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**Melting Markets: The Rise and Decline
Of the Anglo-Norwegian Ice
Trade, 1850-1920**

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1. Introduction

“During the late tropical weather ice represented a real power in the community; just as in winter coal is an absolute necessity”
The Times, Sep 11, 1868

1.1 Background And Research Questions

The first merchant trading in Norwegian natural ice was the Englishman William Leftwich in 1822. Judged by Mr Leftwich’s

transfer and structural change. The dissertation will try to answer four fundamental questions:

- i. Why Norwegian ice?
- ii. Which factors explain the strong and persistent growth of British imports and consumption of natural ice from around 1850 to about 1914?
- iii. Technology and shocks: what factors lead to the decline of Norwegian ice exports to Britain?

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1.2. Existing Knowledge

The integration of the global economy and the modernisation of Western economies in the 19th century changed the parameters of production, distribution and trade of foodstuffs. While economic historians have paid heed to mechanical refrigeration and its role in facilitating the integration of markets, assisting urbanisation and increag the

the historian Gøtheson offers a broad outline of the history of the trade in ice and timber.⁸ However, Gøtheson is concerned mostly with the links between timber, ice and shipping than with the economic history of the ice trade *per se*, and the book has more of a narrative than an analytical character. For the British side of the story, the use of British icehouses and storage of ice have attracted the interest of Ellis and Beamon and Roaf.⁹ However, the first real attempt to cover the British-Norwegian ice trade was the work of Robert David.¹⁰ David focused on the demise of the Anglo-Norwegian ice, and his findings further our understanding of this trade. However, in many ways he tells a one-sided story as his primary sources and literature are exclusively of British origin. Moreover, the broader consequences are not obvious, as he does not apply either a theoretical or a comparative perspective in his analysis.

The lack of literature on the natural ice industry cannot be ascribed to the lack of source materials. On the contrary: there is plenty of contemporary material in both Norway and Britain dealing with various aspects of natural ice. Most of this material is in customs records, newspapers and trade journals.¹¹ These sources have played a crucial role in answering the four questions outlined above.

2. Why Norway?

2.1. Emerging Markets For Ice In The 19th Century

The use of cold for preserving foodstuffs is a far from modern invention: it can be traced back to 1100 B.C. through Chinese poems

⁸ Gøtheson (1986).

⁹ Ellis, M., *Ice and Icehouses through the Ages* (Southampton, 1982); Beamon, S.P., Roaf, S., *The Ice-houses of Britain* (London, 1990).

¹⁰ David, R., 'The Demise of the Anglo-Norwegian Ice Trade', *Business History*, 37 (1995), pp. 52-69.

¹¹ On the British side, the main trade journals were *Cold Storage*, *Fish Trades Gazette* and *British R R*, 671TT1R Jj10.98 0 f0 M8 2um0013j1rchiv63.5204e Ice-house

describing 'ice houses'.¹² The first references to icehouses in England can be found in the 16th and 17th centuries. Icehouses were used mainly for storing foodstuffs.¹³ However, before the 19th century food preservation in Europe involved mainly the traditional techniques of salting, spicing, pickling, smoking and dehydration.¹⁴

The development of a commercial market for natural ice in the 19th century started in the urbanised areas of North America. The primary market was New York. The combination of hot summers, population growth, and the expansion of the brewing and meat packing industries led to a positive shift in demand for natural ice.¹⁵ The Boston entrepreneur Wyeth invented and patented tools that advanced large-scale ice harvesting. Wyeth supplied the 'ice king' Fredric Tudor with ice for his growing markets. Tudor's vision was to export ice to the colonies, and his ice empire soon stretched from the West Indies to Australia.¹⁶ He aimed his product towards the British gentry worldwide, offering the privileged classes ice for their iced drinks and for cooling saloons. However, Tudor did not focus on the British domestic market. The first export of American ice to Britain was in 1844, and was carried out by the Wenham Lake Ice Company, named after the Wenham Lake in Massachusetts. The ice from this lake was well received and admired in England for its clarity and purity, and the pure blocks of crystal ice from Wenham were a great improvement on the local ice. In fact, Wenham Ice was later to become known as a standard of quality rather than a given lake or company.

¹² The first European source mentioning icehouses dates from the 5th century B.C., when Protagoras described how the Egyptians in the Nile valley made ice by putting containers on the roofs of their houses; see Thevenot, R., *A History Of Refrigeration throughout the world* (Paris, 1979), p. 23. dates from the 5th century B.C.,

American ice exports to Britain, however, faced substantial bottlenecks.¹⁷ Above all, the distance implied huge losses of cargo as the ice melted during the Atlantic crossing. Moreover, the distance is also reflected in the transport costs. The combination of both factors limited supply and ensured relatively high prices of American ice in the British market.

2.2. Norway's Competitive Advantages 632.78036 T50y 87eT05 96j0.refE

and timber. Timber was the prime domestic cargo for the shipping industry. Timber and timber produc

shipping sector was the skilled labour, and by the late 1870s, Norway had the world's third largest merchant fleet.²⁵

2.3 Production Of, And Trade In, Natural Ice

Norwegian ice was first exported by foreign, mainly British, merchants, who possessed the know-how for production and marketing. British entrepreneurs found that Norwegian ice was of similar quality to Wenham ice but could be attained at a much lower price. In December 1864 the newspaper *Morgenbladet* reported that a foreign entrepreneur had bought Lake Opegård and renamed it 'Wenham Lake'.

Subsequently the ice from Opegård was sold in England as "Wenham lake ice", posing as the famous American ice.²⁶ In 1868 *The Times* reported that the cubes of pure crystal ice seen on the fishmonger slabs and in the windows of the Wenham Lake Ice Company were in fact all produced in Norway.²⁷ By the 1880s and 1890s, Norway had gained control over its own market and Norwegian merchants and took over the ships that had previously belonged to the English ice merchants.

The transport of the ice from the natural lakes inland was a costly and risky business, as it was heavily dependent on a cold Norwegian winter and a warm British summer. Soon Norway was unable to produce enough ice to meet the foreign demand. This led to the establishment of artificial lakes on agricultural land closer to the ports. Icehouses were built to contain the ice for up to a year, increasing the storage capacity and the

²⁵ The fleet consisted almost exclusively of sailing vessels with wooden bottoms, as metal hulls were prone to rust and sailing vessels offered cheaper freight rates than steamships. Windmill pumps were also fitted on the ships to pump the water away by the late 19th century. See *British Refrigeration and Allied Interests* (February 1899), p. 31.

²⁶ *Morgenbladet* (24 December 1864), p. 2; *British Refrigeration and Allied Interests* (February 1899), p. 31.

²⁷ *The Times* (11 September 1868), p. 5.

possibility of expanding the trade.²⁸ The creation of artificial lakes on the higher points close to the fjords became the best practice.²⁹ Long inclines constructed of boards were built through the forest, leading to long runners half a mile in length, which reached out into the harbours.³⁰ The ice industry brought significant income for areas in the southern part of Norway, as well as significant freight earnings for the shipping companies.³¹ However, ice production and its export were capital-intensive and competitive.³²

Graph 1 illustrates the rise, peak and decline of the ice export (left axis), and the annual average temperatures in Oslo (right axis).³³ We cannot observe any major changes in domestic temperatures that can explain the massive surge in exports of ice, as the temperatures seem to have been relatively stable, fluctuating between 3.8-7 degrees Celsius.

²⁸ Ouren, T., 'The Norwegian Ice Trade', in Proctor, D.V. (ed.), *Ice Carrying Trade at Sea* (London, 1981), pp. 31-55.

²⁹ Gøthesen (1986), p. 129.

³⁰ Interview with Mads Olsen, whose research confirms the trade's importance for the local population; *Harmsworth Magazine* (August 1901), p. 18.

³¹ *Kragerø Blad* (13 December 1977), p. 1; on9H3r4t2r4ortance /asTm9c2570 10153.4797.98 380.33321

2.4 European Competitors

*again, before the vessels belonging to the Bothnian ports could begin the navigation of the year”.*⁴⁰

As we see in graph 2, Norwegian ice exports and English ice imports moved in accord with each other. In many ways, Norway enjoyed both first-mover and second-mover advantages compared to its European competitors. While the first-mover advantages can be ascribed to the pre-emption of scarce assets and buyer-switching costs, Norway had second-mover advantages by being able to use the American advances in technology and the British ice merchants' knowledge of the market.⁴¹

The ice export was significant for Norwegian development and can be seen as example of the 'vent for surplus' theory.⁴² Ice was a plentiful natural resource in Norway. North has argued that international demand for export has been 'the prime mover' for economic development.⁴³ Furthermore, Hodne stresses that the economic history of Norway in the 19th century was an export-led story. He emphasised Norway's primary export growth, where free trade and the export of natural resources above subsistence levels allowed for specialisation and capital formation, which in turn allowed the Norwegian economy to catch up with the modernised

Graph 2: Norwegian Exports And British Imports Of Ice, 1854-1913

natural ice was progressing slowly but steadily.⁴⁶ However, the arrival of ice from North America (see 2.1) raised new scepticism about the quality of domestically produced ice, and lo

explained by the high wastage of ice, as few invested in iceboxes and storage devices for keeping the ice.⁴⁸ Rural consumers were also involved in this new demand, as by the middle of the 19th century the development of the railway network meant that ice imported from Norway could be supplied from large urban depots to the countryside, and could supply the icehouses all year round.⁴⁹

3.2.2. *Producers*

Producers included a large range of different trades and industries, including the fishing industry, medicine and hospitals, technical institutions, the brewing industry, confectionary producers, and also the meat, poultry and the fruit and vegetable businesses. These different trades were perhaps the main customers for the increasing imports of natural ice.

3.2.3. *Transport Industry*

The third group can be categorised as the transport industry - the railways and road vehicles - which used ice for transporting a multitude of different products to the domestic market. While mechanical refrigeration became a necessity on long-distance journeys from such places as Australia, Argentina, and Am

either directly to customers or to huge ice wells at Shadwell and King's Cross.⁵¹ The major challenge for the distributors was to organise efficient depots. Ice merchants procured their ice stocks from Norwegian suppliers, whose prices reflected different qualities of ice. The crystal ice was a luxury good used for table purposes, and had to be collected from the interior of Norway, as this ice was clear and very hard.⁵² The more porous and white type of ice was more prominent in the various meat industries and the fish trade. The marked difference between the American and British trade was the absence of distribution of ice to private homes in Britain. Also few ice merchants sold ice alone; ice was complementary to their other business. Ice for private consumption in Britain was bought usually at the fishmongers, butchers and chemists.⁵³

One of the leading ice merchants in England was the firm of Messrs. Leftwich and Company. From 1880 onwards, this company built a networkssrkssr

Pole Company, to offer minimum prices of 18 to 20 shillings per ton. North Pole's offer made them the main supplier of ice to the meat trade. However, the main strategic aim of the company was to supply the fishing trade, which was the largest purchaser of Norwegian ice.⁵⁵

3.4 Development In The Short And The Long Run

The main long-term changes include environmental and climatic adjustments and the major changes in the British society, such as urbanisation, structural and societal changes

Graph 3: Annual Average Temperatures In England, 1659-1934

Moreover, average wage levels almost doubled between 1845-54 and 1905-13, rising from £33.7 to £60.⁵⁹ England's urban growth and its early economic maturity meant even as late as 1910 its ratio of urban to rural population was twice that of continental Europe.⁶⁰

Structural changes and rising wages dramatically changed consumption patterns as an inevitable consequence of the urban way of life.⁶¹ The increased social mobility and the growth of the middle classes and their purchasing power played a significant role in creating new markets for mass culture and services.⁶² The growth of pubs, hotels and the increased consumption of whisky and champagne fuelled demand for ice. The urban population was also dem.02 364.1 an70.0033 Tw 13.02 0 On655.22017 T

trade by allowing longer voyages, and larger quantities of fish could be brought back for sale.⁷⁰

3.4.3. *Temperature Changes In The Short Term*

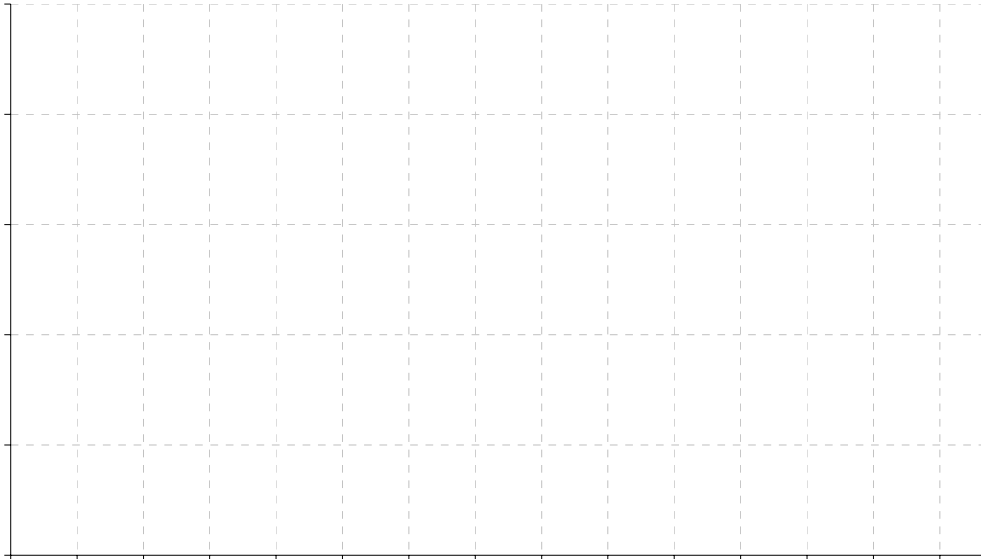
Short-term trends such as seasonal and temperature variations had a large impact on the demand for ice. Furthermore, it was these fluctuations and shocks that effected various interest groups and created not only a higher demand for natural ice, but created the impetus for the technological changes that changed the trade altogether.

“What chiefly regulates the demand for ice is firstly the winter secondly the summer.”⁷¹

What is consistent in the literature from this period was the focus on ice being a necessity during warm summers. While the use of ice was steadily increasing, the temperature shocks were closely linked to the scale of Norwegian exports. Graph 4 shows the extent of the heatwave that struck England in the late summer of 1898. England was experiencing an ‘Indian summer’, which created a very high demand for ice.

3.4.4 *Falling Prices And Freight Rates*

Graph 5: British Imports Of Norwegian Ice, 1853-1913: Price And Volume Indices (1913=100)



1913.⁷⁴ The prices of Norwegian ice show a clear, falling trend. The prices here are expressed as the price per measurement ton of ice imported. However, as these figures are referring to c.i.f, or cost insurance freight, this might partly be explained by falling transport costs. Indeed, when comparing the fall in freight rates (Graph 6) with the fall in ice prices for the period 1883-1913, a pattern of close correspondence emerges.

4. Technology And Shocks

4.1. New Technology

The demand structures led to a preference for a more elastic supply of ice. Many of the growing trades

across the oceans.⁷⁹ The development of imports of lamb, beef and mutton from Australia, America and Argentina had linkage effects in Britain, as many new ice and cold storage companies were founded to support this trade.

On the consumer side, the most

while at Hull and Fleetwood, ports that

mechanical ice making equipment stressed that their purification was assured by distillation.⁸⁴

In 1876 the

“Natural ice imported to this country is collected from lakes, which, without doubt, receive the surface drainage from the surrounding country...it is nauseating to think of that.”⁸⁹

Not only was this an attack on the use of Norwegian ice for table purposes, it was also a call to the various food trades to adopt the new ice-making machinery.

4.3. Continuity

Despite the various shocks to the ice trade, mechanised production was unable to meet demand as late as 1911, when the daily consumption of ice was 2000 tons a day, while artificial ice-makers were capable of producing only 500 tons per day.⁹⁰ This meant that the greatest supply was still coming from Norway, and London was still receiving 20 vessels each day. Most towns outside London were also still dependent on imports during the warm months.⁹¹ Moreover, while many large businesses could invest in ice-making machinery, other trades and consumers were more reluctant to change. Businesses transporting ice over short distances, such as the railways and the road hauliers found it unnecessary to invest in new equipment. Tanks containing ice and salt freezing mixtures were the predominant means of transporting the large quantities of frozen meat that arrived from abroad as late as 1912.⁹² Equally, private consumers and small shops continued to purchase natural ice. Public opinion did not alter despite Hamer’s report, and the public still believed that Norwegian ice was of superior quality and durability. This general belief persisted despite tests as early as 1899,

⁸⁹ *British Refrigeration and Allied Interests* (Feb 1899), p. 31.

⁹⁰ *The Times* (26 July 1911), p. 13.

⁹¹ *Ibid.*

⁹² Critchell, Raymond (1912), pp. 344-345.

where a 50-lb block of manufactured ice outlasted an equivalent block of natural ice by six and a half hours.⁹³

4.4 World War I

“How the Norwegians must curse the war... it is likely to receive its death-blow, as retailers awake to having small ice-making plants of their own”⁹⁴

Historically, any shock such as the disruption or total blocking of an accustomed source of supply has played a crucial part in stimulating technological change. The outbreak of war being the most apt example, with the imposition of a previously nonexistent constraint, and new searches for a substitute, and a more productive process was the consequence.⁹⁵ World War I accelerated the ongoing trend that had unfolded since the initial shocks. Its impact was favourable to the refrigeration trade, which exploited the fears of ice shortages. The German blockade of the North Sea damaged the natural ice trade. Reports in 1915 doubted whether demand (apart from demand from hotels and restaurants) would be reduced as a consequence of the war. However, with ice consumption estimated to be 300,000 tons a year, ice-making plants were supplying only a third.⁹⁶ Total imports of ice for the first half of 1915 were 21,182 tons, compared with 107,136 tons for the same period in 1914.⁹⁷ The change was largest for the small retailers such as fishmongers and butchers, who had not invested in mechanical refrigeration. The mechanical refrigeration trade press warned the various

⁹³ *Cold Storage* (Septembe

trades of the risks that the war could impose on their businesses, and urged them to instal

discussed, with a more varied framework in which changes are more gradual, and influenced by a broad set of factors that included the seasonal nature of ice, the social perceptions as well as the high cost and technical limitations of the ice-making machinery.

The interesting aspect of this case study is that when looking specifically at ice (rather than refrigeration and cold storage) the two different technologies were near-perfect substitutes. Therefore the cost per unit of ice should determine the best option. Natural ice was more expensive than artificial ice, largely because of transport charges.⁹⁹ However, the trade press shows that natural ice was still significant up

unable to produce enough ice to meet demand, the use of natural ice was only supporting the process of change.

5.3.1 Seasonal And Cost Restraints

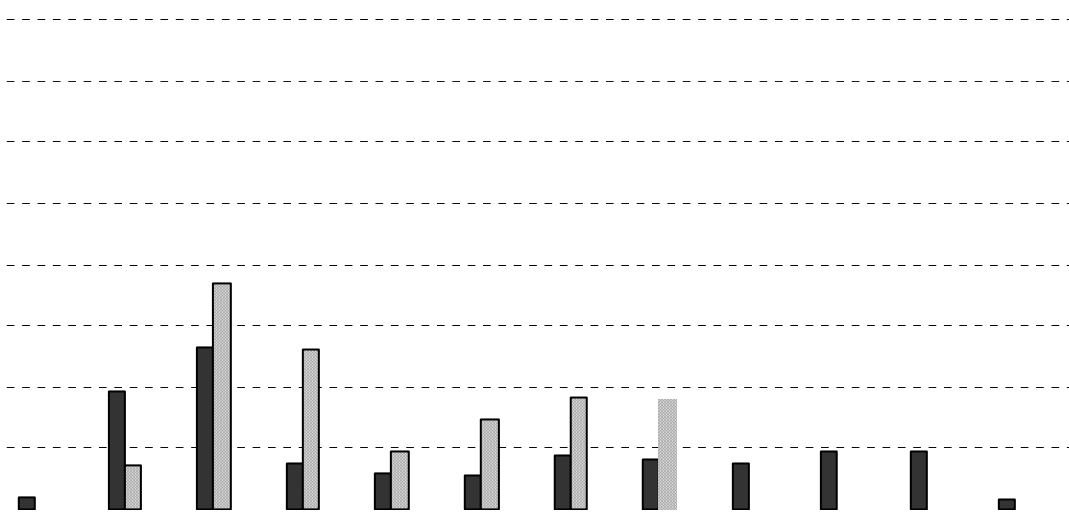
“Those who have not the bulk of business nor the capital to lay out, which machinery calls for, may rest well content with the modern non-mechanical contrivances”¹⁰⁹

What becomes apparent was that that incentive structure was linked intimately to the nature of the different trades involved. Many of the larger companies in brewing and fishing, and trades dependent on cold storage rather than ice, such as the meat industry, invested readily in the new technology.

The extent to which companies chose to mechanise ice production depended on the rewards and penalties, and on the feasibility of the new technology for their use. This also depended on the environmental or climatic discrepancies and on the institutional pressures, which were greater for different trades at different times. For industries such as fishing and brewing there was a clear dependency on an all-year supply, and during shocks the natural ice was both expensive and inadequate. However, for other industries the benefits of technological change were less obvious, as for example for the ice cream producers and ice merchants Gatti, for whom the two operations were complimentary and largely seasonal.

¹⁰⁹ *Fish Trades Gazette & Poultry Game & Rabbit Trades Chronicles* (March 1905), p. 30.

Graph 7: Monthly Exports Of Norwegian Ice, 1867-1870



Graph 8: Monthly Ice Imports Into England And Wales, 1901 And 1902

to lend money for refrigeration machinery was discussed frequently in the trade journal *Cold Storage and Ice Traders Review*. It seems the main reason for this was the mismanagement and failur

a costly process, mainly because of the high price of coal and ammonia.¹¹⁷ This allowed Norwegian Crystal to remain competitive in the market for crystal ice.¹¹⁸

5.3.3. Macro And Micro Inventions, And The Broader Context

As Mokyr acknowledges, the essential feature of technological progress is that macroinventions and microinventions are not substitutes but complements.¹¹⁹ Mokyr's ideas can be discer

constraint by Hagerstrand.¹²³ The trade press at the time was highly active in promoting the new available technology. Instead the forces of restraint and change also fit into the larger picture of British economic development between 1850 and 1920. Britain's relative decline has been a much-debated topic.¹²⁴ From a position of dominance, 1870 Britain's international role diminished after 1870.¹²⁵ Shortcomings in science and technology, and institutional constraints in the form of a lack of financial backing have been suggested as reasons for this decline. However, despite the passing of Britain's economic predominance, the country's highly urbanised economy and rising wages meant that the boom in the food and drinks industries, together with the growing demand for luxuries, ensured that natural ice remained important despite its higher price.¹²⁶

The rate of change, as noted by Mansfield, was faster where the outcome was more profitable and where the investments were less severe.¹²⁷ This picture supports the evolutionary ideas, where the development of technology is not a uniform process, but was heavily dependent on the size, capital and the nature of the businesses involved. The process of technological change can in this case be understood only by looking at both the micro and macro pictures of Britain's relative maturity and stagnation, as well as its institutions and its social and technological restraints.

¹²³ Inkster, I., *Science and Technology in History* (London, 1991), p. 16.

¹²⁴ For an overview of this debate, see Pollard, S., *Britain's Prime and Britain's Decline* (London, 1989), p. 51; and more recent findings Crafts, N.F., 'Long Run Growth', in Floud, R., Johnson, P. (eds),

6. Conclusions

The Anglo-Norwegian ice trade was a short-lived adventure, and this is perhaps why it has almost entirely escaped the literature. However, its role was significant and portrays the development, processes and nature of technological transfer and change in Europe before the Great War. While this paper could only focus the role of ice from one of the prime exporter and importers in Europe, natural ice was a global trade and deserves further analysis.

Norwegian exports to the British market had a long trajectory, as the timber trade had paved the way for later trades. It was this advantage that enabled Norway to take a less peripheral role in the trade, and gain a near monopoly in the largest market at the time. However, the Norwegians were heavily indebted to American ingenuity and technology transfer, as well as English enterprise and English efforts to find alternative and less expensive solutions. However, the Norwegian comparative advantage in terms of location, climate, and shipping left them with few contenders from the European or Russian shores.

The sudden rise in demand for ice was related to both long-term and short-term changes. The long-term trends were crucial in creating an increased demand. The large structural changes, particularly urbanisation and population growth all required changes in the way food was supplied. The improvements in living conditions and increased life expectancies were due to improvements in and aware

different rates, and was by no means immediate or universal in the British
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Bibliography

Primary Sources:

Archival Sources:

Berg-Kragerø Museum, Kragerø, Norway:

bb sjoefart 88

Wiborg Papers

Wiborg, Thomas, "Grenmar", "Lidt om vor Isexport fra dens foerste dage"
["Part of our ice export in its earlier days"], unpublished manuscript
(Christiania, 1914).

bb sjoefart 88

Telegraphic Address and letter from A. Hutchinson & Co., Leith,
14.10.1894.

bb sjoefart 88

Wiborg, Haakon, "Familen Wiborg og iseksporten I Kragerø" ["The Wiborg
family and the ice export in Kragerø"], unpublished manuscript
(Oslo, April 1943).

The National Archives, Kew:

BT31, Files of dissolved companies, 1855-1973.

C26, Liquidation (Companies) Proceedings, 1849-1910.

CUST4, Ledgers of imports, 1809-1899.

J14, Supreme Court of Judicature: High Court of Justice, Chancery
Division, Debenture Actions Files.

LAB2, Ministry of Labour and Predecessors, Correspondence 1886-1955.

RAIL 484/29, Middlesbrough and Redcar Railway Company, Proposed
ice house for salmon, 1846-47

RAIL252/423, Great Western Railway Company, Use of refrigerating
railway van, 1871.

Contemporary press and specialist journals:

Board of Trade Journal (March 1894).

British Refrigeration and Allied Interests (1899).

Cold Storage and Ice Traders Review (later *Cold Storage and Produce
Review*) (1898-1920).

Fish Trades Gazette & Poultry, Game and Provision Trades Chronicle
(1890-1900).

Fish Trades Gazette & Poultry, Game and Rabbit Trades Chronicle
(1905-1915).

Harmsworth London Magazine (August 1901).

Kragerø Blad (1943, 1977).

The Lancet (1876).

Morgenbladet (1864).

The Times (1846, 1862, 1868, 1870, 1911).

Vestmar (1880, 1900-01, 1922, 1996).

Statistics Norway:

Statistiske oversikter 1948, Utgitt and Statistisk Sentralbyrå [Central Bureau of Statistics of Norway, *Statistical Survey 1948*] (Oslo, Aschehoug & Co, 1949), tabell 121, side, 209.

Historical Statistics 1978, Statistics Norway (Oslo, 1978), Table 1: 'Air temperatures, degrees centigrade'.

Norges Offisielle Statistikk C 188, Historical Statistics 1994, Statistics Norway (Oslo, 1994), Table 2.7; 'Average air temperatures at 10 meteorological stations',

http://www.ssb.no/emner/historisk_statistikk/hs1994.html

C. No. 3, *Tabeller vedkommende Norges Handel og Skibsfart I Aaret 1867* [Tables concerning Norwegian Trade and Shipping in the year 1867], Departementet for det Indre (Christiania, Det Steenske Bogtrykkeri, 1869).

C. No. 3, *Tabeller vedkommende Norges Handel og Skibsfart I Aaret 1868* [Tables concerning Norwegian Trade and Shipping in the year 1868], Departementet for det Indre (Christiania, Det Steenske Bogtrykkeri, 1870).

C. No. 3, *Tabeller vedkommende Norges Handel og Skibsfart I Aaret 1869* [Tables concerning Norwegian Trade and Shipping in the year 1869], Departementet for det Indre (Christiania, Det Steenske Bogtrykkeri, 1871).

C. No. 3, *Tabeller vedkommende Norges Handel og Skibsfart I Aaret 1870* [Tables concerning Norwegian Trade and Shipping in the year 1870], Departementet for det Indre (Christiania, Det Steenske Bogtrykkeri, 1872).

Other Contem

The British Atmospheric Data Centre (BADC). The BADC's database is operated by the Natural Environment Research Council (NERC). Subsets are subject to strict conditions of use. Thus, please do not quote the series presented in this thesis, but rather contact the NERC directly http://badc.nerc.ac.uk/data/list_all_datasets.html

Anderson, O.E., *Refrigeration in America* (New Jersey, Princeton University Press, 1951).

Bairoch, P., *Cities and Economic Development, From Dawn of History to the Present*, (Chicago, University of Chicago Press, 1988).

Beamon, S.P., Roaf, S., *The Ice-houses of Britain* (London, Routledge, 1990).

Bean, S.S., 'Gold Mine', *American Heritage* (July/August 1991), pp. 71-76.

Cooper, A.J., *The World Below Zero: A History of refrigeration in the UK* (Buckingham, ACR Today and Battlepress, 1997).

Cowan, R.S., *A Social History of American Technology* (New York, Oxford University Press, 1997).

Crafts, N.F., 'Long Run Growth', in Floud, R., Johnson, P. (eds), *The Cambridge Economic History of Modern Britain, vol. II* (Cambridge, Cambridge University Press, 2nd ed., 2004), pp. 1-24.

Crowhurst, B., *A History of the British Ice Cream Industry* (London, Westerham, Food Press, 2000).

David, R., 'The Demise of the Anglo-Norwegian Ice Trade', *Business History*, 37 (1995), pp. 52-69.

David, P.A., *Technological choice innovation and economic growth: essays on American and British experience in the nineteenth century* (London, Cambridge University Press, 1975).

-----"Clio and the Economics of QWERTY", *American Economic Review*, 75 (May 1985), pp. 332-339.

-----"Path Dependence and the Quest for Historical Economics: One more Chorus of the Ballad of OWERTY", *Discussion Papers in Economics and Social History*, 20 (Oxford, University of Oxford, 1997).

-----*The Development of Large Technical Systems*, eds Mayntz, R., Hughes, T.P.(Frankfurt, Campus Verlag, 1988).

Ellis, M., *Ice and Icehouses through the Ages, With a Gazetteer for Hampshire* (Southampton, Southampton University Industrial Archaeology Group, 1982).

Gardåsen, T.K., 'Isblokkar viktig eksportvare. Isbruk i grenlandsfjordane 1835-1962' ['Ice blocks: a crucial export commodity. Ice-mining in Grelansfjords, 1835-1962'], Slokvik, R.(ed.), *Kulturmenneske før og no* [*Human culture then and now*] (Skien, 2004).

Giedion, S., *Mechanization Takes Command, a contribution to an anonymous history* (N

Mo

- Olsen, M., Interview with Severin Hansen, 5 November.1977.
- Interview with Bodil Blain, 2 August 2005.
- For details contact Mads Olsen, Joeransberg 7, 3770 Kragerø, Norway.
- Olsen, M., 'Issjau I Kragerø-distriktet' ['Ice collection in the Kragerø district'], *Budstikker gjennom loka lhistorien [Messages through local history]*, Årsskrift 1981 (Kragerø, For Kragerø og Skatøy Historielag, 1981), pp. 14-35.
- Ouren, T., 'The Norwegian Ice Trade', in Proctor, D.V. (ed.), *Ice Carrying Trade at Sea* (London, 1981), pp. 31-55.
- Petersen, K., *The Saga of Norwegian Shipping: an outline of the history, growth and development of a modern merchant marine* (Oslo, Dreyers Forlag, 1955).
- Pollard, S., *Britain's Prime and Britain's Decline* (London, Edward Arnold, 2nd ed., 1990).
- Ronald, F., Lundahl, M., *Natural Resources, "Vent for Surplus and The Staples Theory"*, Columbia University Discussion Paper Series (New York, Columbia University, 1992).
- Rosenberg, N., 'The Direction of Technological Change: Inducement Mechanisms and Focusing Devices', *Economic Development and Cultural Change*, 18 (1969), pp. 1-24.
- 'Factors Affecting the Diffusion of Technology', *Explorations in Economic History*, 13 (Fall, 1972), pp. 3-33.
- Perspectives on Technology* (Cambridge, Cambridge University Press, 1976).
- Exploring the Black Box: Technology, economics and history* (Cambridge, Cambridge University Press, 1994).
- Science, Technology and Everyday life 1870-1950*, ed. Chant, C. (London, Routledge, 1989).

- Scott, P., 'Path Dependence and Britain's "Coal wagon Problem"', *Explorations in Economic History*, 38 (2001), pp. 366-385.
- Sedgley, N., Elmslie, B., 'Do We Still Need Cities?' Evidence on Rates of Innovation from Count Data Models of Metropolitan Statistical Area Patents', paper presented at the '5th International Atlantic Economy Conference', Lisbon, March 2004.
- Sigworth, E.M., 'Science and the Brewing Industry, 1850-1900', *Economic History Review*, 17 (1965), pp. 536-550.
- Thevenot, R., *A History Of Refrigeration throughout the world* (Paris, International Institute of Refrigeration, 1979).
- Urbanization in History*, ed. Van der Woude, A., Hayami, A., De Vries, J. (Oxford, Oxford University Press, 1990).
- Vaage, J., 'En utdødd virkshomhet; Isskjæring og iseksport' ['A bygone industry: Ice cutting and ice export'], *Byminner [Town memories]*, 1 (Kragerø 1979), pp. 30-39.
- Whetman, E.H., 'The London Milk Trade, 1860-1900', *The Economic History Review*, 17 (1964), pp. 369-380.

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