

**THE NORTH ATLANTIC MEAT TRADE AND ITS INSTITUTIONAL CONSEQUENCES
1870-1913**

by

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Abstract

Transportation improvement and population growth in Europe and in the older settled areas of the United States generated settlement and the export of both grain and meat in the periphery. The central areas increasingly specialized in manufacturing and services. Europe and the eastern United States became dependent on food from newly settled peripheral regions. At first the great increase in periphery exports consisted primarily of grain, but by the 1880s a trade of similar importance in livestock for slaughter and in meat developed. Expansion of the international grain market has been extensively studied [Malenbaum, Jazy, Harley], but the trade in meat and meat animals, which by the eve of the First World War was of nearly comparable value and had some particularly striking organizational consequences, is relatively poorly explored. There are many broad similarities between grain and meat but sufficient differences to warrant closer attention. High quality meat, either as animals destined for slaughter or as dressed meat, was more perishable than grain. The perishability of meat led to organization of the trade with integrated firms playing key role in development. In addition, the transportation requirements of meat and cattle transformed the nature of North Atlantic shipping.

Intercontinental trade in meat, however, occasioned much more fundamental alterations in the nature of distribution than had the earlier development of the grain trade. Although preserved meat, both bacon and ham and pickled beef had long been traded, only in the late 1870s did high quality meat, in the form of live animals and chilled and frozen beef and mutton began to be traded internationally. The meat trade bore considerable resemblance to the grain trade, but differences are at least as striking. Lower transportation costs and increased demand generated by increasing population and income drove the developments as they did in grain. In contrast to grain, however, the impact of new technology cannot be simply summarized in terms of much lower freight rates. Long distance trade in meat inexorably altered conditions of meat supply and was tied to the evolution of new wholesale and retail distribution of fresh meat. Regulation and technology combined to replace the age-old system by which live animals essentially walked to the retail butcher shops with a new system where slaughter was centralized and dead meat moved in a wholesale trade to the retail butchers. Major changes in industrial organization emerged. With the new distribution came larger firms and greater vertical integration in both meat distribution and in transportation. In meatpacking and distribution, the American firms of Swift, Armour, and Morris emerged dominant in both exporting and importing regions. In ocean shipping, liner companies transported the cattle and meat. These meat cargoes aided liner dominance in world shipping.

The international division of labor was radically transformed in the second half of the nineteenth century. Traditionally high transportation costs fundamentally determined the extent of trade and specialization and international specialization possessed decided spatial characteristics. Transportation improvement and population growth in Europe and in the older settled areas of the United States combined to generate settlement in the periphery and the export of both grain and meat. Core areas increasingly specialized in manufacturing and services. Europe and the eastern United States became dependent on food from newly settled peripheral regions.

Before mid-century, an integrated economy centered on the industrial areas of northwestern Europe and extended into the Baltic hinterland for agricultural supply. A similar, but still largely independent supply and demand network existed between the northeastern and mid-western United States. Over the succeeding generations, these two economies became integrated and extended their influence to the Russian Steppes and beyond the Mississippi. At first the great increase in periphery exports consisted primarily of grain, but by the 1880s a trade of similar importance in livestock for slaughter and in meat developed. Technological improvement in transportation revolutionized the spatial nature of the North Atlantic so quickly in the late nineteenth century that disequilibrium and adjustment dominated for some thirty years.

Expansion of the international grain market has been extensively studied [Malenbaum, Jazy, Harley], but the trade in meat and meat animals, which by the eve of the First World War was of nearly comparable value and had some particularly striking organizational consequences, is relatively poorly explored. Although there are many broad similarities between grain and meat significant differences warrant closer attention. High quality meat, either as animals destined for slaughter or as dressed meat, was more perishable than grain. The perishability of meat led to organization of the trade in which integrated firms playing key role in development. In addition, the transportation requirements of meat and cattle transformed the nature of North Atlantic shipping.

The intercontinental grain trade emerged first. New technology of iron and steam had dramatic impact, but the organization of the industry changed little. Agricultural production expanded into the interior of the United States and of Southern Russia largely on the basis of the existing, even if very different, agricultural techniques already in use in each region. The trade certainly led to innovations and improvements in organization — automatic handling of grain in bulk; futures markets — but there was no fundamental change from the organization of the European grain trade. Without much injustice, the changes may be said to have been confined to lowering the cost of transportation in an already sophisticated trade.

Intercontinental trade in meat, however, occasioned much more fundamental alterations. Although preserved meat, both bacon and ham and pickled beef had long been traded, only in the late 1870s did high quality meat, in the form of live animals and chilled and frozen beef and mutton began to be traded intercontinentally. The meat trade bore considerable resemblance to the grain trade, but differences are at least as striking. Lower transportation costs and increased demand generated by increasing population and income drove the developments as they did in grain. In contrast to grain, however, the impact of new technology cannot be simply summarized in terms of much lower freight rates. Long distance trade in meat inexorably altered conditions of meat supply and was tied to the evolution of new wholesale and retail distribution of fresh meat. Regulation and technology combined to replace the age-old system by which live animals essentially walked to the retail butcher shops with a new system where slaughter was centralized and dead meat moved in a wholesale trade to the retail butchers. Major changes in industrial organization emerged. With the new distribution came larger firms and greater vertical integration in both meat distribution and in transportation. In meatpacking and distribution, the American firms of Swift, Armour, and Morris emerged dominant in both exporting and importing regions. In ocean shipping, liner companies transported the cattle and meat. These meat cargoes aided liner dominance in world shipping.

I. Simple Spatial Model

The integration of the North Atlantic meat markets brought about by railroads and steamships was similar in overall dimension to the integration of grain markets. The trends of grain and meat (or cattle) prices in US mid west and Britain over the second half of the nineteenth century are compared in Figures 1. The difference between Midwestern and British prices declined both because of unprecedented revolutions in direct transportation changes and as the result of other organizational changes.

A simple model that focuses on the spatial character of trade aids discussion. Consider two regions with different supply and demand schedules. The new region had abundant land and access to competing factors (much by emigration from the older areas) but little population; the old is densely populated relative to resources. Consequently, the new region had an elastic supply and modest demand like the schedules (local price on the price axis) drawn as region A in Figure 2. The old region had inelastic supply and large demand schedules as drawn in region B. Without trade, price would be high in the old region and low in the new region. The potential price differential provided the incentive to trade. Trade will not equalize prices in the two regions, however, because transportation costs were incurred in trade. Thus equilibrium price in the importing region exceeded that in the exporting region by the amount of transportation cost. If the difference were more, traders would increase trade; if less, traders would cease shipment. Thus in equilibrium there would be a pair of prices: that in the importing region exceeded that in the exporting region by transportation costs. The equilibrium pair of prices generated excess supply in the exporting region equaled excess demand in the importing region.

Equilibrium can be found in Figure 2 (one of several diagrams that could illustrate the same point). Transportation costs are the distance T_0 (in panel B). For any price in the exporting region (A) there is a corresponding price in the importing region (B), higher by T_0 . Consider, for example, price P_{1a} , which corresponds to the low non-trade price in the exporting region. That price plus transport cost equals P_{1b} . P_{1b} in the importing region is below the market clearing price in that region in the absence of trade so

excess demand exists. To find equilibrium, this demand from the importer can be added to the domestic demand in the exporter to generate a total demand curve facing the low-cost country. Obviously there is excess demand at this price in the exporting region open to trade — supply equaled demand without any export demand. A total demand curve (domestic plus export) for the exporting region can be constructed by repeating this procedure with other pairs of prices. At various prices in the exporting region, the excess demand in the importing region at that price plus transportation cost is added to the domestic demand curve as in Figure 2. Supply in the low-cost region equals demand (domestic plus foreign excess demand at corresponding price plus transport costs) at P_{ea}^0 (and P_{eb}^0 , the corresponding price in region B).

Falling transport costs can be analyzed by reducing T_0 to T_1 . For any particular price in the exporting region there is a lower corresponding price in the importing region. At the lower price, less will be supplied and more demanded — the demand for imports will have increased. Consequently, at any given price, the total demand will have shifted out in the exporting region. Thus excess demand will drive up price in the exporting region. This price rise (to P_{ea}^1), however, will be less than the decline in transportation costs and price will fall in the importing region (to P_{eb}^1). It is easy enough to understand why this is true. At the higher prices in the exporting region more will be produced but less demanded, thus exports must rise. However, for the importing region to import this greater amount (since one region's exports is the others import) demand there must have increase and/or supply decreased. A fall in price generates this result.

Of course, any shift of the underlying supply or demand curve will also shift equilibrium. Population growth increasing demand, in fact, played a major role in the expansion of late nineteenth century intercontinental trade. The simple model can be extended to multiple supplying and demanding regions at the expense of some complication. In this case all trading regions' prices must differ by relevant transportation costs. Equilibrium yields a price constellation contingent on the transportation costs. In equilibrium, prices generate total excess demands in importing regions equal to total excess supplies in

exporting regions.

An empirical implementation of this type of model of the late nineteenth century grain market draws on existing estimates of supply and demand elasticities [Harley, 1986]. Both falling transportation cost and increasing central economy population were crucial to the evolution of the pre First World War grain market. The benefits from the fall in transportation costs accrued primarily to the consumers rather than the producers of wheat. In the absence of population growth transportation improvement would have resulted in considerably increased specialization and increase in frontier production. In fact, however, most the increase in production occurred in response to population growth. These results arise primarily because demand was very inelastic and supply was elastic. Consequently the fall in transport costs mostly lowers price which population gain increases output.

II. The Long Distance Meat Trade

Meat joined grain as a great long distance food trade in the late nineteenth century. Soon after the Civil War, New England and the eastern American cities came to depend on meat shipped east on the railroads. By 1900, Britain's meat imports exceeded the value of wheat imports by about a third. The general course of the Britain's meat trade is illustrated in Figure 3. The broad outline of the meat trade was similar the grain trade, although large-scale international shipments were confined to Britain. British and Eastern American prices fell and American producer prices rose as transportation costs fell and markets integrated.

Traditionally pig meat has been distinguished from butchers' meat and we will follow that tradition since the trade in beef and mutton evolved very differently from the trade in pig meat. Trade in pig meat concentrated in bacon and hams. In 1900, bacon, ham and other salt pork made up £16.2 mn. of Britain's total pig meat imports of £17.7 million (92%). £13 million of this came from North America and most of the balance from Denmark. Shipment of salted pork products from the western United States

predated those of grain. The shipment of provisions to Britain began to grow rapidly only slightly later than did the American export trade in grain. The pig meat was preserved by traditional methods and could be shipped without special treatment. The technology changed little over the course of the century. While there are some issues of the quality of the product (American pig meat tended to be fatty, for example), the history of the growth of the trade is essentially the similar to that for grain. Increasing population stimulating demand and falling transportation costs encouraging international specialization.

III. Special Characteristics of the American Beef Trade

The trade in beef, in contrast to that for pig meat, developed in a more complicated manner under the influence of evolving regulation and technology. During the later nineteenth century, both the American and British meat market underwent fundamental change. In America, railroad shipment of beef after the Civil War began a transformation that continued in the late 1870s and the 1880s with the centralization of meat packing in Chicago and the distribution of refrigerated meat to the east. In Britain, meat imports were the vehicle of change. Work by Richard Perren has made that evolution of meat supply in Britain easy to follow. Prior to mid-century most meat, in Britain as in America, found its way to the retail butcher on its own legs, although the railways and steam ships had replaced long-distance droving of cattle and a considerable wholesale trade in dead meat had already developed within the confines of London. Cattle from Ireland and Scotland had long been part of the supply of meat to the industrial areas. After mid-century, animal imports from the Continent, particular from ports in the Low Countries, became important. Both the foreign and Irish and Scots animals were sold live to butchers, as were domestic cattle. By the early 1870s some importers had tried experimental imports of American cattle to Britain and the animals entered the British cattle trade.

As the meat trade grew, changing technology along with increasing urbanization led to altered business organization. Large firms came to dominate the meat trade, both in the United States and in

Britain. In addition, the transatlantic trade in meat and animals profoundly influenced the organization of shipping in the North Atlantic. In America, changes in the transportation technology, developed by the Chicago meat packers, made it possible to transport and market highly perishable fresh meat successfully. This ability to transport perishable fresh meat provided opportunities for firms to capture economies arising from centralized slaughter and also provided savings in transport costs since once the refrigerated railroad cars became efficient, meat was much easier to transport than live cattle. Shipment of meat meant that inedible parts of the carcass did not need to be shipped and the special needs of live cattle did not need to be met. In Britain things were somewhat more complex because the premium on higher quality fresh-slaughtered butcher's meat was higher and persisted longer than in the America. Nonetheless, a large transatlantic trade in carcass meat developed that required organization for transport and marketing similar to that in the United States. Furthermore, statutorily mandated slaughter of most imported cattle in British ports presented very similar distribution needs.

Following the American Civil War, railroads rapidly became the conduit of the interregional trade in cattle in the United States. By the early 1870s, half a million cattle annually were being shipped east from Chicago (at 20 cattle to a rail car 500,000 cattle amount to 25,000 cars per year or 70 cars or two train loads daily). Perhaps half that many more were shipped from St. Louis and other primary markets. This quantity grew to nearly 800,000 head from Chicago in 1878, declined as dressed beef shipments developed and then recovered. In 1884, about 600,000 tons of cattle, about half a million head — equivalent to some 350,000 tons of meat — and 173,000 tons of dressed meat were shipped East by on the railways [Nimmo, p. 58, 63]. By the 1880s, New England and the large Eastern cities were dependant on Western beef in a way that would have been impossible without the railroad and refrigeration. The requirements of railroad shipment, particularly the desires of the Trunk Lines to limit competition among themselves, brought about noticeable increase in concentration in business of cattle shipment [Yeager, Ch. II], but the effect was small compared to the impact of Chicago slaughter and the distribution of refrigerated beef.

Gustavus Franklin Swift began the transformation of the trade in beef in the late 1870s with the successful introduction of refrigerated rail cars and the shipment east of beef dressed in Chicago. Armour, Morris and Hammond emulated his success almost immediately. The four firms each developed fleets of refrigerated rail cars and eastern distribution networks. By the mid-1880s they were able to grow at the expense of rivals to the extent that they were slaughtering some 85 percent of the cattle butchered in Chicago [Yeager, ch. III].

Successfully market refrigerated beef required a new system of distribution with new skills and physical assets that were particular to the industry. Fresh meat is highly perishable and its long-distance shipment required a network of particular physical assets — refrigerated rail cars, refrigerated storage, and wholesale marketing. In addition, successful prosecution of the trade required managerial coordination of the arrival of supplies to particular markets. It was necessary to maintain steady supply in order to develop acceptance of the new product but at the same time to avoid gluts of perishable beef, which either had to be sold at low prices or suffer spoilage. As Oliver Williamson [] has pointed out, such a situation with transaction specific asset of this sort presents difficulties for market arrangements between various stages of production and distribution and invites more hierarchical arrangement. Mary Yeager has documented the growth of integrated firms that replaced small individual firms that had previously been involved at various stages of production and distribution. The growth of the integrated packers began with their developing efficient, special purpose refrigerated rail cars — the railroads had been uninterested because of the highly specific nature of the cars. Success of centralized slaughter and shipment of refrigerated meat, however, also required distribution networks in the principal markets. Chicago-killed chilled beef was a new product that needed skillful control of marketing all the way to the final purchase by consumers. Quality control through proper storage and careful attention to the storage life of the meat was essential to developing a market. Secondly, the packers had to maintain a regular supply of meat to retail butchers. The packers created the refrigerated beef market and its distribution network. Continued success depended completely on maintaining efficient distribution. Not surprisingly the distribution

network remained central to the meat packers' operations and under their direct control. The high fixed costs of the distribution network were the principal source of the concentration in the American beef trade.

The international meat trade also became concentrated into the hands of a few large firms for similar reasons of asset specificity. The relationship between transportation companies and the meat firms was also affected. The asset specificity that led to integrated firms led, in slightly different circumstances, to long-term contractual relationships between firms. Such long-term contracting developed between the meat firms, railroads and the ocean liner companies in the late nineteenth century. These contracts, combined with the technological conditions of cattle and meat transportation, in turn aided the concentration of North Atlantic shipping into the hands of a small number of liner companies.

IV. Organization of the Transatlantic Beef Trade

The British meat trade also changed dramatically during the last third of the century. By the 1860s a considerable portion of Britain's meat supply already came from foreign sources. It came, however, in the form of live animals that entered into traditional distribution channels in Britain. Over the following decades, both the technological changes that transformed the beef trade in the United States and some special considerations of animal health transformed the British market.

In the mid-1860s regulations to control contagious animal diseases suddenly changed the British import market. Regulation developed following the 1865 outbreak of cattle plague in Britain, the first case in the nineteenth century. (Perren pp. 106-114) Official investigation conclusively traced the origin of the disease to cattle arriving from Continental Europe. The disease spread through much of Britain through infection that occurred in the live cattle markets. Initially, infected imported cattle came in contact with British cattle in a number of cattle markets in Britain. Disease then spread further as infected British cattle were taken to other markets. The loss of British cattle was extensive. Authorities reacted in the late 1860s by developing policies that restricted imported cattle. Cattle imported from areas where disease was

prevalent were confined to quarantined areas in the ports of import and had to be slaughtered within 10 days of landing. Imports from some areas, where disease was judged to be particularly prevalent, were prohibited altogether.

The initial regulations were directed towards animals from continental Europe and aided the development of the North American trade. In particular, the complete prohibition of animals from much of Central Europe directed considerable demand towards North America. It would, however, probably be misleading to attribute much of the long-term rise in the North Atlantic trade in live cattle to the health restrictions on the imports of European cattle.

The regulations under Contagious Diseases (Animals) Act of 1878 which came into force on January 1, 1879 initially continued to allow the free import of U.S. and Canadian cattle. For American cattle, however, the advantage was of negligible duration since the Privy Council almost immediately (from March 3, 1879) included the United States among the 'scheduled countries' whose cattle were allowed only for port slaughter. The requirement of port slaughter, particular after American cattle were included, undoubtedly contributed to the organizational changes the trade underwent. Canadian cattle remained free to enter British markets until 1892 and significant numbers of Canadian cattle underwent further fattening, particularly in Scotland. This was undoubtedly of some advantage and Canadian authorities instituted careful quarantine measures in North America to preserve it. Nonetheless, the history of the Canadian and United States trade were broadly similar.

Before the quarantine regulations, imported live cattle joined the existing British distribution network for Scottish and Irish cattle with only modest modification. As larger numbers of cattle were moved longer distances, logistics of moving and caring for the cattle in transit become more complex and urgent. As a result shippers developed more complex organization in the trade. The previous practice of shippers obtaining shipping space and purchasing fodder local sources without serious advanced planning increasingly gave way to prior planning and contracting. But, while coordination failures were potentially more serious than previously, live cattle could be relatively easily cared for in the event of unforeseen

developments and little new specific capital was needed. No major organizational changes were required and relatively small firms could still compete effectively. Statutory requirement of port slaughter greatly increased the urgency of coordination. While coordination failures undoubtedly became inconvenient with the large-scale trade in live cattle, it was physically possible to cope with delay by simply feeding cattle for a few days. This leeway was eliminated by the port slaughter regulation. Meat imports were transformed from (relatively) non-perishable cattle to highly perishable meat. The situation came to resemble the dressed meat trade in the United States. Now adequate and reliable transportation and storage in England had always to be available. Just as in America, successful pursuit of the business required that aggregate supplies brought onto the market regularly to avoid unforeseeable gluts and shortages.

The organizational issues that port slaughter introduced had already been anticipated by the development of imports of American chilled beef to Britain. By the time American live cattle were restricted to port slaughter at the end of the 1870s, some 25 thousand tons of chilled beef was arriving at British ports. The distribution problems for imported chilled beef in Britain was very similar to those in the American dressed meat business, but rather more urgent since the ocean voyage introduced unavoidable additional delay. Not surprisingly, American firms that were developing the dead meat trade in the United States found that their expertise could be transported to similar circumstances in Britain. By the 1880s the leading American firms — Armour, Swift and Morris — had developed substantial interests in the transatlantic beef and cattle trade. In the 1890s, they developed British subsidiaries to handle meat distribution. By the early years of this century they had moved extensively into wholesale distribution not only in London and Liverpool but in provincial centers as well and handled most of the trade (Perren, p. 164-6). This development paralleled and lagged only briefly behind the development of the same firms in the United States.

The multinational business of the meat firms grew for the same reasons their American business had grown. They developed organizations that provided reliable transportation and distribution able to market meat during quickly before it spoiled. In this activity, large, integrated firms proved to have an

advantage over fragmented firms at various stages because the perishable nature of the product and the specialized equipment and organization required for its handling. On one hand, close coordination was essential, while on the other, the organizations that provided the distribution services were specialized. The dressed meat industry provided a striking example of the to of the transaction cost advantages of an integrated firm that Oliver Williamson [1985] has analyzed.

V. The Beef Trade and North Atlantic Liners

In the United States, savings in the transportation of dressed meat rather than livestock were a major source of the success of the innovative packers. Only about 55 percent of the weight of live cattle constitutes meat, the space savings in shipment is even greater, even though meat requires re Fridgeration, the basic source of savings in transportation costs is obvious. Similar transportation cost savings obviously were available in ocean shipping. However, shipment of dressed meat did not dominate the trade because port slaughtered meat brought higher prices in the British market. Despite the fact that in the early 1890's, for example, the shipping costs of dressed meat was only about half the cost of the equivalent shipment of cattle, cattle remained predominant. The higher value of port-killed American and Canadian beef, which sold at prices between first and second quality English beef while chilled imported beef sold for 15 or 20 per cent less, more than compensated for the extra shipping costs. (Perren, p. 160, Hooker)

Shipment of cattle and meat from North America to Britain had an enormous impact on ocean shipping in the North Atlantic. Cattle and then meat were important cargoes for the American railroads but did not significantly alter the business; in ocean shipping their presence altered the organization of the industry and the structure of freight rates in a very significant manner.

The special requirements of the meat trade altered ocean transportation. Because of interrelationships among shipping costs and charges, the impact was greater than might initially be supposed. Shippers of cattle and meat depended on the regular availability of shipping space to enable

them to provide even supply to their markets. Shipping companies, for their part, provided specially built vessels for the carriage of cattle and relatively expensive insulated hold space and refrigeration machinery for meat. Both shipper and carrier made investments and commitments whose value depended on continued performance by the other. Despite the dependence of both shipper and ship owner on the others performance the two activities did not become integrated within the meat firms. Presumably the answer lies in the extremely high capital intensive of ocean shipping and the fact that meat and cattle never exhausted the capacity of the vessels in which it was carried. Instead, transactions between independent meat companies and ship owners were structured to ensure continuing relationships that protected the transaction specific assets of each. In particular, soon after the trade began, the liner companies and the meat firms negotiated contracts of considerable duration for fixed amount of shipping space for cattle or meat per week. Such contracts quickly became the standard. The liner company undertook to guarantee the availability of space and the meat company agreed to pay for space whether used or not. At a minimum these contracts ran for several months. In the North Atlantic, annual contracts seem to have been most common.

Similar shipping contracts for cattle and meat contracts also existed between the packers and American railroads but since the railroads were already large firms, no organizational adjustment occurred. In ocean shipping, however, the contracts increased the importance of large firms. Unlike railroads with their enormous investment in fixed infrastructure, organizing shipping into units larger than a single ship yielded little strictly technological advantage. The long-term contracting that had distinct advantages in the meat trade, however, created an organizational advantage for larger units. Only liner organizations with substantial fleets of vessels that could provide the regular service the meat shippers required.

The cattle and meat contracts, moreover, had an impact far beyond meat shipment itself. The contracts committed ships to regular liner sailings, but never filled the capacity of the vessels provided the service. Consequently the ships, committed to the trade, bid vigorously for the other available cargo. By

the end of the 1880s on the North Atlantic, the capacity of liner companies — particularly those engaged in the cattle trade — had become so great that they could carry all the other American exports to the principal liner ports. Liners bidding for cargoes drove freight rates below rates at which tramp steamers would accept. By this process, the live and fresh meat trade altered the transportation conditions on grain and provisions from America.

VI. Liner Capacity and Freight Rates

The economics of North Atlantic shipping throughout the nineteenth century was complicated and various freight rates did not follow a common pattern over time. In particular the grain rate from New York to Liverpool, which is usually used as a general indicator of North Atlantic freights, fell more rapidly than other rates. Other rates on other exports on principal liner routes fell somewhat less than grain rates but noticeably more than rates to other destinations. The meat trade seems to be an important element in the explanation for variations in the course of freight rates.

Liners came to dominate much of North Atlantic shipping by the 1880s. On one hand, massive European emigration led to extensive passenger liner operations. Intermediate passenger liners, with immigrant accommodations, economical operation and substantial cargo capacity became increasingly important in the carriage of cargo. At the same time the requirements of the meat trade led to the emergence of new lines that concentrated on cattle shipment and cargo. Cattle ships possessed considerable deadweight capacity in their holds and actively sought heavy freight, such as grain, to fill up. The cargo capacity of the various liners became a dominant feature in the Atlantic carrying trade by the 1880s.

The economics of transportation can seldom be fully understood without realizing that various shipping services are jointly produced. In ocean shipping, various types of shipping space are produced jointly — the production of one necessarily creates others. First, shipment on, say the North Atlantic,

requires a round trip even if no cargo is available on one leg of the voyage. Thus eastbound shipment, as that of cotton in the antebellum years, creates westbound capacity. Second, disparity between bulk and weight creates jointness. Light cargoes, such as cotton, will fill a ship but tend to leave it with excess buoyancy for optimal navigation. The ship will be willing to take heavy cargo at low rates. Alternatively, a heavy cargo, such as iron or ore, will exhaust a ship's buoyancy while it still has empty space and light cargo will be sought.

Primary North Atlantic liner cargoes — passengers and live animals — were very light. Passenger or cattle left considerable space and buoyancy available. Heavy cargo could be engaged without any loss of revenue from the animals or the passengers. Cargoes that occupy approximately 40 cubic feet per ton simultaneously weigh down and fill a ship. Live cattle required approximately 120 cubic feet per head, and weighted about 1500 lbs., including feed and fittings. Furthermore, cattle can only be carried on the upper decks of the vessel because adequate ventilation can not be provided in the lower hold. In practice about half of the cattle were carried as deck cargo or in other parts of the vessel (spar deck areas) not available for the carriage of other cargo, so a ton of cattle occupied about 80 cubic feet of cargo capacity. Passengers, of course, even immigrants, received much more room. Thus a passenger ship or a cattle ship typically had considerable space and buoyancy available after cattle and/or passengers had been loaded. Heavy cargo to fill that capacity could be engaged without any loss of revenue from the animals or the passengers.

When cargo capacity is jointly produced, the freight rates on individual items in a competitive market depend on an interaction of the demand for the variously jointly produced capacity. Quantities of outward and homeward space, passenger capacity and capacity for various types of specialized cargo will be available. In the long run, competition will equate the total revenue from the entire voyage to the total costs. The long-run equilibrium freight rates for each category of cargo will then be determined by the price that shippers of various commodities are willing to pay for the available space. It is highly unlikely that the competitive process will result in each type of cargo paying its proportional share of the total

voyage costs. For example, if homeward cargoes are more plentiful, homeward freights will exceed outward.

In the North Atlantic in the late nineteenth century the shares of voyage costs paid by various cargoes altered. Westbound demand increased as the United States increased its raw material imports, and more importantly, immigrants demanded shipping space to the United States. At least equally important, however, eastbound liners came to have excess lower hold capacity. This capacity was partially generated by the passenger liners, particularly by ships specializing in the immigrant traffic, and ever more importantly by the export of live animals that grew rapidly after 1875.

During the 1880s, live cattle imports into the United Kingdom from North America grew to about 400,000 head per year. The liner companies (c.f. Warren Line, National Line, Hill Line, Allen Line, with others such as the Inman and Cunard Lines with some involvement) principally carried the cattle. In 1880s, the average cattle carrying vessel was about 2,000 net register tons, typically carrying 300 to 500 head of cattle a trip. Deadweight capacity averaged about 4,000 tons while 500 cattle and their fittings would have weighed less than 500 tons. Remaining cargo capacity amounted to between 7 and 12 tons per head of cattle.¹

Examination of the numbers of live cattle and sheep (aggregated as 10 sheep = 1 cattle, as was the usage of the trade) shipped and quantity of grain and provisions imported into Britain from U.S. and Canadian Atlantic ports provides an idea of the relationship between capacity and cargo. These data are provided in Figure 4. The scales have been chosen so that one head of cattle is plotted equivalent to 10 tons of grain and provisions (bacon and ham). This approximates (perhaps with some modest exaggeration) the cargo space that accompanied each head of cattle. The graph is striking. The livestock series approaches the grain and provisions series rapidly in the early 1880s and then surpasses it.

Passenger vessels also made significant contributions to capacity. To be sure, and increasingly as the century progressed, the great luxury liners of the Cunard Line, the White Star Line and the Hamburg America Line, were built as luxury hotels afloat and had little cargo capacity although they also had

extensive immigrant steerage accommodation. Nonetheless, newspaper listings of exports, although probably incomplete, provide an indication of considerable cargo capacity on most passenger liners. For example, the Cunard's Serbia, one of the luxury liners on Cunard's main New York service built the previous year, departed New York for Liverpool on Aug. 29, 1882 and a substantial list of commodities was enumerated. Among them were the following American bulk exports: Wheat, 28,539 bushels; Flour, 1,495 sacks; Cotton, 1,606 bales; Bacon, 220,127 lbs.; Hams, 47,625 lbs.; Tallow, 34,580 lbs.; Lard, 5,600 lbs.; Cheese, 86,836 lbs.² The major passenger and mail liners provided between five and ten voyages a week from American ports and, despite their sacrifice of cargo capacity for passenger accommodation and speed they were large vessels which typically carried one or two thousand tons of cargo per voyage. The Cunard records show about 125,000 tons of eastbound cargo a year in the 1880s on two voyages a week. By the early twentieth century that figure increased to about 250,000 tons³. These liners provided between a quarter million and a million tons of bulk cargo capacity annually in addition to that provided by the cattle steamers. The cattle and passenger liners possessed the cargo capacity to carry the of North American exports by the 1880s.

The assertion that the carriage of cattle and passengers provided considerable earnings to the liners and the remaining cargo capacity was so large as to drive down other freights on the liner routes demands information on the rates at which the 'primary' cargoes were carried. Passenger rates are presented in Figure 5. The trade in live animals and meat was the second main primary shipping demand. When the trade began in the late 1870s freight rates on cattle were £7 per head, probably above the long run equilibrium given the contemporary shipping technology. The rate fell to between £3.5 and £5 in the early 1880, probably removing any excess profits. The rate continued to fall to around £3 in the late 1880s, £2 for most of the 1890s and around 30 shillings after the turn of the century. In the years immediately before the First World War the live cattle trade fell away to comparative insignificance⁴. The chilled meat exporters used major passenger liners almost exclusively, shipping cargoes of between 150 and 200 tons per voyage. Sporadic freight quotes indicate that in the late 1870 rates were 30 s. and 55 s.

per carcass or 40 cubic feet; in 1890, 20 s.; 1892, 24 s.; 1897 \$5 or \$6 (21 s. to 25 s.) for four quarters of a steer⁵.

The division of the beef trade between cattle and chilled meat shipments arose from an equilibrium that involved adjustment of two prices. Both the relative price of chilled American dressed meat and port killed meat and the relative freight rates moved in response to disequilibrium. Figure 1 shows that imported meat had a significant impact on the relative prices of different grades of British meat. Similarly, the relative price of chilled and port killed meat certainly was subject to variation. The relative freight rates were also free to move. Although the cargo liners experimented with shipments of chilled beef, they discovered that it did not pay them as well as shipments of live cattle. It seems that the passenger liners, which avoided cattle since carriage of cattle lessened the desirability of the vessel to passengers, were willing to carry chilled beef at freight rates too low to attract the cargo liners that carried live animals. The extent of the differential was part of the equilibrating mechanism in the market.

VII. The Effect on Other Freight Rates

By the 1880s cattle and passengers had become primary cargoes for the North Atlantic liners. The characteristics of these cargoes insured that the liners had the capacity beyond that used by the primary cargoes to carry all of the remaining cargoes offered on their routes. The freight rate on these cargoes was determined by this circumstance. Grain was the most important of these cargoes and the most affected. The freight rate per bushel to ship part cargoes of grain on berth terms from New York to Liverpool is readily available, particularly in the *US Statistical Abstract* and has been widely used to represent rates generally. This is unfortunate since this rate is far from representative. Rates to other ports and on other commodities decline less rapidly. Figure 6 displays (on a semi-log scale) a sample of freight rates. The rates for flour from New York to Liverpool and for whole cargoes of grain to Cork for orders to Northern European ports have both been taken from published sources. The records of the Cunard Company make it

possible to construct a series for average earnings per ton of cargo on eastbound voyages.

Berth rates, such as that on grain from New York to Liverpool, were subject to special influences as a leading contemporary American authority noted:

A distinction needs to be made between the regular cargo rates of ocean lines and their so-called “berth cargo” rates. The berth cargo of lines consists mainly of commodities such as grain or case oil, which line vessels regularly carry to fill surplus cargo spaces not taken up by traffic that they carry at regular line rates. Berth cargo rates are frequently reduced to a low level at large ports, such as New York, which are served by many regular lines. At times such cargoes are carried in lieu of ballast, and their rates are regarded as profitable so long as they yield anything over and above the immediate costs incurred in handling them⁶.

The extent to which large available tonnage and limited berth cargo could depress rates, attempts at agreement among the liner companies notwithstanding, is illustrated by the extreme case reported in the freight report of *New York Shipping and Commercial List*, for June 3, 1882. “An indication of the depression is afforded by the fact that the Liverpool steamers have taken Grain free of charge in preference to buying ballast.” The annual report of the British Consul in New York for 1901 [p. 20] contains a similar remark. In New York, shipments to Liverpool after 1880 were dominated by liners throughout the season. The extent of liner domination to other destinations varied with the volume of liner traffic and the season.

The New York to Liverpool grain traffic benefited particularly from the available liner capacity. First, the passenger liners sailed almost exclusively to Liverpool. Cattle liners were less dependent on a single port, but here too most ships went to Liverpool (strictly Birkenhead across the Mersey). The remaining vessels went overwhelmingly to Glasgow and London, with a small number going to Bristol and Hull. In contrast only about half the exports of American grain to British ports went to Liverpool, Glasgow and London combined. The liners thus concentrated excess capacity on these ports. Second,

grain was particularly desirable as a filling cargo for the liners. It was readily available in bulk. By the 1880s elevator facilities existed in the exporting and importing ports that made it possible for liners to load and discharge with dispatch thus not interrupting their scheduled sailings or incurring additional expenses of delay. The grain freights on primary liner routes were fell particularly low and drew a larger proportion of the traffic to these ports than would have been the case without the capacity created by livestock and passengers.

The special nature of the New York to Liverpool berth rate on grain can be gauged by comparison to other rates on the North Atlantic. The overall opportunity cost of North Atlantic shipment is indicated by the freight on the considerable quantities of grain was carried as full cargoes in tramp steamers, often large recently built vessels, of from North Atlantic ports to Europe. These cargoes were usually carried under so called “Cork, for orders, charter parties”. The berth rate fell rapidly relative to the charter rate (Figure 6). By the 1880s low berth rates created by liner capacity attracted most of the grain on the main British routes. The charter rates were paid from other U. S. to other European ports and savings of internal shipment costs within the U. S. or Europe offset the extra costs.

At the other extreme from tramps, we can compare the grain berth rate with Cunard's average earnings per ton of cargo. Earnings per ton of freight were essentially unchanged between the early 1880s and the First World War (Figure 6). The Cunarders carried a variety of cargoes. The fastest ships catered to high value cargoes willing to pay high freights for special care and rapid delivery. During the last years of the century, refrigerated cargoes, particularly of fresh beef made useful contributions to freight earnings. Grain was a filling up cargo but the decline in its rate had modest effect on average earnings.

Clearly most of the liners' earnings came from cargoes other than grain at the berth rate. Berth rates to Liverpool on other commodities such as flour (Figure 6) and provisions declined less than the grain rate because carriage of these commodities was less convenient for the liners and the rates were not depressed by competition for filling up cargoes. Rates on flour and provisions from New York to various European ports moved fairly closely together at levels substantially above the grain rate. The ratio of these rates to the New York to Liverpool grain rate varied somewhat with market conditions because grain rates moved more closely with the prosperity of shipping in general. The rate on flour was about a quarter above the rate on grain in the 1880s, as much a two thirds above in the shipping depression of the early twentieth century and still a third above when prosperity returned in the last years before the war. Provisions — largely bacon, ham and cheese — to Liverpool were usually between a third and a half higher than flour while provisions to other ports were higher again by about the same proportion. Berth rates on grain to other ports also declined less than those to Liverpool. Rates from New York to Glasgow and London, the other two main liner routes, exceeded the rate to Liverpool by about ten percent. Rates on routes with less intensive liner traffic were higher still. Less comprehensive data on the exports of other U.S. ports are available. The berth rate from Baltimore to Liverpool was some ten percent higher than the rate from New York. Boston, however, which was the largest single port for the export of live cattle and, at least at the end of the 1890s, shipped grain exclusively as berth cargo, seems to have had berth grain rates that were very similar, and perhaps even lower than New York's⁷.

The range of commodities and destinations makes it difficult to provide a summary assessment of

the overall effect of liner capacity on North Atlantic freights. New York to Liverpool was undoubtedly the single most important route between United States and Europe. Liners carried large amounts of grain on this route, much of it undoubtedly attracted by low rates, but its importance should not be overemphasized. Glasgow, London, Bristol, Antwerp, Harve and Hamburg were important alternative liner destinations. Between 1873 and 1900 only about 15 percent of the wheat and corn exported from New York was destined for Liverpool. An additional 43 percent went to other U.K. ports; London and Glasgow, the other two main liner ports, together taking slightly more than Liverpool. Most of the balance of New York's grain went to other European ports.

Liners came to carry the majority of East Coast grain exports, but they did not completely displace tramp steamers. In 1895, 78 million bushels of wheat and corn were exported from North Atlantic ports of the U. S. Some 32 million bushels were carried as berth cargoes from New York and an additional 30 million as berth cargoes from other ports. The more than 16 million bushels remaining were carried as full cargoes; nearly 8 million bushels of that from New York. This grain was carried at the higher "Cork, for orders" freight rate. In 1896, 123 million bushels were exported. New York berth cargoes still made up 32 million bushels while some 51 million bushels were carried as berth cargoes from other North Atlantic ports. The remaining 40 million bushels were carried as full cargoes at the "Cork" rate from various North Atlantic ports⁸.

Passengers, meat and cattle undoubtedly were the source of the dominance of liners in the export of American bulk commodities in the late nineteenth century. The cargoes that justified liner organization — passengers, cattle and refrigerated meat — made space available that the liner companies could profitably sell at rates below those that were attractive to tramp shipping. The extent of the impact of freight rates is difficult to judge. The extreme impact of liner capacity was on the berth rate on grain from New York to Liverpool. This rate is usually taken to indicate the course of U.S. export freight rates. However this rate was particularly reduced by liner capacity. Moreover, less than ten percent of the grain shipped was carried at this rate. Other rates were much less effected, as their rate relative to the "Cork, for

orders” rate indicates.

The contrast between the low freight rate on grain to the British liner ports and higher rates to Continental ports has sometimes been noted. The considerable difference in the rates for very similar services has sometimes been taken to indicate a lack of effective competition between the services. That conclusion is misleading, however. The competition between ports takes place at the level of the earnings of the voyage not at the level of freight rates on individual commodities. Cattle and meat to British ports provided revenue to vessels on these routes that was not available to Continental ports. Competition resulted in lower grain freights to Britain. The higher freight rates to Continental ports resulted from competition not from successful market segmentation.

Endnotes:

¹ See “Dept Com. on Transatlantic Cattle Trade”, 1890-1 *PP* LXXVIII.

² *New York Shipping and Commercial List*

³ These are in the voyage accounts of the Company in the Liverpool University Library.

⁴ Dept. Comm. on the Transatlantic Cattle Trade, S.C. on Combinations in the Meat Trade.

⁵ “S.C. on the Transatlantic Cattle Trade, 1890/91” *PP*. LXXVIII, Q. 6180. “Canadian Dept. of Ag. Agent Report, 1893”, p. 44. “Report on the U.S. Cattle Raising Industry” 1897 *PP* LXXVIII.

⁶ Johnson and Huebner, *Principals of Ocean Transportation*, p. 318.

⁷ See Harley “North Atlantic Shipping..”

⁸ “Grain Trade of the United States”, *Monthly Summary of Commerce and Finance*, Jan. 1900, p. 1987.

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Figure 1
Wheat and Beef Prices, Britain and America, 1875-1913
(deflated)



Figure 2
Modelling the Effect of Transportation Cost Decline

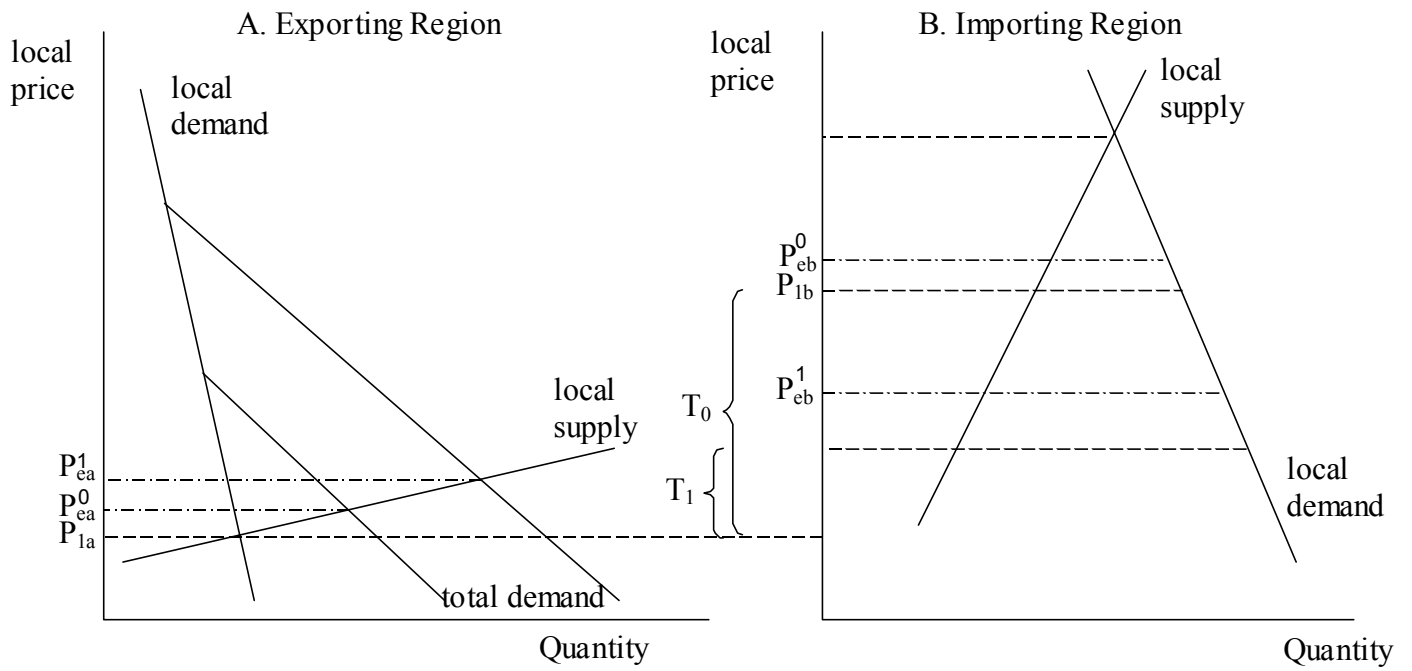


Figure 3
British Imports from main divisions of the world, 1877 - 1908

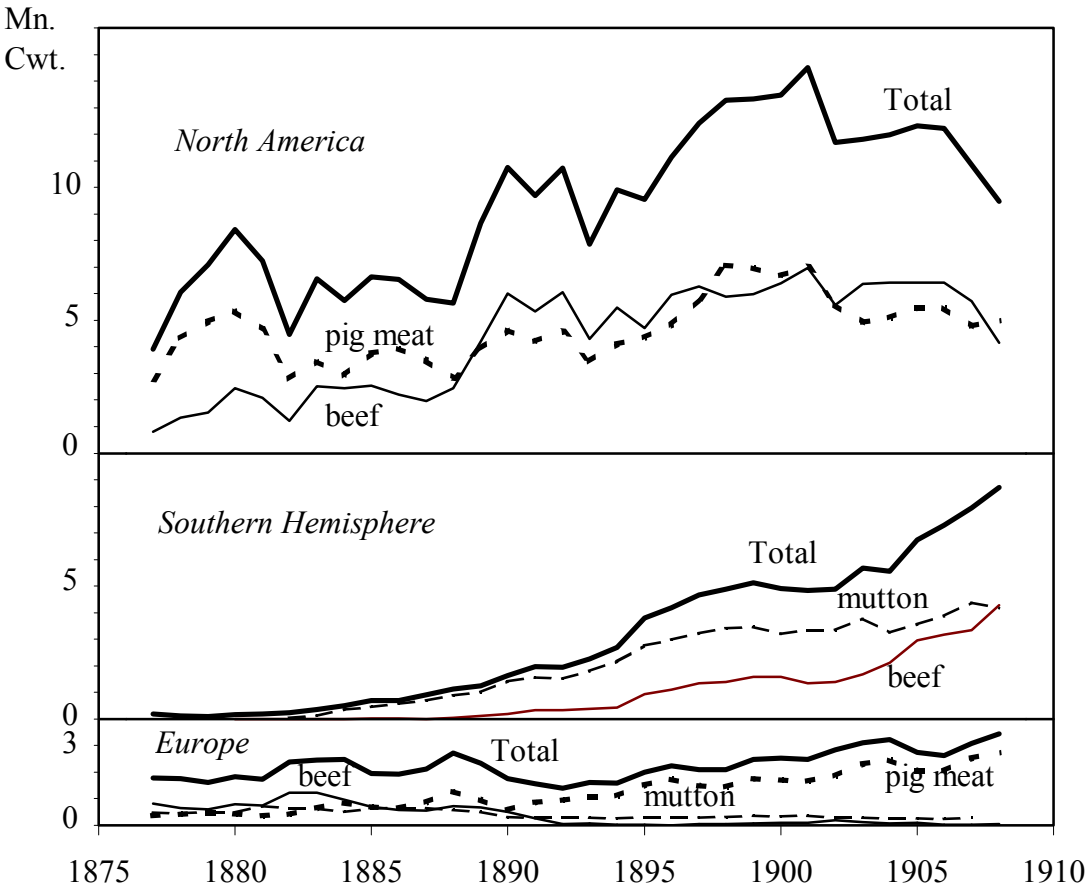


Figure 4
Shipping capacity on cattle vessels vs grain and provision shipments
North Atlantic, 1870 - 1913

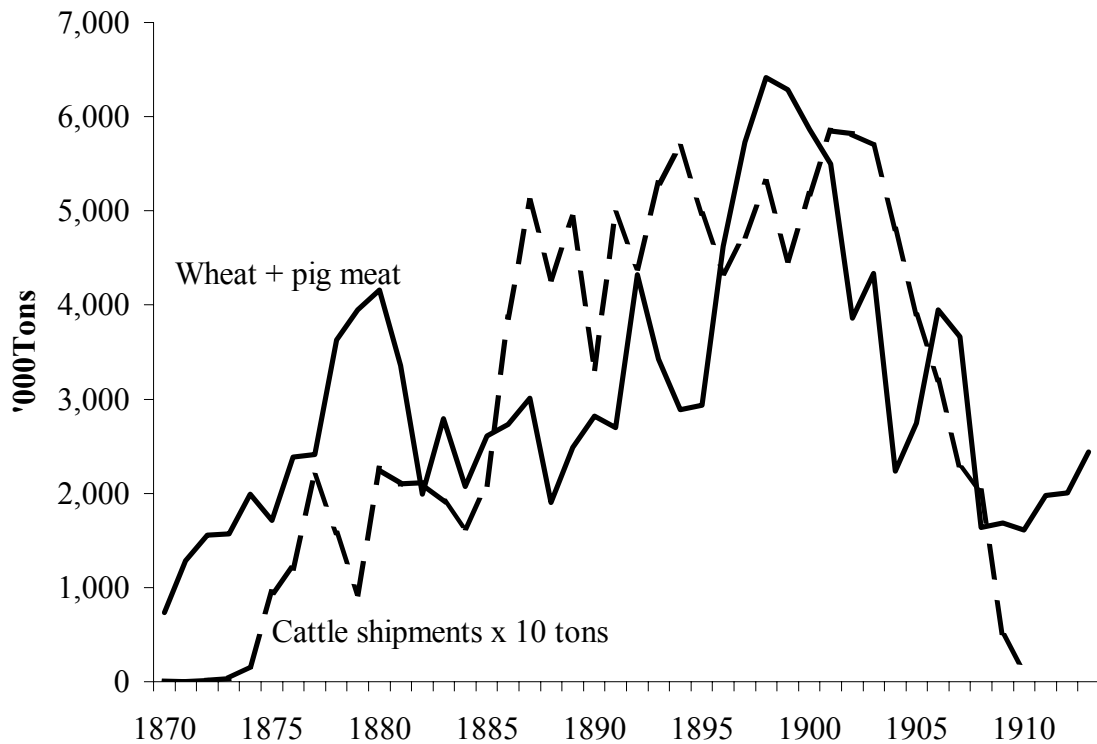


Figure 5
Passenger Fares, 1860 - 1913

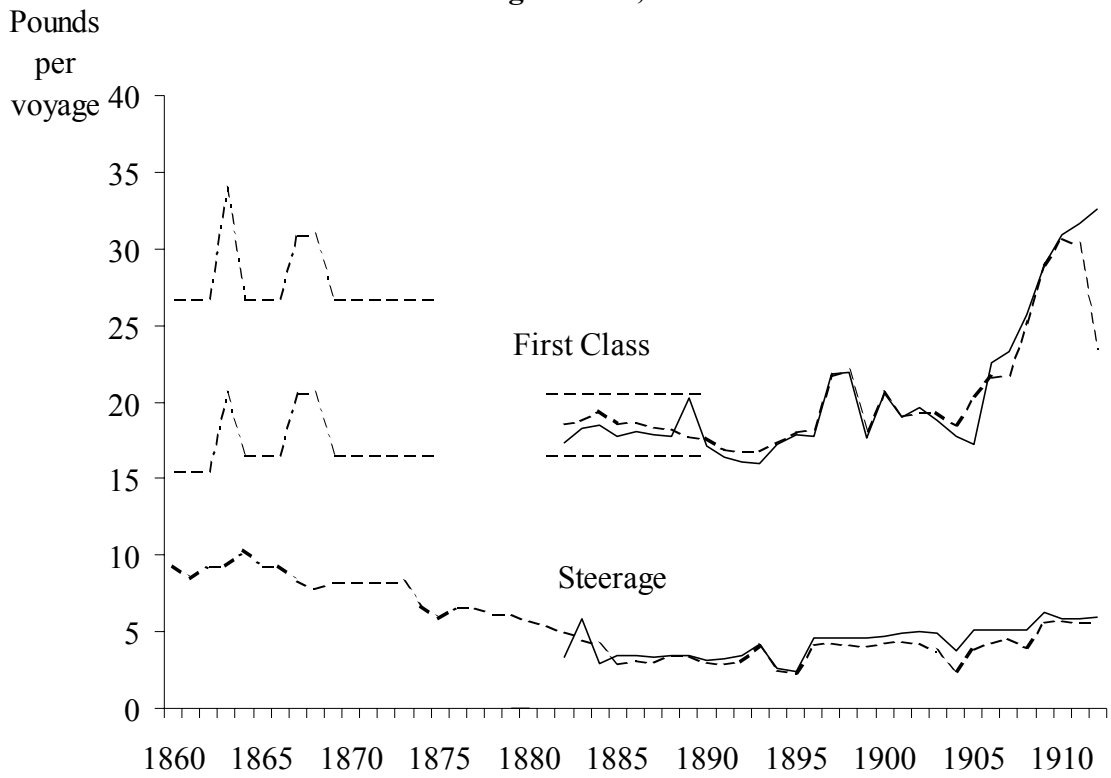


Figure 6
Various North Atlantic Freight Rates, 1863 - 1913

