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Where is Capital?

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“IT IS IMPOSSIBLE TO UNDERSTAND THE PAST” without being interested in the present, Marc Bloch wrote in 1940.¹ This essay is an experiment in thinking about the economic and industrial revolution of the late eighteenth century in Europe, and about our own times. It is a list, really, of things to be done; an annotated agenda of possible sources. It starts with some recent economic thought, and with an observation of changing economic circumstances. It is an effort, too, to think about the economic models with which everyone thinks, including economic historians.

These are models of economic life and of the world in which it unfolds. The history of economic transformation is of necessity teleological. It is a story of change over time, from the perspective of the end of the story (or of the infinitesimal present). The growth theories of the mid-twentieth century were the outcome of a time of apparent stability that was itself unusual. To look back at the industrial revolution now, from our own unstable times, is to tell a story that ends in a continuing decline in the wealth and influence of the first industrial nations; in a widespread repudiation of the energy-intensive growth of the nineteenth century, in principle if not in practice; and in a reevaluation of the importance of empire and slavery in European economic growth. Thinking with nature and thinking about slavery are obligations and also opportunities for economic history.

The essay that follows is capacious, in the sense that it is about Europe and its overseas territories over the long half-century from the 1760s to the 1810s, especially in Britain and France. I start with a model and a thought experiment: the essay is divided into a main text, which is about the model and quite informal, and text boxes, which are about historical details—and about the effort, once so derided by economic historians, “to understand

Note: I am grateful to Francesca Trivellato, the referees for *Capitalism*, and to Amartya Sen, Ben Golub, Diana Kim, Ian Kumeakawa, David Todd, and Paul Warde, none of whom have any responsibility for the contents.

¹ Bloch, *L'étrange défaite*, 22.

everything at cross purposes, to reconstruct for oneself, pitifully, the imaginations of contemporaries.”²

The point of departure has been three tendencies in recent economics, all concerned, in different ways, with evidence. The first is work by the late Emmanuel Farhi and David Baqaee on the micro-foundations of macro-economics, on the possibilities of economic as distinct from statistical aggregation, and on understanding the behavior of economic aggregates from below, in a world of potentially infinite information: “macro as explicitly aggregated micro.”³ The second is the micro-economics of development, with its openness to “many . . . types of evidence,” qualitative and quantitative, and its optimism about finding new sources of information, in natural experiments, randomised trials, and (almost) everywhere else.⁴ The third—and the most obscure to historians and sometimes to economists—is the cumulative transformation of the measurement of national output, and the integration into these measurements of information about inter-industrial flows, of which the outcome has been a profound change, as will be seen, in the depiction of capital.⁵

The thought experiment consists in starting not with the data and its limitations—or even with economists’ and historians’ amazing inventiveness and exhaustiveness in finding new data—but with the possibility of limitless information. The present suggests questions about the past, and one question is about the omnipresence of evidence. If it were possible to have essentially infinite data, in this case about Britain and France in the early industrial revolution, then how would one want to think about economic change? This is a familiar inquiry for economists in the twenty-first century. It is feasible, for example, in a world “awash in an ocean of microdata,” to ask new questions about the micro-foundations of macro-economic theory, including the theory of aggregate capital; or in a world of 405 x 405 matrices of the use of commodities by industry to ask new questions about “structural” change in agri-

² Sen, *Collective Choice and Social Welfare*, xxiv. On contemporaries, see Labrousse, *Crise*, 167.

³ Farhi, “Interview,” 23; Baqaee and Farhi, “The Microeconomic Foundations of Aggregate Production Functions,” “Macroeconomics with Heterogeneous Agents and Input-Output Networks,” “A Short Note On Aggregating Productivity,” and “Productivity and Misallocation in General Equilibrium.”

⁴ Banerjee and Duflo, *Poor Economics*, 15. See also Banerjee and Duflo, “Growth Theory through the Lens of Development Economics.”

⁵ Jorgenson, “Production and Welfare: Progress in Economic Measurement”; Lyndaker et al., “Integrated Historical Input-Output and GDP by Industry Accounts, 1947–1996”; OECD, *Measuring Productivity*; Jorgenson and Griliches, “The Explanation of Productivity Change.”

culture, industry, and services; or in a world of multiple sources of evidence to ask new questions about poverty and economic life.⁶

The possibility of an ocean of evidence, just out of sight, is familiar to historians as well: “the chronicler, who narrates events without distinguishing the small from the large, takes account of the important truth that nothing which has ever happened should be lost to history.”⁷ But the idea of seeing everything is imposed, in a particularly exigent way, by the new technologies of inquiry. This is the naturalist omniscience of biological information, or of Jacques Monod’s “NASA from Mars,” arriving on earth in Fontainebleau, and trying to distinguish between the natural and the artificial, by observing every molecule and every bee.⁸ Historians, too, are surrounded by new sources of information, and new possibilities for inductive or naturalist or realist description.⁹ Thinking about evidence, in the end, is a way of thinking about history. “My own feeling,” R. H. Coase wrote of theory and insight, “is that the inspiration is most likely to come through the stimulus provided by the patterns, puzzles, and anomalies revealed by the systematic gathering of data, particularly when the prime need is to break our existing habits of thought.”¹⁰

A Simple Model

The model, in this inquiry into early economic growth, is suggested by the thought experiment. The “classic growth accounting research of the early 1980s,” together with the growth models of the 1950s on which it was based, has been astonishingly enduring within economic history, over successive estimates of “real GDP,” labor inputs, and capital stocks. The basic (macro) model remains

$$1. Y = AK^{\alpha}L^{1-\alpha}$$

where Y denotes income (or product), K denotes capital, and L labor.¹¹

⁶ Baqaee and Farhi, “The Microeconomic Foundations,” 1339; Jorgenson and Timmer, “Structural Change in Advanced Nations”; Banerjee and Duflo, *Poor Economics*.

⁷ Benjamin, *Über den Begriff der Geschichte*, 31, 48, and see Ginzburg, “Preface to the Italian edition,” *The Cheese and the Worms*.

⁸ Monod, *Le hasard et la nécessité*, 19–21.

⁹ Todd, “French nabobs in Egypt,” 5–6; Rothschild, *An Infinite History*.

¹⁰ Coase, “Industrial Organization,” 71.

¹¹ Crafts, “The sources of British industrial growth,” 1, 4. A denotes total factor productivity (TFP), and “ α and $(1 - \alpha)$ are the elasticities of output with respect to capital and labor,

The present inquiry will be organized not around a production function, but around a basic accounting identity—the KLEMS identity—or

$$2. x_{i,t} X_{i,t} = k_{i,t} K_{i,t} + l_{i,t} L_{i,t} + e_{i,t} E_{i,t} + m_{i,t} M_{i,t} + s_{i,t} S_{i,t}$$

where X denotes (gross) output, E energy, M materials, and S (purchased) services.¹² The inquiry takes the form, at least initially, of a series of observations about specific K s, L s, E s, M s, and S s—the sorts of observations about data that might be found elsewhere in footnotes or appendices.

Then, two questions of definition. Almost all the “classic” series of long-term growth accounting are concerned with gross domestic product (GDP) or GDP per capita. The expression GDP, and its now unfashionable companion GNP, or gross national product, are part of the currency, as it were, of public discussion of economic change. But they differ in ways that are of importance in relation to the evaluation of eighteenth- and early nineteenth-century economic change. GNP is defined in US national accounts as the “market value of the goods and services produced by labor and property supplied by residents of the US.” GDP is defined as the value of goods and services “attributable to labor and property located in the US.”¹³ Both are measures of the economic activity of a nation in a particular period. Both depend on concepts that are not uncomplicated—residence, location, attribution—and that were also the subject, as will be seen, of intense discussion in eighteenth-century Europe. I will be concerned, in this thought experiment, with a GNP-like concept of production.

respectively.” The model itself was much older, even when Crafts’ own early research was published in the 1970s. See Solow, “A Contribution to the Theory of Economic Growth”; Crafts, “Exogenous or Endogenous Growth”; “Robert M. Solow,” <https://www.nobelprize.org/prizes/economic-sciences/1987/press-release/>. The aggregate production function, in other recent research, relates Y to H , or “human capability,” defined as “the level of skill of ordinary workers.” Kelly, Mokyr, and Ó Gráda, “Precocious Albion,” Appendix, 2.

¹² “ $x_{i,t}$, $k_{i,t}$, $l_{i,t}$, $e_{i,t}$, $m_{i,t}$, $s_{i,t}$ are price vectors, and $X_{i,t}$, $K_{i,t}$, $L_{i,t}$, $E_{i,t}$, $M_{i,t}$, $S_{i,t}$ are quantity vectors of output, capital, labor, energy, materials, and purchased services, respectively, for industry i at time t .” Strassner and Moyer, “An Analysis of the Composition of Intermediate Inputs by Industry,” 5. The KLEMS system of multifactor productivity measures has been established in US national accounts since the 1980s and in European Union accounts since the 2000s; see Gullickson and Harper, “Multifactor Productivity”; Timmer, O’Mahony, and van Ark, “EU KLEMS,” <http://www.worldklems.net/data.htm>.

¹³ The accounting identity is that “GNP is equal to GDP plus income receipts from the rest of the world less income payments to the rest of the world.” “Domestic measures cover activities that take place within the geographic borders of the United States, while national measures cover activities that are attributable to US residents.” Bureau of Economic Analysis (BEA), *Concepts and Methods of the U.S. National Income and Product Accounts*, chap. 2, p. 6 (hereafter 2.6).

The other definition is of the “gross.” GNP (and GDP) are identified as gross because they do not make allowance for the depreciation of assets like machinery over the course of a particular period.¹⁴ The output X in equation 2 above is different. It is “gross output” in a distinct—and in many ways more intuitive—sense.¹⁵ It is the value of everything that is produced in the nation over the course of the year, and it is equal to the sum of everything that is spent in the course of production on capital, labor, energy, materials, and purchased services. It is much larger than GDP—about 1.75 times as large, in the US in 2020—because it includes flows of goods and services that do not count in national accounts.¹⁶ These are the things that are defined as having been used up in the process of production: “intermediate” inputs. They vanish, in a material or an economic sense.

Intermediate goods were the subject of intense interest in nineteenth-century economic thought, from Böhm-Bawerk’s discussion of property rights in “representative” or *vertretbar* things to Marx’s view that “the coal burnt under the boiler vanishes without leaving a trace; so, too, the tallow with which the axles of wheels are greased.”¹⁷ The economic conception of non-existence is less romantic. Aggregate value added, which is equal to GDP, is a “nonduplicative measure of production,” in which intermediate inputs are subtracted from gross output to avoid double- or triple-counting. Inputs of capital and labor, which are “primary” or “value-added inputs,” count; inputs of energy, materials, and services, which are “secondary,” do not.¹⁸

It is these obscure flows, these intermediate goods and services, that will be at the center of the thought experiment that follows. Intermediate goods do not count in an evaluation of the market value of production for final sale; they must count—or be of interest—in an evaluation of production that takes technical change or nature or business seriously. It is within the “mechanism

¹⁴ BEA, *Concepts and Methods*, 2.12.

¹⁵ “It is conceptually easier to think about productivity in the gross-output function.” Carvalho and Gabaix, “The Great Diversification and its Undoing,” 1720 and n34. As one recent Bureau of Labor Statistics (BLS) study of the dispersion of productivity—an important subject for economic history—observed, the measure adopted “does not include value-added-based productivity dispersion for conceptual reasons. While there is a market for final demand, a market for value-added does not exist.” Cunningham et al., “Dispersion in Dispersion,” 10.

¹⁶ BEA, “Gross Output by Industry,” “Value Added by Industry,” 2020, available at www.bea.gov; Strassner and Moyer, “An Analysis,” 5.

¹⁷ Intermediate goods were *vertretbar* or fungible—that is, replaceable by other similar but not identical goods. Böhm-Bawerk, *Capital and Interest*, 253–54; Marx, *Capital*, vol. 1: 203.

¹⁸ Horowitz and Planting, *Concepts and Methods of the Input-Output Accounts*, chap. 5, p. 1; Strassner and Moyer, “An Analysis,” 2.

of interindustrial relations,” as Wassily Leontief wrote in 1951, that economic change takes place.¹⁹ The US national accounts give the (unhappy) illustration of tires, or the “rubber and metal” used to produce them, which should not, without multiple counting, be included in the value added of the automobile industry.²⁰ Things are not as straightforward in an economic history that can have space, eventually, for alum or potash in the eighteenth-century textile industry; or for the vectors of production in which “wind-borne microplastics” from tires and brake pads deposit “550,000 tons of particles smaller than 0.01mm . . . each year, with almost half ending up in the ocean.”²¹

The inquiry into K, L, E, M, and S—or capital, labor, energy, materials, and purchased services—will stay fairly close, at first, to the conventions of contemporary accounting, and to the “market place” of the “economy.”²² It will return, at the end, to a more extensive view of economic life and of outputs—like microplastics or like urban life—that are not (yet) reflected in economic accounts. Gross output or “gross market activity,” with its double or multiple counting, is a measure of what enterprises and individuals are doing, not of welfare or wellbeing.²³ But it was within enterprises or industries that the industrial revolution unfolded. “It is the composition of interindustry sales that mirrors most directly the effects of changing technology and the organization of production,” Anne Carter wrote in 1970.²⁴ There were uses of resources over very long distances in the world of eighteenth-century commerce, as will be seen, and materials in which new techniques were embodied. For Jean-Baptiste Say, in 1814, it was the “lowliest and most fugitive” of commodities, like bright red dyes, that were often the “indispensable” component of early nineteenth-century capital.²⁵

The industrial revolution is not exactly a thing, in the modern consensus of economic historians, or at least not a revolution. It was “a cluster of technical, organizational, and social changes.”²⁶ It took place over a long period and in a large number of locations; its consequences were diffuse, dispersed, and unequal. Industrialization was “geographically highly dispersed but economically integrated, and temporally long.”²⁷ Even in the *Heimat* of the story, there

¹⁹ Leontief, *The Structure of American Economy*, 20.

²⁰ Horowitz and Planting, *Concepts and Methods*, chap. 5, p. 1.

²¹ Evangeliou et al., “Atmospheric Transport,” cited in Carrington, “Car Tyres.”

²² *National Income, 1929–1932*, 6.

²³ Colander, “Gross Output,” 453.

²⁴ Carter, *Structural Change in the American Economy*, 33.

²⁵ Say, *Traité d'économie politique*, vol. 1: 92–93.

²⁶ Mokyr, “That Which We Call an Industrial Revolution,” 197.

²⁷ Bruland and Smith, “The Global Context of the Scandinavian Copper Industry,” 212.

was an industrial “north” and a depressed “south,” a “stagnant” Wales and a “commercialized” England.²⁸

There has been an imposing sequence of macro-explanations for these changes since the new economic history of the 1970s, with its enduring interest in the “progression of countries from underdevelopment to development,” as measured in the “widely understood and respected” indicators of economic growth.²⁹ The preoccupation with industrial and commercial capital was succeeded by investigations of labor inputs, exemplary technologies, coal deposits, relative prices, the culture of the enlightenment, and English legal institutions.³⁰ Half a century later, capital—now in the form of “human capital” or capacity—is again the elixir of growth.³¹ There is a return, of sorts, to the received wisdom of 1769, as summarised by J. G. Herder: to the “spirit of manufacturing, craftsmen, knowledge,” and to England’s “maritime position, her institutions, her freedom, her mind [*Kopf*].”³²

The point of this inquiry is not to contribute to the sequence of explanations. Nor is it to add a new macro-story, consonant with the concerns of our own times, to do with the economic importance of slavery or with the enduring consequences of the use of natural resources. The point is rather to suggest a framework for putting the different kinds of investigations together. The KLEMS-inspired identity with which this inquiry begins is not itself at all unconventional. It is a way of using national income accounts and input-output data. It was developed in the 1980s out of a concern, in part, with the measurement of capital inputs.³³ The interest in gross output or intermediate exchanges is associated, if anything, with Austrian economic thought.³⁴ But the gross output framework is also, I will suggest, a way of

²⁸ Kelly, Mokyr, and Ó Gráda, “The Mechanics of the Industrial Revolution,” 4, 26; Wallis, Colson, and Chilosi, “Structural Change and Economic Growth,” 895.

²⁹ Broadberry et al., *British Economic Growth, 1270–1870*, xxxi. On the role of economic history as “the queen of the social sciences,” and “why economic growth took off,” see Allen, *Global Economic History*, 1.

³⁰ For a comprehensive recent overview, including of the “explanations that fail,” see Hoffman, “The Great Divergence,” 134. On the rise in the importance of industrial and commercial capital after 1760, see Feinstein, “Capital Formation,” 89.

³¹ Kelly, Mokyr, and Ó Gráda, “The Mechanics of the Industrial Revolution.”

³² “Aber sein Geist der Manufacturen, der Künste, der Wissenschaften wird der sich nicht noch lange erhalten? Schützt es da nicht seine Meerlage, seine Einrichtung, seine Freiheit, sein Kopf?” Herder, *Journal meiner Reise im Jahr 1769*, 92, and see Rothschild, “The English *Kopf*.”

³³ On capital inputs, see Jorgenson, Gollop, and Fraumeni, *Productivity and U.S. Economic Growth*.

³⁴ On Austrian economists, inventories of intermediate goods, and the price of capital inputs in the industrial revolution, see Solow and Temin, “Introduction: The Inputs for Growth,” 18–19.

thinking with economics about historical evidence. It is even a way of thinking with history about economics, and eventually about capital in our own times.

Episode 1: Capital

The first depiction, in this economic history of eighteenth- and early nineteenth-century Europe, is of capital. The distinctive condition of capital is that it is owned.³⁵ It is identified as a primary input into production (or its services are primary inputs) because it represents owners, in the enduring dichotomy of economic accounts. Labor is a primary input because it represents the employed, of whom compensation is the indicator in GDP/GNP (or national income); capital is a primary input of which the indicator is profit, proprietors' income, and rental income.³⁶ "Stock cultivates land; stock employs labour," as Adam Smith wrote of proprietors in the *Wealth of Nations*.³⁷ But the things that individuals own are extraordinarily heterogeneous—even those of the things that are used "repeatedly, or continuously" in production—and they were at least as heterogeneous in the eighteenth century.³⁸

Needles and flocks of sheep, workhouses and "masquerade dresses," forges and engines: Smith had a capacious vista of the varieties of capital. He also included within "fixed capital" (as in the US national accounts, in a tentative way, since 2013) "the acquired and useful abilities" of individuals.³⁹ These are familiar things, with the possible exception of the sheep: the sorts

³⁵ Capital consists of things in respect of which an individual possesses rights in the present, in relation to (certain kinds of) uses in the future; they are at the disposal of an individual in respect of use in the future. In national accounting systems, assets, including capital assets, "are entities that must be owned by some unit, or units, and from which economic benefits are derived by their owner(s) by holding or using them over a period of time." BEA, *Concepts and Methods*, 2.2. On things which are at an individual's disposal, or *verfügbar*, see Menger, *Grundsätze*, 129–135; Menger, *Principles*, 155, 159, 303–4; Coase, "The Problem of Social Cost," 43–44.

³⁶ NIPA Table 1.12, National Income by Type of Income, available at <https://apps.bea.gov>.

³⁷ Smith, *Wealth of Nations*, 849. "Stock," in Smith's account, consists of all the things that individuals have acquired and stored up; he uses the example of the goods that a weaver has accumulated over time (276–77). "Capital" is the part of stock that an individual expects to provide future revenue. It is divided into "fixed capital," which provides revenue or profit without being sold, and "circulating capital," including money and materials, which is transient or on the way to "changing masters" (279, 282).

³⁸ "Fixed assets are produced assets that are used repeatedly, or continuously, in the processes of production for more than 1 year." BEA, *Concepts and Methods*, 2.3.

³⁹ Smith, *Wealth of Nations*, 280–83, 307. On "intellectual property products" as nonresidential fixed investment, see BEA, *Concepts and Methods*, 2.4.

of assets that could be included in the aggregate stock of a contemporary society, or in an “instantaneous photograph of wealth.”⁴⁰ To estimate the flows of capital services associated with the assets, as in modern economic accounts, is not entirely straightforward, but it is easy to imagine, in our thought experiment, what the vectors of (imputed) k_i prices and (inferred) K_i inputs would be like.⁴¹

Eighteenth- and early nineteenth-century capital is in other respects less familiar. The point of this experiment in thinking with data (or with the possibility of data) is not to lament the fragility of evidence or the impossibility of asking aggregate or at least important questions.⁴² It is rather to arrive at the aggregated quantities in a different way: “to understand the behavior of economic aggregates from the ground up,” in Farhi’s account, which was also, in a different setting, the perspective of one of the great pioneers of capital accounts in economic history, Sidney Pollard, in his observation that “instead of being derived, as it were, from above, the series has to be built up from below.”⁴³

The “line of demarcation” between fixed capital (such as machines) and circulating capital (such as oats or wood) was itself elusive, in David Ricardo’s description; it was “a division not essential.”⁴⁴ Fixed capital (such as wooden machines) was made out of circulating capital (such as wood).⁴⁵ Machines were on occasion made, used, paid for, repaired, and worn out within a single “unit” or estate.⁴⁶ (See Capital 1.1.) In the “ocean of unconscious cooperation”

⁴⁰ The photograph would reveal, in addition to durable wealth, “trainloads of meat, eggs and milk in transit . . . Even the supplies on the table of a man bolting his dinner would find a place.” Fisher, “Senses of ‘Capital,’” 199. Animals or “cultivated assets” are not considered to be capital assets in US national accounts. See Soloveichik, “Plants and Animals as Economic Assets.”

⁴¹ Antràs and Voth, “Factor Prices and Productivity Growth during the British Industrial Revolution.”

⁴² Berg and Hudson, “Rehabilitating the Industrial Revolution”; Hoppit, “Counting the Industrial Revolution”; Hoppit, “The Nation, the State, and the First Industrial Revolution.”

⁴³ Farhi, “Interview,” 23; Pollard, “Introduction,” 2; Baqaee and Farhi, “Productivity and Misallocation.” The effort to see aggregates from below in contemporary economics is not the same as the effort to see history from below. But the former is also an attempt to find disparate and unfamiliar sorts of evidence. To derive “structural relationships ‘from below,’” for Leontief in 1953, was to reconstruct “technical coefficients from engineering data.” Leontief, *Studies in the Structure of the American Economy*, 13. On new uses of data, see Baqaee and Farhi, “The Microeconomic Foundations,” and Jaravel, “Unequal Gains.”

⁴⁴ Ricardo, *Principles*, 26.

⁴⁵ Smith, *Wealth of Nations*, 283.

⁴⁶ The contemporary demarcation of transactions in capital goods and in intermediate goods is based on the conventions of business accounting; capital goods are goods of “types normally depreciated over more than one year.” Coughlin et al., “New Structures and Equipment,” 45. But all intermediate goods are capital goods (of a distinctive, relatively ephemeral sort), and all capital

Capital 1.1

The “estate” or “master and steward system” was of enduring popularity in eighteenth- and early nineteenth-century Britain, as Sidney Pollard showed in his remarkable work on the genesis of modern management. The system was in effect an “elaborate cash account,” in which capital expenditure was recorded as part of current outlay. It extended even into the enterprises that have loomed so large in subsequent evocations of the industrial-technological-cultural revolution: the mine in which the costs of building the counting house, carpenters’ shop, and storehouse were included in the accounts for “this quarter;” the South Yorkshire ironworks in which the re-lining of the forges was accounted for as running costs; the expenses “of erecting a large cotton mill” that appeared in the weekly wage bill; the “equipment of the Duke of Norfolk’s collieries [that] was valued according to the weight of iron and timber in the various engines and machines.”

Source: Pollard, *Genesis*, 209–12, 239.

of market relationships, to use Dennis Robertson’s expression, in his 1923 “survey of capitalism,” made famous by Coase, the manufacture and use of capital unfolded within “islands of conscious power”—and in particular, even, within the distinctively unmodern islands of landed estates.⁴⁷

The romance of the industrial revolution was already familiar, in more or less its twentieth-century form, by the 1810s. The extension of “civilization” was itself to be measured in the proportion of fixed to circulating capital.⁴⁸ The “accumulation of property [was] extensive beyond all credibility,” according to a 1814 account of the “aggregate property of the British Empire.”⁴⁹ But in our naturalist perspective, or the view from outside, fixed

goods, or all flows of capital inputs, are intermediate goods. As Stone and Stone wrote in 1977, “Even if we start from an empirical point of view we shall find ourselves listening to the suggestions of theory at every turn: it is not the facts themselves that lead us to distinguish between current and capital expenditure, we do so at the suggestion of theory despite the difficulties involved in carrying out the distinction.” Stone and Stone, *National Income*, 163.

⁴⁷ Robertson, “A Survey of Capitalism,” in *The Control of Industry*, 84. See also Coase, “The Nature of the Firm,” 388.

⁴⁸ John Barton, quoted in Ricardo, *Principles*, 479: as “civilization is extended, fixed capital bears a larger and larger proportion to circulating capital.”

⁴⁹ Colquhoun, *Treatise on Wealth*, 49, 54.

capital was distributed sparsely (and unevenly) across the territory of the British and French empires. The “steam engines, and other expensive machinery,” in this aggregate, or the property that corresponded most closely to “special goods” or “capital goods,” were estimated to account for about 3.4 percent of the “productive private property” of England, Scotland, and Wales. They were listed in the category of “dwelling houses . . . including warehouses and manufacturies;” “animals” were valued at more than twice as much, or 7.5 percent of the total.⁵⁰

Individuals were surrounded by capital in Britain and France. But it was circulating capital, rather than fixed capital, that was so widely distributed in every parish. It was circulating capital that was used “in the support of labour” (in Ricardo’s expression), and that was so proximate in the agricultural and commercial activities where a large majority of the population was employed.⁵¹ At least part of this capital consisted of what would be considered, in contemporary accounting convention, to be intermediate-type goods: goods that had been bought with cash or credit in intermediate transactions.⁵² Many of the transactions, too, took the form of investment in what Amartya Sen described as “landesque” rather than “laboresque” capital, or in goods—“fertilizers, pest control, irrigation”—that replace land rather than labor.⁵³

The differences in accounting conventions point to another awkwardness in thinking about eighteenth-century economic growth with the models of the 1950s or the 2020s. This anomaly has to do with land as a factor of production (or with the services of land as a primary input into output or value added). The dualism of modern national accounts, with the hypostasis of K and L as primary factors, fits only approximately into eighteenth-century classifications of the three estates or orders of people: the proprietors of land who live by rent, the laborers who live by wages, and the owners of stock or capital who live by profit.⁵⁴ The difficulty is not so much that Britain and France were in fact substantially agricultural societies in the period of “take-off” to

⁵⁰ Colquhoun, *Treatise on Wealth*, 55–57; Solow and Temin, “Inputs,” 19.

⁵¹ Ricardo, *Principles*, 27. For a vivid account of the varieties of capital—including fodder, fertilizer, and manure—and growth in total factor productivity in eighteenth-century France, see Hoffman, *Growth in a Traditional Society*, esp. 134–50, 202–4.

⁵² Circulating capital, for Smith, consisted of money, provisions, materials, and “finished work” (or inventories). Smith, *Wealth of Nations*, 282–83. It is “provisions” and “materials” that correspond to intermediate-type goods in contemporary accounts.

⁵³ Sen, “The Choice of Agricultural Techniques,” 280, 282.

⁵⁴ For a recent discussion of growth accounting with N, or land, as well as K and L as factor inputs, see Crafts, “Understanding Productivity Growth.”

sustained economic growth, and to rapid expansion in overseas and colonial power. It is that land and capital were extremely difficult to disentangle.

The “undertakers” or entrepreneurs who loom so large in the economic history of the industrial revolution were also, often, the proprietors of land. It was the landlords who had the capital with which to buy machines; or rather, to pay the laborers living on their estates to cut down their trees and build their (wooden) machines. It was landlords, too, who had the incorporeal or “political economy” assets that were so complementary, in the eighteenth century as now, to the flow of capital services from produced assets: positions, in Britain, in the House of Lords and the House of Commons, and also in the magistrates’ courts and parish councils that regulated the mobility of labor, the police of “nuisances” or torts, and the property rights that have been at the center of the institutional theories of long-term economic development. Pollard, in his view from below of early industrial capital, suggested that “repair and maintenance” were the dominant form of capital expenditure, and also that the “parliamentary and legal costs” of private acts of parliament in connection with changes in land use—“surveyors, lawyers, witnesses before Committees, etc.”—were “logically not very different” from the management costs included in twentieth-century capital formation.⁵⁵

Land was the denominator in contemporary calculations of the equivalent of productivity—“oh prodigy of industry! A space of earth equal to that enclosed in the park at Versailles, produces more riches than half the Russian empire!” as a French official wrote (very approximately) in 1776 of the part-island of Saint-Domingue, the modern Haiti. It was even the denominator of political representation: blades of grass or parcels of land were the entities to be represented (and taxed), in the summary of the most eminent British jurist of the time.⁵⁶ But land was also a resource that could be depleted and depreciated. It was finite; its value appreciated over time—with the anticipation of discoveries of coal, the establishment of Turnpike Trusts, or the development of new seaside towns—and its characteristics could be lost, irreversibly. The “ground taken up by highways” could eventually be plowed up, in Adam Smith’s expression; the soil of Saint-Domingue was depleted over generations of intensive

⁵⁵ Pollard, “Introduction,” 7–8.

⁵⁶ Malouet, “Les quatre parties du jour à la mer,” in *Mélanges de littérature*, vol. 2: 370. “There is not a blade of grass growing in the most obscure corner of this kingdom, which is not, which was not ever, represented since the constitution began.” Speech of Lord Camden of February 10, 1766, *Parliamentary History*, vol. 16: 179.

cultivation.⁵⁷ “Real estate” accounts for 70 percent of the non-financial assets of contemporary American business, compared to 15.1 percent for “equipment” and 7.8 percent for “intellectual property.”⁵⁸ It was important, too, in the (implicit) balance sheets of eighteenth-century capital.

The calculation of capital inputs is even more disconcerting as one moves to a GNP-like measure of production. The half-century with which this essay is concerned was a time of intense controversy over more or less territorial conceptions of national capital and national income. In one popular view of economic measurement, the appropriate entity of evaluation was the capital owned by British subjects as well as residents, wherever it might be found. In another view, the frontiers of the British nations were not maritime, but along the littorals of the nations with whom the British traded. In a third, the British economy was thought of as equivalent to a nation with a vast “exterior population” of overseas consumers and of the labor employed by British (private and public) capital. (See Capital 1.2.)

The territory of the British and French colonies—on a less fanciful accounting—was considered in the established (and sometimes questioned) jurisprudence of the time to be part of the sovereign dominion of the state. The overseas departments of France are a component of the “economic territory” of the state in contemporary national accounts, just as French Guyana, in eighteenth-century descriptions, was “la France équinoxiale.”⁵⁹ The eventual defeat of free-market reforms in France, in 1776, turned on the inalienability of the territory of Saint-Domingue. (See Capital 1.3.) The reform of mortgage lending in the West Indies turned, as will be seen, on the rights of alien creditors and the inalienability of land in the British colonies. But even in our own unfanciful conception of GNP versus GDP, and of the French hexagon and the island of Britain—rather than their discontinuous territory—as objects

⁵⁷ Smith, *Lectures on Jurisprudence*, 378, 503. Moreau de Saint-Méry, in 1797, introduced his description of the French part of the island of Hispaniola with a dire warning: it is “hotter and more exposed to the droughts that are becoming more frequent and longer lasting, ever since—out of an avidity that counts the future as nothing, and is often deluded as to the value of the present—the trees that covered the mountainous regions have been cut down.” *Description topographique*, vol. 1: 4–5. On the enduring consequences, see Bargout and Raizada, “Soil Nutrient Management in Haiti,” and Lindskog, “From Saint-Domingue to Haiti.”

⁵⁸ Federal Reserve, Z1, Flow of Funds, tables B102 (Balance Sheet of Nonfinancial Corporate Business) and B103 (Balance Sheet of Nonfinancial Noncorporate Business). Figures for 2020, available at <https://www.federalreserve.gov/apps/fof/>; March 11, 2021.

⁵⁹ Barrère, *Nouvelle relation de la France équinoxiale*; on contemporary definitions, see INSEE, “Territoire économique,” <https://www.insee.fr/fr/metadonnees/definition/c1686>.

Capital 1.2

Statistics of English exports and imports and shipping reflected only a portion of the progress of English commerce, according to the account of the publicist Friedrich Gentz in 1800. English funds were employed around the world, and “from the mines of Carinthia to the looms of Bengal there are few places inhabited by industrious men where foreign labours are not brought to life by British capital.” Even war was a source of prosperity, and the English government “brings to life all operations from Lisbon to the Gulf of Finland, and from the North Sea into the deserts of Syria.” England was an unnational city-like state, for the economist Adam Müller in 1809, and its frontiers were the coastal cities of Europe: “Petersburg, Danzig, Gothenburg, Copenhagen, Hamburg, Amsterdam, Bordeaux, Oporto, etc.” English commerce, for Alexandre d’Hauterive in 1800, could be thought of as a country with a vast “exterior population,” constituted by all the individuals around the world who consume English goods, for “consumers belong less to the nation in which they live, than to the one whose productions they consume.” English national wealth could be considered to include the subsistence of the “Chinese, Indians and Russians whom her yearly consumption keeps alive, and the wages and expenses of the German, Italian and Ottoman soldiers whom her subsidies support.”

Sources: Gentz, *Essai*, 65, 203; Müller, *Die Elemente der Staatskunst*, vol. 3: 20–21; Hauterive, *État*, 207, 210, 271–72.

of inquiry, the measurement of capital inputs into overseas production poses troublesome questions.

A substantial part of the “riches” produced by or in Saint-Domingue would thus be counted as part of the GNP, and not the GDP, of France in 1776—“the portion of the value that reflects [French] residents’ labor or property,” as in the treatment of farflung auto assembly plants in contemporary accounts.⁶⁰ Much of the value produced in the British colonies would be part of British GNP. The concept of residence was as elusive—and

⁶⁰ For a Japanese-owned assembly plant in the US, “all of its output is included in GDP, but only the portion of the value that reflects US residents’ labor and property is included in GNP.” For a US-owned assembly plant in Britain, “none of its output is included in GDP, but the portion of the value that reflects US residents’ labor or property is included in GNP.” BEA, *Concepts and Methods*, 2.6.

Capital 1.3

The ministry of the French economist and statesman A. R. J. Turgot ended in May 1776, with the reversal of his free market reforms. He was reported, in the last hours of his ministry, and at his last council of ministers, to have made a dramatic proposal, in which the glittering jewel of the French overseas colonies—the part-island of Saint-Domingue—was no more than a piece of property, or an asset to be sold in the ongoing enterprise of improving public finances. As the British ambassador reported in May 1776, “M. Turgot had formed the project of selling to Spain for a sum of money, that part of the Island of S. Domingo which belongs to France. He gave his opinion upon it in the Council with uncommon warmth, but [other ministers] opposed him with equal firmness . . . I am told the project was totally rejected.” The Venetian ambassador recounted the same story, with further details: Turgot’s argument had been that “this Island, unified in a single sovereign, could be of great use to the Spaniards,” and that the proposal “could bring in considerable sums to the royal Treasury.” The dominions of the crown were “inalienable,” his opponents retorted; they proposed, “as a substitute,” that the French should acquire the Spanish portion of the island, “giving Corsica in exchange.”

Sources: Letter of May 15, 1776, from Mr St. Paul to Lord Weymouth, in TNA, SP78/299/126v-127r; Dispatch no. 191 of May 13, 1776, ASV, Senato Dispacci, Francia, filza 255, 517v.

as elastic with respect to changing tax regimes—among eighteenth-century owners of capital as it is today. In Adam Smith’s description, “the proprietor of stock is properly a citizen of the world, and is not necessarily attached to any particular country.”⁶¹ So too are the concepts of the “reflection” of property in value and of the “attribution” of activities to residents. But it is still the case, in a fairly straightforward sense, that much of the value that was produced in both the French and the British eighteenth-century colonies can be attributed to property owned by residents of France or Britain.

The inventory of capital or property and of capital services is even more unfamiliar. The author of the 1814 estimate of aggregate capital, Patrick Colquhoun, attributed the increase in national property in substantial part to the “impetus from the capitals of individuals,” “returning” from overseas

⁶¹ Smith, *Wealth of Nations*, 848–49.

and “invested in landed and other property”—“in fact, nearly the whole produce of the Colonies . . . may be said to center in the parent State.”⁶² This is an observation about “income receipts from the rest of the world,” in the conventions of contemporary national accounts, and about the sources of capital flows or new investment: the question of the role of overseas and colonial capital in the British industrial revolution, so much discussed since the work of Eric Williams by economic historians, especially Barbara Solow.⁶³ But the 1814 estimates also suggest a very different view of the composition of the aggregate capital “stock.”

The “general view” of the property of the British empire was panoramic, in Colquhoun’s account.⁶⁴ Of the “productive private property” of the empire, excluding India, the West Indies accounted for 4.0 percent or around £96 million.⁶⁵ Of this, £34.8 million, in Colquhoun’s summary, took the form of the “Estimated Value of Negro Labourers.”⁶⁶ So property in the enslaved, in this early capital account, was valued at a little over half of the £60 million that was estimated to be the value of “steam engines, and other expensive machinery.” This was property, on our GNP-like conception, that was supplied, for the most part, by British residents. The flow of capital services was also a flow of the services of the enslaved.

The valuation of an estate on the island of Grenada in 1770—which was eventually the occasion, as it happened, for a change in financial regulation that led to much of the “financial innovation” of the times—can provide an illustration of the calculation of capital services. The estate, called “Bacaye,” was owned by a British army officer who was a resident of Middlesex in England. The inventory was carried out by five neighboring proprietors and the estate was valued at a total of £59,385. Of this, the land was valued at £33,675. The balance of the estate included “improvements,” buildings, “implements,” and “utensils.” There was a “canal” valued at £320, a “hospital,” a “boiling house” with a “copper hole shade,” a “water mill,” and an “iron pulley.” Forty-five

⁶² Colquhoun, *Treatise*, 53.

⁶³ BEA, *Concepts and Methods*, 2.6. Williams, *Capitalism and Slavery*; Solow and Engerman, *British Capitalism and Caribbean Slavery*; Solow, *Slavery and the Rise of the Atlantic System*.

⁶⁴ It included the sum of £1,072,427,751 for the “Territorial Possessions under the Management of the East India Company.” Colquhoun, *Treatise*, 59–60.

⁶⁵ Colquhoun, *Treatise*, 55, 60, 313, 379. “Gold and silver coin in circulation” was considered to be “unproductive” private property.

⁶⁶ Colquhoun, *Treatise*, 379, 381; “Mr Bryan Edwards and Sir William Young estimated negroes at £50 each; their value has however since greatly increased, particularly since the abolition of the Slave Trade. Averaged, they cannot now be worth less than £55” (381).

percent of the value of the estate, excluding the land, or £11,482, was listed in a “particular inventory,” and took the form of 266 slaves.⁶⁷

There were 82 “field men” valued at £53 each, 62 “ditto women” at £47, and 16 “infirm & superanuate” at £6 each; three carpenters “@ £94,” and three coopers, of whom two were valued at £94 and one at £63; “31 children @ £19.”⁶⁸ These men, women, and children were part of the capital “supplied” (as in the definition of national product) by residents of Britain. They were listed as capital even into posterity: the initial mortgage, when the Bacaye plantation was purchased in 1766, listed the enslaved by name—“Molly-Rose,” “Princess,” “Queen”—together with “the issue and increase of the said female slaves hereafter to be born.”⁶⁹

In 1763, when the island of Grenada was acquired by the British from the French, there were 81 estates whose proprietors owned at least 50 slaves, and 13,055 enslaved individuals.⁷⁰ Most of the estates were then sold to British subjects, of whom many were residents of England or Scotland. When the French reconquered the island in 1779, they estimated that the number of slaves had increased to 36,000.⁷¹ This, too, was an addition to the capital or stock of the British nation. The proprietor of the Bacaye estate was the brother of one of Adam Smith’s students and closest friends; the neighbor who carried out the valuation—who considered himself to be a resident of France, Grenada, and England, successively and simultaneously—was later elected a fellow of the Royal Society of London on the basis of his research on sugar cane. (See Capital 1.4.)

Capital 1.4

Jean-Alexandre Cazaud, the neighbor, was born in Guadeloupe in 1727. He served briefly in the French army and settled in Angoulême, in southwest

(continued)

⁶⁷ “Inventory & Valuation of Bacaye Estate,” December 1, 1770, UB/WIP, Westerhall Estate, DM41/32/1. There was also a “marking iron” and a “Pair of Stocks for Runaways with Chains,” valued at £13. On the enslaved as capital, see Wright, “Capitalism and Slavery,” and Price, “Credit in the Slave Trade.” On nineteenth-century accounting for slavery in the United States, see Rosenthal, *Accounting for Slavery*, and on property rights in the enslaved as a source of credit, see González et al., “Start-up Nation?”

⁶⁸ “Inventory & Valuation,” December 1, 1770, DM41/32/1. These are the values in pounds sterling; there were rounder numbers in the local pound currency, as in “31 children @ £30.”

⁶⁹ “Mortgage,” December 26, 1766, DM41/30.

⁷⁰ Census of Grenada, 1763, in TNA, CO 101/1/part 1.

⁷¹ “Réflexions sommaires” (1779), in ANOM, C10a/3/1.

France. He acquired a plantation in Grenada, and traveled back and forth to the island over the course of the 1750s. In the wartime year of 1759, he moved definitively to Grenada, where he “made some considerable acquisitions.” In 1763, he was listed as the owner of 50 slaves. He was naturalized as a British subject. Cazaud was over the ensuing decades either British or French, or both at the same time. He took the Oaths of Allegiance and Supremacy to the British crown in 1767 (according to a petition by his son about his own naturalization.) Cazaud also subscribed to the Test Act, affirming his allegiance to the Church of England and the repudiation of his Catholic faith, although this was a matter of some dispute. It had been inadvertent, he declared when the French reconquered Grenada in 1780. “I was by inattention given one piece of paper instead of another, and I signed it without paying any more attention than the person who presented it to me,” he wrote to the new French governor of the island. The conclusion of the official investigation by the new French administration was cool: “if this inscription is no more than the outcome of a lack of attention, it is an error even more unfortunate than it is implausible.” Over the entire period—according to a later lawsuit over his wife’s will—Cazaud “came and went, sometimes in France, sometimes in Grenada, and sometimes in Italy, or elsewhere, according to the affairs of his business.” He maintained a continuing domicile in Grenada, the “seat of his fortune”—or in his lawyers’ description, of the “immense fortune that he was acquiring every day.” In 1779, he was in Paris, where one of his slaves, Jean-Alexandre James, sued for freedom in the Admiralty Court, having escaped from imprisonment (and starvation) with the help of a neighbor. In April 1780, Cazaud was elected a fellow of the Royal Society of London. He returned to France soon after, and died in England in 1796.

Sources: Baptism of Jean Alexandre Cazeau, Sept. 19, 1727, ANOM, Basse-Terre, Guadeloupe, 1727, 4/15. Census of Grenada, 1763, TNA, CO 101/1/part 1/22v,25r. Undated letter from Dugout de Casaude, enclosed in a letter of July 9, 1811, TNA, HO/1/6/6. Letter from Cazaud to the Comte de Durat, Nov. 12, 1781, “Le Sieur de Cazaud, François, habitant de la Grenade,” undated, in “Cazaud de Roumillac habitant de la Grenade 1780–1782,” ANOM, COL E 66. “Cause entre le sieur de Cazeaux et la Dlle. Lucie,” 370. Petition of Jean-Alexandre Gintz, June 9, 1779, in AN, Amiraute, Minutes, 1779, Z/1d/135. Election of Mr Cazaud, <https://royalsociety.org/about-us/fellowship/fellows/>. Burial record for Jan. 20, 1796, St Mary the Virgin, Woodford, www.seax.essexcc.gov.uk.

Episode 2: Labor

The thought experiment that is at the center of this essay—the possibility of limitless information about the economic lives of individuals in the past—is even more counterintuitive in relation to labor than to capital. A needle is a needle. It is possible, *à la limite*, to imagine oneself calculating the value of the services of the needle or the value of the services of the iron pulley. It is more difficult to imagine an omniscient observer who can see and count the services of the seamstress or the “field woman.” The calculation of labor inputs and hours of work in early-industrial Britain—to return, for the moment, to the unenslaved—has been the subject of outstandingly ingenious investigation.⁷² But the composition or structure of the British economy at the time imposes the most demanding requirements on the exercise in omniscience, or the approximation to the view of the Martian observers. An “instantaneous photograph” of work—the counterpart to the capital theorists’ photograph of wealth—would be a portrait of women and men and children, frozen in motion, washing and weaving and selling, carrying and begging and breaking rocks.⁷³

The founding text of the US national accounts, published in 1934, begins with the assertion of a modern labor theory of value, or at least of a theory in which labor is the most primary of factors: “year in, year out the people of this country, assisted by the stock of goods in their possession, render a vast volume of work toward the satisfaction of their wants. Some of this work even-tuates in commodities . . . other takes the form of direct, personal services, such as are rendered by physicians, lawyers, Government officials, domestic servants, and the like.” The 1934 accounts were concerned only, like the present experiment in economic history, with “efforts whose results appear on the market place of our economy.”⁷⁴ But even these efforts, or these inputs of labor services, are awkward to observe, in the eighteenth century as today.

Part of the difficulty has to do with the multiplicity of occupations and with mobility—across occupations and across the frontiers of the marketplace—over even very short periods of time. One of the recent studies of the sources of US economic growth investigates changes over time in the inputs that flow, into 63 industries, from “100 types of capital assets” and “170 different types of workers by industry.”⁷⁵ Colquhoun, the statistician of aggregate capital

⁷² Voth, *Time and Work in England, 1750–1830*.

⁷³ These depictions of work are in Joseph Vernet’s *Les ports de France*, painted for Louis XV, and in *La construction d’un grand chemin* and *Les abords d’une foire*, his two paintings of economic development for the controller general of France, the abbé Terray.

⁷⁴ *National Income, 1929–1932*, 1, 6.

⁷⁵ Garner et al., “Integrated Industry-Level Production Account,” 1.

in 1814, and of the “value of Negro labourers,” had been concerned some years earlier with the “resources” of the nation in relation to the occupations of the “population of the country, in the inferior stations.” (See Labor 2.1.) Colquhoun identified 46 different kinds of industrial or industrious labor for women and 128 different kinds of labor for men.⁷⁶ (My own inquiry into the parish records of a single year, 1764, in one small provincial town in France revealed 144 different male occupations.⁷⁷) In our omniscient gaze, we would observe changes over time in occupations, industries, and tasks.

The inquiries of the past generation into the history of “occupational structure” have been concerned for the most part, following the contemporary sources used, with a census-like or stock-like conception of occupation.⁷⁸ One of the possibilities in our thought experiment would be to use this information in a flow-like measure of labor inputs or of the volume of work.⁷⁹ The proportion of all individuals in France employed in agriculture changed, for example, from 1740 to 1780, and so did the content of the work in which they were engaged. So too did the capital with which they worked, as estimated in measures of the increase over the period in notarial credit and thereby in the “stock” of things—immaterial or material—by which they were “assisted.”⁸⁰

The skills of “instrument makers, millwrights, ironmongers” have been identified, in recent economic histories of the industrial revolution, as a form of “human capital” or capacity. This human capital is associated, in turn, with a distinctive form of social or institutional capital: the “institution of apprenticeship” that had been the object of so much opprobrium to contemporary economists.⁸¹ (In the expression of his first editor, “Dr Smith is an enemy to apprenticeships.”⁸²) But the activities of the millwrights can be seen as flows of (“quality-adjusted”) inputs of labor services at least as plausibly as flows of services from a stock of (immaterial) capital. To do so provides some

⁷⁶ Colquhoun, *Indigence*, 167–71.

⁷⁷ Rothschild, *An Infinite History*, chap. 3. The occupations were largely self-declared, to the parish clerks.

⁷⁸ Shaw-Taylor, “The Occupational Structure of Britain.”

⁷⁹ On estimates of hours worked in a later period, see Litvine, “French Occupational Structure.” On the sorts of data available for contemporary measurements, see Donovan et al., “Labor Market Dynamics and Development,” and the American Time Use Survey, available at <https://www.bls.gov/tus/>.

⁸⁰ On the credit provided by notaries and uncounted in indicators of modern financial institutions, see Hoffman, Postel-Vinay, and Rosenthal, *Dark Matter Credit*, chap. 2.

⁸¹ Kelly, Mokyr, and Ó Gráda, “Precocious Albion,” 381: “apprenticeship was at the core of human capital formation before the Industrial Revolution everywhere.”

⁸² Playfair, “Supplementary Chapter,” 243–44. See also Rothschild, *Economic Sentiments*, chap. 4, “Apprenticeship and Insecurity.”

Labor 2.1

Patrick Colquhoun (1745–1820), the author of *A Treatise on the Wealth, Power, and Resources of the British Empire*, has had an impressive afterlife in the literature of economic history. He was described in the 1827 *Real-Encyklopädie* as “renowned for his writings on statistics” and his *Treatise* as the “most reliable work” on the subject. His estimates of capital are discussed at length in celebrated studies by Phyllis Deane and Charles Feinstein.

Colquhoun’s renown is one of the striking instances of what Stephen Thompson has described as the “remarkable reluctance” of “historical national accountants” to abandon “the guesswork of the political arithmeticians,” whose “conceptual modernity” has served to obscure their “empirical backwardness.” For the economist James McCulloch, objecting in 1841 to Colquhoun’s estimate of the number of sheep in Great Britain and Ireland (42 million), citing “that learned person” would be equivalent to quoting the “Arabian Nights.” But Colquhoun and his “valuations of capital” were still there in 1889, in Robert Giffen’s *Growth of Capital*, with Giffen’s endorsement of him as an authority who “was, I believe an officer of the Board of Trade, and who at any rate speaks of himself as an official person.”

Colquhoun was not entirely an official person. He emigrated from Dumbarton to Virginia at the age of fifteen, “for the purpose of following commercial views.” He returned to Scotland in 1766, and by 1770 he had settled in the commerce of “forwarding” all the convicts sentenced in Scotland to be transported to America. He became the owner, in the process, of the last individual deemed to be a slave by a court in Scotland: “Bell alias Belinda,” who was sentenced by the judges of the North Circuit in September 1771; “the said Lords Transfer Convey and Make over the said Bell alias Belinda to the said Patrick Colquhoun or his assigns to be sold as a Slave for Life.”

Sources: “Colquhoun,” *Real-Encyklopädie*, vol. 2: 778–79; Deane, “The Industrial Revolution and Economic Growth,” 165–69; Feinstein, “Capital Formation in Great Britain,” 6–7; Thompson, “The First Income Tax,” 892–93; McCulloch, *Dictionary*, 1539; Giffen, *The Growth of Capital*, 101. [Iatros], *Colquhoun*, 5; Rothschild, *Inner Life of Empires*, 90, 439n130.

perspective on their place in economic life. The “machines and tools” industry, even at the end of our period, accounted for no more than 1.1 percent of adult male employment in England and Wales.⁸³ The skilled dyers or *teinturiers* who played a comparable role in French industry were similarly scarce. They were also itinerant, including to England: “twenty French *teinturiers* have gone there [to Manchester],” according to a complaint of 1788.⁸⁴

The labor of the (approximately) half of the population who were female, and who were employed in agriculture, manufacturing, and services, including domestic services in private households, was mentioned only fleetingly in public records of occupations.⁸⁵ But inputs of female labor also varied over time, even if one excludes work in the household that was unpaid—the value of which “must be imposing indeed,” in the words of the 1934 report.⁸⁶ “Our spinners are poor people, women commonly, scattered about in all different parts of the country, without support or protection,” Adam Smith wrote in the *Wealth of Nations*, and they were uncounted, too, in the “public registers of which the records are sometimes published with so much parade.”⁸⁷ It is interesting that the occupation that has come to epitomise the spirit of the industrial revolution was listed, in Colquhoun’s survey, as one of the opportunities or “resources” for the employment of “female industry” in the “inferior stations”: “Pin makers, part of the division [of] labour.”⁸⁸ (See Labor 2.2.)

Then there is the substantial part of the population, mostly male, that was employed in or by the military.⁸⁹ There were close to a million men, in

⁸³ Kitson et al., “The Creation of a Census of Adult Male Employment,” 37.

⁸⁴ *Observations de la Chambre du commerce*, 93. On surveys of *teinturiers*, see Bondonio, “État de l’industrie textile en France”; Amiot, “Nouvelles techniques et transmission des savoir-faire à Rouen.”

⁸⁵ Berg and Hudson, “Rehabilitating the Industrial Revolution”; Humphries, “Lurking in the Wings”; Horrell and Humphries, “Women’s Labour Force Participation”; Terki-Mignot, “Patterns of Female Employment in the Pays de Caux and the Perche, 1792–1901.” In my own micro-historical work on France, parish records show that only 2 out of 122 women who were married in 1764 in Angoulême declared an occupation; both were domestic servants. *An Infinite History*, 63.

⁸⁶ *National Income, 1929–1932*, 4. Unpaid work in the household is excluded from contemporary national accounts, in part because to include it would reduce the “usefulness of the accounts for long-standing analytical purposes, such as business cycle analysis.” BEA, *Concepts and Methods*, 2.2; Kanal and Kornegay, “Accounting for Household Production.”

⁸⁷ Smith, *Wealth of Nations*, 103, 644. In cheap years, Smith wrote, “the women return to their parents, and commonly spin in order to make clothes for themselves and their families . . . The produce of their labour, therefore, frequently makes no figure” in the public registers (103).

⁸⁸ Colquhoun, *Indigence*, 167–8.

⁸⁹ The turbulent island of Grenada, once again, was the scene of a legal drama, in 1766, over the compensation of the wife of a sergeant who might or might not have been subject to martial law on the grounds that she had enlisted in the British army “in the quality of Leagerlady; one of

Labor 2.2

Patrick Colquhoun, as the commerce in convicts to Virginia came to an end in 1776, turned his attention to the lesser American colonies. He was deeply engaged, in 1787, in the details of an investment in the Bahamas, and outraged by the laxity of his local associate over the terms of an agreement to buy 32 slaves. He wrote to his partner that “not one penny” ought to have been paid

until you saw your bargain and had complete possession . . . in case the Slaves had met with any accident that they were reduced by deaths or under different and worse circumstances than you at present suppose . . . [you] ought to have hired the Negroes for one year and to have reserved an option to purchase at the end of the first six months if you found them in all respects what they were represented to be.

Colquhoun was already, by then, a public figure. He became the chief magistrate of Glasgow in 1782, and Lord Provost in 1783; he was a frequent visitor to Manchester; in his own self-description, “he is stated a *Public Benefactor*.” He introduced himself in 1787, a few weeks after his negotiations with his associate in the Bahamas, to William Pulteney, the brother of the Bacaye proprietor, as a writer with a shared “zeal & anxiety to do good.” Colquhoun and Pulteney were partners, five years later, in the purchase of 1.2 million acres of formerly Native American land in upstate New York—the Genesee Tract—for 23 cents an acre. “I am already deeply interested in American lands,” Colquhoun wrote to Jeremy Bentham in 1798: “I gave £63,000 for a million of acres, more or less . . . in 1791; and in 1797, the property sold and remaining was estimated at nearly a million, and producing an interest of £50,000 a-year, to those for whom I transacted the business.”

Colquhoun was an agent for the Virgin Islands, over the coming decades, for the “West India Merchants,” and for the Hanseatic towns. He became an expert on the measurement of indigence and poor relief—it was “the same connected chain of statistical labour,” he wrote—and eventually of capital. In the economic crisis of 1800, at a time when “vast multitudes of the lower orders of the people” were “under the pressure of extreme and universal distress,” he promoted the distribution of “cheap substitutes for bread.” The consequence, in the account of his biographer and son-in-law, was that the

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poor of London were “tranquilized into quietism.” As a merchant in Glasgow in the 1780s, Colquhoun had been actively engaged in the supply of food for slave plantations, and in particular of “Gottenburgh Herrings at Cork for the West India Consumption.” The outcome of his “unexampled exertions,” in 1800, was “a large supply of herrings and other cheap fish for the poor of the Metropolis.”

Sources: Letters of April 20 and April 26, 1786, from Patrick Colquhoun to George Dempster, of April 25, 1787, to James Brisbane, and of May 29, 1787, to William Pulteney, “Copy Letter Book Patrick Colquhoun,” GUL, Ms Murray 551, 79v-80r, 81v-82r, 150r-151r, 166v-168r; [Iatros], *Colquhoun*, 7–13, 35, 37; “Mr Colquhoun—Family and Public Services,” n.d., LMA, acc. 1230/7; letter of October 20, 1798, from Colquhoun to Jeremy Bentham, <https://www.e-enlightenment.com>. Colquhoun, *A Treatise on Indigence*, 178.

France, who served in the armed forces in the Seven Years War of 1756–63, out of a population of some twenty-five million.⁹⁰ Even in Britain, where the conflicts were further off shore, Adam Smith described the consequences of the demobilization of the armed forces as “so great a change in the situation of more than a hundred thousand men, all accustomed to the use of arms, and many of them to rapine and plunder.”⁹¹ The long half-century of economic revolution was a time of only occasionally interrupted war or preparations for war. The efforts of soldiers are inputs into the output of “government services” in modern national accounts; they were counted intermittently in the population surveys of the times.⁹² The inputs also changed over time, and the way of working of an individual who was recruited into the armed forces was not the same, on his return, as it had been in the world before the war.

There was the substantial population employed in construction, in turn, female as well as male, who are elusive in different ways.⁹³ Two large changes—urbanization and the construction of infrastructure, in streets, roads, canals and ports—were essential to the economic revolution of the eighteenth century,

those females who are allowed to follow the camp in order to wash the mens cloaths, cook their victuals, and minister to their other necessary occasions [and] though she had no pay, yet she was entitled to, and received the common allowance of provisions.” *Audi alteram partem*, 113.

⁹⁰ Riley, *The Seven Years War and the Old Regime in France*, 78–79.

⁹¹ Smith, *The Wealth of Nations*, 470.

⁹² Litvine, “French Occupational Structure,” 33.

⁹³ On the employment of women in construction in early modern France, see Delsalle, “Le travail des femmes.”

in England and in France. They were essential, too, to the division of labor, the use of intermediate inputs, and to technical change (in the sense, for our purposes, of change in “KLEMS multifactor productivity.”)⁹⁴ There is no point in producing the “head of a pin,” or of four thousand pins, if there is no way of transporting the head to the “wire” into which it is to be placed, or of the four thousand whitened pins to their eventual gratified users.⁹⁵ There was no expansion in the market economy without the material infrastructure of exchange.

Our inquiry into inputs has been concerned only indirectly, so far, with change over long periods of time. But the individuals who worked in producing structures were also producing the material conditions for lasting change. Construction, which is classified as a goods-producing industry, is seasonal and cyclical, with small enterprises and transient workers.⁹⁶ It was “one of the most dynamic and innovative economic domains” in eighteenth-century France, as in England, with an increasing labor force.⁹⁷ In our thought experiment, we would observe individuals at work building warehouses and new streets; itinerant workers far from home; peasants fulfilling their obligations for the *corvée* of uncompensated labor in the construction of new roads; workers who were building things in whatever industry they were employed, and workers employed in the building industry, whatever they were doing; the servants of the Duke of Norfolk’s estate who built his “engines” and the structures in which the engines were stored. These were inputs into economic growth and into the transformation of nature.

The industries clustered together as retail and wholesale trade, and as services—which account for more employment in the contemporary United States than manufacturing and construction combined—can be seen as playing a role similar to that of construction in the economic revolution of the eighteenth century.⁹⁸ If there were indeed an “industrious revolution” in early modern Europe—or at least a newly “industrious disposition,” as Jan de Vries has argued, and as Adam Smith surmised (“we are more industrious than our forefathers”)—then warehouses, shops, and stalls, like infrastructure,

⁹⁴ Gullickson and Harper, “Multifactor Productivity in U.S. Manufacturing,” and see below on change over time and “backcasting” KLEMS accounts.

⁹⁵ This is Adam Smith’s illustration of the division of labor in the first pages of the *Wealth of Nations*, 14–15.

⁹⁶ On the London building trades in an earlier period, see Harding, “Employment and Opportunity,” and on France, Corbin, *Archaïsme et modernité en Limousin*, and Moulin, *Les maçons de la Creuse*.

⁹⁷ Carvais, “Les statuts des métiers,” 138; Wrigley, “A Simple Model of London’s Importance.”

⁹⁸ BLS Employment by major industry sector, 2019, <https://www.bls.gov/emp/tables/employment-by-major-industry-sector.htm>.

were the essential condition of the expansion of markets.⁹⁹ The households in which individuals worked more in order to buy more commodities, including the commodities produced in the European colonies, were also the consumers of the distribution and sale of these enticing commodities.

The tea trade alone, legal and illegal, supported hawkers and peddlers, shopkeepers and smugglers.¹⁰⁰ Even in the small inland town of Angoulême, in my own inquiry, tax rolls for the 1760s show 73 different occupations for women, more than half of them specializations within retail trade.¹⁰¹ Colquhoun included “shop women” in the list of possible occupations for inferior women, in 1806; he added a baleful summary of occupations or “suspicious and dangerous trades” that should be controlled by “inquisitorial” license, in his view, including “retail purchasers of rags and unserviceable cordage, for sale to paper-makers,” “walking itinerant purchasers of second-hand apparel,” purchasers of “second-hand naval stores” and “second-hand metals,” and “all petty hawkers.”¹⁰²

These are only the kinds of labor that would have been counted as economic activity within the categories of the time, and that A. R. J. Turgot recognized in his vista of interconnected commerce, “from the woman who spreads out herbs for sale in the marketplace, to the shipowner of Nantes or of Cadiz.”¹⁰³ There was also the uneconomical population of whom Colquhoun counted 1,320,716 individuals in England and Wales in the distressed year of 1803 (out of an overall population of around 9 million): “paupers” or adults receiving relief, mendicants, vagrants, “petty chapmen and low Jews,” and “lewd and immoral women.”¹⁰⁴ These were individuals in motion, whose numbers varied dramatically with economic conditions, and who were counted in order to be repressed.¹⁰⁵

The “services” of the enslaved population of the colonies—including the skills or “human capacity” of the slaves who were also carpenters or watchmakers—are not a component of labor inputs in our “GNP-like” model of the eighteenth-century economy.¹⁰⁶ They are a service flow from capital or

⁹⁹ De Vries, “The Industrial Revolution and the Industrious Revolution,” 262; *Wealth of Nations*, 335.

¹⁰⁰ Mui and Mui, “Smuggling and the British Tea Trade.”

¹⁰¹ AM-A, “Cahiers de l’état des classes,” CC42 (1763), “Répartition de la taille,” CC62 (1766).

¹⁰² Colquhoun, *Indigence*, 95–96, 105, 169.

¹⁰³ *Réflexions*, in *Oeuvres de Turgot*, vol. 2: 573–74.

¹⁰⁴ Colquhoun, *Indigence*, 38–43.

¹⁰⁵ There was no state in which there were as many “laws about the poor,” as in England, or books about the poor, or as many poor people, Dangeul wrote in 1754. *Remarques*, 307.

¹⁰⁶ The carpenters on the Bacaye estate were estimated at 1.8 times the value of a “field man,” in 1770. The “nègres à talents” for sale or lease in Saint-Domingue, in 1789, included *menuisiers*,

stock; the work of the slaves on the Bacaye plantation enters into the national value added of Britain in the form of a (factor) income receipt from the island of Grenada (or the “reflection” of the property of a British resident, Alexander Johnstone). But their lives mattered, and their labor was very large. The employed population of Glasgow was around 20,000 in 1763 and that of Manchester some 15,000.¹⁰⁷ Over the sixteen years from the British conquest of Grenada to the French reconquest in 1779, British traders disembarked 58,356 enslaved people on the island. It was a tiny colony, a bit smaller in area than Glasgow; the British disembarked 168,792 slaves in Jamaica over the same period, and the French disembarked 241,311 slaves in Saint-Domingue.¹⁰⁸

The costs of slave production—the consumption of capital, in the terms of the Bacaye accounts—were also very large.¹⁰⁹ There were 58,356 individuals who landed in Grenada in the period of the first British occupation; 70,998 had been “embarked” in Africa, destined for Grenada, and never arrived; a loss of more than 12,000 people.¹¹⁰ The French officials, when they returned, and immediately discharged the inhabitants from paying any of their obligations to creditors in London, estimated that there had been an “excess loss of Negroes” amounting to 86,500 individuals over the period. The conditions of the traverse from Africa were such, in their estimation, that “many thousands” died within one to three years of arriving on the island. (See Labor 2.3).

Labor 2.3

When the French reconquered Grenada in 1779, the new governor-general, the Comte de Durat, passed an ordinance that discharged the inhabitants of

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charpentiers, selliers, éperonniers, orfèvres, and a serrurier, as well as a woman who was “remplie de talens.” Affiches américaines (1789): 407, 746, 752, 761, 1090.

¹⁰⁷ Chaloner, “Manchester,” 41; *Scottish Population Statistics*, 29.

¹⁰⁸ <https://www.slavevoyages.org/>. The land area of Grenada is 344 square kilometers and of greater Glasgow 368 square kilometers. See <https://www.paho.org/>; *Focus on People and Migration*, 47.

¹⁰⁹ This is consumption in the sense of the depreciation of capital. “How should we treat the consumption of slaves,” Solow and Temin asked in 1978. “From the point of view of the slaveowner, slaves were part of his capital, and their consumption was the cost of maintaining this capital. Clearly, the consumption of slaves was an intermediate good to the slave owner . . . To the slave, on the other hand, his consumption represented a final product of the economy, and he would have thought that it should be counted as such.” Solow and Temin, “Inputs,” 4.

¹¹⁰ <https://www.slavevoyages.org/>.

Grenada from paying any of their obligations to creditors in London or elsewhere in the British empire. There was a related memorandum of justification. The calculation, described as a “proof,” was that there had been 16,000 enslaved people on the island at the time of the British conquest in 1762, and that the British “commerce” (the slave trade) had imported an additional 155,000 individuals, for a total supply of 171,000 slaves. At the time of the reconquest, there were 36,000 slaves on the island. A maximum of 40,000 enslaved people had been “exported” from Grenada to the French colonies, and the expected loss was “evaluated at 5 percent per year” or a total of 8,500 individuals. It was on this basis that the “excess loss”—“perte excessive de negres”—was evaluated at 86,500. The anonymous author of the memorandum attributed the mortality of the slaves to the “odious calculations” and “speculations of interest” of the British slave trade with respect to conditions on the passage from Africa.

Source: “Réflexions sommaires au soutien de l’ordonnance rendüe par M. le Comte de Durat le 7 Juillet 1779,” undated and unpag., in “Correspondance à l’arrivée,” ANOM, C/10a/carton 3/pt. 1.

Episode 3: Energy

Energy, the third input in the KLEMS identity, is an intermediate or secondary flow; it is no longer a matter, as with K and L, of a factor of production. Total factor productivity (TFP), of which the change over time has been an approximation to technical progress in growth accounting, or to changes in the “stock of ideas,” is a “measure of the efficiency with which labor and capital are used.”¹¹¹ Changes in the technology of using energy over the past two centuries thus enter only indirectly into TFP.¹¹² In an older view, that is also a newer view, “land, but this includes any natural resource used to produce goods and services” would itself be a primary factor of production.¹¹³ (It is possible to imagine a model in which energy is the only “factor” or primary

¹¹¹ Fernald and Jones, “The Future of US Economic Growth,” 45; Fernald and Matoba, “Growth Accounting, Potential Output, and the Current Recession,” 1.

¹¹² On TFP and multi-factor productivity (MFP), see Jorgenson and Timmer, “Structural Change in Advanced Nations,” 9n11.

¹¹³ “Factors of Production,” <https://www.stlouisfed.org/education/economic-lowdown-podcast-series/episode-2-factors-of-production>; see also Crafts, “Understanding productivity growth.”

input, and in which increases in productivity are therefore by definition the change over time in value added per unit of energy input.)

Energy has been of enduring importance to macro-histories of economic growth. The transition from the “advanced organic economy” of eighteenth-century Britain to the “inorganic” economy of modern times was a consequence, in E. A. Wrigley’s classic account, of new technology.¹¹⁴ The access to coal, together with “New World resources,” was for Pomeranz the principal explanation for the great divergence of the late eighteenth century.¹¹⁵ The transition was in particular “a qualitative change: the capacity to convert thermal energy into kinetic energy.” Britain had relatively high energy consumption per capita around 1800, and a strikingly high share of the energy came from coal. But the coal was used for heat in homes and in industry. It was only with the mechanical use of coal, as Paul Warde has shown, that coal (like other materials and machines) could be moved over large distances, and that more coal could be mined, in deeper and deeper seams.¹¹⁶

The history of coal was a familiar and not entirely flattering narrative in early descriptions of British industrial advantage. As a French parliamentarian wrote in 1859, in one of the early uses of a subsequently famous expression, “if Great Britain be the first industrial nation in the world, she owes it in great measure to her mineral wealth:” “the Englishman is the king of matter.”¹¹⁷ The costs of mineral production were familiar—and even a subject of satire—at least a century earlier. (See Energy 3.1.) Thinking with nature would require reflection on the environmental consequences of all this kinetic energy: the external social benefits of not having cut down all the trees that would have been required to produce the same amount of kinetic energy with an older technology, and the external social costs in illness, pollution, and irreversible loss, just as the death of so many individuals was an external social cost of colonial production. These costs were incurred over generations, and even centuries. In the hyper-materialist—and not particularly liberal or welfare-centered—model in which productivity change is measured by changes in value added per unit of energy input, the course of British advantage would have a less imposing trajectory over time.

There is a different way of thinking with nature that is suggested by our thought experiment, in relation to energy inputs and the long-distance

¹¹⁴ Wrigley, *Continuity, Chance and Change*, 50–57.

¹¹⁵ Pomeranz, “Political Economy and Ecology on the Eve of Industrialization,” 426.

¹¹⁶ Warde, “The First Industrial Revolution,” 133.

¹¹⁷ Esquiros, *The English at Home*, vol. 1: 2.

Energy 3.1

The first substantial work by Edmund Burke, *A Vindication of Natural Society* (1756), has been widely considered to be ironic or satirical or both. It is an indication, in any case, that the costs of mining were the subject of widespread public discussion in Britain, well before the take-off to sustained energy-intensive growth:

I suppose that there are in Great-Britain upwards of an hundred thousand People employed in Lead, Tin, Iron, Copper, and Coal Mines; these unhappy Wretches scarce ever see the Light of the Sun; they are buried in the Bowels of the Earth; there they work at a severe and dismal Task, without the least Prospect of being delivered from it; they subsist upon the coarsest and worst sort of Fare; they have their Health miserably impaired, and their Lives cut short, by being perpetually confined in the close Vapour of these malignant Minerals. An hundred thousand more at least are tortured without Remission by the suffocating Smoak, intense Fires, and constant Drudgery necessary in refining and managing the Products of those Mines. If any Man informed us that two hundred thousand innocent Persons were condemned to so intolerable Slavery, how should we pity the unhappy Sufferers, and how great would be our just Indignation against those who inflicted so cruel and ignominious a Punishment? This is an Instance, I could not wish a stronger, of the numberless Things which we pass by in their common Dress, yet which shock us when they are nakedly represented. But this Number, considerable as it is, and the Slavery, with all its Baseness and Horror, which we have at home, is nothing to what the rest of the World affords of the same Nature. Millions daily bathed in the poisonous Damps and destructive Effluvia of Lead, Silver, Copper, and Arsenic.

Source: Burke, *A Vindication of Natural Society*, in *The Writings and Speeches of Edmund Burke*, vol. 1: 178.

economies of the eighteenth century. There was an “economic revolution” in late eighteenth-century Britain, in Wrigley’s expression, which was not an industrial revolution.¹¹⁸ It was this earlier transformation in the advanced organic economy, well before the expansion of mechanical power, that was at the heart of the disputes of economic historians over labor inputs and the industrious disposition. Our progression through the Ks, Ls, Es, Ms, and Ss suggests an additional source of (non-factor) inputs, such that traditional accounts may actually have underestimated the energy inputs into late eighteenth-century output.

The question about the past is inspired, as so often, by an observation of the present. There is intense discussion, in the epoch of accelerating and man-made climate change, of green or free or renewable energy. These sources of energy have been only of marginal importance in the new energy histories of Europe, because they were only marginally “economic.” As Astrid Kander, Paolo Malanima, and Warde wrote, solar heat is “a free source of energy from a human’s perspective, because we do not need to do anything to make it flow.” It becomes an “economic resource” only when there is an opportunity cost to its use, as with “the capture of solar radiation by means of some technical device in order to heat water or produce electric power.”¹¹⁹

The suggestion inspired by present ideas of energy is that there were indeed new technologies, in late eighteenth-century Europe, for capturing solar radiation and wind energy, with the use of labor and capital—and that the free resources in question were far beyond the territorial boundaries of the British isles. Pekka Hämmäläinen, in his work on the politics of grass in North America, has described the success of the Comanche empire in “harness[ing], more directly than anyone before, the vast pool of solar energy stored in the plains grasses . . . a spiraling energy stream of grass, flesh, and sunlight.”¹²⁰ The radiation or insolation was captured in the metabolism of buffalo and in their movement over large expanses of space. The British empire, too, had its technologies of sunlight and space.

The use of distant winds is a familiar illustration, and one that was much discussed at the time. (See Energy 3.2.) Calculations of inputs of wind power in recent energy histories have emphasized stationary and land-based sources, particularly windmills, rather than sailing ships. But the visualization of a century of ocean shipping by Ben Schmidt suggests that the prodigious expansion in long-distance shipping that started in 1763 can also be

¹¹⁸ Wrigley, *People, Cities and Wealth*, 58.

¹¹⁹ Kander, Malanima, and Warde, *Power to the People*, 18–19.

¹²⁰ Hämmäläinen, “The Politics of Grass,” 180.

seen as a map of winds and ocean currents—a *Global Wind Atlas* before its time.¹²¹ It is misleading to think of the geography of the eighteenth century oceans in terms only of distance; one should think, as contemporaries did, in terms of winds and isochrones, or of journeys which take an equal period of time.¹²² Lord Clive sailed to Calcutta via Brazil, when he returned to India from England in 1765 to assume the *diwani* or financial administration of Bengal, and “[fix] firm the foundation of the British empire in India.”¹²³

The technologies that made possible the large-scale use of distant wind power in the eighteenth-century empires were not for the most part mechanical. They were technologies of information, above all, and of materials: about navigation, ocean currents, insurance, weather conditions, exchanges with correspondents to secure supplies in distant ports, contracts for repairs, and copper sheathing. They were ideas about combinations of intermediate inputs, in contemporary terms.¹²⁴ The measurement of the use of wind power—in mechanical or “horse-power” or kilowatt-hours per ton equivalents—is an approximate exercise.¹²⁵ The increase in tonnage is unequivocal.

There were 3,531 slave trading voyages in British ships from 1700 to 1749, with 859,194 enslaved people embarked and a tonnage of 2,642,000. From 1750 to 1799, the number of voyages increased more than 50 percent to 5,356, the number of slaves embarked increased more than 70 percent to 1,480,443, and the total tonnage more than doubled to 5,504,000. The increase in the French slave trade was even greater, with the number of voyages, the number of slaves embarked, and the total tonnage all more than doubling over the period. These were large, heavy vessels with a high specific gravity: floating prisons.¹²⁶ The *Duke of Clarence*, which left Liverpool for Jamaica in

¹²¹ See <https://www.youtube.com/watch?v=tnqxrcfUMsw>; <https://webs.ucm.es/info/cliwoc/>; <http://sappingattention.blogspot.com/2012/04/visualizing-ocean-shipping.html>. On the World Bank’s *Global Wind Atlas*, see <https://globalwindatlas.info/>.

¹²² Dermigny, *La Chine et l’Occident*, vol. 1: 250–51.

¹²³ Farrington, *Catalogue of East India Company Ships’ Journals*, 360; Malcolm, *The Life of Clive*, vol. 2: 338.

¹²⁴ For a recent account of the contribution of “changing input combinations to productivity growth,” using input-output data, see Acemoglu and Azar, “Endogenous Production Networks,” 36.

¹²⁵ Kander, Malanima, and Warde, *Power to the People*, 67–70. On copper sheathing, see Solar and Rönnbäck, “Copper Sheathing and the British Slave Trade.”

¹²⁶ See the remarkable note by David Eltis, “Tonnage.” “Tonnages of French slave ships between 1784 and 1792 were inflated (that is to say the size of the ton was deflated) substantially, as the French government based their subsidy of the slave trade on tonnages . . . A Portuguese law of 1684, and clauses in the 1815 and 1817 Anglo-Portuguese slave trade treaties, limited Portuguese and later Brazilian ships to a ratio of between 2.5 and 3.5 slaves per ton, depending on the con-

Energy 3.2

The transport of goods “thro’ the trackless Waves, by the Power of the Clouds” was the most surprising “of all the Wonders which the white Men perform,” the Choctaw negotiator Nassuba Mingo was reported—by a British scribe—to have exclaimed in West Florida in 1765, in a meeting with the new British governor. The governor, who was one of the brothers of the owner of the Bacaye plantation, three thousand kilometers to the southeast, returned to the image of windborne power some years later, in correspondence with a friend in the service of the East India Company, about the invention of air balloons: “the Pen Ink Paper & Marks arresting my thoughts & sending them in a Ship to my Friend at the extremity of the Globe Passing through the trackless Waves born long by the Power of the Clouds directed by the invisible Power of the Loadstone & bringing back the Treasures of the East is sufficiently surprizing but all our Inventions seem lost in this. Who shall say that all this Merchandize may not pass through the Air.”

Sources: Speech of Nassuba Mingo, in Mobile, April 1, 1765, transcribed in *Mississippi Provincial Archives English Dominion*, 242; letter of December 24, 1783, from George Johnstone in London to John Macpherson, Macpherson Correspondence, BL/OIOC, Mss Eur F291/110.

late 1799, weighed 726 tons and embarked 852 slaves; the *Monétatty*, which left Bordeaux for Saint-Domingue in 1790, in the early months of the French revolution, weighed 784 tons and embarked 938 slaves.¹²⁷

The use or capture of solar energy—the flow of the free services of insolation, or the solar radiation reaching different places, as an intermediate input into British or French value added—took advantage of the same technologies of information. But it also required a different and more material innovation. There is another world map that is now familiar: the map of insolation, as in the *Global Solar Atlas*, in which there are places that glow orange and red—the interior of Africa, the southwest of the North American continent, parts of the Caribbean islands—and places that are blue or temperate. British entrepreneurs in the eighteenth century did “not need to do anything to make” the sun shine in Africa, or to make solar radiation “flow,” in the expression of the

struction of the ship [and it was suspected that] the Portuguese tonnage measurements were being inflated by 60 percent on average so that more slaves could be confined on board.”

¹²⁷ <https://www.slavevoyages.org/>.

energy historians. But the insolation was in the wrong place. It could not be an “economic resource,” because there was no technology, or so it seemed, to use capital and labor to transform it into an input into the production process.¹²⁸

Cultivation with enslaved labor was such a technology. The British and French and other colonial powers, in capturing or purchasing so many millions of African children, women, and men, were also capturing, in their bodies, the flow of resources, including insolation, by which they had been nurtured over the course of their lives until the moment of sale. The past, which is composed of memory and relationships and songs and ideas, from the point of view of the human individual, is from the point of view of economic history composed of an embodiment of past inputs. The enslaved, in the accounting system of the Bacaye plantation, were produced means of production, and the past inputs into their production included the free services of insolation, long ago and far away.¹²⁹

The system of cultivation, when the enslaved arrived on the islands, was itself a technique for capturing solar radiation, or sun that was shining in the wrong place. The tropical commodities that were so enticing to the newly industrious English were novel because they could not be cultivated in England; they too were the embodiment or incorporation of free energy.¹³⁰ They were cultivated, in turn, with economical inputs. The cost of “raising,” from infancy, a 13-year-old slave in Grenada, who had been captured in Africa a few months earlier, was less than the cost of raising an unenslaved English girl would have been, two generations later, in the sugar beet fields of East Anglia. The Europeans asserted, as Eric Williams showed and disproved, that individuals who had been born “in the temperate climate of Europe” could not survive the labor of cultivation “under the burning sun of the West Indies.”¹³¹ (See Energy 3.3.) But the enslaved, too, did not survive.¹³²

¹²⁸ Kander, Malanima, and Warde, *Power to the People*, 18–19. On the *Global Solar Atlas*, see <https://globalsolaratlas.info/map>.

¹²⁹ If one imagines the individuals who were sold in the Atlantic trading posts in a model with no institutional constraints on enslavement, then the equilibrium price would reflect the relative cost of purchasing a slave in the Cape Coast and transporting her to the West Indies versus the cost of raising a “field girl” to the age of 13 in the temperate (blue) countryside of England and of transporting her overseas. See Barbara Solow’s account of Domar’s free land model in “Slavery and colonization,” 36–38. I am grateful to Indrani Sen for discussion of this (Swiftian) view of equilibrium.

¹³⁰ On cane and beet sugar, see Hagelberg, “Economic Comparisons.”

¹³¹ Williams, *Capitalism and Slavery*, 20–23.

¹³² There was a continuing “retrograde—a diminution,” Colquhoun wrote of the “black population” of Grenada: “according to this scale of mortality, the population would be annihilated in less than 40 years.” Colquhoun, *Treatise*, 375.

Energy 3.3

Adam Smith described the prevailing view, with his customary distance: “In all European colonies the culture of the sugar-cane is carried on by negro slaves. The constitution of those who have been born in the temperate climate of Europe could not, it is supposed, support the labour of digging the ground under the burning sun of the West Indies; and the culture of the sugar-cane, as it is managed at present, is all hand labour, though, in the opinion of many, the drill plough might be introduced into it with great advantage.” His former student, William Pulteney Johnstone, the brother of the owner of the Bacaye plantation, expressed the supposition explicitly some years later, in a speech in parliament opposing the abolition of the slave trade: “the real fact was agreed upon by all parties to be this: the West Indies cannot be cultivated by Europeans, whose constitutions will not bear fatigue in that climate. It is therefore necessary, if they are to be cultivated at all, that it must be by some other class of the human species.”

Sources: Smith, *Wealth of Nations*, 586. Speech of William Pulteney of February 28, 1805, *The Parliamentary Debates*, vol. 3: 658.

Episode 4: Materials

The next input in the KLEMS identity, M or materials, is the most obscure. Intermediate inputs are not a particular kind of thing, in modern national income accounts; they are defined as the goods and services that are sold in the course of the year, and that are used in production. They are a residual, of sorts: the things that are not sold to the final demand of personal consumption, fixed investment, or government.¹³³ Materials are a residual within the residual. They are the things that are not sold to final use, and are not either energy or services. They are additives and copper and polystyrene and semiconductors. They are obscure in the sense that they cannot be seen, in an accounting vista or in the vista of the end of the year.

The distinction between “final consumption or product” and “intermediate consumption or costs” was in Simon Kuznets’ description “basic in the ideological framework of modern society as well as in economic analysis

¹³³ Final demand is equal to personal consumption expenditure, plus gross private fixed investment, plus net changes to inventories, plus net exports, plus government consumption expenditure and investment. <https://www.bea.gov/help/glossary/final-uses>.

and measurement.”¹³⁴ It turns in practice on the practices of business accounting. Some enduring or capital-like things are intermediate and some are sold into the (unobscure) destiny of “gross private domestic fixed investment.” The frontier of intermediacy is contingent; amidst the continuing flow of electronic components or small machines, it is “transactions involving structures and equipment of types normally depreciated over more than one year” that are “recorded as sales to final demand.”¹³⁵

The point of our thought experiment in the infinite availability of data—and of thinking about economic life in the eighteenth century in terms of gross output rather than, or in addition to, value added or sales to final demand—is to look in a different way at flows of intermediate goods. It is to explore the possibility that technical change, in the eighteenth century as today, can be seen as embodied in the changing use of intermediate goods, and in particular of M inputs. One can think of machinery, computers, and electrical equipment, now, as the industries in whose output technical change is embodied. But only 20 percent of their sales went to “final demand,” in the form of fixed investment, in the United States in 2018; 50 percent of these industries’ gross output—and the entire output of semiconductors—was sold into the obscurity of intermediate use.¹³⁶ “Intermediate goods are just another form of capital, albeit one that depreciates fully in production,” as Charles I. Jones has written, and their invisibility in theories of economic growth “may prove to be an ill-advised omission.”¹³⁷ This is also the case in economic history.

One of the conditions of intermediate goods, in the eighteenth century as now, is that they are not particularly easy or glorious to own.¹³⁸ There

¹³⁴ Kuznets, *Economic Growth of Nations*, 77.

¹³⁵ Coughlin et al., “New Structures and Equipment,” 45.

¹³⁶ Data for industries 333 (Machinery), 334 (Computer and Electronic Products), and 335 (Electrical Equipment, Appliances and Components), in US Department of Commerce, Bureau of Economic Analysis, Input-Output Accounts Data, Use of Commodities by Industry, 71 Industries (2018), <https://www.bea.gov/industry/input-output-accounts-data>.

¹³⁷ Jones, “Intermediate Goods and Weak Links,” 2, 4. On the adjustment of measures of productivity to the presence of intermediate inputs—notably electronic components—of which the production was itself research-intensive, see Wilson, “Capital-embodied Technological Change;” “it is often the case in production function or productivity regressions that intermediate inputs (materials) dominate the explanatory power of the independent variables and obscure the effects of the other inputs” (121.)

¹³⁸ On the Roman law of fungible or *vertretbar* goods, see Böhm-Bawerk, *Capital and Interest*, 253–54.

Materials 4.1

The *Additions and Corrections* to the *Wealth of Nations* that Smith published in 1784 as a slim separate volume, and that begins abstractly and audaciously—“Wealth, as Mr Hobbes says, is power”—is almost entirely about the details of overseas commerce, and in particular about flows of intermediate inputs. In the additions, which appear at length in the new chapter “Conclusion of the Mercantile System,” Smith addressed himself to, inter alia, wool cards, sheep’s wool, cotton wool, undressed flax, dying drugs, undressed hides, seal skins, pig and bar iron, brown linen yarn, masting timber, hemp, tar, pitch, turpentine, indigo, wood, raw silk, pipe, hogshead and barrel staves, fuller’s earth, tobacco-pipe clay, raw hides, tanned leather, woolen yarn, worsted, white cloths, dial-plates, iron, copper, mundic metal, copper bars, unmanufactured brass, gun-metal, bell-metal, shroff-metal, alum, lead, lead ore, tin, copperas, coals, lapis calaminaris, skins of all sorts, glue, coney hair or wool, hare’s wool, litharge of lead, gum senega, gum arabic, beaver skins, and beaver wombs. “Coals,” he concluded, “may be considered both as a material of manufacture and as an instrument of trade.”

Sources: Smith, *Additions and Corrections*, [1]; *Wealth of Nations*, 642–62.

have been railway kings and coal kings, but not so many business histories of turpentine kings.¹³⁹ Their archives are correspondingly unheroic. The commodities depreciate fully by the end of the year, and so too, in many cases, have the invoices and balance sheets in which their existence was recorded. But there was an extraordinary variety of M-type inputs in eighteenth-century Britain. They were even the subject of one of the most elaborately composed chapters of the *Wealth of Nations*, which is in large part a list of what Adam Smith described as the “materials of manufacture,” and of the efforts of “master manufacturers” to encourage their import and prohibit their export: dying drugs, undressed flax, alum, gun senega, mundic metal. (See Materials 4.1.)¹⁴⁰

¹³⁹ Jeremy Zallen’s *American Lucifers*, a study of sources of illumination, including turpentine, is a notable exception. On “copper kings” in eighteenth-century Britain, see Harris, *The Copper King*, esp. xiii–xiv, and in late nineteenth-century Montana, Glasscock, *The War of the Copper Kings*.

¹⁴⁰ “Conclusion of the Mercantile System,” in Smith, *Wealth of Nations*, 642–62.

The records of English overseas trade statistics over the long eighteenth century, studied by Elizabeth Boody Schumpeter, are a history of materials, from pitch and tar to pig iron.¹⁴¹ An economic history that takes intermediate inputs seriously would be an investigation, in part, into where these materials came from, where they were used, and why they were so important—a sequence of micro-histories of obscure industries. It would be a history of business correspondence, from the perspective of the things that were sold, and a history of the correspondence of colonial, naval, and consular administrations, engaged, as throughout the eighteenth century, with the interests of merchants and the procurement of vital supplies.¹⁴² It would be a history, too, that could eventually help illuminate some of the largest or macro questions about early industrial economies.

The idea of gross output—or output to intermediate as well as final use—is of some ideological importance in contemporary economic policy. Gross output is seen as a measure of economic life that is business-centered, and that identifies businesses, rather than government or consumers, as the principal object of economic inquiry.¹⁴³ But business is important, too, in our own inquiry into economic history. In our microscopic view of exchanges or transactions, there are multiple exchanges between one enterprise and another, and the exchanges embodied a substantial proportion of the technologies associated with new industries. A little over 40 percent of all output is sold to intermediate use in the contemporary United States, and the proportion was undoubtedly much smaller in the advanced economies of the late eighteenth century. It was relatively high, all the same, in the most modern industries, including those selling intermediate-type materials to the “final” demand of exports and government. There were beaver hats and men’s worsted stockings in Boody Schumpeter’s lists of “principal English exports.” Far more of the exports were distinctively *vertretbar*, from “copper wrot” and cordage, to red lead and iron nails.¹⁴⁴ (See Materials 4.2.)

¹⁴¹ Schumpeter, *English Overseas Trade Statistics 1697–1808*. The share of two commodities, dyestuffs and cotton wool, increased from 3.5 percent of non-food imports in 1750 to 15.2 percent in 1790; percentages calculated on the basis of the table in Ashton, “Introduction,” 11.

¹⁴² See Zahedieh, “Colonies, Copper, and the Market for Inventive Activity.” For an interesting study of the gum trade and the “Gum Atlantic,” see Cussen, “Capital and Critique.”

¹⁴³ The recent policy discussions are surveyed in writings by Mark Skousen, including <https://mskousen.com/2020/10/macroeconomics-on-the-go-how-wall-street-economic-analysts-use-gross-output-go-2/>; and see, on the importance of “B2B” or business-to-business spending, “Business not Consumers Drives the Economy,” <https://mskousen.com/category/gross-output/>.

¹⁴⁴ Schumpeter, *English Overseas Trade Statistics*, Tables 7, 12.

Materials 4.2

One of the stylized differences between French and British manufactures, for eighteenth-century observers, was the unfinished condition of British exports. The British were inhibited, according to the abbé Galiani, by an underdeveloped taste for luxury: “with them, if a farmer sees a ribbon or a piece of embroidery, he believes he is seeing the devil, he cries out *au luxe, au scandale, au french-dog*, and manufactures go nowhere.” A description of Turgot’s brief period as minister of the navy and colonies in the summer of 1774, by Dupont de Nemours, described him as planning to reduce the cost of ships for the royal navy by procuring them in Sweden. The cost of the vessels would be cut by 40 percent, in Turgot’s estimate, and the French builders who were dispatched to the Swedish shipyards would help to promote French exports: “he knew that our *constructeurs* in Sweden would drink French wine and brandy, consume sugar and coffee from our colonies, wear cloth, serges, and silk materials of French manufacture, and extend the taste for these products among the Swedes.”

Sources: Galiani, *Dialogues*, 33; Dupont de Nemours, *Turgot*, 125.

One of the large or macro questions to be considered, in relation to materials, has to do with the role of the military-fiscal state in the economic revolutions of the 1750s to the 1810s, in Britain and in France. The importance of military production to economic advantage was obvious to contemporaries. (See Materials 4.3.) It was obvious, in turn, to nineteenth-century observers, as when Tocqueville concluded, on the basis of his inquiry into the archives of the expanding, naval-oriented economy of west-central France in the late ancien regime, that the state was “the greatest consumer of industrial products and the greatest entrepreneur of construction projects that there was in the kingdom.”¹⁴⁵ It has been evident in some of the most innovative studies of the history of economic (and financial) life in Britain, from the fiscal state, to war and international capital markets, to industrial organization and technical change in the gun industry.¹⁴⁶ The

¹⁴⁵ Tocqueville, *L'Ancien Régime et la Révolution*, 225.

¹⁴⁶ Brewer, *The Sinews of Power*; Neal, *The Rise of Financial Capitalism*, 218–22; Satia, *Empire of Guns*.

Materials 4.3

The Liverpool doctor James Currie, who emigrated from Dumfriesshire to become a merchant in Virginia, was under the pseudonym “Jasper Wilson” one of the popular economic writers of the 1790s. The destiny of England, in his description, “more commercial than any other nation,” was to be “the universal carrier of provisions and warlike stores,” supplying the “clothing of the various armies in the field.” Even England’s enemies were customers: “Yorkshire furnished the greater part of the clothing of the Sans Culottes of America,” and in France, “the Sans Culottes rushed into the field—and Arms! Arms and clothing! was echoed from Picardy to Provence. These demands could only be supplied by England.”

For Currie’s contemporary Alexandre d’Hauterive, “the vessels of England cover all the seas: she sends soldiers, arms, gold, agents to the four corners of the world,” in an “indefatigable spirit of discovery, monopoly, and contraband.” The “faculty of giving a vast and powerful organisation to her credit; of subordinating the credit of all other nations; of attaching all foreign and domestic traders to her by the ties of credits and debts” had provided England with the power to destabilize other countries while remaining secure herself: “to cover Europe with frauds, ruins, bankruptcies, banks which are discredited from their birth, state notes which are depreciated from the first moment of their emission.”

The linkages among credit, materials, and “warlike” stores were a matter of legend by the time of a British parliamentary inquiry into the woolen manufacture, in 1806:

Q. Have you ever heard what was the cause why the cloth merchants of the West Riding of Yorkshire, many years ago, lost the cloathing of the Russian guards?

A. I believe it was lost by regulations of the Russian government, it never returned back to Leeds after it was lost.

Q. Did you never hear it mentioned, as a leading cause of those regulations, that upon a grand review of the Russian guards, who turned out clad in coats, on a very rainy day, that the same coats the next morning were very much shrunk into jackets?

A. I recollect great complaints were made by contractors under the Russian government, and very extortionate abatements were required on that account . . . They were contracts taken perhaps forty years ago, when I was a boy.

Sources: Wilson [Currie], *A Letter, Commercial and Political*, 7, 13, 22, 27; Hauterive, *État*, 117–22, 182; *Minutes of Evidence*, 373–74.

military was “arguably the most dynamic sector of Europe’s pre-industrial economy.”¹⁴⁷

Our thought experiment in observation could suggest possibilities for connecting these inquiries to the macro or cosmic questions of British economic growth. The incantatory lists of materials in the *Wealth of Nations* were an evocation, in particular, of the connections between industry and the naval and military enterprises of the time. Sail yarn and tar and turpentine were of importance to the navy; unmanufactured brass, like screws and bolts, was of importance to the army. The materials were no longer intermediate, in the terms of modern national income accounting, if they were sold to the “final demand” of the Admiralty or the Ordnance Office. But they were sources of innovation, and important to other industries. Our KLEMS-inspired accounting identity, and the inquiry into gross output, can suggest ways of evaluating linkages or multipliers throughout the economy, and of thinking about how the causal connections between military and economic power really worked.¹⁴⁸

The vicissitudes of copper provide an interesting case. Innovations in the use of copper—or technical change embodied in inputs from the copper industry—were of importance to naval construction, as well as to the construction and maintenance of slaving ships and of the copper boilers and “hole-shades” of the plantation economy.¹⁴⁹ The European exchange of copper—from Sweden and Norway to London and the distant colonies—has

¹⁴⁷ Hoffman, “Prices, the Military Revolution, and Western Europe’s Comparative Advantage in Violence,” 41.

¹⁴⁸ “The multiplier that works through intermediate goods turns out to be readily quantified and large; incorporating intermediate goods into our models has a first-order impact on how we think about economic development.” Jones, “Intermediate Goods and Weak Links,” 2–3.

¹⁴⁹ Zahedieh, “Colonies, Copper, and the Market for Inventive Activity”; Solar and Rönnbäck, “Copper Sheathing and the British Slave Trade.”

been seen in recent scholarship as evidence of a more diffuse pattern of technical change, over a longer-lasting industrial revolution, less dependent on “critical” or “exemplary” technologies in Britain (or Britain and France).¹⁵⁰ But it is also a vivid illustration of the consequences of European wars, as demand for copper rose and fell over a half-century of industrial transition that was also, endlessly, a pre-war and a post-war period.¹⁵¹

To take intermediate inputs seriously can suggest ways of connecting micro-inquiries to a different and even larger question, about the industrial revolution and the natural environment. Materials that are used up in the process of production do not vanish without a trace; they become residues, or raw materials again. To consume something is to destroy utility, in Jean-Baptiste Say’s definition. It is not to destroy matter, which is impossible: the “particles which are detached” from an article of clothing, for example, “are spread in the universe, and still exist somewhere.”¹⁵² E and M, energy and materials, are profligate in the “particles” they diffuse. There is also an asymmetry that is familiar from the history of environmental policy. The way in to the production process, for M inputs, is orderly, priced, and reflected in market transactions. The way out is slow, a matter of unsold negative outputs and semi-organized markets for secondhand metals.¹⁵³

Metals and minerals are distributed unevenly in the earth’s crust, and so are environmental costs. One of the melancholy conditions of macro-economics, as of macro-history, is that it has so little space for space or location. The individuals who produce intermediate goods are invisible in the economic sense that their output is not recorded in the statistics of final demand. They are invisible, too, in the sense that the locations in which they work—the mining villages or forest clearances—are unimportant, like other enterprises and industries, in a national or macro vista. Their local histories are stories, all the same, of economic change—dramatic histories from time to time, as in the transformation of copper towns in Montana in the nineteenth century, of arsenic towns (with arsenic a by-product of copper smelting), or, over the course of the industrial revolution, of the communities that produced kelp and other alkalis.¹⁵⁴

¹⁵⁰ Bruland and Smith, “The Global Context of the Scandinavian Copper Industry.”

¹⁵¹ Olofsson, “Svensk koppar- och mässingsexport under 1700-talet,” Figures 1 and 2.

¹⁵² Say, *Catéchisme d’économie politique*, 89.

¹⁵³ “The way in is profitable, the way out is slow.” Speech of February 6, 1967 on urban economic and environmental policy, in Palme, *Politik är att vilja*, 142.

¹⁵⁴ Warde, “Tiree”; Tepper and Tepper, “Tacoma Arsenic”; Jarrige and Le Roux, *La contamination du monde*.

The history of the alkali potash, as Warde has shown in important recent work, points to the international networks of the “advanced organic economy,” to the early importance of the chemical industry, and to the possibilities of an “ecologically-minded input–output model of early industrial development.” Warde has also quantified the overseas requirements of Britain’s potash use in the eighteenth century: at 2,000 kilograms of spruce wood needed to produce 1 kilogram of potash, there were by 1792 the equivalent of more than 10 million cubic meters of wood—imported from lands reaching across Russia, Poland, and the Baltic—consumed in Britain in the form of potash, compared to some 5 million cubic meters in the 1760s. By 1810, with the expansion of the wartime economy and the new supply of potash from North America, British use had increased to 26 million cubic meters—or more than the entire wood production of the German states in the same period.¹⁵⁵

These connections were familiar to the economists of the time. Turgot, in 1773, evoked an immense vista of the long-term and long-distance free commerce in resources, in which the production of iron ore, the “raw material” of the “instruments” of agriculture and manufacture, became a business for ever more underdeveloped nations. No one would think of using wood from the forests around Paris to produce charcoal for use in iron forges, in Turgot’s account; this was an industry, like the production of potash, for “new nations, for nations which have vast uncultivated forests, distant from all markets, and where there is an advantage in burning an immense quantity of wood for no more than the value of the mineral salts which can be derived from washing their ashes.”¹⁵⁶

Turgot’s vision of an international product life cycle is a dystopia, in an “ecologically-minded” economic history. But eighteenth-century theorists of free commerce were themselves intensely conscious of proximate as well as distant environmental costs, as when Condorcet—in his *Life of Turgot*—described the misuse of the exercise of property rights in rivers or ponds, “which, by their nature, harm everything in their environment.”¹⁵⁷ The nineteenth-century history of turpentine is a story of horror, beyond dystopia, of environmental and occupational (or human) destruction.¹⁵⁸

¹⁵⁵ Warde, “Trees, Trade and Textiles.”

¹⁵⁶ “La marque des fers,” *Oeuvres de Turgot*, vol. 3: 622–25.

¹⁵⁷ *Vie de M. Turgot*, in *Oeuvres de Condorcet*, vol. 5: 147–48. Condorcet wrote elsewhere of the uses of land for an agricultural practice that “by corrupting the air, causes illnesses in neighboring homes,” and of the potential for environmental regulation “if a factory is unhealthy for neighboring houses.” *Réflexions sur le commerce des blés*, vol. 11: 165; *Sur les assemblées provinciales*, vol. 8: 513.

¹⁵⁸ Zallen, *American Lucifers*.

There are social costs of the production, use, and enduring existence of M-inputs, over the life history of interindustry transactions and an eventual, uncounted destiny as the residue of a residual. Tallow did not, in the end, vanish without leaving a trace.

The largest question, in relation to economic change, is about combinations of intermediate inputs. Say's description of the uses of "technology" in the production of wealth—and thereby of the industriousness of modern times—was an evocation of the transformation of materials. Sand, with soda and fuel, was transformed into glass, straw into hats, and indigo, wool, alum, and fuel into blue cloth.¹⁵⁹

There are two ways in which the importance of intermediate inputs could have increased over the period of the long industrial revolution—through an increase in the value of the inputs and an increase in their (factor) productivity—and there is some evidence of both.¹⁶⁰ The value of exports of *toiles* from France to the French islands increased from less than 6 million livres in 1775 to more than 18 million in 1788. Potash imports into Britain increased more than 250 percent from 1792 to 1810.¹⁶¹ Over the very long term of British economic growth, it was "mining and transport" that "saw the greatest expansion in the male labour force."¹⁶² The history of the expansion of the French dyeing and textile industry was an intertwined story of the ingenuity of labor and of the factor productivity (or technology) of intermediate goods.¹⁶³

Alum, or sulphate of aluminum and potassium, was the "indispensable" material of daily life, "the greatest indicator of industrial activity ever calculated, from the end of the fifteenth to the beginning of the nineteenth century."¹⁶⁴ It was a "mordant," or biting substance, essential for fixing colors in the textile industry. Its history is relatively obscure because its uses were ancient and widely known; because the most sought-after sites of alum production were in locations—the Papal States and north-eastern Anatolia—that are not understood as having belonged to the heartland of economic innovation; because its industrial importance declined sharply after 1800; and because it was unmechanical, an input into the process of industrial

¹⁵⁹ Say, *Cours complet d'économie politique pratique*, vol. 1: 82–84.

¹⁶⁰ Garner et al., "Integrated Industry-Level Production Account."

¹⁶¹ Tarrade, *Le commerce colonial*, vol. 1: 123; Warde, "Trees, Trade and Textiles," 60–61.

¹⁶² Estimates for 1600 to 1900 in Shaw-Taylor, "The Occupational Structure of Britain."

¹⁶³ See Gayot and Minard, *Les ouvriers qualifiés de l'industrie*.

¹⁶⁴ Delumeau, *L'alun de Rome*, 317, 319; Chaunu, "L'alun de Rome," 761.

production and into the value of industrial output, but not into the substitution of capital for labor.¹⁶⁵

Alum was a peculiarly intermediate of inputs. It was counted multiple times: when the alum crystals were sold by the mine-owners, when the mordants were sold to the textile enterprises, and when the colored textiles were sold. There were transactions in packaging, storage, shipping, and insurance. It was also a peculiarly circulating form of capital. It was used “in the support of labour,” as in Ricardo’s classification, and it constituted the surroundings or environment of labor as well.¹⁶⁶ The mines and quarries were scenes of devastation, with underground furnaces in which broken stones were reduced to a whitish-pink paste, one-fiftieth of the weight of the stones.¹⁶⁷ Goethe began his “economical and technical investigations” with a visit to the Saar, and to the production of alum (“this so necessary material”); “a strong smell of sulphur surrounded us” and we “found ourselves in the region of the Burning Mountain,” a fire, fueled by coal, “that had smouldered for ten years already.”¹⁶⁸

The market for alum, like the market for potash, was Europe-wide. One distinctive indicator—the ships carrying alum that were seized by British adventurers in the course of eighteenth-century wars—included a French merchant vessel bound from Smyrna to Livorno, Danish vessels bound from Barcelona to Honfleur and from Hamburg to Bordeaux, and a Swedish vessel bound from London to Nantes.¹⁶⁹ An elaborate conspiracy in 1771–73 to “corner” the world supply of alum, led by the chairman of the British East India Company, involved “speculative insurances,” investments in the coal needed to fuel alum furnaces, and twenty co-conspirators and twenty-six correspondents, from Archangel to Cadiz.¹⁷⁰ These too were the networks of the economic revolution.

¹⁶⁵ Faroqi, “Alum Production.” On alum production in China, see Singer, *The Earliest Chemical Industry*, 218–19. On the techniques that came to the Mediterranean from Persia, see Aygun, “The Flesh Eating Stone.”

¹⁶⁶ On pollution associated with the textile industry, see Jarrige and Le Roux, *La contamination du monde*, 35–37, 67–71.

¹⁶⁷ Description of the Tolfa mines outside Rome, where the furnaces were fueled by local wood. Bondaroy, *Mémoire sur les aluminières*, 4–11. On the contemporary landscapes of historical alum production, see Dallai et al., *I paesaggi dell’allume*, esp. 183–94, and <https://east-cleveland-industrial-heartland.co.uk/2018/01/17/the-alum-industry-of-north-east-yorkshire/>.

¹⁶⁸ Goethe, *Autobiography*, vol. 1: 362–63.

¹⁶⁹ <https://discovery.nationalarchives.gov.uk/>.

¹⁷⁰ Sutherland, “Sir George Colebrooke’s World Corner in Alum.”

Episode 5: Purchased Services

The last of the inputs in our KLEMS identity—S or purchased services—is at first sight the least evocative in a thought experiment in eighteenth-century history. The expansion of value added in services has been the principal stylized fact of the late-modern economic growth of the late twentieth and early twenty-first centuries. In a large symmetry of changing times, early modern economies were supposed to have a low-productivity agricultural sector, a modern sector largely made up of manufacturing, and a small service sector. In modern economies—from the mid-nineteenth century to the *Trente Glorieuses*, the years of rapid growth in Europe from 1945 to 1975—labor moved from agriculture to an expanding manufacturing sector; in late-modern economies, there is a small agricultural sector and labor moves from manufacturing to an expanding and initially low-productivity service sector.

This tripartite scheme is stylized to the point of obscurity, in that both agriculture and services are now understood to have been sites of extensive innovation.¹⁷¹ But services are undoubtedly at the center of economic activity in the advanced economies of the twenty-first century. “Other services” and financial services accounted for the largest share of aggregate value-added growth in the US from 1987 to 2018, for a substantial share of growth in capital inputs, and, especially towards the end of the period, for a significant part of the growth in multifactor productivity.¹⁷² They were also major sources of intermediate inputs. In the United States, in 2018, financial, business, and professional services accounted for 31 percent of “gross” use of output and 43 percent of intermediate use, up from 25 percent and 32 percent respectively in 1997.¹⁷³

The experiment in seeing with a multiplicity of data suggests the potential for rethinking the economic importance of services in late eighteenth-century Britain and France. “It is for the more developed countries, which have a greater share of complex material products and a greater weight of the service sectors, that the problems of measurability seem to be more acute—‘seem’ because we may be insufficiently cognizant of the quality differentials within what seem to us the simpler economies of the less developed coun-

¹⁷¹ On late twentieth-century services, see Jorgenson and Timmer, “Structural Change in Advanced Nations.” On late eighteenth-century agriculture, see Hoffman and Rosenthal, “New Work in French Economic History.”

¹⁷² Garner et al., “Integrated Industry-Level Production Account.”

¹⁷³ Data for industry sectors FIRE (finance, insurance, real estate, rental, and leasing) and PROF (professional and business services), Input-Output Accounts Data, Use of Commodities by Industry, 15 Industries (2018), <https://www.bea.gov/industry/input-output-accounts-data>.

tries,” Kuznets wrote in 1976.¹⁷⁴ Britain and France were indeed less developed countries in the eighteenth century—less developed in many respects than parts of China and India at the time, and less developed, certainly, than they later became, even though they can seem to be exquisitely and even ancestrally developed, in the retrospect of theories of industrial take-off and the culture of the enlightenment.¹⁷⁵ There were multiple quality differentials, in turn, within the service sectors of the time.

It is evident that a substantial part of the population of late-eighteenth century Britain and France was employed in the production of services, as has been seen in relation to the L inputs: a very significant part, in any vista of economic life that included the labor of female and male domestic servants, the employees of religious institutions, and the government employees, including the armed forces, who were excluded from the major inquiries of the 1770s and 1780s (and who are, in modern accounts, part of the “service sector” but not the “service-producing sector.”)¹⁷⁶ Most of the output of these industries was destined for the equivalent of final demand; it was sold to or used by households and governments. It was not—with one important exception—sold to other industries in the form of S inputs.

The exception was the service-producing industry that has been so prominent in late modern growth, which is finance, insurance, and credit. There are two large and incipiently heroic narratives about economic growth, now as in eighteenth-century Europe. One is a story of the real or industrial economy, and the other is a story of financial revolution or financial innovation. The two histories are for the most part, as so often in economic thought, parallel rather than integrated. They have in common a narrative of change in institutions and an explanatory variable—or elixir—in the security of property rights. There was investment and ingenuity, and there was also an expansion of public credit in England and of notarial credit in France; there were newly secure capital markets even amidst the insecurity of the Napoleonic wars.¹⁷⁷

¹⁷⁴ Kuznets, *Economic Growth of Nations*, 102–3.

¹⁷⁵ Hirschman, “The Rise and Decline of Development Economics,” 24.

¹⁷⁶ In Leigh Shaw-Taylor’s summary of evidence for England and Wales, findings indicate “(i) that the tertiary sector was, with mining, the most dynamic area of relative employment growth throughout the period; (ii) that the tertiary sector has been growing almost continuously as a share of all employment for the last three hundred years.” Shaw-Taylor, “The Occupational Structure of Britain.” See also Litvine, “French Occupational Structure”; Kutscher and Mark, “The Service-Producing Sector: Some Common Perceptions Reviewed.”

¹⁷⁷ Hoffman, Postel-Vinay, and Rosenthal, *Dark Matter Credit*; Neal, *The Rise of Financial Capitalism*.

The history of credit is of importance to any depiction or model of economic growth that takes K as a factor of production. It is of evident importance, too, to those depictions that identify four factors of production, “land, labor, capital, and entrepreneurship.”¹⁷⁸ As Carl Menger wrote in 1871, in a series of snide comments about the relationship between “so-called *entrepreneurial activity*” and risk, entrepreneurship can only happen if the person involved has at their disposition large quantities of capital: “credit increases, and legal uncertainties diminish these quantities.”¹⁷⁹

The expansion in inputs with which we have been concerned, in our journey through K , E , M , and even L , required credit at almost every stage. Investment in new engines and the relining of iron forges; imports of turpentine and exports of guns; the procurement of potash from networks of small suppliers and large landowners in the Baltic littoral and the Russian interior; the worldwide speculation in alum that led to the bankruptcy of the chairman of the East India Company in 1773: all these transactions required flows of information, insurance, and credit.¹⁸⁰ New credit institutions were essential for the “supply of working capital,” and they were a response, in Joseph Inikori’s account, to the financial needs of the “Atlantic economic system” and the African trade.¹⁸¹ The expansion of public and private credit was itself the obsession of what was described, in 1779, as “this age of information.”¹⁸² The “correspondence of the moneyed and the mercantile world,” for Edmund Burke, constituted a “kind of electric communication everywhere.” (See Services 5.1.)¹⁸³

The invisibility of intermediate inputs in economic history is in part a matter of statistics, or of the absence of statistics. There are no input-output tables for eighteenth-century economies and no prospect of deriving them, even though flows of raw materials—of the commodities that were of such interest to contemporaries—were counted more assiduously than the “out-

¹⁷⁸ <https://www.stlouisfed.org/education/economic-lowdown-podcast-series/episode-2-factors-of-production>.

¹⁷⁹ Menger, *Grundsätze*, footnotes on 136–37 and 149–50; Menger, *Principles*, 160–61, 172–174. The translation elevates the footnotes to the text and makes the tone slightly less snide.

¹⁸⁰ Sutherland, “Sir George Colebrooke’s World Corner in Alum.” On the spike in prices of Roman and English alum around 1770, see Figure 4 in Delumeau, *L’alum de Rome*, 172–73.

¹⁸¹ Inikori, “The Credit Needs of the African Trade,” 199, 213, and on the use of foreign bills of exchange in country banking, 202.

¹⁸² “On Preaching and Sermon Writers,” in Knox, *Essays Moral and Literary*, vol. 2: 157.

¹⁸³ Burke, *Letters on a Regicide Peace*, vol. 5: 259.

Services 5.1

Credit, like commerce itself, was identified as a form of information. London was described as a city of newspapers, gazettes, Lloyd's shipping lists, Lloyd's lists of the prices of East India funds, parliamentary reports, advertisements for auctions, records of bankruptcy proceedings, and pamphlets about ruin and indebtedness. It was the "public notoriety" of government finance, Jacques Necker wrote in 1781, that supported England's immense credit: the regular publication of parliamentary information about government revenues and expenditures. The French-Venetian writer Ange Goudar related in 1780 that, in the bookshops on the Strand, he had found "80 volumes which were concerned directly or indirectly with public debt." For Louis-Sébastien Mercier, the resilience of the British government's credit was a subject of continuing wonder. He too, in 1780, presented a benign explanation for why the "Bank of London" had become the "Bank of the universe." "It is important for the nation that nothing is hidden from her," he wrote: the number of gazettes was unlimited, and the *Daily Advertiser* was essential to commerce and businessmen; at the stock exchange, there were depositories of foreign newspapers where the traders gathered to evaluate the latest information: "nothing escapes, everything is known."

Private credit was by contrast assumed to be less secure. The first literally global financial crisis, with consequences from Calcutta to Virginia, began in 1772 with the failure of a small London bank with Scottish connections, and with rumors about Sir George Colebrooke's speculation in alum. "One link gave way—the charm was instantly dissolved, leaving behind it consternation in the place of confidence, and imaginary affluence changed to real want and distress," a Hamburg linen merchant said in the House of Commons in April 1774, looking back at a "black swarm of projects," and a "terror which oppressed all men."

Sources: Necker, *Compte rendu au roi*, 2–3; Goudar, *L'espion François à Londres*, vol. 1: 86–91; Mercier, *Parallèle*, 85, 118–24. Letter of June 27, 1772, from David Hume to Adam Smith, *Correspondence of Adam Smith*, 162; Sheridan, "The British Credit Crisis of 1772"; Goodspeed, *Legislating Instability*. Mr Glover, debate of April 20, 1774, in *Parliamentary History*, vol. 17: 1115.

puts” that have been imputed in subsequent accounts.¹⁸⁴ But it is also, and more profoundly, a matter of the understanding of early societies—of “simpler economies,” in Kuznets’ expression, with a lower incidence of “complex material products.” It is even a matter of a related understanding of pre-industrial economies as societies in which market institutions and economic ways of thinking were insufficiently developed. But this understanding is exactly what has been called into question by a generation of economic historians. It is called into question, too, by the evidence of circulating capital itself, from the long-distance markets for materials to the credit services of eighteenth-century Europe.

The economy of slavery—to return to the Bacaye plantation in Grenada—was made possible by networks of credit. The owner of the plantation needed a detailed inventory, in December 1770, in order to secure a substantial mortgage with a Dutch lender—a mortgage that was eventually the subject of litigation over more than fifty years. Another plantation owner, the brother of the Bacaye proprietor, introduced legislation in the House of Commons in 1772 “for encouraging Foreigners to lend Money upon Estates in the West Indies.” “Had we all the money in Europe at a reasonable interest, and could we actually employ it in trade, so much the better,” he declared in support of the West Indian loans; “we should thus be the bankers of Europe.”¹⁸⁵ Slaves were “by British laws deemed as perfect Freehold as land,” in the expression of a different Dutch lender in a different case over disputed mortgages on Grenada plantations; this case was resolved in 1774, with the intervention of George III and Louis XVI, after the lenders invoked the prospect of “a catastrophe similar to that of 1772,” “of the worst consequence to commercial faith.”¹⁸⁶

The expanding networks of credit required the activities of writers, in the sense of solicitors, and writers in the sense of copyists, as well as factors, agents, brokers, translators, clerks, and messengers. The (archaic) technology of financial information was itself news, as when a London periodical reported, during the first global financial crisis of 1772, that the news of the

¹⁸⁴ For a pioneering effort for the UK in 1841, see Horrell, Humphries, and Weale, “An Input-Output Table for 1841.” It is interesting that in long-term national income accounting, “for several key industries the scales of their raw-material inputs provide the relevant proxies” for the necessarily elusive statistics of “value-added outputs.” Broadberry et al., *British Economic Growth, 1270–1870*, xxxv–xxxvi.

¹⁸⁵ Speech of William Pulteney of April 29, 1772, *Parliamentary History*, vol. 17: 484. On the consequences of the ensuing legislation, see Price, “Credit in the Slave Trade and Plantation Economies.”

¹⁸⁶ Letter of Lord Dartmouth of August 27, 1774, “Memorial of Messieurs Bosanquet and Fatio,” “Memorial of James Ballmer,” TNA, SP78/293/123r, 126v, 130v, 131r.

initial bank “having stopped payment, was received at Edinburgh, just 43 hours after it happened at London.”¹⁸⁷ It is plausible that at least some of these activities should be counted, in our thought experiment, as intermediate inputs in the form of purchased services. The messengers and solicitors, or some of them, were employed by partnerships that sold their services to intermediate use.¹⁸⁸ These were uses in which technical change was embodied; or at least the technology of receiving market information a few hours ahead of everyone else, in much the same way as the technologies of the (organic) chemical industry were embodied in inputs of potash, or the technologies of the electronics industry in inputs of semiconductors.

The finance, insurance, and real estate industry that has been at the center of the service-led expansion in the United States has seen its flows to intermediate use increase even faster, over the past decades, than its output in the sense of value added.¹⁸⁹ One explanation has been the increased division of labor in late-modern economies, whereby services that were once performed “in house” by manufacturing or banking enterprises were now purchased from specialized providers.¹⁹⁰ In eighteenth-century Britain and France, prior to the rise of large-scale commercial banking or of vertically integrated manufacturing, there was also a proliferation of financial intermediaries.¹⁹¹ It extended, as in late-modern commercial society, from finance, including the transactions of notaries, to insurance, including the transactions of underwriters and commission agents, and to real estate. (See Services 5.2.) There were new services sold to final demand—like the services of the intermediaries Colquhoun described as “lottery vagrants,” or “persons employed in producing insurance during the drawing of the lotteries, or as proprietors of Little Go lotteries”—and there were also new intermediate flows.¹⁹²

¹⁸⁷ “Edinburgh is distant from London above 425 miles,” *The Gentleman’s Magazine* 42 (1772): 293.

¹⁸⁸ The “surveyors, lawyers, witnesses before Committees, etc.” invoked by Pollard in connection with the “political economy” costs of private acts of Parliament, were also in many cases self-employed or employed by partnerships—selling intermediate inputs in the form of professional services—rather than employees supplying labor services to the proprietors in question. Pollard, “Introduction,” 8.

¹⁸⁹ Use of commodities by industry, 15 Industries, 1997–2018, <https://www.bea.gov/industry/input-output-accounts-data>.

¹⁹⁰ Fort, Pierce, and Schott, “New Perspectives on the Decline of US Manufacturing Employment”; Sorbe, Galm, and Millot, “Can Productivity Still Grow in Service-based Economies?”

¹⁹¹ A recent study of maritime safety is an evocative journey into M-type inputs, like nails and “knees” and copper sheathing, and also into the services of financial and insurance intermediaries. Kelly, Mokyr, and Ó Gráda, “Safety at Sea in the Industrial Revolution.”

¹⁹² Colquhoun, *Indigence*, 42. The “Little Go” was a private lottery organized around the lotteries of the state. Raven, “The Abolition of the English State Lotteries.”

Services 5.2

One of the neighbors, in France, of the evaluator of the Bacaye plantation—Cazaud, the fellow of the Royal Society—was a litigant, in 1774, in the Chancery Court in London, in respect of “bills drawn on England at one hundred and ninety thousand pounds sterling” and of the insurance payments on an ill-fated voyage carrying slaves to “the coast of Mallay, the streights of Malacca and Borneo.” Another of the brothers of the proprietor of the Bacaye plantation, who was himself one of the plantation’s eventual mortgagors, acquired his initial capital in the form of “presents” from Bengali/Jain bankers, remitted it to Britain in the form of jewels and bonds on the French East India Company, and invested it in real estate and (unproductive) coal mines. The brother who was so concerned with encouraging “foreigners” to lend money to the owners of slave estates was the leading investor in urban real estate in the west of England, and in the Genesee purchase—together with Patrick Colquhoun, the statistician of capital—of 1.2 million acres of formerly Cayuga, Mohawk, Oneida, Onondaga, and Seneca land in upstate New York.

Sources: “Complaint of Claude Ogerdias,” July 16, 1774, TNA, C12/1041/9; Osgood, *The Title of the Phelps and Gorham Purchase*; Conover, *The Genesee Tract*.

The evocation of financial inputs in the late eighteenth-century economy has been inspired, once again, by an observation of the present. The financialization of the late-modern US economy has suggested a question about the importance of financial services in earlier economic growth. It has also suggested a different and more disconcerting question about the past. This question has to do with financial innovation. One of the conventional explanations for the resilience of the US economy from the 1990s to the 2010s—the “new age of markets”—has been the combined effect of information technology and “financial” technology, particularly securitization. Finance is identified as an “information-intensive business,” and one which has had the recent effect—in the presence of the elixir of private property rights and enforceable contracts—of expanding both the supply of credit and the efficiency with which “resources, especially capital, will flow to their highest-return use.”¹⁹³ Intermediate inputs of financial services, in our inquiry, could even be the equivalent of the explanatory variables of macro-

¹⁹³ Summers, “The New Wealth of Nations: Lessons from the 1990s,” 27, 32; Summers, “New Lending For A New Economy.”

history, like literacy or skill supply, or like semiconductors in our own times, with respect to increases in efficiency or total factor productivity.¹⁹⁴

The disconcerting possibility is that something like the hypothesis of efficient allocation was true of the British economy in the late eighteenth century, and that the highest-return users to whom so much capital flowed were the entrepreneurs of slave-dependent commerce. The financing of ventures in the slave trade, together with war finance, was of importance to financial innovation from the *Asiento* to the Napoleonic wars.¹⁹⁵ The brother of the Bacaye proprietor, as a student of Adam Smith, made a concise argument about resource allocation in support of the 1772 legislation for encouraging foreign lending: proprietors in the West Indies could not borrow money at less than 8 percent, while “foreigners” were prepared to lend at 5 percent “where the security is unexceptionable”—“what objection, then,” to providing them with security or securitization by enabling them to recover their money through the sale of mortgaged estates.¹⁹⁶ (See Services 5.3.)

Services 5.3

The discussions in 1772 and 1773 were eerily evocative of modern expectations about “securitization.” In the description of a witness heard in the second debate on the West India loans, a proprietor from the island of Dominica, “the greatest part of the money to be borrowed would be procured in small sums, paid in by subscribers at perhaps 100 l. [pounds sterling] or so, to the different houses in Holland, and again lent out to the West India planter, on a collateral security of some eminent merchant in London.” He added “that the Dutch, and other foreigners, when legally secured, would be very well pleased to have 5 per cent for their money; that he knew of money being already procured in the same manner by the planters in the island of St. Croix, and that the salutary effects arising therefrom were too notorious to require any proof.” The prospects were imposing: “the sum wanted would not in the whole exceed one million and a half he believed.”

Source: Examination of Oliver Nugent, January 22, 1773, *Parliamentary History*, vol. 17: 687.

¹⁹⁴ Kelly, Mokyr, and Ó Gráda, “The Mechanics of the Industrial Revolution.”

¹⁹⁵ Neal, *The Rise of Financial Capitalism*. The slave trade was only one, particularly risky component of the overall slave-based economy: Williams, *Capitalism and Slavery*, chap. 3.

¹⁹⁶ Speeches of William Pulteney of April 29, 1772, and January 22, 1773, *Parliamentary History*, vol. 17: 483, 688–89.

Even the legal case that ascended to George III and Louis XVI, in 1774, was over a related exercise in regulatory arbitrage. A number of proprietors had borrowed money on the security of their estates in Grenada—in which slaves were as perfect freehold as land—and then removed themselves, with their slaves, to Martinique or other French islands, in which by French law—as by the laws “of all advanced nations,” in the expression of the royal governor—the enslaved were something other than (immoveable) things. The resolution of the case was to permit the lenders to recover, not the slaves, but the proceeds of the sale of the slaves—a vindication, as the governor of Martinique wrote to the governor of Grenada, of “the order of property, contracts, and the security which citizens have a right to presume under the government of civilized states.”¹⁹⁷

The Value of Capital

This is the end of the thought experiment in omniscience, and of the journey through K, L, E, M, and S. There are some tentative conclusions—or an agenda, rather, for further investigation, in our own real world of imperfect information.

To think of British or French national income or output in terms of GNP rather than GDP can lead to a re-evaluation of the capital supplied by residents of the metropolis, and used in the slave colonies. To think about gross output and not only about value added—to take intermediate inputs seriously—is to have a different view of economic change. The military economy has been omnipresent, in our overview of a half-century of war and preparations for war, and so has the economy of slavery.

The micro-empirical perspective that has been explored here—and the KLEMS accounting identity—can provide a framework, I would like to suggest, for thinking about the colonial economy and the use of natural resources. It can also, I hope, contribute to a new way of thinking about the industrial revolution itself, and about the place or places of capital within it. Capital was everywhere in the enterprises that have been at the center of this inquiry. But it was circulating or working capital, as in the models of the economists of the time, more than fixed capital or than the “human” capital of the unenslaved. It was overseas or at sea; it was fixed in agricultural land or used up in agricultural production; it was invested in the alum hills of

¹⁹⁷ Letter of the Comte de Nozières to Governor Leyborne, July 6, 1774, ANOM, C8A/73/150.

Tolfa or the uplands of Saint-Domingue; it was stored in barrels of kelp or ells of sailcloth or sheets of copper.

Like all historical reflection, this inquiry has been an attempt to engage with overlapping generations of ways of thinking about the world—to think about the past on the basis of observations of the present, and also to think about the ways in which past historians (or economists) observed their own present, and embodied it in their models of the past. It has been an exercise, at the same time, in the most disorienting of all historical obligations, or the effort to forget what is now obvious: to understand that individuals in the past did not know what happened next.

The very momentousness of the industrial revolution in recent historiography—that it “irreversibly changed the course of global economic history”—has in this sense been something of an inconvenience.¹⁹⁸ It has obtruded an interest in what came after; an interest that has been even more exigent to the extent that the European experience is seen as a model as well as a precedent. But the explanation of what happened in a particular period is to be found within that period, and in the period of minus infinity to *t*, or in this case to 1760. There was no one who knew, when the *Monétatty* left Bordeaux for Saint-Domingue in early 1790, that the prosperous colony was almost at an end. There were entrepreneurs who knew that the alum industry was in decline, and other entrepreneurs who looked forward to the future of potash and kelp.

The models of economic growth of the mid-twentieth century, which have been the foundation of so much economic history, were the outcome of a particular historical moment, with its idiosyncratic sources of data, expectations of stability, and understanding of *K* and *L* as factors of production. The contemporary system of national income and product accounts was established amidst the wartime emergency of 1941–42, and at a time when investment in physical equipment, in the US, was at its highest modern level, as a share of investment and as a share of GDP.¹⁹⁹ In the subsequent postwar expansion, “the single most important contribution to US economic growth . . . was made by capital input.”²⁰⁰ There were “special goods,” “capital goods,” as Robert Solow and Peter Temin wrote of the inputs into British economic growth

¹⁹⁸ Mokyr, “That Which We Call an Industrial Revolution,” 197.

¹⁹⁹ Stone and Stone, *National Income*, 7–8; Jorgenson, “Production and Welfare”; Fourquet, *Les comptes de la puissance*, 30–47. On investment in structures and equipment in the United States, see Jones, “The Facts of Economic Growth,” 13.

²⁰⁰ Figures for the period 1948–1979, in Jorgenson, Gollop and Fraumeni, *Productivity and U.S. Economic Growth*, 1.

during the industrial revolution, and they were “distinguished by their usefulness in production over time.”²⁰¹ The importance of fixed capital is less, in recent macro-history, and the importance of technical progress, “human capital,” and “human capacity” has increased.²⁰² But change is understood to be embedded, still, in millwrights, ironmongers, and the blueprints of fixed things.

This inquiry is the product of different historical times—of the twenty-first-century moment of service-led growth, oceanic amounts of data, and of an evolving, etiolated understanding of capital. The 1970s marked a high point, in retrospect, of what Martin Weitzman called the “capital theory of value,” and of its application to the process of economic development.²⁰³ It was a theory that had been counterposed, from the outset, to a view of the multiple sorts of inputs or inventories as all much the same—the view of “Austrians,” in Solow and Temin’s summary, and “more appropriate to agricultural than to industrial economies.”²⁰⁴ It was counterposed, in other perspectives, to a more general skepticism about the economic importance of the physical conditions of production—the “faulty concept of a factor of production . . . as a physical entity,” in Coase’s description, instead of as a “right to perform certain (physical) actions”—and of the owners of physical capital; “in the Lancashire cotton industry, a weaver can rent power and shop-room and can obtain looms and power on credit.”²⁰⁵

But the contemporary, etiolated understanding of capital is itself the outcome of the successes of the capital theory of value.²⁰⁶ Capital, or the flow of capital services, became tractable or easy to measure, and the metaphor of capital was applied ever more widely. The US national accounts “expanded the asset boundary” to intangible things (intellectual property, computer software, “artistic originals”); there were extended efforts to incorporate “human capital” and natural capital (“the environment is itself a gigantic capital asset”).²⁰⁷

²⁰¹ Solow and Temin, “Inputs,” 19.

²⁰² Kelly, Mokyr, and Ó Gráda, “Precocious Albion,” and the overview in Hoffman, “The Great Divergence.”

²⁰³ Weitzman, “Shiftable versus Non-Shiftable Capital,” 516. As Weitzman also wrote, “to an economist, the study of economic development is in large part an investigation into the mechanics of capital formation” (511).

²⁰⁴ Solow and Temin, “Inputs,” 19.

²⁰⁵ Coase, “The Problem of Social Cost,” 43–44; Coase, “The Nature of the Firm,” 388.

²⁰⁶ On capital services, see Griliches and Jorgenson, “Capital Inputs.”

²⁰⁷ On the asset boundary in US national accounts, see BEA, *Concepts and Methods*, 1.6, 2.3, 2.4; on estimates of human capital, see Jorgenson, “Production and Welfare”; on the valuation of environmental capital, see Rothschild, “Maintaining (Environmental) Capital Intact.” The com-

The boundaries of capital at the same time became narrower, or less imposing. Even the tractability of capital—its transposition into flows of capital services and calculated rental prices—had the cumulative effect of flattening the distinction between primary and secondary inputs. The descriptions of capital by theorists of economic growth became less than entirely respectful: it was “an intertemporal intermediate input,” investment was “an intermediate good,” “intermediate goods are just another form of capital,” “capital is treated as an intermediate product.”²⁰⁸ Capital was simultaneously stretched beyond recognition and reduced to mediocrity. Intermediate inputs themselves became incipiently epochal, as the embodiments of technical change in a new universe of virtual innovation. Semiconductors were *vertretbar* or replaceable, and they were also the repository of memory and expectation—the sim cards amongst which everyone exists.

These circumstances of our own times have disconcerting consequences, it seems to me, for understanding economic history. If the idea of capital is so diffuse in our own late-industrial times, then why should it be of such explanatory power in the early industrial economy of the late eighteenth and early nineteenth centuries? To own something was indeed to be able to wait, as in Turgot’s description of the countryside around Paris in 1770. It was a form of security with respect to the future, in an uncertain world, in the sense that a peasant woman who owned a little gold cross would in “times of distress” be able to sell it, albeit at a loss, and thereby gain the “means to wait for less hard times.”²⁰⁹ Capital was a form of power, as it was for the English undertakers with their acts of parliament and turnpike trusts. Adam Smith’s explanation for the endurance of slavery in the West Indies, in the end, turned on a circumstance in the world—that the “profits have been so enormous”—and on a circumstance of human nature: “this love of domination and tyrannizing.”²¹⁰

“Some other, necessarily more general, system”

Our minimal model of inputs and outputs—and the exercise in thinking with omniscience—has so far been evasive about two momentous questions, to

ment about the environment as an asset is from Dasgupta and Mäler, “The Resource Basis of Production and Consumption,” 7.

²⁰⁸ Baqaee and Farhi, “Beyond Hulten,” 10n17; Barro, “The Double-Counting of Investment,” 4; Jones, “Intermediate Goods and Weak Links,” 2; Hulten, “On the ‘Importance’ of Productivity Change,” 127.

²⁰⁹ “Lettres sur le commerce des grains,” in *Oeuvres de Turgot*, vol. 3: 335.

²¹⁰ Smith, *Lectures on Jurisprudence*, 186, 523.

do with time and with the boundaries of economic life. The $X_{i,t}$ of gross output in the KLEMS identity, like the Y of national income, is the depiction of a flow and not a stock—the flow of goods and services, or value, over time. In standard national accounts, the period in question is one year, although it can be “quite helpful,” in the measurement of technical change, to use a time period of a “decade.”²¹¹ The metaphor of an instantaneous photograph of wealth or work is itself incoherent in any account of economic history that aspires, eventually, to be empirical or founded on evidence. Measurement, like the compilation of the records or registers on which it is based, takes place in space and time, and requires the expenditure of resources.

Our long, indistinct period of observation, from the 1760s to the 1810s, was imposed by the diffuse literature on the industrial revolution, and in particular by the economic-cultural explanations of recent years. The spirit of the enlightenment does not turn on a dime. But one of the objects of the exercise, evidently, has been to think about change within or over the course of this half-century. It is not to propose an array of (almost entirely imputed) KLEMS-like measures for successive years, as in the exercise that the US national accounts calls “backcasting.”²¹² It is rather to think about different sorts of evidence and different ways of juxtaposing them.

Time itself, meanwhile, unfolded in multiple cadences. There was the time of good and bad harvests. There was mobility of employment over the course of the day, the season, or a lifetime—into and out of occupations, the army, or the market. There were large-scale and long-distance financial crises, starting in 1772. There was the time of war and of the end of war, with all its consequences for industrial production, employment, and financial innovation. No year, over the fifty-year period, was a representative year, and fewer than half were years when Britain and France were not at war. War was a joint venture, with its own booms and busts.²¹³ There was an “essential continuity of the economic process,” as in Leontief’s prologue to the eventual dynamic understanding of “historical input-output relationships,” and there were also discontinuities.²¹⁴

²¹¹ Domar, “On the Measurement of Technological Change,” 722n2. Intermediate purchases, in such an accounting, would be purchases of goods “normally depreciated over” less than ten years.

²¹² Garner et al., “Integrated Industry-level Production Account.” On the awkwardness of the construction of dates in economic history, see Grenier and Lepetit, “L’expérience historique.”

²¹³ On the extent of the connections between England and France, see Crouzet, *La guerre économique franco-anglaise*, especially chap. 2, and Morieux, *The Channel*.

²¹⁴ Leontief, *Studies in the Structure of the American Economy*, 22.

The other momentous question that has been avoided so far—of the boundaries of economic life—is also, among other things, a question about time. We have followed, so far, the US national accounts’ delineation of the economic in its initial iteration of 1934: “efforts whose results appear on the market place of our economy.”²¹⁵ This corresponds, more or less, to the “production boundary” in contemporary accounts.²¹⁶ But the boundary has itself changed continually over time, with changes in economic life, in the “functional” limits on the enterprise of measurement, and in concepts of economic value.²¹⁷

One of the stylized facts of economic observation is that “the more price- and market-oriented a country is, the smaller is the imputation problem,” in Oskar Morgenstern’s account; “the less developed a country is, the larger looms the imputation problem.”²¹⁸ But the irresistible desire to impute has a tendency to rise again. About 16 percent of the GDP of the United States in 2019 took the form of “imputations” for “own-use and nonmarket transactions.”²¹⁹ “Early-industrial” imputations—like “farm products consumed on farms”—declined as a share of US GDP after World War Two; the share of “late-industrial” imputations—like owner-occupied housing and the services of commercial banks—has more than tripled.²²⁰

There is an “extreme variability” in the theoretical idea of national income, Leontief wrote in 1951 of anxieties over “double counting,” and what he described as the “suppression” of intermediate exchanges. The “more or less arbitrarily defined” flow of values was of interest, no doubt, to “welfare economics,” but to a “more detached observer,” it was a “mere by-product”

²¹⁵ *National Income, 1929–1932*, 6.

²¹⁶ The use of the words “market” or “market place” has been replaced, in the standard international accounts, by the mildly euphemistic “institutional unit . . . that owns . . . or is entitled to be paid.” BEA, *Concepts and Methods*, 2.1.

²¹⁷ The “functional” limits include “practical considerations about whether the productive activity can be accurately valued or measured. For example, illegal activities, such as gambling and prostitution in some states, should in principle be included in measures of production.” BEA, *Concepts and Methods*, 2.2.

²¹⁸ This was the relatively reassuring conclusion in Morgenstern’s critique of national accounts. *On the Accuracy of Economic Observations*, 246.

²¹⁹ BEA, *Concepts and Methods*, 2.5. “In order to be comprehensive, [GDP] must include some goods and services that are not traded in the market place. Those components of the GDP are called imputations . . . Imputations approximate the price and quantity that would be obtained for a good or service if it was traded in the market place.” BEA, “Why does GDP include imputations?” <https://www.bea.gov/help/faq/488>.

²²⁰ NIPA Table 7.12.

of a “whole highly complex process.”²²¹ Flows of intermediate goods are market transactions that are not counted. There are also near-market transactions that are sometimes counted and sometimes not, and here too the theory varies over time. Like the understanding of change in technical coefficients, for Leontief, the choice of what to count evokes “some other, necessarily more general, system of theoretical reference.”²²²

Monod’s inquiry—to return to the naturalism of the Martian NASA—was a reflection on the “microscopic” and the “macroscopic.” The macroscopic was measured in centimeters, not in the satellite or earth observatory sense that the scientists could gaze down at everyone who was working for British capital, for example, and count individuals at work in Glasgow or Jamaica.²²³ The Martian scientists were interested, rather, in the possibility of intelligent life on Earth and in the procedures for distinguishing, amidst the multitude of different sorts of things by which they were surrounded, between the “natural” and the “artificial.” They were led inevitably into telling themselves stories about the past of disparate things—were they the products of human industry?—and even about the future.

The large question of the boundaries of economic activity is similar, in that it, too, is an inquiry into which of the multitude of different things that individuals in the past were doing or endowing to the future were economic and which were not; things that should be taken into account in economic history. The idea of the instantaneous is incoherent, here, for a different reason. To look at a metal object, and to ask the question, is it a capital good or an intermediate good, is to ask a question about the past and the future. So is the question, is it an economic good? The object may be something that is artificial, of which the history required the use of economic resources (and not a lump of ore). But is it something that is for sale, like the “second-hand metals” that were hawked by vagrants in 1806? Or is it a residue, left to rust and defile?

The services of capital goods are the outcome, in principle, of a sequence of inputs over the period from minus infinity to now.²²⁴ But even in the finite practice of national accounts, in which assets are estimated to last a maximum of 95 years, past and future flows are arrayed over an expanse of time in which the frontiers of the economic—the idea of the

²²¹ Leontief, *The Structure of American Economy*, 19–20 and n1.

²²² Leontief, *Studies in the Structure of the American Economy*, 20.

²²³ <https://earthobservatory.nasa.gov/>; Monod, *Le hasard et la nécessité*, 19.

²²⁴ Some capital goods, like residential structures, can also be seen as the source of a sequence of outputs (of imputed housing services) over the period from now to plus infinity.

territory of economic measurement or of economic history—are likely to change in radical ways.²²⁵ Things that were once counted or imputed are uncounted now, and things that are uncounted now will be counted in the future. These are services and things of which the “results” sometimes appear in and sometimes disappear from “the market place of our economy,” and from economic history.

The almost-market flows can be positive or negative; some of them are “‘suspected’ in advance,” like new technologies, in Samuelson’s description, thereby inducing “anguish and revaluations.”²²⁶ The construction of roads, in a familiar example from eighteenth-century Europe, can be thought of as the source of future inputs into the transport of goods, into the possibility of the division of labor, or even into the spirit of modern times. “Financial innovation,” like the securitization of mortgages, can be thought of as an input into future investment. Some of the almost-market flows are sometimes thought of as good and sometimes as bad. One important work on the measurement of economic welfare, in the early 1970s, took “the disamenities of urbanization” as a principal example of negative externalities. Urban life and agglomeration are celebrated, half a century later, as sources of amenity, invention, and future economic progress.²²⁷

Other flows are only bad. The “poisonous Damps and destructive Effluvia of Lead, Silver, Copper, and Arsenic” of 1756 were unsold outputs of industrial production.²²⁸ One of the benefits of an economic history that takes intermediate inputs seriously would be to show the trajectories—in space and time—of raw materials to which costs could be imputed in future measurements. “The right to do something which has a harmful effect . . . is also a factor of production,” in Coase’s account, and some of the effects—the effluvia and the rusting metal—are unsold negative inputs into future welfare.²²⁹ The enslavement of 58,356 children, women, and men in Grenada,

²²⁵ The longest lasting asset, in US accounting practice, is “other railroad structures,” estimated at 95 years. “BEA and BLS Mean Asset Service Lives,” in BLS, “Overview of Capital Inputs for the BLS Multifactor Productivity Measures,” Table 1.

²²⁶ Samuelson, “The Evaluation of ‘Social Income,’” 303.

²²⁷ Nordhaus and Tobin, “Is Growth Obsolete?”; Glaeser, *Triumph of the City*.

²²⁸ Burke, *A Vindication of Natural Society*, in *The Writings and Speeches of Edmund Burke*, vol. 1: 178.

²²⁹ Coase, “The Problem of Social Cost,” 44. The economic or almost-market harms associated with market production can be thought of as negative joint products, which are capital-like to the extent that they take the form of flows arrayed over an often extended period of time; a period, in turn, over the course of which the definition of the almost-economic is likely to change. The Coasian negotiation between the owners of the right to pollute and the neighbors who incur the

of 168,792 individuals in Jamaica, and of 241,311 in Saint-Domingue—these were the “flows” of newly disembarked slaves in the sixteen-year period from 1763 to 1779—was also an unsold negative output of economic production, then and into the indefinite future.²³⁰

Economics and History

The story has returned, at last, to the teleology of economic change. Britain and France, in the late twentieth-century epoch of macro-economic history, were no longer economic superpowers. They had no more colonies, or only a few. But the historical destiny of having been “first”—in inventiveness or property rights or resilient political institutions—was a consolation. It was something to be commended to others—a model. It had changed the course of history.

The teleological history is inspiring, still, in respect of the economic expansion of the long nineteenth century, and of spectacular (if unequal) improvements in living conditions and life expectancy. But fifty years later, there are new models of change. There has been a convergence of eastern China and western Europe; there are new industrial histories, as in Bangladesh and Indonesia since 1990, and new disamenities. The share of France-Britain in world GDP was around 9 percent in 1970, and around 6 percent in 2019; China’s share increased over the same period from 3 percent to 16 percent.²³¹ The transformations of the late eighteenth and early nineteenth centuries are seen, now, as the founding moment of the fossil-fuel intensive model of development that is leading the world towards catastrophe; or as the foundation of a racialized capitalism in which the lives of millions of individuals did not or do not matter. There is only a glow of industrial-revolution kitsch—smokestacks and stagecoaches and dancing “Brunels.”²³²

costs of being polluted is a process that can last for a few weeks, or a few decades, under conditions of continuing change in institutions and in the understanding of environmental change.

²³⁰ <https://www.slavevoyages.org/> and see Episode 2: Labor above.

²³¹ World Bank, World Development Indicators, GDP in current US dollars, available at <https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=FR>

²³² “The stadium contains a rural scene . . . stagecoaches enter, carrying fifty businessmen and early industrialists in Victorian dress complete with top hats . . . fifty ‘Brunels’ step down from the carriages . . . industrial workers emerge . . . seven smoking chimney stacks rise from the ground.” See “London 2012 Olympic Games Opening Ceremony Media Guide”; “Industrial Revolution Sequence,” www.achistoryunits.edu.au.

This thought experiment in omniscience has been an attempt to see the economic life of the industrial revolution from outside. It is not an exercise in the impossible idyll of observation without theory, but an effort to see with different theories.²³³ This was part of the point of the evocation of Jacques Monod's Martians. The imaginary Martians have been important because they were so empirical, or empiricist. They were thinking like microbiologists, and thinking, eventually, with the possibility of a sort of "complete description" that is not the same as understanding, but that is irresistible in our own world of quasi-infinite information.²³⁴

The inquiry has itself been assertively micro-historical. Its point of departure, in recent economic ideas about aggregation, was interesting, important economic thought, and not at all the "routine gruel that the economic theorist gives to the historian." I hope that the thought experiment has pointed in turn to something other than the "same routine gruel" that "economic history gives back to the theorist."²³⁵ The optimistic suggestion is that good or modern or mainstream economics can be complementary to good or modern or mainstream history, and that there is a possibility, even, of exchanges that go beyond the sort of interdisciplinarity in which everyone, as in Condorcet's expression of 1793, is consecutively "boring" and "bored."²³⁶

The micro and the macro of economics map only imperfectly onto the micro and macro of history. But history, as much as economics, is living with a new abundance of information or evidence. The information is not new, but the ways of finding and using it have changed beyond recognition. The inquiries by historians that I have referred to in this essay—into the toll records of the Danish port of Elsinore, or the Tolfa alum works, or the evidence of witnesses in criminal trials, or the correspondence of Birmingham gun merchants—have been based on prodigious ingenuity in using old sources, and in thinking about sources in different ways. The critique of statistical and archival sources, which is so central to historical inquiry, is also essential for economics, amidst the new ocean of information.

²³³ As in Einstein's comment, reported by Heisenberg, that "It is the theory which decides what can be observed." Bethe et al., *From a Life of Physics*, 40; and see Jones, "The Facts of Economic Growth," 4.

²³⁴ On the possibility of the "complete descriptions of everything [that] can be attained," and on the incompleteness of these descriptions in relation to novelty and computation, see Brenner, "Theoretical Biology," 1964. On Brenner's identity as an "empiricist" and on the "unprecedented means of collecting data at the deepest molecular level," even as "understanding all this information has lagged far behind its accumulation," see Brenner, "Sequences and Consequences," 207.

²³⁵ Solow, "Economic History and Economics," 330.

²³⁶ "Fragment sur l'Atlantide," in *Oeuvres de Condorcet*, vol. 6: 609.

The view from outside (or from Mars) of late eighteenth-century economic life has been an inquiry, in part, into the sorts of activities that no one was interested in measuring at the time, and in part into things that were measured assiduously (like red lead), and that have seemed, ever since, to be impossibly dull. Condorcet believed that statistical registers should be designed “even for the results of research that people have not yet begun to think about,” or that no one “had the intention of looking for when the tables were drawn up.”²³⁷ This was an impossible dream, then as now. But the registers that exist can be used in different and hitherto unimagined ways. There is the possibility of sampling; there are multiple opportunities, as Claire Lemerrier and Claire Zalc have shown, for using quantitative techniques in new ways.²³⁸

Histories of economic life can be as eclectic and as inventive in their sources as the modern micro-economics of development. It is not possible, for historians, to live amidst individuals in the past, asking questions and listening to stories, and having conversations about new sources of data.²³⁹ But it is possible to know something of the conversations of the past, to the extent that they were reflected in high or low economic texts, or in legal records, and the ways of doing so extend across almost all the distinctions of social or intellectual or micro or financial or economic history. In a “complicated and uncertain” world, as Abhijit Banerjee and Esther Duflo have written, “the most valuable thing economists have to share is often not their conclusion, but the path they took to reach it—the facts they knew, the way they interpreted those facts, the deductive steps they took, the remaining sources of their uncertainty.”²⁴⁰

The perspective of micro-economics—in the economists’ sense—can itself be productive in thinking about the most momentous question with which this inquiry has been concerned: the relationship between slavery and economic change. The individuals who invested £37 million (or more) in slave plantations in the British colonies, and the other individuals who invested in the slave trade, did so because the rate of return on their capital was greater than it would have been (or than they believed that it would have been) in other uses. So too did their creditors, in Holland and elsewhere. It was “recognized in Saint-Domingue,” Say wrote in 1814, that the

²³⁷ “Sur l’instruction publique” and “Tableau général de la science,” in *Oeuvres de Condorcet*, vol. 7: 558, vol. 1: 554.

²³⁸ Lemerrier and Zalc, *Quantitative Methods in the Humanities*, and their article in this issue.

²³⁹ Banerjee and Duflo, *Poor Economics*, viii.

²⁴⁰ Banerjee and Duflo, *Good Economics for Hard Times*, 7.

purchase price of an estate would be recovered in six years; in “Europe” this would have taken twenty-five or thirty years.²⁴¹

The economy of slavery was risky, and some of the risks were insurable. Others were less easy to insure, within the fluctuating jurisprudence, across different legal systems, of security on different kinds of property. Some were “political economy” risks, in the economists’ sense; the uncertainty, for example, over whether the brother of the Bacaye proprietor would succeed, in the end, in influencing regulation and eventually legislation in Britain with respect to security on Dutch mortgages. As Turgot wrote in 1770 of the fluctuating regulation of the grain trade, “they would no doubt count these new risks, and their shame, as among their expenses of doing business.”²⁴²

The encouraging prospect for historians is that all these investments were intensely productive of pieces of paper. Information, and especially information about long-distance exchanges, was written down—it left a trace.²⁴³ This is micro evidence. But there is an immense quantity of it. There are the steam engines for a sugar plantation in Jamaica about which Boulton wrote to Watt in 1783, and the Perrier steam engine “for irrigation,” powered by coal, that was inaugurated in 1786 in the plains of Artibonite in Saint-Domingue.²⁴⁴ The distribution of credit—at sea or in rural France, on the move between Smyrna and Livorno, or between Lisbon and Königsberg, as in Smith’s evocation of the invisible hand—had a requirement, at the margin, in purchased services, and a requirement in the written instruments of exchange.²⁴⁵

The owners of capital in slaves were adept, undoubtedly, in concealing the flows of their funds, as were the nineteenth-century heirs of their fortunes and their records. The flow of fortunes from the “East Indies” to slave plantations, and eventually back to Britain, was even more obscure. This has

²⁴¹ Say, *Traité d’économie politique pratique*, vol. 1: 287.

²⁴² “Lettres sur le commerce des grains,” in *Oeuvres de Turgot*, vol. 3: 323.

²⁴³ There were mortgages, customs declarations, visas, passports, contracts, denunciations, insurance documents, signs of prices, advertisements, ships’ registers, court records, and lawyers’ invoices. “I have seen very much writing, I have instructed very much to be written, I have myself written a great deal,” as the theorist of Britain’s extra-territorial output recalled at the end of a long and devious official career. D’Hauterive, *Quelques conseils à un jeune voyageur*, 39. See also McCusker, “The Demise of Distance.”

²⁴⁴ Letter from Boulton to Watt of 1783, quoted in Williams, *Capitalism and Slavery*, 103. On the Perrier steam engine and coal in Saint-Domingue, see McClellan, *Colonialism and Science*, 74, and McClellan and Regourd, *The Colonial Machine*, 219, 394.

²⁴⁵ The unindustrial figure who serves as Smith’s illustration of the famous metaphor of the invisible hand was an “Amsterdam merchant” trading between Lisbon and Königsberg, much concerned with the “double charge of loading and unloading.” Smith, *Wealth of Nations*, 454–56.

posed redoubtable difficulties for any macro evaluation of capital investment. But there are records of ownership over several generations, as in the extraordinary documentation of the Haitian indemnity, in France, and the eventual compensation of slave-owners in Britain.²⁴⁶

Even the semi-licit capital flows required paper, in a world, unlike our own, in which information had to be transmitted over long distances in the material form of written or spoken words. Lord Clive, in the course of the momentous wind-borne journey from London to Calcutta via Brazil, stopped in Madras, from where he sent a letter in cypher, by a French ship, to his lawyer in London, with instructions to his stockbrokers to borrow as much as they could in his name, to be invested “without Loss of a Minute” in East India company shares.²⁴⁷

This inquiry has been an extended reflection, in a sense, on my own circuitous journeys into the micro-history of hundreds (or thousands) of individuals in eighteenth- and nineteenth-century Europe. The outcome of the journeys has been a multitude of stories; about picaresque or uneventful or self-interested lives. But I have had the intuition, throughout, or the pretention, that to think about these individual histories of economic life is also to think about data, and about some of the very large questions in economic history—and even in economics—with which historians and economists have been concerned for so long. To think about the micro-foundations of macro-economics is not entirely dissimilar to thinking about the micro-foundations of macro-history, and it is promising, in any case, or in both cases, to start with industries, or enterprises, or individuals.²⁴⁸

I am not sure—how could one be?—about the future direction of the (historical as well as economic) aggregation of the micro into the macro that I have tried to outline. It does not lie in an entire imputed KLEMS accounting of eighteenth-century economic life, or in the assembly of “even a series of convincing micro-empirical studies” into “cross-sectional growth regression exercises.”²⁴⁹ It is an exercise, rather, in thinking with evidence.

²⁴⁶ On the *État détaillé des liquidations opérées par la commission chargée de répartir l'indemnité attribuée aux anciens colons de Saint-Domingue*, see Rothschild, *An Infinite History*, chap. 8, and <https://esclavage-indemnites.fr/public/>.

²⁴⁷ The letter arrived three weeks in advance, as it turned out, of the sharp increase in the price of the shares when official information about events in India reached London; it was made public, some years later, when the lawyer was himself a witness before a committee of the House of Commons. *Third Report from the Committee*, 313–14, 404–5; Rothschild, *Inner Life of Empires*.

²⁴⁸ Trivellato, “Is There a Future for Italian Microhistory?”

²⁴⁹ See Banerjee and Duflo, “Growth Theory through the Lens of Development Economics,” 535, 542, on the possibility of “non-aggregative growth theory.”

What I am certain of is the extraordinary abundance of the evidence about capital that I, following so many others, have been able to find.

I am certain, most of all, that the inquiry is important. One of the ways in which the micro/macro of economists and the micro/macro of historians are not, in the end, so different, is that the macro is no longer a signifier of the important, or the interesting, or of that which is of public consequence. To see the macro from below, or from the ground up, is to see different, disconcerting sorts of evidence. The eclectic inquiries of the past generation into the history of economic life, with their multiplicity of sources, have changed understanding of the institution of serfdom—on the basis of estate records—and of early modern credit, on the basis of (high and low) economic writings.²⁵⁰ An inquiry into the varieties of capital in the industrial revolution—so profoundly, disorientingly different from our own—is also of macro importance. This was not a time when nothing happened, even if the end of what began, then, is the unidyllic world in which we now live.

Everyone thinks with circumstances, and with theories, or models, of the world as it is. The individuals who have come and gone in this inquiry were not ingenuous figures, with no interest in the future. They had their own models of economic growth, and their own understanding of the world they were inventing; they were suspicious in advance of changes in the political economy of slavery, and anxious about the destructiveness of coal mining. It is impossible, for economists and historians in 2021, with our models of our own times, to think of ourselves as individuals with no interest in the circumstances around us; “there is no route back from reflectiveness.”²⁵¹ But this makes it all the more important to try to make sense—enterprise by enterprise or family by family—of the origins of the modern, suffering world.

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Abbreviations for Archives and Libraries

AM-A:	Archives municipales d'Angoulême
ANOM:	Archives nationales d'outre-mer, Aix-en-Provence
AN:	Archives nationales, Paris
ASV:	Archivio di Stato, Venice
BL/OIOC:	British Library, Oriental and India Office Library Collections

²⁵⁰ Dennison, *The Institutional Framework of Russian Serfdom*; Trivellato, *The Promise and Peril of Credit*.

²⁵¹ Williams, *Ethics and the Limits of Philosophy*, 163.

GUL: Glasgow University Library, Special Collections
 LMA: London Metropolitan Archives
 TNA: The National Archives, Kew
 UB/WIP: University of Bristol, West Indies Papers

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