Non-renewable Resources, Extraction Technology and Endogenous Growth – Supplementary Appendix*

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Abstract

The goal of our new data set is to provide a comprehensive view of all non-renewable resource quantities produced globally and of their prices over the past three decades. This appendix provides details on sources and descriptions to make the data set easily replicable. We also include additional figures and tables.

In section 1, we describe and discuss which non-renewable resources we have included in the data set. In section 2 we lay out the general methodological principles that have guided us and the main sources used in constructing the production and price series.

In section 3, we provide resource-specific information about sources and methods for each of the global resource production series. In section 4, we do the same for the price series. Section 5 describes sources and methods for the data on global population, real global GDP, inflation and exchange rates used in the paper.

Finally, section 6 provides additional figures and tables.

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* The views in this paper are those of the authors and do not reflect the views of the Federal Reserve Bank of Dallas, the Federal Reserve System or the World Bank.

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We support the supplementary appendix by an excel spreadsheet that contains our data set.

1 Non-Renewable Resources Included

We include 65 non-renewable resources in the data-set. Three fossil fuels: coal, natural gas, petroleum; 37 metals: aluminum, antimony, arsenic, beryllium, bismuth, cadmium, cesium, chromium, cobalt, copper, gallium, germanium, gold, indium, lead, lithium, magnesium, manganese, mercury, molybdenum, nickel, niobium, platinum-group metals, pig iron, rare earths, rhenium, salt, selenium, silver, strontium, tantalum, thorium, tin, tungsten, vanadium, zinc, zirconium; and 25 non-metals: asbestos, barite, boron, bromine, cement, diatomite, feldspar, fluorspar, garnet, graphite, gypsum, iodine, kyanite, nitrogen, phosphate rock, potash, pumice, silicon, sulfur, talc& pyrophyllite, tellurium, thallium, uranium, vermiculite, wolalstonite.

We currently do not include the following metals: bauxite, iron ore, hafnium, cesium; non-metals: natural abrasives, clays, diamond, gemstones, iron oxide pigments, lime, peat, perlite, quartz, sand, soda ash, sodium sulfate, stone, titanium, and helium. We exclude these resources for a variety of different reasons, including lack of global historical data, e.g. for stones, unclear separation between natural and synthetic materials, e.g. diamonds, and prevention of double-counting due to different products in the value chain, e.g. iron ore is not but pig iron is included. Most of the excluded commodities would not change the results of our analysis because the extracted quantities and market value are negligible. The only exception is salt, which exhibits relatively large extracted quantities.

The number of resources increases over time, as more and more mineral commodities are explored and employed in the manufacturing of goods. In 1700, our dataset includes copper, gold, mercury, pig iron, salt, silver, tin, and coal. These were all resources that broadly used in the global economy at the time with the exception of stones. The number of non-renewable resources increases to 34 in 1900 in our data-set, including petroleum, natural gas and a broad variety of metals and non-metals, and 65 in 2000.

2 General Methodological Principles and Data Sources

2.1 Production Series

We describe major sources and quality of the data, how we deal with missing data, how we connect data series, and the main specifications for production data.

2.1.1 Data Sources and Reliability

We use global production data, where available, and create global series based on individual countries' data, if necessary. We take data from four main sources, which are then supplemented by numerous commodity or country specific data sources. The first main source is Neumann (1904), which we use for data for the 18th and 19th century. The author provides a detailed account of the history and geology for roughly 40 non-renewable resources. He collected an extensive data set on global and by-country annual statistics on production and prices going back as far as possible. We have worked with this book over a decade, and it has always been extremely reliable when comparing it to the original data sources or alternative sources. The book is only available in German.

The second main source is the dissertation by Schmitz (1979), who collected annual price and production series for numerous metals. This source has also always been very reliable when cross-checking with other sources.

Third, we use individual country production data for fossil fuels from Mitchell (2013). The reliability of this data is mixed. It can be spotty sometimes and series have breaks, as it seems the authors have not tried to create data series that are consistent over time.

Finally, we rely heavily on historical compilations by U.S. Geological Survey (2015) for the years from 1900 up to 2011. We take the data for 2012 to 2016 from the U.S. Geological Survey (2016) and the most recent data for 2017 and 2018 from U.S. Geological Survey (2019). The data points from the latter sources are mostly estimates. We refer to ”usual sources” and ”general principles” if we use these sources for exactly these time periods. The data from the USGS is generally very reliable and well document.

2.1.2 Data Coverage

Data coverage is generally good in our data set. However, there are a couple of important issues. First, coverage in China and India is very spotty for historical data. We know that there must have been significant production of metals and fossil fuels in these countries during the 18th and 19th century, but this is unfortunately not reflected in the data. As the economies of the two countries have mostly stagnated during these times, adding the production data would most likely only lead to a one-time upwards shift in the level of production but not change the growth rate of production.

Second, if there are missing data, we interpolate these gaps with growth trends from Excel. We are aware that this method is fairly simple. As we are only interested in long-run trends and not short-term fluctuations, we believe that this method is appropriate. We certainly agree that this is one area, where the data set could be improved with more sophisticated methods.

Another issue is the starting points of the production data. We put a lot of effort into understanding whether the first data point reflects that it was the first resource production at the time or whether there was production but no data available. We are reasonably confident that the former is the case for most of the by-country series that we use to construct global series. However, there are some global series that we do not build based on by-country data, but mostly obtain from U.S. Geological Survey (2015) for which this is an issue. We know that there has been earlier production somewhere, but we have a hard time to collect enough by-country data to extend it backwards. This issue is not a problem for the estimations. However, when summing up the production of all commodities, the growth in the aggregate could potentially be upward biased.

We believe that one area in which progress needs to be made is to smoothen some of the starting points through more individual country data.

2.1.3 Data Specifications

We carefully connected data from different sources such that we obtain a consistent series over time. Where possible, we compare data series from different sources and with different specifications and choose to connect those series that have the closest specifications and during years with the smallest marginal differences in the levels. The data specifications are often quite important because production data can refer to different products of a certain resource along its value chain.

All data is the content of the respective commodity in mine production unless otherwise stated. We carefully convert all data to metric ton (mt). We do not include secondary (recycling) production in the data. However, some series could still include some marginal amounts of recycling, because some countries do not report it separately.

2.2 Price Series

We describe the main sources for price data, we discuss the data coverage, and general principles with regard to specifications and adjusting the data for inflation.

2.2.1 Data Sources and Reliability

We source price data from several main sources. For the 18th and 19th century the two main sources are Neumann (1904) and Schmitz (1979). We describe both above. We supplemented the data with information from other sources that collected price data for a variety of commodities such as Jacks, Cole, Potter and Christy, and the U.S. Energy Information Administration. We supplement the data with information found in sources specific to certain resources.

Regarding the 20th century the main sources are U.S. Geological Survey (2015) for the time period 1900 to 2015 and U.S. Geological Survey (2019) for the most recent years 2016 to 2018. We refer to these two sources and these time periods as the "usual sources" in the context of prices. The start date of the data U.S. Geological Survey (2015) varies across commodities, depending on when the data overlaps most closely to the previous series. We supplement these sources with information from a variety of resource-specific sources and oftentimes price series sourced from Schmitz (1979) also reach into the middle of the 20th century.

We interpolate data using linear trends from Microsoft Excel to fill missing observations. This is a simple method that is effective for our purposes as we only look into long-run trends. However, we think that this is an area that could benefit from work with more sophisticated statistical methods.

One other area of potential progress that needs to be made is to extent the price series further backwards based on a more extensive research.

2.2.2 Data Coverage

As more researchers have collected price data before compared to the global production data, the availability of data is much better than for production data. However, the difficulty is to construct price series that are consistent over time. We do this by focusing on U.S. prices whenever possible.

During the 18th century and the first half of the 19th century, most of the metal and coal production and trade was centered around Great Britain and continental Europe.

U.S. prices are not available for many resources. We hence carfully connect British and German price data to U.S. price data when necessary. This assumes that there is a world market for the respective resources, which was approximately the case for most of the more expensive metals and non-metals that were traded at the time (e.g. tin, copper, etc.). We were often surprised how close the price levels for British and U.S. data were after applying exchange rates.

Our price data set mostly centers on transatlantic trade. There is some Japanese data available, but generally Asian data sources are non-existent or non-explored. We leave this to future research

2.2.3 Data Specifications

We carefully connect data from different sources to obtain consistent series over time. Where possible, we compare data series from different sources and with different specifications and choose to connect those series that have the smallest marginal difference in the levels and where specifications are closed in terms of marketplace and product specification. Our goal was to obtain series without any breaks. If there are potential breaks, which is very rare, we mention this in the description of the individual series below. We always convert prices to U.S. dollars per metric ton of content of the resource commodity if not otherwise mentioned in the descriptions. The inflation-adjustment suffers from the availability of only U.S. and U.K. inflation time series over the long time horizon. We leave it to future research to figure out a better way to deflate annual price series with global inflation indices over the long time period.

3 Non-Renewable Resource Production

The following descriptions provide an explanation for the data that do not follow the ”usual sources” for sources of world production.

3.1 Aluminum, 1854-2018

We source data for primary production from Neumann (1904) for the period 1854 to 1862 and from Schmitz (1979) for the period 1863 to 1904. Afterwards U.S. Geological Survey (2015, 2016, 2019) is the source as outlined in the general principles. We interpolated the data for the years 1865 to 1868 and 1860 to 1861 based on linear trends. Up to the year 1889 firms produced most aluminum using the Deville process. Afterwards the Hall-Héroult process for refined production became the dominant production process. The data refers only to primary production from bauxit and does not include production from recycled materials. Recycling is significant as it provides roughly half of the aluminum used (Emsley, 2011).

3.2 Antimony, 1866-2018

We obtain world antimony metal mine data by summing up data for all major producing countries, namely Germany, France, Austria, Hungary, Italy, the U.S., Japan and the U.K. from Neumann (1904) for the years 1866 to 1899. Afterwards, we source it from U.S. Geological Survey (2015, 2016, 2019) following the general principles. There is no break due to this procedure. All data are world mine production in terms of antimony content. U.S. production data is withheld and not available in the total, for 1985 to

1992 and 2000 to 2018, to avoid disclosing proprietary data. U.S. data mine production was less than one percent of global mine production in the years immediately before these two time periods, and the omission does not cause a significant break in the data.

3.3 Arsenic, 1891-2018

For the years 1891 to 1899 world mine production data is the sum of data for for all major producing countries, namely Prussia, Saxony, England, Italy, Portugal and Canada sourced from Neumann (1904). We use data from U.S. Geological Survey (2015) starting in 1900 and going through 2015. Data for 2016 is from the U.S. Geological Survey (2018) and data for 2017 to 2018 is from the U.S. Geological Survey (2019). We interpolated data for the years 1906 to 1909 when it was not available. According to the U.S. Geological Survey (2015), Chile, Mexico, and Peru were significant producers of commercial-grade arsenic trioxide, but have reported no production in recent years. The dataset might therefore underestimate the true world production for the recent period.

All data up until 2015 is for arsenic content in arsenic trioxide. The U.S. Geological Survey (2019) is unclear about the specification for the years 2016 to 2018 and we have reached out to assemble more information. We compute the ratio between the 2015 world mine production data for arsenic trioxide from U.S. Geological Survey (2015) and the corresponding 2015 from U.S. Geological Survey (2017), which likely includes arsenic compounds production: 27,600/36,500=0.7562. We rebase the 2016 to 2018 data using this factor. This procedure allows us to create a consistent time series but implies a lower bound estimate for global production.

3.4 Asbestos, 1879-2018

We source data from U.S. Bureau of Mines (1902) for the time period 1879 to 1900. Data from 1901 to 2018 follows the general principles and is from U.S. Geological Survey (2015, 2016, 2019).

World mine production data of asbestos consists of U.S. and Canadian data for 1879 to 1904, and of U.S., Canadian and Russia data for the time period from 1905 to 1912. The data more than doubles when Canadian production starts including asbestic (a fibrous sand formed by mixing second-grade asbestos and serpentine) into its production numbers in 1897. World output increased by 34 percent in the year before, which leads us to believe that a substantial part is driven by genuine production increases. It seems that there are no major breaks in 1905 and 1913 due to the later inclusion of Russia and other countries, respectively, but data is generally pretty lumpy in the early 20th century.

3.5 Barite, 1913-2018

We construct the data series following the general principles and source them from U.S. Geological Survey (2015, 2016, 2019). We interpolate data for the years 1914 to 1918. All data refers to world mine production.

3.6 Beryllium, 1935-2018

We use data from U.S. Geological Survey (2015, 2016, 2019) and construct the series based on the general principles. We interpolate U.S. production data for 1964 to 1967 and 1969 to 1979, as these data were not available for proprietary reasons but amounts are significant. Data represent the estimated beryllium content of beryllium-bearing ores produced based on an assumed content of four percent.

3.7 Bismuth, 1825-2018

We sum by country data for Germany, England, Prussia, Austria and Australia provided by Neumann (1904) for the years 1825 to 1900. Neumann (1904) mentions that there was also significant production in Bolivia but that this data was too uncertain to include into his statistical compilation. The data between 1880 and 1900 is quite lumpy. There is a strong decline in 1882 in the German data, and Australia's data also changes significantly. One potential explanation is that bismuth is a by-product of lead production. We use data from the U.S. Geological Survey (2015) for the years 1912 to 2015, an estimate from the U.S. Geological Survey (2017) for 2016 and estimates from the U.S. Geological Survey (2019) for 2017 to 2018. We interpolate missing data using growth trends for 1900 to 1912 and for 1922 to 1936. U.S. Geological Survey (2015) excludes U.S. production data for 1912 to 1921 and 1972 to 1996 for no specified reason. This does not cause a break in the data.

All data up to the year 2016 are for bismuth content of mine production. Starting in 2017 the U.S. Geological Survey (2019) publishes only world refinery production data as mine production data has become too unreliable. World refinery production is significantly higher due to recycling. To mitigate a break we use the ratio of world mine to refinery production data for 2016 from U.S. Geological Survey (2017, 2018) (computation: 10,200/17,100=0.596) and rebase the 2017 to 2018 refinery data using this factor.

3.8 Boron, 1900-2017

We take data for 1900 to 1913 and 1976 to 2015 from the U.S. Geological Survey (2015) and interpolate the gap using a growth trend. Data for 2016 to 2017 are from the U.S. Geological Survey (2018) and 2018 data are taken from U.S. Geological Survey (2019). Data exclude U.S. production from 2006 to 2017 due to proprietary information. We assume that U.S. production data stays stable at its 2005 level to correct for this break in the world production data. All data are gross weight of world boron production. There is no recycling to our knowledge.

3.9 Bromine, 1880-2015

We use U.S. bromine mine production data from U.S. Bureau of Mines (1902) for the years 1880 to 1899 and from U.S. Geological Survey (2015) for the years 1900 to 1960. Based on the ratio of world mine production to U.S. production in 1961 (92,300/82,000=1.1256), we rebase the U.S. production numbers to the level of world mine production for the entire time period 1880 to 1960. Starting in 1960, we source the data following the general principles and use data from U.S. Geological Survey (2015, 2016, 2019). World production data from 2007 to 2018 does not include U.S. production for proprietary reasons. To avoid a break in the data, we compute the ratio between world and U.S. production data in 2006 (671,000/243,000=0.361) and use it to re-base the world production data. All data refers to the bromine content of world mine production.

3.10 Cadmium, 1853-2018

We retrieve German cadmium mine production data from Neumann (1904) for the years 1853 to 1903. Germany was the only producer according Neumann (1904). We interpolated missing observations for the years 1871 and 1872 with a growth trend. Data are from the U.S. Geological Survey (2015) for 1904 to 2015. Data for 2016 and 2017 through 2018 come through the U.S. Geological Survey (2018) and the U.S. Geological Survey (2019), respectively. Data from 1904 to 1932 are production data from selected countries, but this does not seem to lead to a break. Data for 2016 to 2018 exclude U.S. production numbers, but the U.S. only produces negligible amounts.

The data refers to cadmium mine production during the period 1853 to 1903 and to refinery production due to the introduction of new production techniques afterward. There is no recycling, so the change in specification does not cause a rupture in the data.

3.11 Cement, 1926-2018

We source data for cement production for 1926 to 2015 from U.S. Geological Survey (2015), data for 2016 from U.S. Geological Survey (2016), and data for 2017 and 2018 from U.S. Geological Survey (2019). All data are for world production of all types of cement.

3.12 Chromium, 1933-2018

Chromium data for 1933 through 2015 are from U.S. Geological Survey (2015). Data for 2016 are taken from U.S. Geological Survey (2018). We source data for 2017 to 2018 from U.S. Geological Survey (2019). Data for 1933 to 2015 are world production as an estimate of world chromite ore mine production measured in contained chromium. Data for 2016 to 2018 is only available as gross weight. We re-base the series from 2016 to 2018, using the ratio between world production (content) from U.S. Geological Survey (2015) and world production (gross weight) from U.S. Geological Survey (2017) (Computation: 9,360,000/30,400,000=0.3079). This ratio is close to the typical chromium content in chromite ore.

3.13 Cobalt, 1900-2018

World cobalt mine production data for 1900 is from Neumann (1904). We construct the remaining data according to the general principles and based on U.S. Geological Survey (2015, 2016, 2019). Soviet Union data are not included prior to 1961, but this does not cause a significant break. For 1901 to 2011, data represent the cobalt content of refined products or the cobalt content, recoverable cobalt content, or recovered cobalt content of mined ores, concentrates, or intermediate products depending on the producing country and year. For 2012 to 2018, data is for mine production and does not include refinery production. This change in specification does not cause a break in the data.

3.14 Copper, 1700-2018

We base the construction of the data-series on the sum of by-country data from Schmitz (1979). However, we correct for discontinuities in the data-set by including data from other sources and by interpolation. We get data for by-country production data during the years 1700, 1710 and 1720 from Neumann (1904). We interpolate the gaps by growth trends.

For the time period from 1726 to 1800, we adjust world production from Schmitz (1979) by adding annual data for Chile and Russian (both from Neumann (1904)) as well as Japanese copper production data from Suzuki (2012) to handle breaks in the data. We construct the Japanese data as follows: For 1724-1741 we derive an estimate based on export numbers multiplied by 3.3, as we assume in line with information in the book that about 30 percent of copper production was exported; for 1761: real production data; 1742-1760: linear trend; 1762-1800: linear trend. The world production series has a gap from 1790 to 1793, which we interpolate with a linear trend. During the time period 1800 to 1820 we add Japanese estimates based on a continuous growth trend from the previous period to the world production data series by Schmitz (1979). From 1821 to 1919 we make use of the world production series from Schmitz (1979) without any adjustments.

We use world copper mine production data from U.S. Geological Survey (2015) for 1920 to 2015 and from U.S. Geological Survey (2018) and U.S. Geological Survey (2019) for 2016 through 2018. All data refers to the copper content of world mine production. They reflect the copper content of concentrates, precipitates, and electrowon copper.

For some countries, including the United States, recoverable copper content is used. For other countries, such as Chile, data includes copper content of non-duplicative mine and metal products produced from domestic ores and concentrates.

3.15 Diatomite, 1900-2018

The diatomite data follow the general principles from 1900 to 2018, and we source them from U.S. Geological Survey (2015, 2016, 2019). Data before 1913 is U.S. production only. The series is volatile, which makes it hard to identify a break. The U.S. share in world production also varies quite significantly. The U.S. contributed about 75 percent of world production in 1913 but nearly 100 percent in 1914. All data starting in 1913 are for world production. Data for 1908 and 1910, and 1927 to 1947, are interpolated with a growth trend.

3.16 Feldspar, 1908-2018

The feldspar mine production data follow the general principles from 1908 to 2018 and are sourced from U.S. Geological Survey (2015, 2016, 2019).

3.17 Fluorspar, 1913-2018

The mine production data for fluorspar follow the general principles from 1913 to 2018. We source them from U.S. Geological Survey (2015, 2016, 2019).

3.18 Gallium, 1973-2018

Gallium data from 1973 to 2015 are taken from U.S. Geological Survey (2015). Data for 2016 and 2017 through 2018 are taken from the U.S. Geological Survey (2018) and the U.S. Geological Survey (2019), respectively. Data for 1973 to 2018 represent world primary low grade production data and do not include high grade production data. Data from U.S. Geological Survey (2018) suggest that high grade production is substantial but smaller than low grade production.

3.19 Garnet, 1913-2018

The data for garnet follow the general principles and we source them from U.S. Geological Survey (2015, 2016, 2019) from 1913 to 2018. Data for 1927 to 1959 are interpolated with a linear growth trend. Data from 1913 to 2011 are defined as world production data. Data for 2012 to 2016 are for world crude production, and data for 2017 to 2018 are defined as world mine production. There are no breaks in the data despite the different series specifications.

3.20 Germanium, 1945-2018

Germanium data are taken from U.S. Geological Survey (2015) from 1957 to 2015. Data for this time period represent the total quantity of germanium metal that was produced annually from refineries throughout the world. We take data for the years 2016 and 2017 from the U.S. Geological Survey (2018) and data for 2018 from U.S. Geological Survey (2019). Data for 2016 to 2018 are world refinery production numbers and exclude U.S. data to avoid disclosing proprietary data. The U.S. only produces a negligible share of world production and this does likely not cause a break in the series.

3.21 Gold, 1700-2018

We source global gold mine production for 1700 to 1851 from Neumann (1904). The data is only available as annual averages for twenty year periods for the 18th century and as annual averages for ten year periods during the 19th century. We use these annual averages as midpoints in the respective sub-periods and then interpolate data using growth trends. For example, we use the annual average for the period 1701 to 1720 as estimate for 1710 and the annual average for the period 1721 to 1720 as estimate for 1730. We then use a growth trend between these two estimates to interpolate the data.

We utilize world mine production data from Schmitz (1979) for the period from 1852 to 1899. We then follow the general principles and source the remaining data from U.S. Geological Survey (2015, 2016, 2019). Gold data follow the general principles from 1900 to 2018. All data refer to world mine production.

3.22 Graphite, 1896-2018

We obtain data for world mine production of graphite from U.S. Bureau of Mines (1902) for the period 1896 to 1899. For the period 1900 to 2018 we follow the general principles and source the data from U.S. Geological Survey (2015, 2016, 2019). All data is world mine production data. No synthetic graphite is included.

3.23 Gypsum, 1924-2018

We follow the general principles and source the data from U.S. Geological Survey (2015, 2016, 2019). Data are for world mine production.

3.24 Indium, 1972-2018

We take indium data for the years 1972 to 2015 from U.S. Geological Survey (2015), for 2016 to 2017 from U.S. Geological Survey (2018) and for 2018 from U.S. Geological Survey (2019). World production data from 1972 to 1974 are for smelter production of indium, and data from 1975 to 2018 are for refined indium. It is possible that there is some break in the data due to this change in specification. Data do not contain U.S. production, which was likely minor and stopped completely in 1993 (see U.S. Geological Survey, 2015).

3.25 Iodine, 1960-2018

Iodine data follow the general principles from 1960 to 2018 (Sources: U.S. Geological Survey (2015, 2016, 2019)). U.S. production is excluded from 2006 to 2018 to avoid disclosing company proprietary data. U.S. production was about 6 percent of global production in 2005. However, there is no break in the data detectable. All data refer to mine production.

3.26 Kyanite, 1928-2018

The data for kyanite follow the general principles from 1928 to 2018 and are sourced from U.S. Geological Survey (2015, 2016, 2019). Data for 1928 to 2016 are world production for kyanite and related minerals. Data for 2017 to 2018 are the sum of the United States production of kyanite, India's production of kyanite and sillimanite, Peru's production of andalusite, and South Africa's production of andalusite. The change in data source and specification does not cause a break in the data.

3.27 Lead, 1700-2018

We construct a data series for the years 1700 to 1837 based on adding up by-country data in Schmitz (1979) and were able to fill some of the missing observations with data from de Perceval Verde and Pion (2000). Austria data is from de Perceval Verde and Pion (2000) for 1801 to 1808, from Schmitz (1979) for 1809 to 1910, again from de Perceval Verde and Pion (2000) for 1811 to 1820, and finally from Schmitz (1979) for 1823 to 1837. We know from Neumann (1904) that there has been substantial lead production in Austria during the 18th century. We therefore assume that annual production from 1700 to 1800 was the same as annual production during the years 1801 to 1808, namely 2,300 mt. We interpolate data for the years 1821 to 1822 using a growth trend.

For the French series we use the data from Schmitz (1979) for the time period 1816 to 1837. To fill the missing data before this time period, we assume that annual production from 1700 to 1815 was the same as the the annual average production during 1816 and 1817.

To construct a series for Germany, we employ data published by de Perceval Verde and Pion (2000) for the years 1801 to 1806 and data from Schmitz (1979) for the years 1807 and 1823 to 1837. As there is evidence for continued production in Germany, we assume that annual production during the years 1700 to 1800 was equal to the annual average during the time period 1801 to 1806 (5,000 mt). We interpolate missing data with a growth trend.

We use a datapoint for Spanish lead production in the year 1801 and another in 1817 published by de Perceval Verde and Pion (2000). We source the data for the subsequent period from 1818 to 1837 from Schmitz (1979). We interpolate the data from 1802 to 1817 using a growth trend. We use this trend to extend the series backwards from 1801 and to let it approach zero in the year 1700, as Spanish production increased over this period. For countries that are in the area that was formerly the U.S.S.R, we source the data from Schmitz (1979) and fill gaps with growth trends.

Data for the United Kingdom comes from Schmitz (1979). We fill gaps in the data by interpolating using growth trends. We assume that annual production during the years 1700 to 1705 was the same as in 1706. With regard to the U.S., data in de Perceval Verde and Pion (2000) suggests that annual production was steady at about 1,200 mt during the period 1801 to 1820. As we know that there has been lead mining in the U.S. for a long time, we assume that production levels were constant during the period 1700 to 1800. Starting from 1821, we make use of the annual U.S. lead production data in Schmitz (1979).

de Perceval Verde and Pion (2000) estimate that other countries production was about 1,100 mt per year from 1801 to 1820 and 1,600 mt in the subsequent period from 1821 to 1837. As lead is one of the metals that has the longest track record in mining around the world, we assume that other countries' production was also 1,100 mt per year during 1700 to 1800.

We use world lead mine production from Schmitz (1979) for the period 1838 to 1854. Several gaps in the data, notably 1839-40, 1842-44, 1846-49, 1853-54, and 1865 were interpolated with growth trends. Lead data for 1955 to 2015 comes from U.S. Geological Survey (2015). The later data are for contained lead in world smelter production originating from ores and may include secondary lead when inseparable. Data for 2016 come from the U.S. Geological Survey (2018) and data for 2017 to 2018 come from the U.S. Geological Survey (2019). Data for 2016 to 2018 are for world mine production. Data for 2015 to 2018 is slightly lower than before, but there is no sharp break detectable due to the slightly different specifications.

3.28 Lithium, 1936-2018

We source world mine production data for the years 1925 to 2015 for lithium from U.S. Geological Survey (2015). After 1954, world production does not include U.S. production. This does not cause a break in the data, as U.S. production was relatively small at the time. World production data for 1966 to 1967 do not include Rhodesia (Zimbabwe) and some other African countries, which causes a significant drop in the data for these two years, as Zimbabwe was by far the largest producer at the time. We drop the observations for the two years and interpolate the data by using a linear trend. Data for 2016 is from the U.S. Geological Survey (2018) and data for 2017 to

2018 is taken from the U.S. Geological Survey (2019).

The data are generally in metric tons of gross product of lithium minerals and brine. For the years 1967 to 2015 lithium production is reported as gross product of ore and ore concentrates from mines and lithium carbonate from brine deposits. The data for the years 2016 to 2018 from U.S. Geological Survey (2018, 2019) are for lithium content of mine production. To account for this difference, we divide the 2015 lithium production observation from U.S. Geological Survey (2015) by the 2015 lithium production observation from U.S. Geological Survey (2016) and obtain a ratio of 19.61, which we apply to the data from 2016 to 2018.

3.29 Magnesium Compounds, 1900-2018

We source world mine production data for magnesium compounds for the years 1900 to 1918 from Schmitz (1979). We assume that Austria's production in 1900 is the same as in 1901. Data for magnesium compounds follow the general principles from 1919 to 2018 (Sources: U.S. Geological Survey (2015, 2016, 2019)). Data for 2012 to 2018 are world production of magnesite. Data for 2017 to 2018 exclude U.S. data to avoid disclosing proprietary data. Both deviations do not cause an obvious break.

3.30 Magnesium Metal, 1937-2018

Construction of the magnesium metal mine production series follows the general principles from 1937 to 2018 (Sources: U.S. Geological Survey (2015, 2016, 2019)). Data for 2012 to 2018 exclude U.S. data to avoid disclosing proprietary data. This does not cause a break in the data.

3.31 Manganese, 1880-2018

For the years 1880 to 1936, we source manganese mine production data from Schmitz (1979). Manganese data from the U.S. Geological Survey (2015) go from 1937 to 2015 in our data set. Data for 2016 come from the U.S. Geological Survey (2018) and the data for 2017 to 2018 come from the U.S. Geological Survey (2019). All data are for world mine production of manganese.

3.32 Mercury, 1700-2018

We source mercury production data for the years 1700 to 1779 from Neumann (1904). The data is for Spanish and Austrian production, which were the only producers at the time. We derive Spanish estimates from the midpoints of annual averages during certain sub-periods (the source only provides the total production during a certain subperiod but this obviously allows us to compute annual averages), namely estimates for 1698, 1705, 1718, 1727 to 1729, 1732, 1738, 1744, 1748, 1754, 1765, and 1778. We obtain annual data for Austria for the years 1700, 1760, 1765, 1770, 1775 and 1780. We interpolate all missing data using growth trends.

For the years 1780 to 1903 we obtain annual production data from Schmitz (1979). For the subperiod from 1780 to 1872, the world production data is the sum of individual countries production series. We interpolated missing data in the Spanish production series using growth trends. For the subperiod 1873 to 1903 we take the world production series, which is readily available.

Mercury data follow the general general principles from 1904 to 2018 and we source them from U.S. Geological Survey (2015, 2016, 2019). The USGS notes that mercury production data for the United States, primarily as a byproduct of gold, copper, and zinc mining, were withheld from world mine production data for 1993 to 1997 and were not available for 1998 to 2018. The data have a high degree of uncertainty because most companies and countries do not report principal mine, byproduct mine, or recycling data for mercury. Quantities may appear erratic from year to year because production may not be reported until shipped, and stockpiling may take place prior to shipment. All data refer to mercury content of mine production.

3.33 Mica, 1900-2018

Production data for natural sheet mica for the years 1900 to 2015 come from U.S. Geological Survey (2015). Data were not available for the years 1919 to 1924 and 1961 to 1967, 1919 to 1924 and 1961 to 1967. We interpolate the data using growth trends. Data for 2016 is sourced from U.S. Geological Survey (2018) and for 2017 to 2018 from U.S. Geological Survey (2019). All data refers to natural sheet mica produced. Data for 2016 do not include scrap and flake, but this change in specification does not cause a break.

3.34 Molybdenum, 1900-2018

Data for molybdenum follow the general principles from 1900 to 2018 and are sourced from U.S. Geological Survey (2015, 2016, 2019). The data are world mine production.

3.35 Nickel, 1850-2018

We sum nickel mine production data for individual countries sourced from Neumann (1904) for the years 1850 to 1866. For the years 1867 to 1899 we use world nickel mine output data from Schmitz (1979), and for the years 1900 to 2015 the data comes from the U.S. Geological Survey (2015). The U.S. Geological Survey (2015) data does not include production data for countries once comprising the former Soviet Union until 1952. When the U.S. Geological Survey (2015) begins to include the data starting in 1953, this results in a break in the series and production jumps by roughly 25 percent. To correct for this break, we add USSR production data from Schmitz (1979) for the years 1935 to 1952. There was no nickel data before 1939 in the USSR. Data from 2016, and 2017 to 2018, come from U.S. Geological Survey (2018) and the U.S. Geological Survey (2019), respectively. All data represent mine production and are reported as recoverable nickel contained in the ore mined.

3.36 Niobium, 1964-2018

Niobium data from 1964 to 2015 is from the U.S. Geological Survey (2015). Data for 2016 is from the U.S. Geological Survey (2018) and data from 2017 to 2018 is from the U.S. Geological Survey (2019). All data represent mine production.

3.37 Nitrogen, 1946-2018

Nitrogen data from 1964 to 2015 are from the U.S. Geological Survey (2015). Data for 2016 and data from 2017 to 2018 are from U.S. Geological Survey (2018) and U.S.

Geological Survey (2019) respectively. All data are for world ammonia production.

3.38 Phosphate Rock, 1896-2018

For the years 1896 to 1899 we source the data from U.S. Bureau of Mines (1905). The phosphate rock data set is made up from the U.S. Geological Survey (2015) for 1900 to 2015. The data for 2016 is from the U.S. Geological Survey (2018) and data for 2017 to 2018 is from the U.S. Geological Survey (2019). All data are the gross weight of world mine production.

3.39 Pig Iron, 1700-2018

We combine individual country data from Neumann (1904) with data from other sources to come up with a world production series of pig iron for the period 1700 to 1849. Unless otherwise noted we always refer to Neumann (1904). One characteristic of the data by Neumann (1904) is that it also provides five-year sums of the production. This allows us to infer missing values. For example, we know that the sum for German production from 1821 to 1825 is 194,454 mt. There is data for the years 1821 (38,000 mt) and 1823 to 1825 (40,746, 36,868, 40,836 mt). We compute the sum of production for these year, which is 156,450 mt and subtract this sum total 5-year sum (194,454-156,450 = 40,004). The production in 1822 was hence 40,004.

Neumann (1904) provides data for Germany during the years 1784, 1798, 1807, 1821, 1823 to 1849. We compute the value for 1822 as described above and interpolate the remaining data with growth trends. For the production series for Austria, we interpolate missing data for the years 1808 to 1809, and 1811 to 1820 with growth trends. We infer from the total for the time period 1821 to 1825 that the production was an estimated 60,000 mt in 1821 and 1822 each. Unfortunately, the series for Austria only goes back to 1807. As Austria accounts for roughly 10 percent of world production in that year, there is notable break in the data in 1806. We derive missing data for Hungarian production for the years 1821 and 1822 in a similar way as for Austria.

To construct a production series for France, we first source data for the years 1725, 1750 and 1789 from Wikipedia (2019). Then we add data for the year 1819 from Mitchell (2013). The data-series from Neumann (1904) starts in 1822. We interpolate the missing data using growth trends. For the year 1823 we infer the value based on the five-year sum as described above.

We source data for pig iron production in Belgium for the years 1811 to 1835 from Groningen Growth and Development Centre (2000). The data from 1836 to 1846 is from Neumann (1904). We interpolate data for the years 1812 to 1821, 1823 to 1824, 1826 to 1827, and 1829 using growth trends. We were able to compute values for the missing data in 1840 and 1840 based on five-year sums as layed out above.

We obtain a data series for the United Kingdom by combining data from several sources. We first use annual data from Neumann (1904) for the year 1700 and in five year intervals up to the year 1790. We interpolate the in-between data using growth trends. From 1791 to 1822 we take a complete series from Mitchell (2013). For the period from 1823 to 1848, we rely on data by Neumann (1904). We fill several gaps in the latter data by inferring data from the five-year totals.

We collect data for the series on Russian pig iron production from Malcom (2006). The source provides annual data in 10-year intervals starting in 1700 and ending in

1770. We interpolate the missing data using growth trends. We use annual data that goes from 1780 to 1850 from Mitchell (2013). The only missing data points in this series for 1815 and 1816 are interpolated employing a growth trend.

The first data-point for the United States is available from Wikipedia (2019b) for the year 1776. The U.S. production amounts to 30,000 mt, which is about 10 percent of world production and causes a non-negligible break in the series. Ideally, we would find data for the time period before. We take the data-points for the year 1810 and for the period from 1828 to 1848 from Neumann (1904). Missing data is interpolated by growth trends, except for data during the years 1826 and 1827, which we infer from the five-year sum for 1826 to 1830.

Finally, we collect data on Spain, Norway and Sweden published by Neumann (1904). We fill gaps in the data based on growth trends and, where possible, using the information from the five-year sums.

Data for the time period 1850 to 1901 are the sum of individual countries' production in Neumann (1904). Some missing values have to be interpolated using linear trends: Norway: 1885, 1886; Italy: 1850 (assume same production as in 1848), 1880, 1883; Spain: 1853, 1855 (assume same production as in 1854), 1874, 1875; Russia: 1861-1863; England: 1851, 1853.

We use world pig iron production data for the period 1902 to 1919 from Verein Deutscher Eisenhuettenleute (1950). For 1910 to 2015 we take data from the U.S. Geological Survey (2015). Data for 2018 was from the U.S. Geological Survey (2018). The data for 2017 to 2018 was taken from the U.S. Geological Survey (2019). All data refer to world production of pig iron. Pig iron is by definition primary production from iron ore. To prevent double-counting, we do not include iron ore in the dataset.

3.40 Platinum-Group Metals, 1900-2018

Data for the platinum group follow the general principles from 1900 to 2018, and we source them from U.S. Geological Survey (2015, 2016, 2019). Data for 1900 to 2016 are for world mine production of the content of platinum group metals. Data for 2017 to 2018 are for the content of platinum and palladium group metals. This does not cause an apparent break.

3.41 Potash, 1919-2018

Potash data follow the general principles from 1919 to 2018 (Sources: U.S. Geological Survey (2015, 2016, 2019)). The observations are all for world mine production data, which are reported in terms of K_2O equivalents.

3.42 Pumice, 1902-2018

We construct the data series following the general principles from 1920 to 2018 and using the usual sources (see U.S. Geological Survey, 2015, 2016, 2019). We interpolate data for the years 1926 to 1947 with a linear trend. Data for 1920 to 2011 are for the gross weight of pumice and pumicite output. Data for 2012 to 2018 also include volcanic related materials for some countries. This does not cause an apparent break in the data.

3.43 Rare Earths, 1900-2018

We follow the general principles and use data from U.S. Geological Survey (2015, 2016, 2019). All data are for the content of rare earth in world mine production.

3.44 Rhenium, 1973-2018

The world mine production data for 1973 to 2015 come from U.S. Geological Survey (2015), for 2016 from the U.S. Geological Survey (2018) and data for the years 2017 to 2018 from the U.S. Geological Survey (2019). The data refers to content of rhenium.

3.45 Salt, 1700-2018

We source world salt production for the year 1881 from House of Commons (1884). For the years 1890 to 1899 we obtain data published by U.S. Bureau of Mines (1902). We interpolate the missing data from 1882 to 1889 using a growth trend.

Data for 1900 to 2018 follow the general principles and is sourced. World production was not recorded from 1907 to 1912, so a linear trend was used to fill the data. All data refer to world mine production of salt.

3.46 Selenium, 1938-2018

Data for selenium from the U.S. Geological Survey (2015) are for the period 1938 to 2015. Data for 2016 are from the U.S. Geological Survey (2018), and data from 2017 to 2018 are from the U.S. Geological Survey (2019). World production estimates for 1985 to 1987 and 1997 to 2018 do not include U.S. production data for proprietary reasons. We interpolate the data for 1985 to 1987 using a linear trend. We also assume that U.S. production stayed at the level of 1996, the last year when production was reported. Some countries are known to produce selenium but data is not available. These countries include Australia, China, Iran, Kazakhstan, Mexico, the Philippines, and Uzbekistan. One of the reasons that the data is not reported is probably that selenium is a by-product of copper and other metals' production. All data are for world refined production and may include smaller amounts of recycled materials.

3.47 Silicon, 1964-2018

We take data for silicon from the U.S. Geological Survey (2015) for the years 1964 to 2015. Data for 2016 was taken from U.S. Geological Survey (2018) and data for 2017 to 2018 are from U.S. Geological Survey (2019). World production data for 1964 to 2001 does not include production in China. The production was most likely not substantial at the time, as there is no break in the data in 2002. From 2006 to 2010, data exclude the amount of silicon metal that was produced annually in the United States for proprietory reasons. These amounts were minor. The world mine production series represents the total silicon content in all ferrosilicon and silicon metal.

3.48 Silver, 1700-2018

For the time period 1700 to 1848 annual average silver mine production data is available in 20-year periods from Neumann (1904). We use the midpoints of these 20 year periods (e.g. 1710 for the period 1701 to 1720, 1730 for the period 1721 to 1740...) to construct a time series, where we interpolate data for the gaps (e.g. 1711 to 1729) between the midpoints by using growth trends.

From 1849 to 1899 we source the world mine production series from Schmitz (1979). From 1900 to 2018 we get the data from U.S. Geological Survey (2015, 2016, 2019) following the general principles. All data represent the recoverable silver content of precious-metal ores that were extracted from mines throughout the world.

3.49 Strontium, 1951-2018

We constructed the global strontium mine production series following the general principles and based on the standard sources (see U.S. Geological Survey, 2015, 2016, 2019)for the years 1951 to 2018. Production is reported as a gross weight of strontium-bearing mineral celestite.

3.50 Sulfur, 1900-2018

We source the world production data from U.S. Geological Survey (2015, 2016, 2019) and follow the general methodological principles. The data include the content of sulfur from all types of production. Most sulfur production is a result of the processing of fossil fuels.

3.51 Talc and Pyrophyllite, 1904-2018

The data for talc and pyrophyllite follow the general principles (sources: U.S. Geological Survey (2015, 2016, 2019)). World production data for 1904 to 1912 represent the summed weights of all talc and soapstone materials that were produced annually throughout the world. Data for 1913 to 2018 represent the summed weights of all talc, pyrophyllite, soapstone, steatite, and other unspecified talc-related materials that were produced annually throughout the world.

3.52 Tantalum, 1969-2018

The tantalum data follow the general principles from 1969 to 2018 and we source them from U.S. Geological Survey (2015, 2016, 2019). The data represent the tantalum content in ores and mineral concentrates that were produced from mines throughout the world.

3.53 Tellurium, 1930-2003

World tellurium production data are only available until 2003 from U.S. Geological Survey (2015). World production data relate to refinery output only. Thus, countries that produced tellurium concentrate or other impure mixtures containing tellurium from copper ores, copper concentrates, blister copper, and/or refinery residues, but did not recover or report refined tellurium, are excluded. The world production data is not totaled because of exclusion of data from major world producers, notably the former Soviet Union and the United States. In addition to the countries listed in the world production table (Canada, Japan, Peru, and the United States), Australia, Belgium, Chile, Germany, Kazakhstan, the Philippines, and Russia are known to have produced refined tellurium, but output is not reported or the available information is inadequate for formulation of reliable estimates of output levels. World production estimates do not include U.S. production data for 1931 to 1933 and 1976 to 2003 because the U.S. data are proprietary. To prevent breaks in the data, we interpolate the U.S. production data with a linear trend during the years 1931 to 1933. We also assume that U.S. production stayed at its 1976 level through 2003. Overall, the series is most likely an underestimate of the true amount of tellurium produced.

3.54 Thallium, 1942-2011

Data for world thallium mine production are from 1980 to 2011 and are sourced from the U.S. Geological Survey (2015).

3.55 Thorium, 1951-1977

Data from thorium are from the U.S. Geological Survey (2015) and range from 1960 to 1977. Data represent contained ThO_2 mine production.

3.56 Tin, 1700-2018

We add data for production in Banka and Malacca from Reyer (1991) to the world production series from Schmitz (1979). Banka and Malacca were major production centers at the time and they were not considered in Schmitz (1979).

To be more precise, we know from (Neumann, 1904, p. 240) that tin production started in Banka in 1725. We hence assume that the production there was close to zero during that year. The next datapoints for Banka tin production were published by Reyer (1991) and are 1733, 1740, 1765, 1770 to 1779, 1785 and 1812. We interpolate data for the gaps by using growth trends.

(Neumann, 1904, p. 239-240) also describes that tin has been mined in Malacca since the middle ages. Our data from Reyer (1991) includes the years 1720, 1740 and

1777. We assume that production during the years 1700-1719 was at the same level as in the year 1720. We use growth trends to interpolate and fill in the gaps from 1721 to 1739 and from 1741 to 1776. We assume that production during the years 1778 to 1800 stayed at the level of 1777. Overall, the data series is in line with the observation by (Neumann, 1904, p. 240) that Malacca's annual production was between 1,500 to 2,000 mt in the 18th century.

For the years 1801 to 1948 we source the production series from Schmitz (1979). For the time period 1949 to 2018 we construct the series following the general principles and employing the usual USGS sources (U.S. Geological Survey, 2015, 2016, 2019). All data refers to tin content of mine production.

3.57 Tungsten, 1884-2018

World mine production data is the sum of the production of individual countries for the years 1875 to 1898. We used the following sources: Australia 1894-1898: Schmitz (1979), 1895-1897: growth trend; Germany 1875-1898: Schmitz (1979), 1893-1897 and 1878-1879: growth trends. We assume that production in 1875 and 1876 was the same as in 1877. Portugal: 1895 and 1896: Neumann (1904) (The data are tungsten ore data. We apply a factor 0.75 to compute tungsten content assuming that it was mined from Wolframit (see Neumann, 1904, p. 406), p. 406), 1897 and 1898: growth trends; Spain: 1895 and 1896: Neumann (1904) (The data are tungsten ore data. We apply a factor 0.75 to compute tungsten content assuming that it was mined from Wolframit (see Neumann, 1904, p. 406), p. 406), 1897 and 1898: growth trends; United Kingdom: We use annual averages for certain time periods from Neumann (1904) as midpoints of the respective periods. For example, we employ the annual average during the period 1875 to 1880 as estimate for the year 1877. we use the annual average during the period 1881 to 1885 as estimate for the year 1883. We then connect the different midpoints by using growth trends. Again, we use a factor of 0.75 to compute tungsten content. We use the midpoints for the following years: 1877, 1883, 1888, 1893 and 1898. We interpolate the remaining years we the above described method. We assume that 1875 and 1876 are equal to 1877. Finally, we take U.S. data from Neumann (1904) for the year 1898. The data-point refers to tungsten metal content.

For the years 1899 to 1904 we add up individual country data from Schmitz (1979). We employ linear trends to derive estimates for the following data points: Germany 1901 to 1904, Portugal 1899 to 1904, Spain 1899 to 1904, United Kingdom 1899, United States 1899 and 1900. For the year 1905 to 1945 we source world tungsten mine data from Schmitz (1979). The remaining data series follows the general principles and we get the data from the usual USGS sources. All data refer to tungsten content of mine production.

3.58 Uranium, 1945-2018

We get uranium world mine production data from OECD Nuclear Energy Agency and International Atomic Energy Agency (2006) for the years 1945 to 2003. For the years 2004 to 2005 we obtain the data from OECD and International Atomic Energy Agency (2008), for 2006 to 2007 from OECD and International Atomic Energy Agency (2010), for 2008 to 2009 from OECD and International Atomic Energy Agency (2012), for 2010 to 2011 from OECD and International Atomic Energy Agency (2015), for 2012 to 2013 from OECD and International Atomic Energy Agency (2017), for 2014 to 2017 from OECD and International Atomic Energy Agency (2019). Estimate for 2017. All data refers to uranium content of mine production.

3.59 Vanadium, 1912-2018

We source the production data for vanadium following the general rules and using data from from U.S. Geological Survey (2015, 2016, 2019). We interpolate estimates for the years 1923 to 1924 and 1948 to 1959 using linear trends. The U.S. Geological Survey (2015) generated data by interpolation for the years 1926, 1932 to 1933, 1944, and 1985 to 1989. World production data for 1927 to 1931 and 1997 to 1999 do not contain U.S. production for proprietary reasons. We interpolate the data employing linear trends and add them to the world production data. All data refers to vanadium content of mine production data.

3.60 Vermiculite, 1925-2018

We construct the series following the general rules using data from U.S. Geological Survey (2015, 2016, 2019). Data for 1925 to 1947 are for the U.S. only, but which was essentially the only consumer as data for 1948 and 1949 suggest. World production for 1996 to 1998 excludes U.S. production. We interpolate U.S. data for 1997 using a linear trend. Together with U.S. data for 1996 and 1998, we fill the gap. The data refer to gross weight of vermiculite concentrate in mine production.

3.61 Wollastonite, 1950-2018

Wollastonite data from 1950 to 2015 come from the U.S. Geological Survey (2015). Data from 1951 to 1958 were filled with a growth trend. Data for 2016 and 2017 to 2018 are from the U.S. Geological Survey (2016) and the U.S. Geological Survey (2019), respectively. Data for 1950 to 2018 are for world mine production. Data after 2009 do not include U.S. production numbers to avoid disclosing company proprietary data. We assume that U.S. production stays at 2009 level throughout 2018 to avoid a break in the data. All data refer to wollastonite mine production.

3.62 Zinc, 1800-2018

We derive estimates for the zinc world mine production during the period 1800 to 1822 from annual averages for the periods 1800 to 1808, 1809 to 1815, 1816 to 1820, and 1821 to 1825, and then interpolating the data using linear trends. For example, the annual average during the period 1800 to 1808 was 1,400 mt. We use this data for 1804. The annual average during the period 1809 to 1815 was 3,764 mt and we assume that this is the data for 1812. We then interpolate the data between 1804 and 1812 by a linear trend.

For the years 1823 to 1955, we make use of world production data published in Schmitz (1979). From 1956 to 2018 we obtain data from the usual sources, namely U.S. Geological Survey (2015, 2016, 2019), following the general methodological principles. All data refer to the content of world mine production zinc.

3.63 Zirconium, 1944-2018

Zirconium data for 1944 to 2015 is from the U.S. Geological Survey (2015). Data for 2016 is from U.S. Geological Survey (2018), and data for 2017 to 2018 is from U.S. Geological Survey (2019). Production data for the U.S. are not included for 1944 to 1952, 1959 to 1987, and 1993 to 2018. We interpolate the data using growth trends. Data refer to gross weight of zirconium concentrate from mine production.

3.64 Hard Coal, 1700-2018

We construct a series for hard coal production during the time period 1700 to 1805 using German and British data from Bartels (2002). The United Kingdom and Germany are the only countries with significant amounts of output according to later data by Mitchell (2013). Annual production data for Germany is available for the years 1735, 1767, 1792 and 1800. The data for the United Kingdom are annual averages during certain decades, namely 1681 to 1690, 1751 to 1760, and 1801 to 1810. For the German data we simply use growth trends to interpolate the data. For the U.K. data, we use the midpoint of the decades, for example 1705 for the decade 1751 to 1760, and interpolate the data employing growth trends.

For the following nearly two centuries, 1806 to 1996, we use data published by Mitchell (2013). We interpolate several gaps in the data with growth trends, namely for Germany: 1801-1816, the U.K.: 1806-1829; Austria 1858, Hungary 1858, Spain 1841, '43, '44, '47, '50, '52-'54, '58, '60, France 1816-19, '21-'24, '26; and U.S. anthracite coal: 1825. There is no data on hard coal only available for the United States before

1935. We compute the average annual share of brown coal in total bitumenous coal production (hard coal plus brown coal) for the years 1935 to 1939, which is 0.759993 percent. We assume that this share stayed constant for the period 1800 to 1934 and subtract it from the total bitumenous coal data available from Mitchell (2013). The difference between the two is the hard coal data. To bring the American data in line with the data of the other countries, we add anthracite coal production data, which is a high quality hard coal, to the hard coal data.

For the time period 1997 to 2016 we source data from Wikipedia (2019a), which cites the USGS and the Bundesanstalt fuer Geowissenschaften and Rohstoffe as original sources. There are no estimates for global hard coal production in 2017 and 2018 available yet. To obtain estimates for both years, we compute the growth rate of the estimate for 2017 global total coal production as published by International Energy Agency (2018), and apply this rate with the 2016 data as a base. Data generally refer to hard coal which includes anthracite coal production. A useful overview of the different types of coal is at https://www.worldcoal.org/coal/what-coal.

3.65 Brown Coal, 1800-2018

We compute global production data for the years 1800 to 1989 from summing individual country data published by Mitchell (2013). We supplement these data with German production data for the years 1802, 1815, 1825 and 1835 from Conrad et al (1901). We interpolate the following gaps in the data with growth trends: Austria: 1858; Canada: 1866, 1872-3, 1973-4; India: 1992-3; Germany: 1800-1, 1804-14, 1816-1824, 1826-1834, 1836; Hungary: 1858; Japan: 1981-3. There is no brown coal data available for the

United States before 1935. We compute the average annual share of brown coal in total bitumenous coal production (hard coal plus brown coal) for the years 1935 to 1939, which is 0.759993 percent. We assume that this share stayed constant for the period 1800 to 1934 and compute the brown coal production from the total bitumenous coal production data available from Mitchell (2013).

For the time period 1990 to 2016 we source data from Wikipedia (2019a), which cites the USGS and the Bundesanstalt fuer Geowissenschaften and Rohstoffe as original sources. There are no estimates for global brown coal production in 2017 and 2018 available yet. To obtain estimates for both years, we compute the growth rate of the estimate for 2017 global total coal production as published by International Energy Agency (2018), and apply this rate with the 2016 data as a base. Data generally refers to brown coal (or subbitumenous coal) production. Some country data might also include smaller amounts of hard coal production.

3.66 Crude Oil

We source world crude oil production data from adding up individual countries' series published in by Mitchell (2003) for the time period 1860 to 1964. We add production data for Russia, which was the second largest producer during the time, from Alekperov (2011) for the years 1863 to 1892. We use a linear trend to interpolate Russian data for the years 1893 to 1894. For the years 1965 to 2017, we employ world production data published by British Petroleum (2018). To derive an estimate for 2018 which fits to the specification used in British Petroleum (2018), we compute the growth rate of world petroleum supply in 2018 from U.S. Energy Information Administration (2019b) and apply it to the 2017 data from British Petroleum (2018).

The data refers to crude petroleum production, excluding production from shale, which was marginal at the time, for the years 1860 to 1964. Starting in 1965, the data include crude oil, shale oil, oil sands and NGLs (the liquid content of natural gas where this is recovered separately) but excludes liquid fuels from other sources such as biomass and coal derivatives. All data were converted to metric tons of oil equivalent based on conversion factors from the U.S. Energy Information Administration.

3.67 Natural Gas, 1882-2018

Natural gas was first commercially used in the U.S. starting in 1882. We obtain U.S. production data from Manthy et al. (1978) for the time period 1882 to 1904. Starting in 1900, we add data for other countries from Mitchell (2013). We switch to use data for the U.S. from Mitchell (2013) in 1905, as the data are closest to the data from Manthy et al. (1978) in 1904. Up until 1972, world natural gas production is the sum of individual countries production as published by Mitchell (2013). For the time period 1973 to 2017, we employ world natural gas production data from British Petroleum (2018). To derive an estimate for 2018 that fits to the data series used before, we compute the 2018 growth rate in global natural gas production from the Oil and Gas Journal/HAVER and apply the growth rate to the data from British Petroleum (2018). We convert all natural gas production data to metric tons of oil equivalents based on conversion factors from the U.S. Energy Information Administration.

4 Real Prices of Non-Renewable Resources

4.1 Aluminum, 1854-2018

In the second half of the 19th century, aluminum was mostly produced and traded in continental Europe. As a result, U.S American price is only available starting in 1895. However, as aluminum was one of the most expensive commodities at the time, relative transportation costs were low. Thus, it is safe for us to use the continental selling of refined aluminum in U.S. Dollars by Deville Company in France for the time period 1854 to 1894 from Stuermer (2017). We convert the price from We source price data from Schmitz (1979) for the time period 1895 to 1966. The data is in U.S. Dollar per metric ton. Aluminum data follow the general principles from 1977 to 2018. Prices from 2016 to 2018 are multiplied by 2.20462 to convert prices from U.S. cents per pound to U.S. dollars per metric ton of aluminum.

All prices starting in 1895 refer to the spot market price of 1 metric ton of aluminum ingot in the U.S. From 1895 to 1945 ingots had a minimum purity of 99 percent, from 1946 to 1976 a minimum purity of 99.5 percent, since then it has to have a purity of 99.9 percent.

4.2 Antimony, 1862-2018

We source antimony price data from Neumann (1904) for the time period 1862 to 1901. The price data is for the London market but denominated in German Mark. We apply the standard exchange, as described in the introduction, to convert the price data to

U.S. Dollar. Antimony values per mt was relatively high, such that production costs did not play an outsized role. The London market price converted into USD matches well with the U.S. market price.

Antimony data follows the general principles from 1902 to 2018. Data are defined as the average NY dealer price in actual U.S. dollars per metric ton of antimony. Data from 2016 to 2018 are multiplied by 2204.62 to convert the U.S. dollars per pound price into U.S. dollars per metric ton.

4.3 Arsenic, 1893-2018

We get price data for the years 1893 to 1899 from U.S. Bureau of Mines (1902). Arsenic follows the general principles from 1900 to 2018. Arsenic's unit value from 1893 to 2015 is defined as the value of 1 metric ton apparent consumption of arsenic content. Excluding 1908, data are estimated using the market price in U.S. dollars per ton of arsenic trioxide. Data for 1908 is the average of the 1908 market price range for arsenic trioxide. The market price of arsenic trioxide was converted to a value for the contained arsenic by dividing the arsenic trioxide price by the percentage of arsenic contained in arsenic trioxide (75.7 percent). Arsenic from 2016 to 2018 uses trioxide's price from Morocco as a proxy. This price was multiplied by 1000 to put it in U.S. dollars per metric ton, and multiplied by 1.33 to splice it on the earlier data. The 1.33 was found from dividing the 2015 arsenic price from the U.S. Geological Survey (2019) by the 2015 arsenic price from the U.S. Geological Survey (2015).

4.4 Asbestos, 1880-2018

We obtain asbestos prices for the years 1880 to 1899 from U.S. Bureau of Mines (1902). After 1900 we construct the series following the general principles from 1900 to 2018.

The unit value of asbestos for 1880 to 1899 is derived from the value and quantities of U.S. asbestos production. From 1900 to 1987 and 1991 to 1994, it is defined as the value of 1 metric ton of asbestos apparent consumption. For the years 1988 to 1990 and 1995 to 2018, the unit value is computed based on import value data. The major changes in value in 2003 and 2008 from previous years reflect a change to higher valued material. These changes in specifications do not seem to cause major breaks in the series.

4.5 Barite, 1900-2018

Barite follows the general principles from 1900 to 2018. Unit values from 1900 to 2015 are defined as the value of 1 metric ton of barite apparent consumption. Substantial increases in unit values beginning in 2008 are a result of revised crude barite sales values and the increase in prices of imported barite. Data for 2016 to 2018 are estimated prices free on board at mill. We normalize them to metric tons of apparent consumption by multiplying them with the factor 0.68. We find this factor from dividing the price for 2015 barite from the U.S. Geological Survey (2015) by the 2015 price from the U.S. Geological Survey (2019).

4.6 Beryllium, 1935-2018

Beryllium follows the general principles from 1935 to 2018. For this time, the unit value is defined as the value of 1 metric ton of beryllium apparent consumption. Unit value data are estimated by using the year end beryllium metal market price for 1935 to 2000. For 2001 to 2015, estimation of the beryllium unit value is calculated on an annual basis from the U.S. dollar value of imports of beryllium-copper master alloy divided by the estimated beryllium content of those imports. Beryllium data from 2016 to 2018 are multiplied by 1000 to convert to the price per metric ton.

4.7 Bismuth, 1825-2018

We collect price data for the years 1825 to 1899 from Neumann (1904). The data measures the price at a major mine in Freiberg, Germany, and we convert them to U.S. Dollar per ton. There is a substantial increase in 1900 when the U.S. data starts. However, the prices in Freiberg are generally at the same level as the U.S. prices, which can be explained by the small role that transportation cost play in the relative highly priced bismuth.

Bismuth price data from 1900 to 2011 are from the U.S. Geological Survey (2015) and data from 2012 to 2018 are taken from the U.S. Geological Survey (2019). The unit value is defined as the value of 1 metric ton apparent consumption of bismuth in current dollars. Unit value data for 1900 to 1998 are estimated based on the bismuth metal market price. Data for 1999 to 2018 are the average domestic dealer price for bismuth. Values from the U.S. Geological Survey (2019) are multiplied by 2204.62 to convert from U.S. dollars per pound to U.S. dollars per metric ton.

4.8 Boron, 1900-2018

Boron follows the general principles from 1900 to 2018. Unit value for data from 1900 to 2015 is defined as the estimated value of apparent consumption in U.S. dollars of 1 metric ton of B2O3 content. For the years where import and export value data are not available, they are assumed zero, and the reported boron production, as defined above, unit value is used. Fluctuations in the unit value in certain years or over a span of years may result from a combination of unavailable data and changes in the mix of boron-containing products used in the calculation. For 2016 to 2018 we use the average value of import price from the U.S. Geological Survey (2019) as a proxy, which we normalize to the price level of the price series from 1900 to 2015 by multiplying the former by a factor of 1.53. The factor is found by dividing the price of boron in dollars per ton in the U.S. Geological Survey (2015) by the price of average value of imports of boron in the U.S. Geological Survey (2019).

4.9 Bromine, 1880-2006

We get bromine price data from U.S. Bureau of Mines (1902) for the years 1880 to 1899. The data represent the value of U.S. bromine production. The data from the U.S. Geological Survey (2015) go from 1900 to 2006. Unit value is defined as the value of 1 metric ton of apparent bromine consumption. This value is estimated using the published bromine market prices. For 1900 to 1953, the USGS uses the average bulk bromine producer value, free on board plant. For 1954 to 1983 they employ the average annual U.S. bromine producer price. For 1984 to 2006, the purified bulk bromine price is used. The changes in specification do not cause substantial breaks in the series.

4.10 Cadmium,1853-2018

For the years 1853 to 1899 we source German cadmium wholesale prices from Neumann (1904). We convert the prices in German Mark into U.S. Dollar. There is no apparent break from switching to U.S. data in 1900, at which point we use the usual sources until 2018. Unit value for data from 1900 to 2015 is defined as the value of 1 metric ton of cadmium apparent consumption. The USGS uses the cadmium metal market price data to calculate this unit value. Data for 1987 to the most recent year represent the New York dealer price for 99.95%-minimum-purity cadmium published in the annual tables of Platts Metals Week. Data for 2016 to 2018 are multiplied by 1000 to convert from dollars per kilogram to dollars per metric ton.

4.11 Cement, 1900-2018

The data for cement follow the general principles from 1900 to 2018. The unit value is defined as the value of 1 metric ton of cement apparent consumption in current dollars. For 1900 to 1944, unit value is estimated from the weighted-average production values of pozzolanic cement, natural cement, and portland cement. From 1945 to 2018, the reported bulk value at the mill is used to estimate the unit value. The reported bulk value at the mill is a weighted-average value of all forms of portland cement and masonry cement.

4.12 Chromium, 1900-2018

Chromium data follow the general principles from 1900 to 2018. Until 2015 the data refers to USGS estimates of the unit value based on the U.S. dollar value and chromium content of reported exports, imports, and production. From 2016 to 2018 the unit value is based on the average annual value of imports of ferrochromium adjusted for the chromium content. There is no break due to this change in specification.

4.13 Cobalt, 1900-2018

Cobalt data follow the general principles from 1900 to 2018. Unit value is defined as the value of 1 metric ton of apparent cobalt consumption. For 1900 to 2015, estimation of the cobalt unit value is calculated on an annual basis from the U.S. dollar value of imports divided by the cobalt content of those imports. Estimation of unit value is based on import data because the greatest part of apparent consumption is imported. Data for 2016 to 2018 were multiplied by 2204.62 to convert into dollars per metric ton. The data for that time are U.S. spot prices by Platts Metals Week for refined cobalt metal produced by an electrolytic process. There is no apparent break in the data due to this change in specification.

4.14 Copper, 1700-2018

We use Norwegian price data for the time period 1700 to 1770. Norway was a major producer of copper at the time and Glamann (1953) regards the series as a proxy for the European market price. We use Glamann (1953) as the source for the time period from 1700 to 1734. We interpolate missing data for the years 1700, 1702, 1704, and 1707. The series refers to Florins per 100 Dutch pounds.

From 1735 to 1770 we use Norway price data published by Schmitz (1979). The data refers to average prices during certain subperiods. We derive annual data by taking the midpoint of the sub samples as an estimate. For example, if the average price is 3,793 Mark during the period 1738 to 1740, we will use this as a data point for the year 1739. We obtain estimates for the years 1739, 1753, 1758, 1763, and 1768. We then interpolate the missing observations with linear trends. The price data is in German Marks per metric pounds.

We normalize the series from Glamann (1953) to the level of the series from Schmitz (1979) by computing the ratio of the two and multiplying the Glamann (1953) series. We compute a U.S. Dollar series using the hypothetical exchange rate between German Mark and U.S. Dollar described in section 5.3.

London became quickly the reference price for global trade in copper. For the period 1771 to 1823 we employ London price data published in Schmitz (1979). The data is in British pounds per metric ton and we convert it to U.S. Dollar using the exchange rate outlined in section 5.3.

We start using U.S. prices in 1824 when the Cole price comes available, which was collected and published by Center for International Prices at Vanderbilt University (2019). The data is for New York market prices for copper sheathing, which was the form of copper that was generally traded at the time. For the time period 1850 to 1899 we source data for New York copper prices from Schmitz (1979). The data series for the 20th century up until 2015 is from U.S. Geological Survey (2015) and refers to the

U.S. producer price. The same is true for the data for the years 2016 to 2018, which we obtain from U.S. Geological Survey (2019). We multiply the latter data by 2.20462 to convert them from cents per pound to dollar per metric ton.

4.15 Diatomite, 1900-2018

We construct the diatomite price series using the usual sources from 1900 to 2018. Data for 1900 to 2015 have a unit value defined as the value of 1 metric ton of apparent diatomite consumption. The USGS estimates the unit value as being equal to the average value per metric ton of diatomite that was produced within the United States. Unit value data for 1908 and 1910 were interpolated from the unit value data series because production data were withheld for those years. Data for 2016 to 2018 are recorded as the average price for free on board at plants.

4.16 Feldspar, 1900-2018

We use the usual sourcse for feldspar data from 1900 to 2018. Data for 1900 to 1974 refer to the value of 1 metric ton of feldspar apparent consumption. The USGS estimates the data by dividing annual production value data by annual production quantity data. For 1975 to the most recent year, unit value is defined as the value of 1 ton of feldspar plus nepheline syenite apparent consumption. Data for 2016 to 2018 is an average of marketable production of feldspar and the import value of nepheline syenite. There are no apparent breaks in the data due to the changes in specifications.

4.17 Fluorspar, 1900-2018

Data from 1900 to 2018 are from the usual sources for fluorspar. Unit value is defined as the value of 1 metric ton of apparent fluorspar consumption. The USGS estimates unit value data for 1900 to 1983 by dividing the fluorspar production value by its quantity. For 1984 to 1992 the data refers to the average value of domestically produced acid-grade fluorspar. This specifications seems to create some breaks in 1984 and in 1993 in the series. For 1993 to 2006 the unit value is defined as the fluorspar imports value divided by its quantity. Due to inaccurracies in the import data, the unit value was not calculated for the years 2007 to 2015. We interpolate the data with a linear trend. For the years 2016 to 2018 data refer to the average value of acid grade imports. The most recent year could not be accurately calculated.

4.18 Gallium, 1943-2018

Data for gallium are from the usual sources from 1943 to 2018. Data are the value in U.S. dollars of 1 metric ton of gallium apparent consumption. Data from 2016 to 2018 use high-purity, refined data and are multiplied by 1000 to convert from dollars per kilogram to dollars per ton. This does not cause an apparent break in the series.

4.19 Garnet, 1900-2018

Garnet data are from the usual sources from 1900 to 2018. Unit value is defined as the value of 1 metric ton apparent consumption U.S. dollars. Unit value is based on the production value for 1900 to 1923, 1928 to 1934, 1936, 1943, and 1945 to 1953.

Unit value for 1924 to 1927, 1935, 1937 to 1942, and 1954 to 2015 is based on the sold or used refined value data. Unit value data was withheld for 1944 in order to avoid disclosing proprietary data. We estimate the price data for 1944 with a linear trend. Data for 2016 to 2018 are the average dollars per ton of imported garnet. There are no apparent breaks in the series due to these changes in specifications.

4.20 Germanium, 1945-2018

Germanium data is obtained using the usual sources from 1945 to 2018. The data is related to U.S. domestic market prices during the period 1945 to 2015 and to European prices for the years 2016 to 2018. There is no apparent break in the data due to the change in specification.

4.21 Gold, 1700-2018

We source London gold price data for the time period 1700 to 1918 from Schmitz (1979). The price is fairly constant at 130.21 British Pound per metric ton due to its role in the currency system at the time. We convert it to U.S. dollars. For 1919 to 2015 we use data from U.S. Geological Survey (2015) and for 2016 to 2018 we use U.S. Geological Survey (2019). The refers to the average world market gold price for 1900 to 1967 and Englehard's average gold price quotation of refined gold for 1968 to 2018.

4.22 Graphite, 1896-2018

For the years 1896 to 1899 we compute prices from world value and quantity of production in U.S. Bureau of Mines (1902). We use data for 1900 to 2011 from the U.S.

Geological Survey (2015) and for 2012 to 2018 from U.S. Geological Survey (2019). Prices refer to the unit value of U.S. imports.

4.23 Gypsum, 1900-2018

We construct the series for gypsum prices following the general principles from 1900 to 2018. U.S. Geological Survey (2016) derives the unit value based on the total sales value of calcined and uncalcined gypsum. The data for 2016 to 2018 from U.S. Geological Survey (2019) is only based on the sales value of calcined gypsum, which makes it significantly higher. We normalize the data down to the level of the earlier data by multiplying it with a factor of 0.53 based on the ratio of the price in 2015 from the U.S. Geological Survey (2016) and the 2015 price from U.S. Geological Survey (2019).

4.24 Indium, 1946-2018

We construct the series of indium prices following the general principles from 1946 to 2018 using U.S. Geological Survey (2015, 2019) as sources. It is not clear from the sources what the price data refers to up to the year 2005. Starting in 2006 it is defined as average New York dealer price for 99.99 percent minimum-purity indium.

4.25 Iodine, 1928-2018

The series for iodine prices follows the general principles from 1928 to 2018, where we use U.S. Geological Survey (2015, 2019) as sources. The data for 1928 to 1969 was calculated using quantities and value of imports. From 1970 to 2018 the data refers to the average import price including cost, insurance and freight.

4.26 Kyanite, 1934-2018

We construct the price series for kyanite using the usual sources from 1934 to 2018 (Sources: U.S. Geological Survey, 2015, 2019). Prices refer to averages of raw and calcined U.S. kyanite and are rough estimates. Unit value data were interpolated for 1937 to 1938 and 1992 to 1993 by U.S. Geological Survey (2015).

4.27 Lead, 1700-2018

We use London price data from Schmitz (1979) for the time period 1700 to 1822. There are missing observations for the years 1701-03, 1705, 1707-12, 1715-23, 1732-33, 1736-37, 1739-46, 1748-53, 1755-64 and 1766-70, which we interpolate by linear trends. The data is in British Pounds and we convert it to U.S. dollars using the exchange rate described in section 5.3.

For the years 1823 to 1899 we employ U.S. price data published by Schmitz (1979). We interpolate missing observations in 1813 to 1814 and 1816 to 1818 with linear trends. U.S. Geological Survey (2015, 2019) provide U.S. refined lead prices for the period 1900 to 2018. We convert data for 2016 to 2018 converted from cents per pound to dollars per metric ton by multiplying the series by 2.20462.

4.28 Lithium, 1936-2018

We construct the series of lithium prices according to the general principles and use U.S. Geological Survey (2015, 2019) as sources. Data refer to U.S. domestic lithium carbonate prices during the years 1936 to 2000. From 2001 to 2015 the unit value is based on U.S. lithium carbonate import prices. For the years 2016 to 2018 the data refers to battery grade lithium carbonate import prices for large contracts. This specification leads to significantly higher prices. We normalize prices to the price level before 2016. We compute the ratio of the 2015 price from U.S. Geological Survey (2015) and the 2015 price from U.S. Geological Survey (2019), which is 0.7. We multiply the series from U.S. Geological Survey (2019) with this factor.

4.29 Magnesium (Compounds), 1900-2017

We construct the price series for magnesium compounds following the general principles and using the standard sources (U.S. Geological Survey, 2015, 2019). The data refers to the average weighted price for contained magnesium oxide in different magnesium compounds produced in the U.S. The price is weighted by the quantity produced of each compound. We calculate the data for the years 2016 to 2017 based on data in U.S. Geological Survey (2019). Data for 2018 is not yet available.

4.30 Magnesium (Metal), 1920-2018

We obtain the price series following the general principles and using the standard sources (U.S. Geological Survey, 2015, 2019). The data refer to annual average U.S. prices for primary magnesium for the years 1920 to 1998 and to year end U.S. Western spot prices for the years 1999 to 2018.

4.31 Manganese, 1880-2018

To obtain a manganese price series for the years 1880 to 1899, we compute prices from quantities and values data of U.S. manganese ore production found in U.S. Bureau of Mines (1902). For the years 1900 to 2015 we use data from U.S. Geological Survey (2015). Unfortunately, this source does not provide any notes with data specifications. The price from this source is 2.74 times higher in 1900 than the one from U.S. Bureau of Mines (1902). Most likely the reason for this is that U.S. Geological Survey (2015) uses a price from a manganese product higher up in the value chain. To deal with this break in the data, we normalize the data derived from U.S. Bureau of Mines (1902) based on the ratio between the two series in 1900.

We employ data for the years 2016 to 2018 from U.S. Geological Survey (2019). The price data for this period refers to the import price of contained manganese in 46 to 48 percent metallurgical ore at U.S. ports. The price includes cost, insurance and freight. Unfortunately, the price series is much lower than the one for the previous years. For example, in 2015 the price from U.S. Geological Survey (2015) is 344.82 higher than the price from U.S. Geological Survey (2019). Information on different prices for products along the manganese value chain in U.S. Geological Survey (2015) suggests that the former price is for the manganese content of ferromanganese, high carbon, while the latter price is for manganese contained in manganese ore. We normalize the latter to the 2015 level of the former.

4.32 Mercury, 1700-2018

We rely on Italian price data for the first half of our sample period. At the time the Idria mine was the second largest producing mine in the world (see Neumann, 1904, p. 281) and the data refers to the sales prices at the mine. We source the data from Neumann (1904) for the year 1700 (note that source does not specifically mention the year 1700 for this data-point. It says that the price peaked at 3036.2 Marks per metric ton sometime in the period between 1669 and 1741) and from Schmitz (1979) for 1741 to 1851. We interpolate data using linear trends for missing data during the periods 1742 to 1789, 1791 to 1800, and 1810 to 1814. Both sources converted the Italian price data to German Mark per metric ton, which we transform to U.S. dollars.

We use U.S. price data starting in 1852. We source data from Schmitz (1979) for the years 1852 to 1976 and from U.S. Geological Survey (2015) for the years 1977 to 2015. Data refers to the average U.S. market price of mercury per metric tons. For the years 2016 to 2018 available data from U.S. Geological Survey (2019) is for market prices in the European Union, where mercury trades in U.S. dollars per flask. We convert the data to metric tons by using the formula: 1 flask = 0.03447 metric tons (see U.S. Geological Survey, 2019, p. 107).

4.33 Mica, 1900-2018

We construct the price series following the general principles and using the usual sources (see U.S. Geological Survey, 2015, 2019). Data refers to natural mica sheet prices in the U.S. for the years 1900 to 1964 and to the average of U.S. prices for natural block, film, and split mica for the years 1965 to 2015. Data for 2016 to 2018 are for the price of block muscovite and phlogopite mica and are converted from dollars per kilogram to dollars per ton. The changes in specifications do not cause substantial shifts in the price levels.

4.34 Molybdenum, 1912-2018

We derive the price series following the general principles and obtaining data from U.S. Geological Survey (2015, 2019). For 1912 to 1970, the unit value refers to U.S. molybdenum concentrate prices, for 1971 to 2015 to molybdenum oxide prices, and for 2016 to 2018 to molybdenum contained in technical-grade molybdic oxide. These changes in the specification do not cause breaks.

4.35 Nickel, 1830-2018

We source U.S. nickel price data from Schmitz (1979) for the years 1830 to 1899. For the years 1900 to 2015 data is from U.S. Geological Survey (2015) and for the years 2016 to 2018 from U.S. Geological Survey (2019). The data refer to U.S. prices until 1978 and from 1979 onwards to U.S. dollar prices at the London Metal Exchange, where global reference prices are set.

4.36 Niobium, 1964-2000

We obtain niobium price data from the U.S. Geological Survey (2015). Data are only available until 2000 because trade journal data was discontinued. Data refer to year-end average price of niobium pentoxide contained in niobium concentrates.

4.37 Nitrogen, 1950-2018

We construct the series for nitrogen prices following the general principles and based on the usual sources (see U.S. Geological Survey, 2015, 2019). Data refers to delivery prices of ammonia (nitrogen content) ”east of the Rockies” for the years 1950 to 1977 and to ammonia import prices (free on board, nitrogen content) at the Gulf Coast thereafter. We convert prices in short tons to metric tons, multiplying them by 0.907185, for the years 2016 to 2018.

4.38 Phosphate Rock, 1880-2018

We source data for the years 1880 to 1899 from Potter and Christy (1962). The source refers to the data as the prefered series of the U.S. Bureau of Mines. We convert the data from U.S. dollar per long ton to U.S. dollar per metric ton.

Starting in 1900, data for phosphate rock follow the general principles and we use the usual sources, namely U.S. Geological Survey (2015, 2019). Unfortunately, U.S. Geological Survey (2015) does not provide notes for the data from 1900 to 2015. There is a notable potential break in the data around 1974 when the level of prices shifts up by more than 100 percent. Data for 2016 to 2018 refers to marketable phosphate rock of all grades free on board at mine. There is no break in 2015 to 2016, which suggests that at least parts of the series from U.S. Geological Survey (2015) have the same price specification.

4.39 Pig Iron, 1700-2018

We construct the price series for the years 1700 to 1730 based on pig iron prices in Kaernten, Austria, a major producer at the time, sources from Neumann (1904). More precisely data is available for the years 1696 (1692-1700), 1704 (1701-1707), 1708, 1709, 1713 (1710-1716), 1719 (1717-1721), and 1724 (1722-1727). We start using U.S. price data with an observation in 1731 and one in 1765 from Neumann (1904). We interpolate using linear trends to fill the missing observations during this period. The difference between U.S. and Austrian prices in 1731 is roughly 30 percent, which is substantial but lower than we expected.

For the period 1784 to 1899 we construct a data series for Philadelphia prices from several sources, allowing us to come up with a consistent series without breaks. For the years 1784 to 1805 we choose unspecified pig iron price data for Philadelphia from Cole (1938). For the years 1806 to 1849 we get data from Swank (1884), which refers to pig iron produced from the use of charcoal traded in Philadelphia. Data for 1850 to 1853 is from Cole (1938) again and is defined as No. 1 charcoal foundry pig iron traded in Philadelphia. For the years 1854 to 1884 we source data from Swank (1884) and for the years 1885 to 1899 from Potter and Christy (1962). Data from both sources refer to No. 1 anthracite foundry pig iron in Philadelphia.

For the 20th century, we first rely on price data that U.S. Geological Survey (2015) derive from the value and quantities of U.S. shipments of pig iron for the years 1900 to 1988. No consecutive data is available from the USGS. We compute unit values from quantities and values of U.S. pig iron import data from United Nations (2019).

We use linear trends to interpolate gaps in the data in 1988 and 2014. We normalize the series derived from United Nations (2019) to the 1988 level of the series from U.S. Geological Survey (2015). For the years 2017 to 2018 we get Brazilian export prices (free on board) for haematite pig iron with phosphorus content of 0.5 percent from Steel on the Net (2019). These prices are relatively close to the U.S. import prices computed for the years before. We normalize the series to the level of the entire new price series in 2016.

4.40 Platinum-Group Metals (PGM), 1900-2018

We take data platinum group metals price data (palladium, platinum, iridium, thodium and ruthenium) from U.S. Geological Survey (2015) for the years 1900 to 2015. For the most recent period from 2016 to 2018, we compute a weighted average price based on pricing information for the different metals in U.S. Geological Survey (2019).

Data refer to unit values based on U.S. production value and quantities for the years 1900, 1901 and 1904, to unit values based on the values and quantities of imports for the years 1902, 1903, and 1905 to 1917, to unit values based on a weighted average of values and quantities of metal sold to industry for the years 1918 to 1994, and to unit values derived from a weighted average of values and quantities of imported refined metals for the years 1995 to 2015. Data for 2016 to 2018 are in dollars per troy ounce. We compute a weighted average price based on imports for consumption. We use the following weights, which we derive from data in U.S. Geological Survey (2015) 57% for palladium, 28% for platinum, .6% for iridium, 7% for thodium and 5% for ruthenium. We also apply a conversion factor of 32150 to convert the price data to U.S. Dollar per metric ton.

4.41 Potash, 1900-2018

We derive the price series following the general principles and obtaining data from U.S. Geological Survey (2015, 2019). Prices refer to the value of 1 metric ton of potash (K_2O equivalents) apparent U.S. consumption. The significant rise in unit value from 1915 to 1921 was a result of an embargo against imports from Germany, coupled with high demand. Data from 2016 to 2018 refer to an average of all products free on board at mine.

4.42 Pumice, 1902-2018

We construct the series following the general principles and obtaining data from U.S. Geological Survey (2015, 2019). Data represent the average price free on board at mine or mill.

4.43 Rare Earths, 1922-2018

We source data from U.S. Geological Survey (2015, 2019) and follow the general principles. Price data refer to a weighted average of prices derived from quantities and values of U.S. imports and exports for the years 1922 to 2015. For the years 2016 to 2018, we use the price of Mischmetal (65% cerium and 35% lanthanum) from U.S. Geological Survey (2019). We normalize the level of the price for the three years to the level of the price during the years before by a factor of 2 (Computation: (2015: Mischmetal price from U.S. Geological Survey (2019), 65% cerium, 35% lanthanum) / (2015: Rare Earth price from U.S. Geological Survey (2015)) = 0.50). The series is very volatile overall with some apparent breaks. The most extreme period is from 1937 to 1939 when prices are about 3,000 percent lower than during the periods before and after. We take these observations out and replace them with a linear trend as we assume that there is a mistake.

4.44 Rhenium, 1964-2018

We obtain data from U.S. Geological Survey (2015) for the years 1964 to 2015 and from U.S. Geological Survey (2019) for the period 2016 to 2018. For the years 1964 to 2007 the data refers to the weighted average of the import value of rhenium metal and ammonium perrhenate metal content. For 2008 to 2015 the price is based on the rhenium metal price series from Metal Bulletin. For 2016 to 2018 the data refer to the price of rhenium metal pellets that are 99.99 percent pure. None of the changes in specifications causes a visible break.

4.45 Salt

4.46 Selenium, 1909-2018

We source data from U.S. Geological Survey (2015) for the years 1909 to 2014 and from U.S. Geological Survey (2019) for the period 2015 to 2018. Data refer to commercial-grade U.S. selenium price until 2014 and to the U.S. spot market price for selenium metal powder, minimum 99.5 percent purity, starting in 2015. We converted the raw price data in U.S. dollars per pound into U.S. dollars per metric ton by multiplying the data by 2204.62 for the years 2015 to 2018.

4.47 Silicon, 1922-2018

Data comes from U.S. Geological Survey (2015) for the years 1922 to 2015 and from U.S. Geological Survey (2019) for the period 2016 to 2018. Data refer to the per unit value of imports for the years 1922 to 1960, to the unit value of apparent silicon consumption for the years 1961 to 2005 and 2011 to 2015, to the weighted average unit value of ferrosilicon production and imports for the years 2006 to 2010, and to the average of price of 50 percent and 75 percent ferrosilicon for the years 2016 to 2018. There are no apparent breaks in the due to these changes in specification.

4.48 Silver, 1700-2018

We source data for silver prices from Schmitz (1979) for the time period 1700 to 1976. The data refers to European (1700-1832, in German Mark) and London (1833 to 1876, British Pound) market prices. We interpolate missing data for the periods 1701 to 1704, 1706 to 1714, 1716-1724, 1726 to 1734, 1746 to 1754, 1756 to 1764, 1766 to 1774, 1776 to 1784, 1786 to 1794, 1796 to 1802, 1804 to 1807, 1809 to 1812, 1814 to 1817, 1819 to 1822, 1824 to 1827, 1829 to 1832, and 1834 to 1834.

We obtain data for the years 1977 to 2015 from U.S. Geological Survey (2015) and for the years 2016 to 2018 from U.S. Geological Survey (2019). These data refer to the Engelhard industrial bullium quotation and refer to silver of a minimum purity of 99.9 percent. Raw data from 2016 to 2018 are multiplied by 32150 to convert from dollars per troy ounce to dollars per metric ton.

4.49 Strontium, 1917-2018

Strontium data follow the general principles and we source them from U.S. Geological Survey (2015, 2019). U.S. Geological Survey (2015) derives the unit value from the total value of strontium imports including, strontium carbonate, chromate, metal, minerals, nitrate, salts, sulfate, and other unspecified compounds, divided by the total tonnage of contained strontium in these imports. Fluctuations in series are not necessarily indicative of changes in value but, instead, may reflect variations in type, quantity, and quality of the strontium imports. This is apparent for the period 1923 to 1933 when the increase in unit value was a result of high imports of value-added intermediate products rather than strontium minerals.

Data for 2016 to 2018 are the average value of celestite imports at the port of exportation in dollars per ton. We splice the data on the series for the time period before 2016 to 2018 by multiplying it by the factor 9.72, which we derive as the ratio of the 2015 price of strontium in U.S. Geological Survey (2019) and the price in U.S. Geological Survey (2015).

4.50 Sulfur, 1900-2018

Sulfur data follow the general principles from 1900 to 2018 and are sourced from U.S. Geological Survey (2015, 2019). The data refer to the unit value based on values and quantities of U.S. production for the years 1900 to 1908, to the unit value of U.S. sulfur shipments for the years 1909 to 2015, and to the price of elemental sulfur for free on board at mine or plant.

4.51 Talc and Pyrophyllite, 1900-2018

Talc and pyrophyllite data follow the general principles from 1900 to 2018 and we construct them based on information in U.S. Geological Survey (2015, 2019). For 1900 to 2015 the data refers to the unit value based on U.S. the value and quantities of U.S. sales, imports and exports. For 2016 to 2018 prices are ex-works unit values of milled talc sold by U.S. companies. We multiply the data for the last three years by a factor of 1.16 (ratio of the 2015 price from U.S. Geological Survey (2015) to the price from U.S. Geological Survey (2019)) to normalize it to the price series for previous years.

4.52 Tantalum, 1964-2018

We construct the series for tantalum prices based on the general principles and data published by U.S. Geological Survey (2015, 2019). Data refer to the yearend average price of tantalum content in tantalite ore. We convert prices for 2016 to 2018 from dollars per kilogram to U.S. dollars per ton of Ta_2O_5 content.

4.53 Tellurium, 1917-2018

We source price data from U.S. Geological Survey (2015) for the years 1917 to 2015 and from U.S. Geological Survey (2019) for 2016 to 2018. Data refer to tellurium metal price for the year 1917 to 1998, to the unit value of U.S. imports for 1999 to 2004, and to prices of metal with a 99.95% minimum tellurium from 2005 to the most recent year.

4.54 Thallium, 1942-2018

We construct the series based on price data from U.S. Geological Survey (2015) for the years 1942 to 2015 and from U.S. Geological Survey (2019) for 2016 to 2018. Data refers to U.S. domestic thallium prices.

4.55 Thorium, 1951-2018

We source the thorium data price data from U.S. Geological Survey (2015) for the years 1951 to 2015, from U.S. Geological Survey (2015) for the year 2011, from U.S. Geological Survey (2019) for 2015 to 2017, and from U.S. Geological Survey (2019) for 2016 to 2018. Data refers to the price of 97 percent content of ThO_2 for 1951 to 1977, 99 percent content of ThO_2 for 1978 to 1994, 99.9 percent content of ThO_2 for 1995 to 2005, and content of 99.99 percent ThO_2 for 2006 to 2010. For the time period 2011 to 2018 the data refer to value of imports from India (the only exporter to the US) for thorium compounds in gross weight. This causes a break in the data, which we remedy by normalizing the series to the level of the earlier series in 2010.

4.56 Tin, 1700-2018

Tin is one the mineral commodities that has been trade for the longest time. We use data from Schmitz (1979) for the years 1700 to 1899. We interpolate data using linear trends for the years 1703-8, 1711-2, 1720-7, 1732, and 1734. The data refer to London prices in British Pounds, which we convert to U.S. Dollar, during the year 1700 to 1888. The London was (and still is) the main price setting mechanism for trade in the metal. Starting in 1889 the data refers to U.S. market prices in New York.

For the years 1900 to 2015 we obtain data from U.S. Geological Survey (2015), which refer to the price for domestic refined tin from 1900 to 1998 and the Platts Metals Week composite price from 1999 to 2015. We source New York dealer prices from U.S. Geological Survey (2019). There are no apparent breaks in the data due to the changes in specifications over time.

4.57 Tungsten, 1884-2018

We use data from Neumann (1904) for the years 1884 to 1899. For the years 1900 to 2015 we employ data published by U.S. Geological Survey (2015) and for 2016 to 2018 by U.S. Geological Survey (2019).

Data for the earliest period are wholesale prices from the company Merck, a producer and global wholesale trader of metals at the time. For the years 1900 to 1986 data refer to the annual average sales price of tungsten concentrates produced in the U.S., for the years 1987 to 1888 to annual average spot price quotations for tungsten concentrates, and for the years 1989 to 2015 to the average U.S. market price of ammonium paratungstate. Data were interpolated to two significant figures by linear regression for 1921 to 1922. Data for 2016 to 2018 are the price of tungsten trioxide on the U.S. spot market as reported by Platts Metals week. As earlier data refer to the price in terms of metal content, we convert the price series for 2016 to 2018 also to metal content. We use the fact that one metric ton of tungsten trioxide contains 7.93 kilograms of tungsten. There is possibly a break due to a change in the price specification and source in the data in 1900.

4.58 Uranium, 1970 to 2018

We obtain uranium price data from OECD Nuclear Energy Agency and International Atomic Energy Agency (2006) for the years 1970 to 2002, from OECD and International Atomic Energy Agency (2008, 2010, 2012, 2015, 2017, 2019) and finally from European Commission (2019) for the year 2018. Data refer to the NUEXCO Exchange Value spot price for the years 1970 to 2002 and to the average Euratom Supply Agency price of spot contracts for natural uranium price for the years 2003 to 2018.

4.59 Vanadium, 1910-2018

We source vanadium price data for 1910 to 2015 from U.S. Geological Survey (2015) and for 2015 to 2018 from U.S. Geological Survey (2019). Data refer to U.S. dollar per metric ton of vanadium content in vanadium pentoxide. We use a factor of 1/0.56 to compute the content following U.S. Geological Survey (2015) for the years 2015 to 2018.

4.60 Vermiculite, 1924-1998

We use vermiculite price data for the years 1924 to 1998 published by U.S. Geological Survey (2015). The data refer to U.S. prices for vermiculite concentrate. Price data was discontinued starting in 1999 as it became harder to track a market with increasingly heterogeneous prices and product specifications.

4.61 Wollastonite, 1950-2015

We employ price data for the years 1950 to 2015 from U.S. Geological Survey (2015). We interpolate missing data for the years 1951 to 1958 with a linear trend. Data refers to sales prices in the U.S.

4.62 Zinc, 1759-2018

We use zinc price data from Schmitz (1979) for the years 1759 to 1899. We interpolate data using linear trends for the years 1760-1779, 1781-1789, 1791-9, 1801-4, 1806, 1809-1813, 1819 and 1821. Data refers to German prices in Marks during the years 1759 to 1824 and to London prices in British pounds during 1825 to 1876. We use the respective exchange rate to convert the data. U.S. data are available starting in 1877.

For the years 1900 to 2015 we source U.S. zinc price data from U.S. Geological Survey (2015) and for the years 2016 to 2018 from U.S. Geological Survey (2019). Data refers to U.S. zinc prices for marketed metal for the period 1900 to 1990, to U.S. prices for high-grade zinc for 1991 to 2001 and to special high-grade zinc in the North American market from 2002 to 2018. There are no breaks due to these changes in specifications.

4.63 Zirconium, 1918-2018

Zirconium price data come from the U.S. Geological Survey (2015) for 1918 to 2013 and the U.S. Geological Survey (2019) for 2014 to 2018. The data refers to the unit value of zirconium ores and concentrates apparent consumption in the U.S. for 1918 to 2013. Unit value was interpolated using two significant figures for 1920 to 1931. Data for 2014 to 2018 are reported as zircon that was imported for consumption from Australia, Senegal, and South Africa. This does not cause a break.

4.64 Crude Oil, 1861 to 2018

We source prices for crude oil from British Petroleum (2018) for the years 1861 to 2017 and from U.S. Energy Information Administration (2019b) for 2018. Data refer to U.S. Average Prices from 1861 to 1944, to Arabian Light posted at Ras Tanura from 1945 to 1983 and to Brent dated from 1984 to 2018.

4.65 Natural Gas, 1900 to 2018

The use of natural gas only became commercialized at the beginning of the 20th century. We source price data for the first twenty years from two sources: 1900 to 1905: (U.S. Bureau of Mines, 1902), 1906 to 1922: (Potter and Christy, 1962). The data refer to unspecified U.S. natural gas prices during the period 1900 to 1905, to average U.S. prices at point of consumption during the period 1906 to 1918, and to average wellhead U.S. prices the period 1919 to 1922. The wellhead refers to the point of production.

For the time period 1923 to 2011 we source data from U.S. Energy Information Administration (rice), which refers to U.S. wellhead prices. We employ Henry Hub natural gas price data from Federal Reserve Bank of St. Louis (2019) for the years 2012 to 2017 and from U.S. Energy Information Administration (2019b) for 2018. No changes in specifications cause breaks.

4.66 Bitumenous Coal,

Bitumenous coal is the fossil fuel with the longest track record of trading. Bitumenous prices refer mostly to hard coal as brown coal was and still is typically only traded regionally due to its heavy weight and use in local power plants.

We source coal price data from Jacks et al. (2011) for the years 1700 to 1796. The data refers to British coals in London. From 1797 to 1856 we use New York price data for bitumenous coal imported from Liverpool published by Cole (1938). From 1857 to 1869 we employ Baltimore price data for bitumenous coal imported from Cumberland, U.K. From 1870 to 1948 we get bitumenous coal price data from Potter and Christy (1962). The data refers to the preferred price series of the U.S. Bureau of Mines, which is the average value of coal at the mine.

Starting in 1949 we use U.S. free on board bitumenous coal price data published by U.S. Energy Information Administration (2019a) (until 2010) and by U.S. Energy Information Administration (2018) (2011 to 2017). We estimate that the price for 2018 stayed the same as in 2017. Data for 2018 will be published on October 8, 2019.

5 Other Series

5.1 World Real GDP

We construct an annual series of world real GDP by first using Maddison (2010b) data-set. He provides estimates for the years 1700, 1820, 1870, 1900, 1913, 1920, 1940, and 1950 based on purchasing power parity (PPP) converters developed by Roy Geary and Salem Khamis (see documentation in Maddison, 2010a). The base year of the data is 1990.

We use growth trends to interpolate the data and to derive annual measures of world real GDP. The data is hence by construction focused on long-run developments and does include any business cycle dynamics.

For the time period from 1950 to 2018 we use the sum of individual countries real GDP data published by Conference Board (2018), which has been PPP adjusted using the method of Elteto, Koves and Szulc. We include the Conference Board's alternative measure for output in the People's Republic of China.

We splice the two series together by normalizing the series based on Maddison (2010b) to the level of the Conference Board (2018) series in the year 1950.

We are aware of the methodological inconsistencies from connecting these two series but believe that the series provides a rough estimate that is in line with its purpose in this paper. We leave it to future work to come up with a better measure of global real GDP at an annual frequency and over the long horizon.

5.2 World Population

Like with world real GDP we use estimates of world population published by Maddison (2010b). The data-set provides estimates for the years 1700, 1820, 1870, 1900, 1913, 1920, 1940. We use growth trends to interpolate the data and to derive an annual series. The data is hence by construction focused on long-run developments. For the time period from 1950 to 2018 we use the sum of individual countries population data published by Conference Board (2018).

5.3 Exchange Rates

To convert price data in British Pound to U.S. dollar we employ the exchange rate published by Officer (2019). The series starts in 1791 and goes to 2018. The dollar became the monetary unit in the U.S. in 1785 such that there are by definition no dollar-based commodity prices before that time. To come up with a way to create "artificial" U.S. dollar denominated price series that go back to 1700, we assume that the exchange rate between British Pound and the U.S. dollar stays constant at its 1791 level going all the way back to 1700. We have not found a more elegant way yet and acknowledge that this potentially needs improvement.

We face similar problems for the earlier parts of the series for the exchange rate between the U.S. dollar and the German Mark. We use the exchange rate series published in Stuermer (2017) for the time period 1850 to 2011. The Mark was only introduced in 1871. The exchange rate refers to the Vereinthaler and the Thaler before that.

5.4 Inflation

To deflate the U.S. dollar denominated prices series, we use the annual consumer price index for the United States published by Officer and Williamson (2011) going back to 1774 and the standard consumer price index for all urban consumers from the U.S. Bureau of Labor Statistics. We fill a missing observation in 1947 with a linear trend. We splice the two series together and normalize the resulting series to the base year 2017.

For the time period 1700 to 1773 there is no U.S. deflator readily available. We use the United Kingdom retail price index from Clark (2019) and splice it together with the other two indices.

The choice of the deflator is important for the long-run trends in real prices. It is important to keep this in mind when interpreting our series and the empirical results. The ideal deflator for our price series would be a global one. To our knowledge there is no such deflator is not available. We leave the construction of such an index to future research.

6 Additional Tables and Figures

	Crustal Abundance (Bil. mt)	**Reserves** (Bil. mt)	**Annual Output** (Bil. mt)	**Crustal Abundance/ Annual Output** (Years)	**Reserves/ Annual Output** (Years)
Aluminum	1,990,000,000[e]	30[b1]	0.06[a]	33,786,078,000	100[1]
Copper	1,510,000[e]	0.8[b]	0.02[b]	76,650,000	40
Iron	1,392,000,000[e]	83[b2]	0.06[a]	1,200,000,000	55[2]
Lead	290,000[e]	0.1[b]	0.005[b]	61,702,000	18
Tin	40,000[e]	0.005[b]	0.0003[b]	137,931,000	16
Zinc	2,250,000[e]	0.23[b]	0.013[b]	170,445,000	17
Gold	70[e]	0.0001[b]	0.000003[b]	22,076,000	17
Coal[3]		510[d]	3.9[d]		131
Crude Oil[4]	15,000,000[6f]	241[d]	4.4[d]	1,297,529	55
Nat. Gas[5]		179[d]	3.3[d]		54

Notes: [1]Data for bauxite, [2]data for iron ore, [3]includes lignite and hard coal, [4]includes conventional and unconventional oil, [5]includes conventional and unconventional gas, [6]all organic carbon in the earth's crust. Sources: [a]U.S. Geological Survey (2016), [b]**?**, [c]British Petroleum (2017), [d]Federal Institute for Geosciences and Natural Resources (2017), [e]Perman et al. (2003), [f]Littke and Welte (1992).

Table 1: Quantities of selected non-renewable resources in the crustal mass and in reserves, measured in metric tons and in years of production based on current annual mine production.

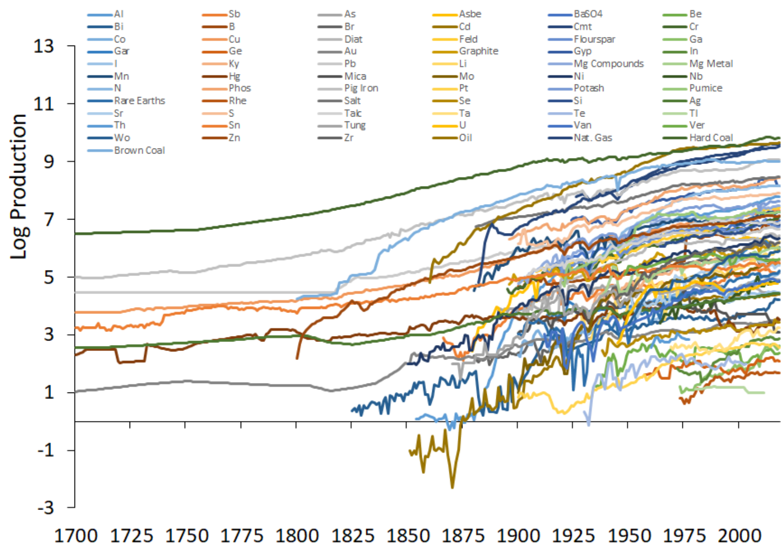

Figure 1: Extraction of all non-renewable resources in our data-set in logs, 1700-2018.

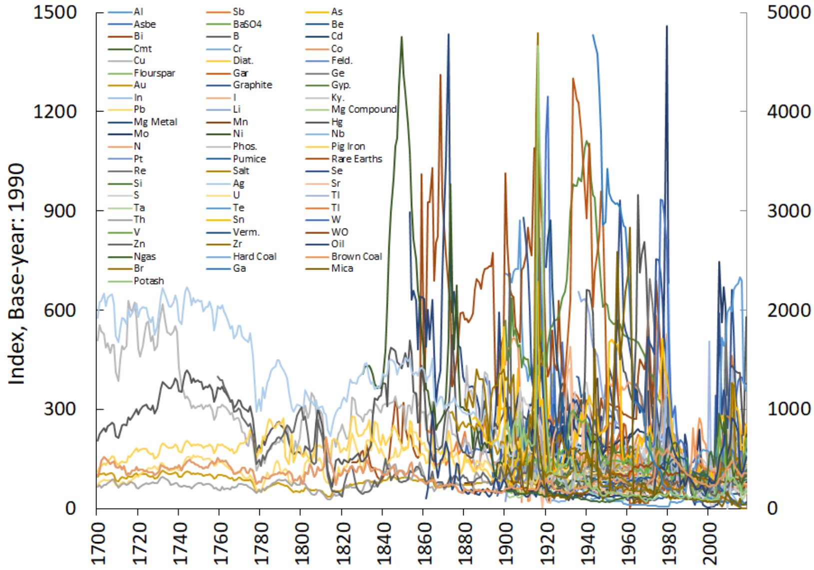

Figure 2: Inflation adjusted price indices of individual non-renewable resources in our data-set, 1700-2018. Note: Potash (Pt), Gallium (Ga), Bromine (Br), and Mica are on the right y-axis.

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