course firm-specific sources for 1911 or thereabouts; since the firms in question were invariably large, their unit capital-cost coefficients are typically adjusted, case by case, to reflect the incidence (and presumably lower capital-intensity) of small-scale production. Absent closer sources, the estimates in question are derived through other censuses, including both near-contemporary American industrial censuses and Italy’s post-war *Censimento i. e. c.* The latter, taken over a number of years in the late 1930s, is exceptionally rich: it generally includes data on sales, labor and materials costs, and value added, and a number of industries were the subject of dedicated monographs.

#### **A03.04 Estimating the value of the results of activity**

As indicated in section A03.01 above, value added in production  $VA$  corresponds both to the value of productive activity ( $wL + rK$ ) and to the value of that activity’s results ( $pQ - zR - S - T$ ). The data generally allow one to estimate value added per unit of output, on the latter basis, as  $(VA/Q) = p - z(R/Q) - (S/Q) - (T/Q)$ . If output estimates are also available, this estimate of  $(VA/Q)$  is simply multiplied by  $Q$  to obtain an estimate of  $VA$ ; if not, this estimate of  $(VA/Q)$  is used to estimate output from the activity-side estimate of value added,  $Q = (wL + rK)/(VA/Q)$ . Most of the sources and methods relevant to the calculation of  $(VA/Q)$ , and thence of  $VA$  or  $Q$ , have been discussed above; only a few further considerations are here in order.

In most cases,  $S$  and  $T$  can fortunately be set at zero. A positive  $S$  is occasionally suggested by monopoly power; but the direct evidence is usually too scanty to allow more than a very rough guess. A positive  $T$  is rather more frequent, and of course better documented; but for the reasons noted above (section A02.04) the legal tax rate is often an overestimate of the effective rate, and  $(T/Q)$  will have to be approximated accordingly.

The output and principal raw material are so defined as to span the appropriate set of transformations, and must be valued accordingly; but the identification of the appropriate unit values is not without problems. Domestic wholesale prices are readily available for only a few dozen industrial products, mainly in the *Sommario* and (with considerable overlap) in Cianci (1933); in the latter, at least, the further disaggregation by product type or quality augments the available information and ensures homogeneity over time. The richest source of price

information by far is the *Movimento commerciale*. After some uncertainty in the early years, the traded goods' unit values were separately calculated for imports and exports, referred to the point of entry or exit before payment of duty, and annually revised, as noted, by a committee of experts; it is clear that the values were estimates but not forecasts, as they were set *after* the year they referred to had come to an end. Even then, of course, the system of valuation was not above criticism (Ottolenghi, 1911); moreover, the indicated values may be representative of the qualities of the goods that dominated foreign trade, and not representative of domestic production as whole (so that even their modification from year to year is an uncertain blend of changes in quality-specific prices and changes in the corresponding weights). These unit values are thus less than ideal; but superior substitutes are not generally available.

As noted, moreover, the calculation of value added from particular (input and output) market prices implicitly assumes that the entire throughput underwent the full transformation between the benchmark levels of fabrication corresponding to those prices, and accordingly neglects the inflows and outflows that actually occurred between or beyond the chosen benchmarks. The unit values reported by the *Rivista mineraria* are instead typically calculated as the ratio of sales to output, and thus reflect the varying degree of fabrication of the output actually sold; but even then the unit value appropriate to the firms covered by the *Corpo delle miniere* need not be appropriate to the entire industry.

In the same vein, the present estimates often apply the same price to a good as an output and as an input. Where transport and transaction costs are not deducted they tend to swell the value added of either the consuming or the producing industry, depending on whether the quoted price is f.o.b. or c.i.f. As a rule, therefore, the value of the results of activity is estimated on the basis of unit values that are not quite the desired figures; but in the context at hand these margins of error are relatively minor.

Since all purchases from other industries are in principle to be deducted from value added, too, *R* normally includes more than the principal raw material. Most minor purchases are dealt with by deducting an allowance for neglected items; but energy costs often warrant explicit consideration, as they can be both significant and variously distributed between materials costs and value added.

In the calculations below, internally generated waterpower is assigned a zero materials cost. Power obtained from prime movers running on purchased fuel (coal, gas, oil, etc.) is normally assigned a materials cost of 43 lire per thousand horsepower-hours. This figure is obtained for steam generation on the basis of the following allowances: coal costs, 35.65 lire per ton of Cardiff coal, delivered in Genova (Cianci, 1933, p. 307); rail transport costs from Genova to land-locked production centers, 1.5 lire per ton plus .05 lire per ton-kilometer for approximately 100 kilometers, or 6.5 lire per ton (see *Rivista mineraria 1900*, p. 368); other handling charges, .85 lire per ton, for a total coal cost of 43 lire per ton; specific fuel consumption, one ton of coal per 1,000 horsepower hours (compare Jevons, 1906, p. 138n, and United Kingdom Coal Conservation Committee, 1918, p. 26; while in Britain average specific fuel consumption seems to have been much higher than that, the high cost of coal in Italy seems to warrant the figure adopted here).

The cost of purchased electricity is also entirely excluded from value added; but that cost is also variable, since it depends on the specific conditions of generation and distribution. Power obtained from steam can hardly have cost much less than steam power itself is here taken to have cost in fuel alone, since the latter estimate already assumes relatively efficient steam engines; and distribution costs could also be significant. In most cases, therefore, it seems reasonable to assimilate the unit cost of purchased electric power to that of power generated by non-hydraulic prime movers: while discrepancies are possible in both directions, the likely error is usually small enough to be neglected. A lower figure, for (purchased) direct



hydroelectricity, will be applied only in the case of industries which are such large users of power that their location was presumably determined precisely by the search for the cheapest available sources of power.

The distribution of power sources among these major types (water, other prime movers, purchased electricity) is estimated from the horsepower data in the *Censimento industriale* or, where appropriate, the *Rivista mineraria*. Total energy inputs, in turn, are estimated where possible from the appropriate technical coefficients (energy per unit of output); in the absence of such information they can be estimated directly but less accurately by applying a reasonable utilization rate to the available horsepower data, with an eye to experience elsewhere (as documented for example by the data in United Kingdom Coal Conservation Committee, 1918, p. 25, or United States Geological Survey, 1928, pp. 198 ff.).

## A04. The real value added series: criteria and evaluation

### A04.01 Preliminary: industry's real value added

In the absence of alternative building blocks, the disaggregated “real value added” series calculated here are simply physical series, weighted by the corresponding estimate of value added at 1911 prices. The procedure is justified as what can be done at the present time, rather than as what should be done; but the theoretical norm remains relevant as a guide both to the evaluation of the present estimates and to the construction of better ones.

“Real value added” was conceived half a century ago; it suffered badly *in utero*, and was born deformed. As has been pointed out (Fenoaltea, 1976, again here broadly summarized; also Fuà, 1993), the literature is so mesmerized by the *res* in “real” as to lose sight of the measure’s very purpose, and of the logical constraints that purpose places on its calculation. The measures in the literature are reviewed below, and evaluated next to a proper one; but the latter must first be defined.

Form follows function. The objective is so to measure production -- the *process* of production -- as to be able meaningfully to compare, and combine, different industries; to that end, we measure all production in net terms, and in a common unit. Value added at current prices takes us most of the way (above, section A03.01); the remaining problem is that of using a common unit over time, to allow somehow for the fact that a 1930 dollar and a 1990 dollar, say, are not the same unit at all. What we want, all we want, is a measure of the production of different years in the same dollars, in dollars of the same purchasing power.

The correct formulation of the problem points to its solution, to the issues it cannot avoid, to those it can and must avoid. The former concern the content of our “constant dollars,” the answer to the question “purchasing power over what?”; as will be argued forthwith the answer can be delimited but not pinpointed. The latter concern the evidence already contained in current-price value added, in measures that are already in a meaningful common unit at their own moment in time.

The point is straightforward. Imagine that we run a boys’ school, and want to photograph the student body, first class by class, then all together; and that we want them neatly arranged, in each photograph, in order of height. When the classes are merged the students of different classes will be interspersed, but the within-class rank-by-height must obviously be conserved; any algorithm that violates that rule is simply wrong.

What this means in the case at hand is that the within-period relatives revealed by the current-price value added figures must be conserved when we calculate the cross-period relatives; and that is obviously achieved if and only if all the current-dollar industry-specific value added figures for a given year are converted to “constant dollars” at the same rate, that is, deflated by the *same* price index. The latter is of course the current dollar value of our standard over which “constant purchasing power” is defined, with the ambiguities we shall encounter soon enough; the unambiguous point is that the objective is to convert current values (added) into constant values (added), variable year-specific dollars into constant dollars.

That conversion we call “deflation”: its very name conveys that the concept was derived to correct for inflation, for the decline in the purchasing power of money. The mark of inflation is that the monetary unit loses value, while things do not; things are by definition real, it was natural enough to call deflated measures “real” measures. But in its technical sense “real” is used metaphorically, not literally. Its antonym is not “unreal,” but “nominal”: “real” here means not simply “like things,” but “like things when things keep their value in exchange, and the currency does not.” Economics cut its baby teeth on the water-diamonds paradox, we know perfectly well that depending on its relative scarcity the same physical good can be worth anything from nothing at all to more than its weight in precious stones: we know that things as

such are no more “real,” in its technical sense, than paper money.

At any given price level, we are agreed, value added relatives properly capture the relative magnitude of production, the relative size of the industries themselves. Perhaps the easiest way to approach measurement over time is to trivialize the issue, to reflect on how our measure of production would and should change on the assumption that the price and wage levels remain constant, that the dollars of the second year are by happy assumption equivalent to those of the first. Consider then a small industry, small in the technical sense that its own changes have no effect on the economy-wide averages. It could for example decline, thanks to productivity growth: assuming the materials it consumes and the primary resources (labor and equipment) it employs are all non-specialized, and that it faces a totally inelastic demand,  $(pQ - zR)$  and  $(wL + rK)$  both decline, with unchanged  $Q$ ,  $R$ ,  $z$ ,  $w$ , and  $r$ , thanks to the fall in  $p$ ,  $K$ , and  $L$ . It could conversely grow in size, with no change in the physical activity of its factors of production or its physical output, if demand increases: assuming again that the supply of raw materials is infinitely elastic, but that the industry’s own supply is nonetheless totally inelastic, because the (specialized) labor and equipment it uses can neither be increased nor applied to a greater quantity of materials,  $(pQ - zR)$  and  $(wL + rK)$  both increase, with unchanged  $Q$ ,  $R$ ,  $L$ ,  $K$ , and  $z$ , thanks to the rise in  $p$ ,  $w$ , and  $r$ . The industry grows from one year to the next because the primary resources (labor and equipment) it employs are more scarce, and worth more, than before: resources are no more “real,” in its technical sense, than things or paper money.

Again, we know this: we accept that at any given moment industry  $a$  is twice as large as industry  $b$ , if both employ the same number of workers and no equipment at all, and wages in  $a$  are twice those in  $b$ ; that it is half as large if it employs half the workers at the same wage (and half the equipment at the same rental rate). If we accept “value added” as we do, we constrain our definition of “real value added,” for the latter must reflect everything the former does. The “deflation of value added” must not alter current-price value added relatives; all the industry-specific current-price measures must be converted to “real” measures at the same ratio of current dollars to constant dollars, i.e., with a *common* deflator. That conclusion is inescapable; what remains to be determined is the appropriate deflator.

#### ***A04.02 The quasi-proper measures of real value added***

The deflator is the price of whatever it is that conserves, to our minds, its “real value”: it is the dollar value of our measure of all things. That measure is not self-evident; self-evidently, though, it must first of all be intuitively appealing, and also, to the extent possible, easily calculated and replicated, in the international context as in the intertemporal one.

The contemporary tendency, among economists, is to consider things “real”: if not any individual thing -- the conversion of everything into “corn” no longer satisfies -- certainly broad collections of things, as in our common measures of “real GDP,” “real wages,” and the like. In the case of contemporary economies amply documented by their statistical bureaus, one might thus simply deflate every current-price value added by some (broad) official index of prices. Among these, the most attractive would appear to be the GDP deflator: since production would then be measured in “real” terms essentially by distributing “real GDP” among the component sectors in proportion to their share of GDP at current prices, the “real value added” measures calculated for any given year would happily sum to “real GDP.”

To that there are various objections. A statistical one is that if “real GDP” is calculated as a Laspeyres quantity index, the corresponding deflator is a Paasche price index; and this creates difficulties of interpretation, since we can no longer speak of the deflator as the price of a given composite good. Intertemporal comparisons (other than to the base year) would be among industries reduced to different physical equivalents; and it is hard to see on what grounds these physically different composites could be considered of equal worth (Phillips, 1961, p. 320;

David, 1962, p. 150n). A Laspeyres price index is not heir to this difficulty (since it keeps the same quantity weights year after year, the good assumed to be of constant worth is simply the base-year basket of final goods and services); in practice, however, GDP deflators are rarely of the Laspeyres type (Hill, 1971, p. 16; the standard aggregate was then not GDP but GNP).

Further statistical objections arise if we seek to compare economies that are significantly different, whether they are the economies of different nations, or of the same nation at widely separated points in time. Each economy has its own product mix, its own GDP deflator; effectively to compare the “real” product of their industries one should measure the production in a common (composite) unit, by a universal yard and not the local yard. Similarly, no given basket seems meaningful if we wish to compare an advanced economy of today to itself a century earlier: the actual mix of goods and services has changed so radically that the two sets seem hardly to overlap.

The deeper objection is not statistical but economic. As all goods become more abundant they may retain their value in terms of each other, but surely become, in a deeper sense, less valuable (and certainly less valuable in terms of labor, about which more below). Diminishing marginal utility is one of our axioms, used for example by Pigou to argue that income inequality reduces aggregate welfare (Pigou, 1920; also Lerner, 1944, pp. 26-27); its empirical relevance is demonstrated by the desire to smooth consumption even with negative returns to “abstinence.” A more radical point is argued by the “Easterlin Paradox” (Easterlin, 1974). Badly argued, for the evidence that economic growth does not improve the human lot is drawn from a self-scoring survey, by asking people if they are happy; and that is much like asking them if they are tall or healthy. The response is inevitably a distribution around what is perceived as average, simply because such words serve to draw distinctions, and to maintain their usefulness their “real” content adapts to the context; the constancy of the above-average share does not preclude, logically, a rising average over time. But a bad argument means only that the conclusion is not supported, not that it is wrong; and it is readily reached if we recognize that we are social animals keenly sensitive to hierarchy, that the “infinite wants” of our textbooks are based on the need for display. To the extent that goods are counters in a positional game, their growing abundance benefits us, collectively, not a whit, and the social gain from increasing abundance is nil. No single good is “real,” but neither, it would seem, are all goods together: our references to “real GDP” and the like pretend they are, but the pretence is transparent.

The historical literature -- the writings of long-past economists, the writings of historians -- points in a different direction: the measure of all things is man, or at least human effort. We have it on good authority that the real value of a good is the quantity not of other goods, but of labor, that it can purchase or command; and all authority aside the strength of that intuition is obvious from the historians’ common practice, when they seek to convey a sense of the period’s monetary values, of indicating not the prices of goods but the typical wage rate (e.g., Hilton, 1966, pp. 4-5).

The deflation of current-price value added by the monetary value of (an hour of) common labor -- simple effort, not rewarded for particular skills or compensated for particularly harsh working conditions -- is in some significant ways superior to deflation by the monetary value (even) of a broad basket of goods. Practically, the deflator is altogether simpler to compute, and the requisite data are more likely to be available; the commodity into which everything is converted is present always and everywhere, simplifying international and intertemporal comparisons. In principle, more significantly, (an hour of common) labor is a simple unit: the wage-deflation of current-value-added series, their conversion into (hours of common) labor, yields a time path that is itself unique. Baskets of goods are complex units: they are infinitely variable, and none is obviously “the” right one. Different

baskets yield different time paths: the result of deflation by a broad-based price index is inevitably ambiguous.

In another way wage-deflation is no better than goods-price-index deflation, for it suffers equally from the implications of growing material abundance, of growing productivity, albeit in the opposite way. Unless one believes in the radical uselessness of additional material goods, it seems obvious that as labor becomes ever more productive, it becomes, as it were, more valuable: not just in terms of goods, which become *less* valuable, but in terms of whatever elusive standard ultimately appeals to our intuition.

There is no obviously correct, intuitively appealing standard of “real value.” To take a broad basket of goods as that standard, to deflate current-price value added by, say, the GDP deflator, seems to overstate “real growth,” because that standard neglects the declining “real value” of goods as they become more abundant; to take an hour of labor as that standard seems symmetrically to understate “real growth,” because that standard neglects the rising “real value” of labor as it becomes ever more productive. But the symmetry is limited: the “goods” index grows faster than the “labor” index, but there is no particular merit to their geometric mean, and the “ideal index” seems impossible to pin down.

We can see our reflection, as it were, only in two distorting mirrors, one slimming, the other fattening (and blurred); all we know is that we are “really” somewhere in between. The situation, if uncomfortable, is at least familiar: it is reminiscent of the calculation of cost-of-living indices, where the Laspeyres index overstates the compensating increase in income, and the Paasche index understates it.

#### ***A04.03 The standard measure of real value added: the “double-deflated” Fabricant-Geary index***

The standard measure of real value added in the literature is the so-called “double-deflated” index presented by Fabricant and Geary during the Second World War, and subsequently adopted by the world’s bureaucracies (Fabricant, 1940; Geary, 1944; *SNA*; Hill, 1971); it measures “the results of activity” at constant prices,  $rVA_{it0} = p_{i0}Q_{it} - z_{i0}R_{it}$ , where  $rVA$  is real value added,  $p$ ,  $Q$ ,  $z$ , and  $r$  are defined as in section A03.01 above, and the subscripts  $i$ ,  $t$ , and  $o$  refer respectively to the industry, to the year for which  $rVA$  is calculated, and to the “base” year, the one whose prices are used, the one in which “real” and current-price value added coincide. The appropriateness of the measure is considered self-evident; it is in fact a dreadful measure, generated by a tragicomedy of errors.

Formally, the standard measure is an ambiguous measure: there are any number of possible base years, and these will in general generate an equal number of alternative time series that differ not just in their levels, but in their time paths. The standard reaction to this “index-number problem” is to update the base year from sub-period to sub-period, at the limit to compute a “chain index” that updates the base from year to year, using the prices of  $t$  to calculate only the change in production from  $t$  to  $t + 1$  (Fabricant, 1940, pp. 33-34, Sims, 1969, n. 2, Arrow, 1974, p. 4, Fuà and Gallegati, 1996, Baffigi, 2013, p. 165). This is equivalent to limiting the error of a slow time-piece by repeatedly resetting it, at the limit every day: the underlying problem is that it keeps time badly, the obvious solution is to junk it and invent one that keeps time properly.

Formally, the standard measure is a dirty measure, in two ways. Current-price value added is insensitive to *horizontal* disaggregation, as the different qualities of a good produced by a particular industry are captured by their market prices; if we measure “real value added” in physical units the distinctions we make are inevitably too few, and different qualities of a good are inevitably aggregated as if they were identical. We count, in practice, the production of, say, “automobiles” where we should distinguish, in principle, each model of each manufacturer; the

standard measure of “real value added” is improperly sensitive to horizontal disaggregation. Again, current-price value added is insensitive to *vertical* disaggregation, as the value added attributed to, say, the steel-from-ore industry corresponds to the sum of those that would be separately attributed to the steel-from-pig iron and pig-iron-from-ore industries. If we measure “real value added” in physical units  $p_{io}Q_{it} - z_{io}R_{it}$  equals  $(p_{io}Q_{it} - x_{io}I^{**}_{it}) + (x_{io}I^{*}_{it} - z_{io}R_{it})$ , where  $I$  is the intermediate good (pig iron) and  $x$  its price, only if  $I^{**} = I^*$ , that is, only if the quantity of the intermediate consumed in the second stage of production is exactly that produced in the first stage of production -- as it will not be, in the presence of international trade in, or changes in the inventories of, the intermediate good. The same criticisms obviously apply to the simple constant-value-added-weighted output series produced here; but the standard measure purports to be the proper one, the present “real value added” series are presented as no more than data-constrained, interim estimates pending the generation of (quasi-) proper ones.

Substantively, the standard measure is based on the bad accounting, and the bad theory of the firm, that underpin the distinction between (the value of) “the results of activity” on the one hand and (the value of) “activity as such” on the other (above, section A03.01). Value added, properly measured, indifferently measures both at once; logically, “real value added” measured in industry-specific physical units at constant prices is indifferently measured as  $(p_{io}Q_{it} - z_{io}R_{it})$  or as  $(w_{io}L_{it} + r_{io}K_{it})$ , with  $w$ ,  $r$ ,  $L$  and  $K$  again defined as in section A03.01 above. These alternative measures do not in general coincide: the ambiguity of “weighted-physical” real value added is thereby doubled, as we have  $n$  possible base years and two alternative measures for each one, for a total of  $2n$  different measures of the same “real value added.”

As was soon noticed, the standard measure is disturbingly prone to yielding *negative* measures of “real value added,” and it is typically criticized on that specific account (Fabricant, 1940, p. 28; David, 1962, p. 419; Arrow, 1974, p. 4): in the case of such low-value-added, heat-intensive industries as the production of pig iron, for example, fuel-saving technical progress reduces  $(R/Q)$  and  $(p/z)$ , and with the low  $(p/z)$  of a “late” year and the high  $(R/Q)$  of an “early” one  $z_{io}R_{it}$  may well exceed  $p_{io}Q_{it}$ . This problem at least the corresponding “activity” measure altogether avoids, as  $(w_{io}L_{it} + r_{io}K_{it})$  is invariably positive: even within the class of “weighted-physical” measures of real value added, the standard Fabricant-Geary measure is inferior to the obvious alternative. It may be noted that simple constant-value-added-weighted output series such as those produced here are conceptually closer to the “activity” measure than to the inferior “results of activity” measure: at the limit, if goods are disaggregated not just by type and quality but by production process, the measures coincide, as each unit is attributed the base-year-price value added it would have involved had it been produced with the technology of the reference year, that is,  $(w_{io}L_{it} + r_{io}K_{it})/Q_{it}$  -- conceptually equivalent to  $(p'_{io}Q_{it} - z'_{io}R_{it})$ , where  $p'_{io}$  and  $z'_{io}$  are the (imputed) prices that would have prevailed in the base year using the reference year’s technology.

Substantively, and more deeply, the deficiencies of the standard measure -- its non-coincidence with the analogous measure of “activity as such,” its tendency to generate nonsense results -- are evidence that it is fundamentally misconceived, that it does not measure “real value added” at all; and it is misconceived because it takes “real” in its literal sense rather than its metaphoric technical sense, as witlessly as one researching the temporary rents accruing to an innovator might examine his earnings from his real-estate holdings, or one studying price-formation might dismiss marginal revenue and marginal cost because in ordinary discourse “marginal” means “unimportant.”

Real value added is a measure of value added in a common unit of value, unchanging over time: whatever the chosen deflator, it must be applied across the board. The standard measure,  $(p_{io}Q_{it} - z_{io}R_{it})$ , is equivalent to  $(p_{it}Q_{it} - z_{it}R_{it})/[(p_{it}Q_{it} - z_{it}R_{it})/(p_{io}Q_{it} - z_{io}R_{it})]$ , that is, to current-price value added deflated by a price index -- the expression in square brackets -- that

considers only the (output and materials) prices specific to the industry at hand. The current-price value added of different industries is deflated by different price indices, converted into different baskets of goods: the desired measure in a *common* unit is never obtained at all.

Because the measure is intrinsically wrong-headed, it can grossly misrepresent what is actually occurring. Return, for simplicity, to our “small” industry in an economy with stable price and wage levels (above, section A04.01). Assume technical progress in that one industry so changes the production function as to reduce at once the consumption of materials, and of labor- and equipment-hours, per unit of output. Value added per unit unambiguously declines; the standard measure, sensitive only to  $(R/Q)$ , as unambiguously registers a spurious increase. It is here inferior to the simple weighted output series of the present work: their error from not picking up any change at all is smaller than the error from picking up the change, and getting the sign wrong.

#### **A04.04 The mavericks: David, Sims, and Arrow**

Three voices stand out of the chorus: those of David, Sims, and Arrow.

David (1966) proposed measuring each industry’s real value added  $rVA_{it}$  as its current-price value added  $VA_{it}$ , deflated by the price of its output  $p_{it}$ :  $rVA_{it} = VA_{it}/p_{it}$ . The measure, in own-output units, is unambiguously positive: David thus exorcises the “unfamiliar and rather harrowing index number problem [of the double-deflated index] -- one which manifests itself in the appearance of negative real value added estimates” (David, 1966, p. 419). More importantly, perhaps, David’s straightforward deflation of current-price value added by a current price marks a long step in the right direction: the false distinction between “the results of activity” and “activity as such” is obliterated, and at least in competitive equilibrium, it is made clear, “real value added” represents both in real terms just as “value added” does in terms of current prices (David, 1966, pp. 421, 425).

That said, however, the David measure differs from the standard Fabricant-Geary measure only in that the deflator ignores the price of the raw material; the two are close kin, and heir to much the same strictures. The David measure is less ambiguous than the standard measure at the level of the single industry, for the real value added series for each industry, in its own physical units, is unique; but any higher-level aggregate is obtained by combining those physical units with the corresponding value added at base year prices, and with  $n$  possible base years we again generate  $n$  alternative aggregate series. The David measure is sensitive, like the standard measure, to horizontal disaggregation: the more narrowly goods and industries are defined, the better it avoids the crude approximation involved in choosing “the” good produced by all the industries which produce, and sell, a broad variety of items. To vertical disaggregation the David measure is even more sensitive than the standard measure. With the David measure the production of steel from ore, for example, is measured entirely in tons of steel if it is attributed to a single industry, and partly in tons of steel and partly in tons of pig iron if it is attributed to the steel-from-pig industry on the one hand and the pig-from-ore industry on the other; the alternative measures of the same production will vary, even in the absence of international trade or changes in inventories, if the relative price of steel and pig iron vary over time in response, say, to differential technical progress. Again, the same criticisms can be levied at the simple time series produced here; but, again, the present value-added-weighting of physical output series is not presented as the proper way to measure real value added.

Like the standard measure, finally, the David measure is fundamentally misconstrued because it takes “real” in the everyday, rather than the technical, meaning of the term. Because it deflates current-price value added by industry-specific indices rather than by a common index, it does not succeed in counting all production, as we wish to, in a common unit: it too does not measure “real value added” at all.

And because it doesn't, it too can grossly misrepresent what is actually occurring. Return once more to our "small" industry in an economy with stable price and wage levels (above, section A04.01). Assume technical progress in that one industry so changes the production function as to reduce at once the consumption of materials, and of labor- and equipment-hours, per unit of output, and that the saving of materials exceeds the saving of primary resources. Value added per unit unambiguously declines, price per unit declines even more; the ratio of the two therefore increases, and the David measure as unambiguously registers a spurious increase. It too is here inferior to the simple weighted output series of the present work: their error from not picking up any change at all is smaller than the error from picking up the change, and getting the sign wrong.

Sims and Arrow are in the mainstream in that they too take "real" in its everyday meaning rather than its technical one; but that apart they strike an entirely discordant note. Sims (1969) was concerned not with the measurement of production, but with the estimation of production functions. "Analysis of production relations is simpler if we can restrict ourselves to looking at two inputs at a time" (Sims, 1969, p. 470); but, he asks, should one estimate a production function linking real value added to capital and labor --  $rVA(K,L)$  -- if such a function does not in fact exist, that is, if the general production function  $Q = Q(K,L,R)$  is not so separable as to be correspond to  $Q = Q(rVA(K,L),R)$ ? To his mind this is equivalent to asking "Does the notion of real value added make any sense?" (Sims, 1969, p. 471); but two comments appear to be in order. One is that "real value added" may well not be "a thing" with its own production function, and still make perfectly good sense as a measure of all production in a common unit, which is what it means in the context in which the notion was created in the first place. The other is that if we object to the use of "real value added" in our production functions because it is not ("really") "a thing," we should similarly object to using "capital," "labor," and "raw materials," as each of these too is not ("really") "a thing" but a construct that aggregates over a complex array of factors of production.

Arrow (1974) begins by discussing real value added in the relevant context, reviewing the justification of "value added" in current terms and the problem of deflating it into "an invariable standard of value"; but he then switches to Sims' problem with the curious argument that "the most natural meaning [of real value added], indeed the only one I can think of, arises from the estimation of production functions" (Arrow, 1974, pp. 3-5), and proceeds to discuss it in a very similar way.

#### ***A04.05 The deficiencies of the present series***

The first-generation series were based on the traditional methodology. The present second-generation series are in some ways clear improvements: the physical output data in the sources are vetted, and corrected or discarded as the evidence may suggest, rather than mindlessly copied; the path of undocumented output is estimated from what indirect evidence can be brought to bear, and not mindlessly assumed to follow that of documented output; and the output estimates are extensively disaggregated, horizontally and vertically, the better to document the (changing) composition of production.

But the improvements do not go far enough. Value added measures the production of all industries -- at once their activity, and its results -- in a common, meaningful monetary unit, in the year of reference. "Real" value added measures do the same, maintaining a common, meaningful monetary unit, from year to year as well: they are measures in "constant dollars," dollars of constant purchasing power in terms of whatever we believe maintains its "real value." There is no obvious standard: an hour of common labor is appealing, but its "real value" may grow with growing productivity; a broad basket of goods is also appealing, but open to endless variations, and its "real value" surely declines with growing abundance. The intuitively



appealing measure would seem to be an internal average of these alternatives, of current value added deflated by the wage on the one hand, of current value added deflated by a broad-based index of goods' prices on the other; but the "best" formula is hardly self-evident.

Self-evidently, though, if "real value added" is so to measure production as to allow meaningful intertemporal comparisons as current-price value added allows meaningful intratemporal comparisons, the current-price value added of each and every industry must be converted into the *same* constant dollar, however defined: it must be deflated by the *same* deflator, the *same* index of the current price of our (elusive) standard of "real value." The standard "double-deflated" Fabricant Geary measure, the proposed David measure, both fail to meet this basic criterion; and so do the present second-generation "real value added" series, obtained simply by combining physical series, typically the estimated output series, with 1911-price value added weights, the only excuse for which is that no more can be done with the basic estimates that are currently available.

All three measures are bad, neither the Fabricant-Geary nor the David measures are the standard by which the present ones are to be judged. In fact, as seen above (and illustrated, numerically, in Fenoaltea, 1976), next to the proper standard neither of those dominates the present ones, as they can readily measure the movements of real value added with an even greater error. What matters is rather the comparison of the present series to "the" proper standard, the distortion introduced by the present algorithm: on the one hand by the use of physical output to track production, on the other by the use of weights calculated for a "late" year, one near the end of the period to which the series refer.

The former distortion is easily established. Let us accept, to simplify the discussion, that the labor-hour is our "real" standard; and let us assume that labor is the only primary input. Consider two industries: one with a stagnant technology, the other marked by technical progress and productivity growth -- say for example one which assembles watches from parts, another which manufactures the parts from metal and benefits from (here, disembodied) technological improvements. On these assumptions the output of the assembly industry is a perfect index of its real value added, as an assembled watch incorporates the same production, the same number of labor-hours, in year  $t$  as in year  $t + n$ . Not so the output of the parts-manufacturing industry. Imagine that from  $t$  to  $t + n$  output doubles, but productivity also doubles: the industry does not grow at all, for the doubled output incorporates exactly the same production, the same number of labor hours, as before. Technical progress, productivity growth, reduces the scarcity and real value of the good that is produced; the present series implicitly assume a constant technology, a constant production per unit of output, and because they neglect the effects of technical change they *overstate* the growth rate of technologically progressive industries.

The point is barely complicated if our standard is a broad basket of goods, "goods in general," as the change in standard merely rotates the axes. The output that is a proper index of real value added is then that of the industry which benefits from *average* productivity growth. The growth of industries with below-average productivity growth is *understated* by the growth of output: the assembly of watch parts involves a constant input of labor-hours per unit of output, but the real equivalent of those hours is ever increasing, and the output series fails to capture that. By the same token, the growth of industries with above-average productivity growth is overstated, for the decline in labor-hours per unit of output exceeds the rise in the real equivalent of those labor-hours themselves.

To represent the path of each industry's real value added by current output  $Q_t$  weighted by base-year unit value added  $va_o$ , as the present series do, is to misrepresent that path. The mismeasurement of (at least one of) the intertemporal real value added relatives  $va_{io}(Q_{it}/Q_{io})$  and  $va_{jo}(Q_{jt}/Q_{jo})$  means in turn that the calculated intratemporal value added relatives

$(va_{io}Q_{it}/va_{jo}Q_{jt})$  fail to reproduce  $(va_{it}Q_{it}/va_{jt}Q_{jt})$ , the (already real, that is, already in a meaningful common unit) relatives at current prices. As one goes back in time, towards the initial year of the series, the present 1911-price estimates increasingly understate the relative size of the more technologically progressive industries, and vice versa: they increasingly distort the composition of production (Fenoaltea, 2015a). From this point of view, that the present base year is near the end of the period at hand is unfortunate: one near the middle would have sharply limited the distortions in the interindustry relatives obtained for the early years, and the introduction of comparably limited distortions in those for the late years would have offset that gain only in part. But 1911 was not selected with these considerations in mind; it was selected simply because production is far more richly documented in that year than in any other.

If the literature is to be believed, the most significant consequence of using late-weighted production series is that the resulting aggregate understates the true growth rate (as the present series are said to do, e.g., Baffigi 2013, p. 169); but once again one believes the literature at one's peril (Fenoaltea, 2015b). The common view is based on the so-called "Gerschenkron effect," the recognition that when intertemporal price and quantity relatives are negatively correlated an "early-weighted" aggregate will grow faster than a "late-weighted" aggregate (Gerschenkron, 1947) -- and that a negative correlation is the empirical norm, as the industries characterized by relatively rapid (slow) technical progress and a falling (rising) relative price benefit (suffer) from cost-reducing substitution. This is viewed as a typical "index-number problem," and so interpreted: the faster-growing measure is taken to overstate, the slower-growing measure to understate, the "true" growth rate of the aggregate.

But what may be true of an output aggregate is not true of a *production* aggregate, of aggregate "real value added"; and the root misconception is again the literal-minded, non-technical interpretation of the word "real." Return once again, to make the point as simply as possible, to our economy with a stable price and wage level (above, section A04.01); and assume further that the entire industrial sector is "small," and made up of two components, both of which use only (homogeneous) labor (and, further to simplify the analysis, no purchased materials). Assume that both employ the same number of workers at the same wage, in the late period as is the early one: in these trivialized "real" terms, neither industry grows at all, nor therefore does industry, industrial *production*, as a whole. Assume now that technology in industry *A* is unchanged, so its physical product is too -- say 100 units, at \$10 each, in both periods -- while productivity doubles in industry *B*; since by assumption the latter does not grow either, its value product is also unchanged -- passing, say, from 50 physical units at \$20 dollars each in the early period to 100 at \$10 each in the late one. The Gerschenkron-effect calculation is straightforward: with early-period weights the early-period product is  $[(\$10*100) + (\$20*50)] = \$2,000$ , the late-period product  $[(\$10*100) + (\$20*100)] = \$3,000$ , for an increase of 50%; with late-period weights the early-period product is  $[(\$10*100) + (\$10*50)] = \$1,500$ , the late-period product  $[(\$10*100) + (\$10*100)] = \$2,000$ , for an increase of just 33%. The early-weighted aggregate grows faster than the late-weighted aggregate; but both grow, whereas by assumption the aggregate, in real terms, in constant dollars, remained equal to \$2,000, and did not grow at all. *Both* the early- and the late-weighted aggregates *overstate* "real" aggregate growth; and they do so whether our "real" standard is an hour of labor, simply because in industry productivity grew, or an economy-wide basket of goods, simply because productivity growth in industry exceeded the economy-wide average.

And so too in the case at hand. The present time series measure industrial production over the decades of Italy's early industrialization, when factory-workers replaced artisans: surely productivity in *industry* grew, and far more rapidly than productivity in agriculture (which was radically transformed, by motorization, only much later) or in the services (where the transformation was essentially limited to the parts of the transportation sector that adopted

machine power). The late, 1911-price weights used here do not understate the true growth rate of industry, however reasonably defined: they overstate it, but far less than early weights would. The year 1911 was selected as the base year simply because production is far more richly documented in that year than in any other; but from the present point of view that it should be near the end of the period at hand is indeed fortunate.

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