

## Hidden energy flows in Danish international trade: a long-run study of energy use under a consumption perspective

Sofia Teives Henriques

Astrid Kander

Paul Sharp

Paul Warde

China and other emerging economies are nowadays perceived as the workshops of the world manufacturing and exporting industrial energy intensive goods to developed and service-based economies. The energy embodied in this international trade is believed to contribute to the downward energy intensity and CO<sub>2</sub> emissions trends of post-industrialized economies. In the 19<sup>th</sup> and early 20<sup>th</sup> century, the production of energy, especially coal intensive manufacturing goods was even more concentrated among a few countries ( the UK, Germany and the United States) than it is today. This means that historical national levels of both energy consumption and CO<sub>2</sub> emissions may look profoundly different when international trade is taken into account. However, with a few exceptions<sup>1</sup>, long-run energy studies only account for the energy that is consumed within the borders of a nation. Although useful, this approach does not capture the hidden flows of energy embodied in the international trade of non-energy goods, obscuring the relationship between energy consumption and the environmental impact of country historical development path.

To understand the role of trade in a country long-run energy consumption and energy intensity, we investigate the historical levels of Danish energy use under a consumption-based perspective by calculating the amounts of energy embodied in Danish international trade from 1870 to the present days. This will be possible through the construction of historical embodied energy technical coefficients for the most important traded products. Denmark has rich literature on the subject for the nineteenth and twentieth century and technical requirements (energy/ton) can be complemented with the input-output tables for later periods<sup>2</sup>. Denmark's is an interesting case for a long-run study. It was a country with practically no fossil fuel reserves which developed through agriculture, reaching high income levels early in history. Furthermore, it was an extremely open economy where trade was of uttermost importance. Denmark exports were composed by agricultural goods, mostly butter and pork that they export to the industrial cities of the UK. Denmark imported most of her raw materials, including energy, iron and minerals. A plausible and likely hypothesis is that Denmark was a significant net importer of energy, and that the energy embodied in fossil fuel energy-intensive imports (such as iron and steel, from countries such as the UK or Germany) outweighed the energy embodied in her supposedly low energy intensive agriculture exports. In a previous and rough attempt, Kjaergaard (1994) would even ignore these agriculture exports, concentrating only in the coal embodied in iron imports to reach the conclusion that Denmark development was only possible due to energy embodied in her imports.

Ignoring agriculture exports is probably misleading. Danish agriculture was particularly energy intensive needing vast amounts of coal and feed, as animal energy, per unit of output. For example, it is estimated that about 20% of Denmark's energy consumption in 1900s was directed to the

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<sup>1</sup> See for instance Kander and Lindmark (2006)

<sup>2</sup> Denmark first input-output table is from 1948 and they are produced in an annual basis since 1966.

production of butter, with the bulk of this being exported<sup>3</sup>. This can lead to the rejection of the hypothesis that coal-poor and agricultural countries are necessarily energy importers, an idea that was also questioned for the recent period by Jacobsen (2000). The results of this study will also allow to understand the ecological flows embodied in the Anglo-Danish trade and the influence of different trade periods in Denmark's long-run energy intensity.

#### References

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<sup>3</sup> See Henriques and Sharp (2014).