**Supplementary Material: Data Sources and Construction**

**The Digitalisation, Dematerialisation and Decarbonisation of the Global Economy in Historical Perspective: The Relationship between Energy and Information since 1850**

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The global energy consumption data is from Malanima (2020). The national-level primary energy consumption data is based on Kander et al. (2013) for European economies, and from Fouquet (2009) for other countries, and updated using BP (2022). Fodder for animal power is not included in the national level, but is in the global estimates.

The estimates for communication use and intensity in this paper are based on collecting statistics on the number of letters, telegrams, text messages and emails, and on the minutes of telephone, mobile and mobile ‘app’ conversations. The historical postal statistics (in number of letters), telegraph statistics (in number of messages) and telephone statistics (in number of calls) are from Mitchell (2007). This data is also available from and updated by CNTS (2020). In addition, mobile phone and SMS text messaging is available from ITU (2022) – the ITU website also provides the original telephone and telegraph statistics back to 1849.

The global consumption of communication estimates are based on converting letters, messages and conversations into bytes of information using the method developed in Fouquet and Hippe (2019, 2022). This method relies on several significant assumptions. For example, one important assumption is that the average letter is 200 words (they tended to vary between 100 and 500 words) and that they averaged four characters per word, thus, equivalent to 800 bytes. It is assumed that emails are of equal length. Text messages are assumed to be shorter – five words long. Turning to conversations, a telephone or mobile phone call generated 120 words or 480 bytes per minute. Based on statistics of the minutes of phone conversation and the number of phone calls made, the average conversation tended to be close to three minutes long – this assumption is used when data only reveals conversations rather than minutes. Also, prior to ITU (2022) data, much of the global telephone data is for the number of phones used rather than minutes or calls (Mitchell 2007). Having data on both for a set of European countries and the USA, an average of the minutes per phone in any year is estimated and used to convert phone ownership into minutes of conversations. In sum, these numerous assumptions ensure that the different communication technologies can be converted into an estimate of one-to-one information sent and received, despite the inevitable limitations about trying to use a single metric for very different behaviours and technologies.

The growth rate has been consistently rapid since the mid-nineteenth century. Waves of new technologies, such as telephones, mobile phones, and email, have boosted one-to-one information that the average person ‘consumed’ and the economy used. Apart from the period between 1925 and 1950, annual growth rates were above 5%. The final quarter of the nineteenth century experienced annual growth rates above 7%, as did the final quarter of the twentieth century, and the first decade of the twenty-first century. The global transition from analog to digital communication took 15 years (here, measured as an increase from a 5% to a 80% share of the market. Yet, it is worth noting that, although the most recent increase in communication use has been associated with digitalisation, the rapid increase began before the transition to digital technologies. This suggests that the demand for communication may also have boosted the transition to digitalisation.

Energy prices are based on the average energy price series in Fouquet (2011). It has been updated to incorporate the ONS (2020) information on the retail price index series for fuel and light, which is available in Fouquet (2020).

Communication prices are the expenditure weighted average of postal prices (Campbell-Smith 2011), telegraph prices (Kieve 1973), and telephone prices (Baldwin 1925 p.657, Post Office 1975, ONS 2020). All prices presented are in real terms (that is, in $(2020) money). The Bank of England Millenium Data set (2020) also builds a series back to the thirteenth century.

**References**

Baldwin, F.G.C. (1925) The History of the Telephone in the United Kingdom. Richard Clay. Bungay.

Bank of England (2020) A Millennium of Macroeconomic Data. <https://www.bankofengland.co.uk/statistics/research-datasets>

BP (2022) Statistical Review of World Energy. <https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html>

Campbell-Smith, D. (2011) Masters of the Post: The Authorized History of the Royal Mail. <http://www.postalheritage.org.uk/page/statistics>

CNTS (2021) The Cross-National Time-Series Data Archive. <https://www.cntsdata.com/>

Fouquet, R. (2011) ‘Divergences in long run trends in the prices of energy and energy services.’ Review of Environmental Economics and Policy 5(2) 196-218.

Fouquet, R. (2020) National Historical Energy Dataset. <https://nic.org.uk/data/all-data/historic-energy/>

Fouquet, R. and Hippe, R. (2019) ‘The Transition from a Fossil-Fuel Economy to a Knowledge Economy’ in Fouquet, R. (ed.) Handbook on Green Growth. Edward Elgar Publications. Cheltenham, UK, and Northampton, MA, USA.

Fouquet, R. and Hippe, R. (2022) ‘Twin Transitions of Decarbonisation and Digitalisation: A Historical Perspective on Energy and Information in European Economies.’ Energy Research & Social Science 91: 102736.

ITU (2022) World Telecommunications Database. <https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx>.

Kander, A., Malanima, P. and Ward, P. (2013) Power to the People: Energy in Europe over the Last Five Centuries. Princeton University Press. Princeton, NJ.

Kieve JL (1973). The electric telegraph: a social and economic history, New York: Barnes & Noble.

Malanima, P. (2020) World Energy Consumption: A Database 1820-2018. <https://histecon.fas.harvard.edu/energyhistory/DATABASE%20World%20Energy%20Consumption.pdf>

Mitchell, B.R. (2007) International historical statistics. Europe, 1750-2005. 6th ed. Palgrave Macmillan. Basingstoke, Hampshire.

ONS (2020) Consumer Price Indices. Office for National Statistics. <http://www.ons.gov.uk/ons/rel/cpi/consumer-price-indices/august-2011/cpi-time-series-data.html>

Post Office (1975) Telecommunications Management Services Department (1975). Telecommunications statistics. Post Office. London.