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## NOTES

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### *Measurement and Assessment of Coal Consumption in Nineteenth Century European Economies: A Note*

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Many historians have used measures of the level or growth of coal consumption to illuminate nineteenth century European economic development.<sup>1</sup> But attempts to employ these data as a proxy for economic performance have not been successful. Since they are biased in favour of coal-rich countries, the data have generally been used to reinforce an impression of inferiority of the French economy relative to that of Britain and Germany. Such impressions, as many have recently shown, are misleading. That France consumed 50% less coal does not mean that it was 50% less economically developed, or that it was less developed at all.

In a 1985 article,<sup>2</sup> Rondo Cameron presented a different argument with respect to coal consumption data. In examining the performance of five late follower countries (Sweden, Norway, Denmark, the Netherlands, and Switzerland) he tried to show that coal

<sup>1</sup>. Notable examples include, D. LANDES, *The Unbound Prometheus* (Cambridge, 1969); S. POLLARD, *Peaceful Conquest*, (Oxford, 1981); and, especially, N. GROSS, "Economic Growth and the Consumption of Coal in Austria and Hungary, 1831-1913", *Journal of Economic History*, 31, 1971, pp. 898-916. Gross termed coal consumption growth "the best single indicator ... [of] the pace of transition to modern economic growth," p. 898.

<sup>2</sup>. R. CAMERON, "A New View of European Industrialization", *Economic History Review*, 2nd. Ser., XXXVIII, 1985, pp. 1-23.

consumption data are descriptive. They reveal, not growth per se, but rather the relative importance of coal energy in the growth process. By comparing coal consumption across economies, we can, in this view, gain insights into the variety of development strategies these countries pursued.

Cameron's approach is entirely plausible, but in attempting to make his case, he chose the wrong measure. By using data on coal consumption per capita, (the measure typically found in the literature), he missed the full implications of his own point. Indeed, this paper will argue that per capita measures can give misleading assessments of the relative importance of coal energy in economic growth.

The central point is simple: a per capita consumption rate does not describe the relative importance of coal energy to an economy. Consider two hypothetical economies. Coal consumption per capita is identical in both. But GNP is significantly higher in the second economy.<sup>3</sup> Clearly both countries have not followed the same development patterns despite identical consumption rates. The weaker economy has relied far more on coal energy (and probably on coal-intensive industry) since the rate of coal consumption per unit of output is higher. Thus, per capita coal consumption data, so far from illuminating patterns of industrial development as Cameron would like, produce a misleading picture.

The important data are those that reflect the relation of coal energy to output. It is the coal-energy intensity level of production that tells us the degree to which coal mattered in economic development. Only by examining the reliance of each country's output on mineral fuel do comparisons of development strategies between countries become meaningful.

Energy intensity measures are given in terms of energy consumption per real unit of GNP. How much coal, or more to the point, how much coal energy is needed to create and sustain a certain

<sup>3</sup>. To cite an actual example: in 1900, Switzerland and Austria had almost identical coal consumption rates, but Swiss incomes were about 20% higher.

level of output. Both the level and growth rate of coal-energy intensity can help distinguish different patterns of economic development.

Most historians have used a simple consumption measure relating population to total resource weight—given in terms of kilograms per person. If weight is related instead to a unit of GNP, the results of cross-country comparisons immediately change. The Table shows a comparison between Austria and Sweden. In 1880, Austria's consumption of coal per capita was 93% higher than that of Sweden, but per dollar of GNP, it was only 45% higher. By 1900, although Austria held a 25% edge in per capita demand, its consumption per dollar of GNP was only 6% greater than that of Sweden. By this comparison, there would seem good reason to doubt that per capita demand describes the relative coal-energy intensities of the two economies.

Yet any measure of weight, even per unit of GNP, is not completely satisfactory. Quantities of coal do not have the same energy or "heating" values. To find the energy intensity level, units of coal have to be converted to units of energy — British Thermal Units (BTU) or kilocalories (kcal). It is crucial to any discussion of coal consumption to appreciate the tremendous variation in energy values between different grades of coal. Anthracite, for example, may have four times the energy value of lignite. In a country such as Austria, which used several different grades, the heating values ranged from 2000 kcal/kg to 6600 kcal/kg.<sup>44</sup> In fact, there can also be great variation within grades. A sample of coal from one region may have had as much as twice the energy per unit of weight as the same variety of coal from another place.

Twice the energy value, of course, means that only half as much coal input by weight needs to be employed for a given output. The implications of this are great. To return to the Austria-Sweden comparison, the 6% difference in weight per unit of GNP for 1900 may not, in fact, present a completely accurate picture. In terms of coal-energy intensity, Austria may have had a wider edge; the two

<sup>4</sup>. GROSS, "Economic Growth", p. 900.

countries might have been equal; or Sweden might have had the more coal-energy intensive economy. Put in terms of economic development, by 1900, despite the greater per capita consumption of coal in Austria, Sweden may have had a greater reliance on coal-energy intensive industry — a pattern of industrialization that per capita measures of coal consumption (by weight) do not reveal.

In fact, the last possibility seems the most likely for two reasons. First, Austria consumed a high proportion of lignite, a fact which is partially taken into account here. Lignite levels are reduced to an approximate “coal equivalent” energy level, but this remains an approximation and could overstate the energy value of the coals actually consumed.<sup>5</sup> Moreover, coal in Austria, excluding lignite, had heating values from 3000 kcal/kg to 6600 kcal/kg, and it would take only a small variation around the median value (4800 kcal) to make Sweden the more coal-intensive economy. If Sweden used coal that was on average only about 4 above the median level (about 5000 kcal) and Austria, about the same percentage below (approximately 4600 kcal) then the coal-energy intensity rank of the two countries is reversed. Since Sweden imported most of its coal and the international market tended to have coals with high energy values, it probably consumed a large proportion of resources with values above the median. Admittedly, some of Austria’s lignite had higher energy values on average than lignites in other countries, but it exported

<sup>5</sup>. Ibid.

Table

Country	1880		1900	
	coal/pop (metric ton)	coal/GNP kg./\$	coal/pop (metric ton)	coal/GNP kg./\$
Austria	0.44	0.8	0.87	1.18
Sweden	0.23	0.55	0.66	1.11

GNP figures are in constant 1970 dollars

Sources: B.R. MITCHELL, *European Historical Statistics 1750-1970*, (New York, 1975); and N.F.R. CRAFTS, “Patterns of Development in Nineteenth-Century Europe”, *Oxford Economic Papers*, 36, 1984, pp. 438-458.

a significant percentage of its best lignites and may well have consumed a higher fraction of inferior quality.

Energy per unit of GNP may provide a better measure of coal use in describing patterns of development, but it is undeniably harder to pin down than per capita consumption measures. Data on population and coal consumption are, in general, more reliable than measures of both GNP and the energy values of resources. But if the effort is to illuminate the importance of coal in nineteenth-century European development, then per capita consumption data do not help. It is clearly preferable to use the right measure, however inexact. Furthermore, even assuming that some of the underlying assumptions of GNP or resource data are questionable, the results from using the crude coal-intensity measures of the Table are compelling. The shift from per capita to per unit of GNP measurement changes the results to such a significant extent, and it is doubtful that weaknesses in current GNP series invalidate them. Of course, energy-intensity measures can be improved as other data improve but, if the goal is to assess how much an economy relied on coal energy, an energy intensity measure of some kind must be employed.

Cameron provided a convincing argument that coal use should be used descriptively to show the variety of nineteenth-century economic development strategies. But in using per capita consumption measures, he did a disservice to his own argument. The place of coal in nineteenth-century development patterns can only be appreciated through a measure of energy intensity, and not per capita consumption.

