

# THE COST OF TRANSPORTATION IN PRE-INDUSTRIAL EUROPE\*

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**ABSTRACT:** In pre-industrial Europe, rising productivity both in agriculture and in industry depended on the expansion of trade, and the expansion of trade depended in turn on the reduction of trading costs. An important component of trading costs—for some goods the most important—was the cost of transportation. This had two elements: the cost of predation and the cost of carriage. This paper examines these two elements and how they changed over time. It also discusses the relative importance in lowering the cost of transportation of organizational change and technological progress.

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In pre-industrial Europe, rising productivity both in agriculture and in industry depended on the expansion of trade, and the expansion of trade depended in turn on the reduction of trading costs.<sup>1</sup> An important component of trading costs—for some goods the most important—was the cost of transportation.<sup>2</sup> In considering the cost of transportation, we shall distinguish between two elements: the cost of carriage—the cost of physically moving goods from place to place; and the cost of predation—the cost of others taking one's goods or money by force. Changes in transportation costs were consequently the result either of changes in the cost of carriage or of changes in the cost of predation.

It was changes in the cost of predation that dominated the short run. The outbreak of war could double or triple freight rates in a matter of weeks; the outbreak of peace could bring them down again just as quickly.<sup>3</sup> However, beneath the violent short-run fluctuations in predation costs, there was a long-run trend. The costs of carriage declined slowly as productivity in the transportation sector improved. This improvement came, as it did in agriculture and in industry, principally from better organization. Technical progress contributed too, but it was itself largely itself a consequence of better organization.

Apart from its importance to other sectors of the economy, transportation was a significant sector in its own right, and its size grew as trade expanded. Transportation was a major employer: many thousands all over Europe found employment as carters, riverboat operators, longshoremen, porters, inn-keepers, and seamen. Many thousands more were employed in building ships, boats, and vehicles and in constructing and improving roads, inland waterways, and harbors. Transportation was a major employer both in the towns, the hubs of the transportation system, and in the countryside, where it provided off-season employment. The means of transportation and transportation

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<sup>1</sup>See Kohn (2001)a; Kohn (2001)b; Kohn (2001)c; and Kohn (2001)d.

<sup>2</sup>Trading costs fall into three categories—transportation costs, transactions costs, and financing costs. Transportation costs are the costs of moving goods from one place to another. Transactions costs are the costs of transferring or 'moving' goods from one owner to another. And, financing costs are the cost of 'moving' goods from one time to another—necessary because trade takes time. See Kohn (2001)a for a more extensive discussion.

<sup>3</sup>Menard (1991)

infrastructure made up a significant part of the capital stock. The particular problems of the transportation sector gave rise to institutional innovations that later had saw much wider application: the two most notable examples being the share company and insurance.<sup>4</sup>

Although we shall focus here on the carrying of goods, the transportation system also carried people. Tourism, in the form of pilgrimage, was a major industry, and pilgrims accounted for a good part of passenger traffic both on land and at sea. In addition to pilgrimage to the Holy Land, there was a great deal of visiting of shrines and relics all over Europe. The Church's interest in promoting pilgrimage—an important source of income—explains its involvement in infrastructure improvements, such as bridges and hostels.<sup>5</sup> Christian ships carried Muslim pilgrims, too: the Genoese and Venetians carried Muslim pilgrims from the Maghreb on their way to Mecca.<sup>6</sup> The transportation system carried armies as well as pilgrims. The transportation needs of the Crusades provided a major boost to northern Italian shipping, and its maritime cities competed fiercely for the business.<sup>7</sup> In an age in which information had to be carried by hand, the transportation system was also the means of communication. Messengers, both commercial and official, carried mail by land and by sea. Speed of communications was vital both to merchants keeping up with fluctuating markets and to governments trying to maintain control over extensive territories. The relatively good roads of England, for example were an important factor in the early centralization of government in that country.<sup>8</sup> It was largely because of its military and administrative importance that governments took such a keen interest in the means of transportation.<sup>9</sup>

We shall begin our discussion of transportation costs with the cost of predation and then go in to consider in turn the cost of carriage by sea and the cost of carriage by land.

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<sup>4</sup>See Kohn (1999)a on share companies and Kohn (1999)b on insurance.

<sup>5</sup>The Medieval boom in the construction of cathedrals and large churches was largely driven by the cult of relics and by the need to accommodate hordes of pilgrims.

<sup>6</sup>Laven (1966) Ch. 3; Scammell (1981) Ch. 3

<sup>7</sup>Byrne (1930); Lopez (1987)

<sup>8</sup>Stenton (1936-8)

<sup>9</sup>They took a particular interest in shipping, because merchant ships also served as warships. Specialized warships began to emerge only towards the very end of our period.

We shall then look at the factors that determined which of the two modes merchants would choose to carry their cargo. Finally, we shall consider the long run behavior of the cost of transportation and its impact on the economy.

### **PREDATION**

The cost of predation was a major part of transportation costs and the part most subject to uncertainty and fluctuation. Of course, predation was a threat to any productive enterprise. However, whenever goods were moved from place to place, vulnerability to predation increases substantially. The ‘predators’ in question were both brigands and governments. As we shall see, the distinction between the two was hazy at best. Predation by either could take one of two forms—forcible seizure or the exaction of payment to avoid forcible seizure. We shall call the former, whether banditry on land or piracy at sea, ‘brigandage’.

### **BRIGANDAGE**

#### **The extent of the problem**

In the Middle Ages, the violent seizure of the property of others was very much a way of life—one shared by common robbers, noblemen, and kings alike. Violence was not only acceptable, but honorable. Indeed it was more highly regarded—at least among the nobility—than either production or trade. While violence itself was therefore not an issue, there was a question about who had the right to exercise it. In particular, princes claimed the right to control the exercise of violence within their own territories: essentially that is what made the territory ‘theirs’.<sup>10</sup> Brigandage that the prince sanctioned was ‘legal’; brigandage that he did not sanction was ‘illegal’. The establishment of the ‘king’s peace’ meant the suppression of illegal brigandage—that is, brigandage without the king’s permission. It certainly did not mean the suppression of brigandage by the king himself.<sup>11</sup>

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<sup>10</sup>Olson (2000) draws an analogy between governments and mafia chiefs trying to establish control over their territories.

<sup>11</sup> Cheyette (1970) p 46 “Violence in the Middle Ages, as in our own day, could be quite respectable. It was a way of life shared by noblemen and thugs. Though monarchies and principalities had made their way, with the aid of the Church or at its behest, by suppressing violence or inventing substitutes, this aristocratic propensity remained a hard political fact. The very emphasis given the French king’s right to prosecute those who bore illegal arms and the frequency with which laymen and clergy, nobles and

The king of England, for example, was probably the first European monarch to establish effective control of his territory. English roads and waterways were mostly free of illegal brigandage, and carts, pack-horses, and boats could travel in relative safety.<sup>12</sup> However, manorial records suggest that traffic was far from safe from brigandage by the king himself: "royal prises, and the blackmail threatening them, were much more common and costly than the occasional loss to robbers".<sup>13</sup>

Rulers were relatively successful in establishing their 'peace' on land. For example, in the eleventh to thirteenth centuries, the Counts of Flanders and Champagne exercised sufficient control over their territories to allow traffic to pass in comparative safety. This was an important reason for the success of the great fairs in those territories.<sup>14</sup> Mountainous areas, however, often remained a problem. In Italy, for example, the roads through the Ligurian mountains and the Neapolitan Appenines were plagued by armed bands organized by local noblemen.<sup>15</sup> Even in peaceful England, the Bishop of Alton was forced to employ a 'private army' to guard the pass at Alton to protect London merchants traveling to the fair of St. Giles.<sup>16</sup>

The regulation of violence at sea was, however, much more difficult: effective control of the seas was not possible with the naval technology then available. While Venice was able to suppress piracy in the Adriatic, at least some of the time, larger bodies of water such as the Mediterranean as a whole could not be controlled.<sup>17</sup>

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burgesses were hailed into court for doing so, is evidence enough. But the key word here is 'illegal': *armorum congregatio illicita*. No one in the Middle Ages was a pacifist. Popes in their decrees clanked swords as well as keys, and monks rode off in arms to burn down rival neighboring chapels. Not all violence had to be suppressed—only some.... St. Augustine, in the City of God, recounts the exchange between Alexander the Great and a pirate who had been seized:

When that king had asked the man what he meant by keeping hostile possession of the sea, he answered with bold pride, 'What thou meanest by seizing the whole earth; but because I do it with a petty ship, I am called a robber, whilst thou who dost it with a great fleet are styled emperor'"

<sup>12</sup>Willard (1926)

<sup>13</sup>Farmer (1991) p 347

<sup>14</sup>Postan (1987) p 185

<sup>15</sup>Laven (1966) p 87

<sup>16</sup>Farmer (1991) p 347

<sup>17</sup>Lane (1973) Ch. 7

Even at sea, however, ‘illegal’ brigandage was the exception. Most pirates were corsairs or privateers carrying letters of marque from some government or another authorizing them to seize the citizens or goods of another nation.<sup>18</sup> One cause for issuing such letters was reprisal. Suppose a citizen of one country suffered a loss at the hands of the citizen of another—through an unpaid debt or, most frequently, through an act of piracy. He could seek redress by obtaining a license from his own government to seize the persons or property of any of the offender’s countrymen.<sup>19</sup> Another excuse for ‘legal’ piracy was famine: when food supplies ran short, governments would commonly license their own mariners to stop foreign grain ships at sea and forcibly bring them to port.<sup>20</sup>

However, the most frequent reason for issuing letters of marque was war. In a time of war, the citizens and property of the enemy were fair game, and seizing them was a popular route to fame and fortune.<sup>21</sup> Privateering provided the aristocracy with a natural outlet for its violent inclinations. English nobles, for example, built private fleets, sometimes of as many as a dozen ships, to engage in piracy and privateering.<sup>22</sup> But merchants, too, found the profits attractive. When war interrupted normal trade, they were more than willing to employ their idle ships in privateering: “... in the late sixteenth century the privateering war against Spain was a different matter once London mercantile wealth, energies and talent were involved.”<sup>23</sup> Even in peacetime, merchant ships usually went well armed, and if a likely prize presented itself, the temptation to seize it was rarely resisted.<sup>24</sup>

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<sup>18</sup>Pryor (1992)

<sup>19</sup>“The injury that brought reprisal could take place anywhere, but it probably most often occurred at sea. Depredations there were clearly considered inevitable and reprisals their inevitable consequence....”  
Cheyette (1970)

<sup>20</sup>Parry (1967) p 157; Smith (1966) p 444. Usually the government paid for the captured grain, but at prices it deemed ‘fair’.

<sup>21</sup>Scammell (1972) “To many, of course, to have some sort of craft and set it to piracy or privateering was the shortest way to wealth.” p 401

<sup>22</sup>Scammell (1972) p 401

<sup>23</sup>Scammell (1972) p 396

<sup>24</sup>“There was no sharp distinction between the peaceful merchantman and the pirate on the one hand and the man of war and the corsair on the other.... Boccaccio related the story of the merchant Landolfo

There was therefore no stigma attached to piracy: it was considered a perfectly legitimate activity. States encouraged 'legal' piracy against their enemies, both as a form of warfare and in order to share in the profits. And they were quite happy to recruit successful pirates for their own uses: "In 1337, when Philip of Valois sought an admiral to command his Channel fleet, he found no one better than Pietro Barbavaira, a Genoese who had been plundering French shipping that very year in the sea off Aigues Mortes."<sup>25</sup>

Piracy was a chronic problem in the Mediterranean throughout the period. It was particularly bad in wartime, but even in times of relative peace, ships in the Mediterranean had constantly to be on the alert. The problem was exacerbated by the continuing Muslim-Christian conflict. One of the more profitable aspects of piracy was the capture of slaves. However, selling one's own coreligionists into slavery was increasingly frowned upon. This made attacks on the ships of infidels all the more attractive. But business was business: pirates were equal-opportunity employers, and Muslim corsairs were quite happy to employ Christian seamen and vice versa.<sup>26</sup> The Mediterranean was so lucrative a hunting ground that it even attracted pirates from the North: Bretons were active in the Mediterranean in the late fifteenth century, and the sixteenth brought the Dutch (who cooperated with the Barbary states) and the English.<sup>27</sup> Compared to the Mediterranean, northern waters were relatively safe, at least in peacetime.<sup>28</sup> However, piracy was never completely absent. Barbary pirates preyed on shipping in the English Channel, and one was even captured in the Thames.

### **Protection**

Governments provided some protection against brigandage on land. However, at sea, merchants and shipowners generally had to look to their own security. For merchants, weapons were no less an accessory of commerce than money or bills of exchange:

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Rufolo of Ravello who, when his business affairs in Cyprus did not prosper, sold his great merchant ship and bought a small, fast ship with which to go privateering against the Turks" Pryor (1992) p 154-5

<sup>25</sup>Cheyette (1970) "The step from rapacity to respectability—and back again—was easy to make. It was easy in part because piracy was not necessarily a dirty word nor a pirate automatically a criminal." (p 46-7)

<sup>26</sup>Pryor (1992) pp. 153-4

<sup>27</sup>Braudel (1972)

<sup>28</sup>Postan (1987); Unger (1998 [1979])

travelers at sea and on land went armed and stood ready to defend themselves.<sup>29</sup>

Moreover, weapons were not only an instrument of defense: in the right circumstances, they could be used to plunder others.

Before the advent of cannon, a ship's main armament was its men—its crew and its passengers: a ship was considered 'armed' or 'unarmed' according to the number of men it carried.<sup>30</sup> Indeed, the size of a ship's crew was determined more by the needs of defense than by the manpower needed for operation. Maritime cities such as Genoa and Venice set a minimum complement for their ships to ensure their safety.<sup>31</sup> Large ships were more secure than small ones, both because they carried a larger crew and because they were more difficult to board. Governments encouraged and even subsidized the building of large ships, which they could mobilize in times of war. Guns, which were used in land warfare from the fourteenth century, did not become sufficiently accurate and reliable for use at sea until the late fifteenth century; and only by the end of the sixteenth did they really have an impact. By then, guns were essential both for defense and for offence, and they raised significantly the productivity of piracy.<sup>32</sup>

On longer voyages, ships often sailed in convoy—usually in groups of four or five, but sometimes many more.<sup>33</sup> The advantage of a convoy was that if one ship was attacked, the others could come to its assistance. This worked well for galleys, which were highly maneuverable, but less well for sailing ships, which were not. So sailing ships were more likely to sail alone—especially larger ones that could defend themselves or smaller ones that might hope to evade capture.<sup>34</sup> The governments of maritime cities and nations often organized convoys, especially in wartime, setting a time of departure

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<sup>29</sup>McNeill (1982)

<sup>30</sup>Lane (1973) Ch. 5. This was as true of warships as of merchant vessels. Naval battles were battles of ship-borne infantry: they were generally decided by hand-to-hand combat, with the crew of one ship boarding another.

<sup>31</sup>Byrne (1930) Ch. VII

<sup>32</sup>Unger (1980)

<sup>33</sup>Unger (1980)

<sup>34</sup>Lane (1973) Ch. 10

and levying charges to pay for accompanying warships. The Venetian system of official convoys that began in the fourteenth century was especially well developed.<sup>35</sup>

On land, too, merchants exploited the economies of scale in protection by banding together in armed caravans. Not only could a sufficiently large group better defend itself, but it could also more readily afford to hire additional armed escort. As land travel became less hazardous, it became more common for merchants to travel alone or to entrust their goods to professional carriers. However, the roads were never entirely safe, especially those that passed through the mountains. Even in the sixteenth century, long-distance carriers organized caravans in the overland trade between Italy, Germany, and Antwerp.<sup>36</sup>

## **TOLLS**

Brigandage, the forcible seizure of property and persons, was one form of predation. The exaction of payment to avoid forcible seizure was the other. We shall call any such payment—whether toll, tax, tariff or license fee—a ‘toll’.

### **The nature of tolls**

Tolls were often little more than protection money. For example, in the fourteenth century one of the greatest dangers for ships carrying wine from Bordeaux to England was running aground on the coast of Brittany. The helpful Duke of Brittany opened an office in Bordeaux selling ‘letters of safety’ that guaranteed the purchaser, if his ship did run aground, against seizure of ship and cargo—by the Duke.<sup>37</sup> Similarly, the lords who controlled the St. Bernard Pass, the most direct route from northern Italy to Champagne, collected tolls in exchange for the security they provided—security mainly from themselves.<sup>38</sup>

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<sup>35</sup>Lane (1973) CH. 10. More on the Venetian system below.

<sup>36</sup>Laven (1966) p 87

<sup>37</sup>Renouard (1970) 6

<sup>38</sup>Bergier (1970). “Protection money, the bribes needed to buy off raiders, as much or more than the costs of maintaining soldiers to defend caravans or convoys, was an ever-present necessity in any trader’s calculations” Musgrave (1981) p 12

Tolls were ubiquitous: “It is not too extreme a generalization to say that there were tolls everywhere on everything.”<sup>39</sup> One major form of toll was the transit toll—a payment to be allowed to pass. Transit tolls were collected at points that were hard to avoid.<sup>40</sup> Because there were few such points at sea, transit tolls on maritime trade were mostly collected in harbors. One place where it was easy to collect a toll on maritime traffic was the Sound, the narrow straits through which ships entered the Baltic: the toll there provided Denmark with a substantial income.<sup>41</sup> On land, tolls were collected at choke points such as river crossings and passes: elsewhere, road traffic found it too easy to go around a collection point. On inland waterways, however, it was easy to collect a toll almost anywhere.

Indeed, because tolls were so easy to collect on inland waterways, the burden of tolls there was especially heavy. For example, in the early fourteenth century there were at least 31 tolls on the Garonne between Toulouse and Bourdeaux.<sup>42</sup> The number of tolls also tended to increase over time. On the Rhine there were 35 tolls in the early fourteenth century; by 1500 the number had risen to 60. While individual tolls were usually modest, the total burden could be heavy. On the Seine in the late fifteenth century, tolls added 50% to the price of grain over a distance of 200 miles, and between Rouen and Chartres they doubled the price of salt.<sup>43</sup> Tolls on land could be high too: to bring their copper from Hungary to Venice in the sixteenth century, the Fuggers paid tolls amounting to 30% of its value.

It was generally easier to collect tolls on bulk goods, because carriers of bulk goods found it harder to avoid the collection points. This was particularly true at sea. While luxury items could be smuggled in or out through cove or open beach, bulk goods required the facilities of a port for loading and unloading. But on land, too, a pack animal carrying luxury goods could more easily avoid a collection point than could a river-boat, barge, or wagon heavy with grain or other bulky commodities.

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<sup>39</sup>Leighton (1972) p 94

<sup>40</sup>Parry (1967)

<sup>41</sup>Bogucka (1996)

<sup>42</sup>Favier (1998)

<sup>43</sup>Postan (1987); Favier (1998)

In addition to transit tolls, there were market tolls. To offer his goods in a city market, a visiting merchant had to pay a tax. This was usually collected at the city gate or at the entrance to the market. Sometimes it was collected—instead, or in addition—by official brokers when goods were actually sold.<sup>44</sup> Many market tolls were really transit tolls in disguise. For example, some goods were required to use a specific market or ‘staple’. English wool had to be exported through the staple of Calais, and Sicilian grain could be exported only from certain specified ports. The reason for establishing a staple, of course, was to ensure collection of the tax. By the end of the fourteenth century, the tax on English wool had risen to the point that it doubled its export price; the Sicilian tax on exported grain added 50% of its price at the farm gate.<sup>45</sup> It was also quite common to require merchants passing through a town, whether a port or a hub of inland transportation, to expose their goods for sale in the town’s market before they could move on; and, naturally, they had to pay a tax for the privilege.

We tend to think of tolls today as ‘user fees’, imposed to finance infrastructure or to pay for services. To a minor extent this was true in the Middle Ages, and some tolls were used to pay for public works, for protection, or for the operation of markets. However, the principal motive for the collection of tolls was fiscal—to raise revenue.<sup>46</sup> For example, historians have often seen laws that required traders to use regulated markets as being motivated by a concern for consumer protection and by a desire to assure the supply of food. However, the obligation to use regulated markets applied not only to essential foodstuffs, but also to goods such as wool, straw, and timber—all bulk goods and therefore easy to tax.<sup>47</sup> The Norman conquerors of England were quick to see the potential, and they soon began to impose tolls on local markets that had previously been toll-free. By the thirteenth century, no market or fair could be established without royal

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<sup>44</sup>Masschaele (1997) Ch 5

<sup>45</sup>See Parry (1967) on Sicilian grain and Munro (1998) on English wool.

<sup>46</sup>The concept of a toll had come down from the Romans, who had levied them to pay for the maintenance of their roads. However, by the early Middle Ages collectors of tolls were pocketing the proceeds and letting the roads fall into disrepair. It was not until the thirteenth and fourteenth centuries, that true user fees began to reemerge. (Leighton (1972); Masschaele (1997) Ch 5).

<sup>47</sup>Nielsen (1998) Ch. 3

license.<sup>48</sup> Their interest in markets was not motivated by a desire to promote trade or a concern for the consumer. Rather, market tolls and transit tolls were the principal source of revenue for all forms of government—cities and territorial princes alike. And the many nobles who shook down passing travelers on road or waterway made no pretense that the payment was for anything but ‘protection’.

### **The struggle over tolls**

Collectors of tolls along a particular route are in danger of killing the goose that lays the golden eggs. Each one imposes what he considers a modest toll, but the total soon adds up. Beyond some point, traffic will begin to decline and revenues to fall.<sup>49</sup> For example, by the end of the Middle Ages there were so many tolls in western Switzerland, along the main overland route between the two trading zones of Europe, that commercial traffic began to seek ways around the region.<sup>50</sup>

The problem can be mitigated if there is a central government strong enough to control the individual toll collectors in the common interest.<sup>51</sup> In Switzerland, for example, the cantons of Berne, Lucerne, and Zurich got together and agreed on a more reasonable (and productive) system of tolls.<sup>52</sup> Of course, this places a somewhat different interpretation on the ‘king’s peace’—not so much an end to predation as its rationalization. Only strong, centralized states had the power to grant, and to enforce, exemptions from tolls. England and Sicily were two early examples and they were both relatively free from internal tolls, to the great benefit of their internal trade.<sup>53</sup> In contrast,

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<sup>48</sup>Sawyer (1986) p 63.

<sup>49</sup>Economists know this problem as the ‘tragedy of the commons’. The usual example is a fishery in the open seas. Since no one owns the fishery, each fisherman looks to his own interests and takes what he can without considering his impact on the whole.

<sup>50</sup>Bergier (1970)

<sup>51</sup>That is, if there is a government that owns the ‘fishery’. The government internalizes the externality: it has an ‘encompassing interest’ (Olson (2000)).

<sup>52</sup>Bergier (1970)

<sup>53</sup>See Postan (1987) on England. Epstein (1999) compares the situation of medieval Sicily, with a strong central government, with that of fragmented contemporary Tuscany.

in France and Germany, where states struggled for control, innumerable tolls sometimes brought internal trade to a standstill.<sup>54</sup>

If tolls on a particular route became prohibitive, merchants would try to find an alternative route. The possibility of losing revenue in this way exerted a competitive pressure on the collectors of tolls. Not only did it lead them to restrain their rapaciousness, but it also led them to invest in improvements. For example, there was considerable competition in the Middle Ages for the North-South traffic between the two zones of European trade.<sup>55</sup> One major route passed through Switzerland, the other through France; although the French route was nearly three times as long, it avoided the Alps and made more extensive use of inland waterways. When trade began in the eleventh century, most traffic took the more direct Swiss route. However, rising tolls in the twelfth century shifted the balance towards France. The Swiss responded by lowering their tolls and by improving their passes. The carters and boatmen on the French route were forced to lower their prices to remain competitive. The passes also competed among themselves. In the thirteenth century, a new bridge across the Schöllenen gorge allowed pack-mules to cross the St. Gotthard pass. In 1338, improvements in the Septimer pass opened it to small carts.<sup>56</sup>

Of course the benefits of competition were available only when there were alternative routes. This was much more likely to be the case for long-distance traffic than it was for local and regional traffic. Moreover, collectors of tolls on local and regional traffic were sometimes able to prevent trade from taking alternative routes by getting the territorial government to pass laws forcing traffic through their collection points.<sup>57</sup> As a result, the burden of tolls and taxes borne by local and regional trade tended to be much higher than that borne by long-distance trade.<sup>58</sup>

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<sup>54</sup>“The total weight of the internal tolls was thus heavy and growing, and may in part account for the gradual clogging of internal trade in the closing centuries of the Middle Ages.” Postan (1987) p 184

<sup>55</sup>Lopez (1987) p373

<sup>56</sup>Ball (1977) Ch. 8; Bergier (1970)

<sup>57</sup>Leighton (1972)

<sup>58</sup>Postan (1987). There were, however, examples of competition at the local and regional level too. The opening of a toll-free bridge across the Thames at Abingdon in 1416 attracted much of the traffic to Gloucester and the West, avoiding the tolls at Wallingford or Nuneham. (Farmer (1991))

## THE COSTS OF PREDATION

### The nature of the costs

The costs of predation included not only actual losses—goods seized, ransoms paid, or tolls given up—but also the cost of mitigating such losses. The cost of mitigation, in turn, included both the cost of defense and the cost of avoidance. Obviously, defending against brigandage involved considerable outlays on armaments and guards. However, some of the costs were less direct. For example, convoys and caravans caused considerable delay: they took time to assemble, and their speed was limited by that of their slowest members; loading and unloading were delayed by congestion.<sup>59</sup> In addition the simultaneous departure or arrival of large quantities of goods had an impact on market prices—raising them at the point of departure and depressing them at the point of arrival.<sup>60</sup> There were adverse impacts too on the markets for freight, insurance, and financing.

Defending against tolls, too, involved costs. Burgesses lobbied to have exemptions from the tolls of other towns included in their royal or seigneurial charters: such favors were not granted without a *quid pro quo*. Towns also fought with one another over the collection of tolls—fights that involved embargoes and the seizure of goods as well as diplomacy and legal action.<sup>61</sup> The great maritime cities invested substantial resources, both military and diplomatic, in securing for their merchants exemption from tolls in the markets of the Levant.

The avoidance of losses—whether to predation or to tolls—often required a change of route. The alternative was generally more costly: it would otherwise have been the first choice to begin with. Perhaps the most striking cases are those in which the burden of tolls on inland waterways diverted traffic to the roads despite the cost of carriage by land being twelve times the cost of carriage by water.<sup>62</sup> For example, much of the grain trade

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<sup>59</sup>Unger (1998 [1979])

<sup>60</sup>Barbour (1929) Ships would sometimes break away from a convoy as it approached its destination, hoping to reach the market while prices were still favorable.

<sup>61</sup>Masschaele (1997) Ch 5

<sup>62</sup>Parry (1967)

that had been carried by boat on the Seine was by 1500 being carried by wagon instead.<sup>63</sup> And it was largely the burden of tolls on the Rhine that led the merchants of Cologne to develop an alternative overland route to the Low Countries in the fifteenth century (the rise of Antwerp owed much to this initiative).<sup>64</sup> Lüneburg salt, used by the Baltic herring industry, was taxed so heavily on the lower Elbe that the merchants of Lübeck found it worthwhile to build a canal just to bypass the collection points.<sup>65</sup>

Both predation itself and the response to it in terms of defense and avoidance contributed to slowing the movement of traffic. This raised the cost of transportation and caused perishable goods to spoil. The collection of tolls took time: goods had to be unloaded for examination and then reloaded, and officials were rarely in much of a hurry. Indeed, it was sometimes these delays rather than the tolls themselves that caused merchants to despair of inland waterways and take to the roads.<sup>66</sup> In some cases, laws forced traffic into a circuitous route to ensure that a toll could be collected.<sup>67</sup> We have seen that convoys and caravans involved considerable delays. Routes chosen to avoid tolls or brigands were generally less direct and therefore slower. Predation, of course, also significantly increased the risks involved in transporting goods. The slowing of transportation and the increased risk raised the cost of finance.

The ultimate cost of predation was, of course, trade foregone. Trade was only worthwhile when the expected gains from trade exceeded the trading costs. Sufficiently high predation costs could tip the balance against a particular trade. This was more likely to happen when the good in question was relatively cheap and the gains from trade, and so the merchant's margin, relatively small. Predation costs fluctuated more rapidly and more widely than the cost of carriage or than other trading costs. So it was largely changes in predation costs that accounted for short-term variations in the volume and in the composition of trade.

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<sup>63</sup>Postan (1987)

<sup>64</sup>Van der Wee (1993) Ch. 5

<sup>65</sup>Vance (1990)

<sup>66</sup>Braudel (1972) p 377

<sup>67</sup>Leighton (1972)

### The effect of war on costs

Changes in predation costs were usually the result of war. War increased brigandage at sea and on land. At sea, as we have seen, governments encouraged piracy both as an instrument of war and as a source of revenue. In addition, distracted by the conduct of war, they were less able to keep the king's peace on land, and banditry flourished. War itself blocked trading routes, and armies and warfleets pillaged wherever they could.<sup>68</sup> Tolls too rose steeply in time of war: the exigencies of war finance eclipsed any long-run consideration of the effect on trade and so ultimately on revenue.

An index of the cost of shipping wine from Bordeaux to London over the period 1290-1669 illustrates how dramatically war could affect shipping costs.<sup>69</sup> The index, from 70 to 100 during the French-English-Flemish conflicts around the turn of the fourteenth century, fell to 30-80 in the relatively peaceful years between 1315 and 1330. With the outbreak of the Hundred Years' War, it rose steadily to reach 190 by the 1380s. The index then fluctuated between 100 and 200 through the end of the fifteenth century. Even during periods of formal peace the weakened governments of England and France proved unable to control piracy. Only with more effective policing in the sixteenth century, did rates fall again, but they did not decline to the level of the 1320s until the seventeenth century.<sup>70</sup>

The ways in which war raised shipping costs were numerous.<sup>71</sup> Shipowners, sailors, financiers, and insurers all demanded a premium to compensate them for the increased risk of loss and injury. Ships and sailors were anyhow in short supply because of losses to pirates and diversion to military use.<sup>72</sup> In response to the increased risk, shipowners switched to smaller ships and loaded them to only partial capacity, both of which reduced

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<sup>68</sup>Bulk commodities were again more vulnerable. It was easier to conceal a packhorse from pillaging soldiers than a riverboat, and it was easier for a packhorse to go around an area of danger. (Favier (1998))

<sup>69</sup>The index was constructed by Menard (1991) by deflating actual shipping costs per ton with a wholesale price index. The index was set at 100 for 1395-1405.

<sup>70</sup>The situation was as bad in the Mediterranean as it was in the Atlantic. For example, freight rates out of Sicily almost doubled during the fourteenth century. (Munro (1997))

<sup>71</sup>Menard (1991)

<sup>72</sup>Land transportation was likewise handicapped by a shortage of horses and wagons, for similar reasons. (Thirsk (1978))

efficiency. Ships had to carry additional arms and men to defend themselves, sometimes doubling the size of the crew.<sup>73</sup> As we have seen, convoying lengthened shipping times and raised costs. Where it was possible, and where it was safe, merchants preferred to send their goods overland, at significantly higher cost.

### **Brigandage versus tolls**

Although both forms of predation—brigandage and tolls—imposed costs, tolls were generally less wasteful (more ‘efficient’). Brigandage involves large deadweight losses—losses to one of the parties that do not constitute gains to the other. Violence causes damage that benefits neither predator nor prey, and the arms race between the two is costly to both. Worst of all, from a commercial point of view, violence creates a great deal of uncertainty.<sup>74</sup> In contrast, the deadweight loss from a toll is much smaller. Damage is avoided and there is a saving in the cost of armament. Uncertain losses are replaced by a known expense that can be factored into commercial calculations. Indeed, a ‘perfect’ toll—one that is unavoidable and costless to collect—is a pure transfer from prey to predator. Of course, even a perfect toll reduces trade, but the impact is minimized, given the size of the take.

Because tolls were more efficient, there was a tendency for them to replace brigandage wherever possible—an alternative interpretation of the ‘king’s peace’. On land, where tolls were easier to collect, they were the preferred form of predation, while at sea, where the collection of tolls was difficult or impossible, brigandage remained much more common. Similarly, brigandage was more common on the roads, where tolls were easier to avoid, than it was on inland waterways. Moreover, even at sea, there were attempts to replace brigandage with tolls. Cities involved in maritime trade were, by the mid-thirteenth century, negotiating treaties to eliminate reprisal—the main cause of piracy during peacetime. In its place, they imposed a tax on goods moving through their

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<sup>73</sup>Catalan records of shipping costs from 1275-1330 show that arming merchant ships raised freights by 25% or more. (Munro (1997))

<sup>74</sup>“...but it must be remembered that the claims of pirates, official or otherwise, were arbitrary and ultimately unpredictable.” (Musgrave (1981)) p 12

ports, the revenue from which they used to compensate parties who would otherwise have demanded the right of reprisal.<sup>75</sup>

### MARITIME TRANSPORTATION

Predation costs were one part of the cost of transportation. The other was the cost of carriage—the cost of actually moving goods from one place to another. Since carriage by sea and carriage by land involved somewhat different issues, we shall consider the two separately.

### THE ECONOMICS OF SHIPPING

The cost of carriage by sea was largely a matter of labor costs: “In the days of sail, the cost of sea transport was principally the cost of paying and feeding the crew.”<sup>76</sup> For instance, the wage bill of a Genoese ship sailing to Chios in the fifteenth century was some 4,500 lire while the ship itself was worth less than 5,000. Of course the two numbers are not directly comparable, since the ship was not ‘used up’ in the single voyage. If we suppose a ship was good for at least ten such voyages, and if we ignore the niceties of calculating user costs, we can see that the wage bill for the voyage was of an order of magnitude greater than the cost of using the ship itself.

In addition to the cost of the crew, which varied with the duration of the voyage and so roughly with distance, there was the substantial labor cost of loading and unloading the ship, which was ‘fixed’. Because of this fixed element, freight rates per mile fell for longer voyages. For example, it cost 25-33 *soldi* to carry a *cantar* of cotton from Chios to Barbary, but only 40-44 *soldi* to carry it to Flanders, perhaps three times the distance.<sup>77</sup>

Because labor costs were so important, labor productivity was crucial. Potential labor productivity depended on the type of ship, on its size, and on technology. It depended too, as we have seen, on the needs of defense, which often called for more men than required purely to operate the ship. All of these considerations, however, only determined *potential* labor productivity. Approaching that potential was largely a matter of organization.<sup>78</sup>

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<sup>75</sup>Cheyette (1970) piracy 1332

<sup>76</sup>Ralph Davis quoted by Lane (1986).

<sup>77</sup>Mazzaoui (1981) p 48-53

<sup>78</sup>Unger (1980)

## Capacity utilization

The cost of a given voyage was largely fixed and indivisible: it made little difference whether the ship sailed fully laden with freight or empty and in ballast. Consequently, the cost per ton of goods carried depended on how close to capacity a ship could be filled. Ships could be used efficiently only if sufficient cargo could be found. However, finding cargo was far from easy: ships stood in port for weeks waiting to fill up, or they were forced to hop from port to port in search of freight.<sup>79</sup>

The greatest problem was finding back cargo. A ship that had to sail in ballast (without paying cargo) in one direction, essentially doubled the cost of shipping in the other.<sup>80</sup> For example, Florence sent its galleys North in the fifteenth century mainly to obtain English wool for its woolen industry. However, there was little for them to carry on the outward journey, and they departed half empty, picking up what cargo they could from Spain along the way. They unloaded this in Flanders, then sailed largely empty again to Southampton to pick up Cotswold wool and English cloth (some of this to be sold in Spain on the return trip).<sup>81</sup> In contrast, the Genoese were particularly skilled in finding complex patterns of trade that kept their ships well loaded. A Genoese ship might, for example, carry salt from Ibiza to Civitavecchia in the Papal States, where it would pick up wheat to bring to Genoa or Tolfa alum to be carried to Flanders.<sup>82</sup>

Another problem was finding the right mix of cargo—balancing ‘light goods’ with heavier bulk commodities. Light goods such as manufactures, spices, and bullion were of high value, but they did not fill a ship. Baltic shipping, in particular, suffered from a chronic imbalance: sailing South, it carried bulk goods such as grain and timber; sailing North it carried light goods such as cloth and silver. As a result, many ships, had to enter the Baltic in ballast.<sup>83</sup> In addition, some bulk goods were light and needed to be

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<sup>79</sup>Lopez (1976)

<sup>80</sup>Unger (1980)

<sup>81</sup>Fryde (1974) The Florentine galleys were a state-sponsored enterprise, set up in imitation of the Venetians. They proved to be an expensive failure, and the difficulty of finding appropriate cargo was one of the reasons. In contrast, the great entrepot of Venice provided its galleys with a wide range of goods for the outward journey.

<sup>82</sup>Laven (1966) Ch. 3

<sup>83</sup>Unger (1998 [1979])The problem was eased when salt began to be shipped North.

supplemented with something heavier for the sake of the ship's trim. For this reason, ships bringing cotton from the Levant to Northern Italy commonly offered special low freights for heavy commodities such as potash, salt, and alum.<sup>84</sup>

Filling ships was largely a matter of commercial organization. One device was to have a regularly scheduled loading period for a particular destination. For example, in the early fifteenth century, the Venetian Senate declared two annual periods of four to six weeks, called *mude*, during which Venetian ships would load cotton and other cargo in the Levant.<sup>85</sup> Merchants or factors resident there could anticipate these dates and gather cargo in advance to be loaded aboard. The Venetians also coordinated the schedules of their Eastern and Flanders galley fleets, so that goods could be rapidly transferred from one to the other, speeding their passage from Alexandria to London or vice versa.<sup>86</sup> The Genoese, too, established regular sailing times for ships carrying bulk goods, alum especially, that made for faster loading and lower costs.<sup>87</sup> In the sixteenth century, the Portuguese and Spanish set regular schedules for the departures of their transoceanic fleets.<sup>88</sup>

Regular sailing schedules not only improved capacity utilization and lowered the cost of shipping, but they also had commercial advantages.<sup>89</sup> The scheduled departure and arrival of large quantities of goods concentrated trading, much like a fair, creating a deeper market and lowering transactions costs. In Venice, for example the arrival of a scheduled fleet would be the occasion for an active wholesale market, attracting large numbers of Venetian and foreign merchants. Information about *muda* cargoes was

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<sup>84</sup>The freight for cotton was double that for spices and four times that for heavy bulk goods. Mazzaoui (1981) p 48-53. Modern freight rates are charged by the 'freight ton' according to either weight or volume, whichever is best for the carrier, using a formula based on average cubic feet per long ton. Medieval practice was less formalized but approximated a similar calculation. (Dotson (1986)).

<sup>85</sup>Lane (1973) Ch. 10; Mazzaoui (1981). The scheduled loading periods also facilitated convoying, if this was considered necessary. However, the *mude*, as opposed to the galley fleets, were established for commercial rather than security reasons.

<sup>86</sup>Mallett (1967)

<sup>87</sup>Unger (1980) The practice began in the early fourteenth century.

<sup>88</sup>Unger (1980)

<sup>89</sup>Lane (1973) Ch. 10

supplied to the market before the fleet arrived, brought to Venice by fast dispatch boats sent from the ports of departure.<sup>90</sup>

Another method of filling ships was the use of trans-shipment centers. The Genoese, in particular, operated a 'hub-and-spoke' system, using first Cyprus and then Chios as their hub in the Eastern Mediterranean and Malaga and Valencia as their hubs in the Western Mediterranean.<sup>91</sup> Smaller ships would bring goods from all over the region to the trans-shipment center: for example, to Chios they brought alum from Phocaea, silk from Bursa, and slaves from the Balkans and the Black Sea. Larger carriers would then load the goods and carry them to other hubs. There, small ships would take over again, distributing the goods to markets within the region.

The Dutch developed a sophisticated market in shipping services centered on Amsterdam. Specialized charterers' houses bought up shipping capacity and then resold it to others. Shipowners could reduce their risk by chartering their ships in advance to these middlemen, who bore the risk of fluctuating freight rates. Merchants could reduce their shipping costs by relying on these specialists rather than having to seek out ships themselves. The charterers relied on a network of overseas agents to supervise the unloading of cargo, to find back cargo, and to provide the home office with information.<sup>92</sup>

### **Sailing times**

A factor that affected capacity utilization, as well as affecting cost directly, was the sailing time. The sailing time affected capacity utilization, because the number of voyages that could be completed per year depended on how long it took to complete a single round trip. Sailing time affected cost directly, because both the labor costs of a voyage and the cost of financing depended on its duration. Sailing times were not only long, they were also highly variable. For example, over a period of thirty years around 1500, the average time for a letter to reach Venice by ship from Alexandria was 65 days: over the same period, the minimum time was 17 and the maximum 89. The average time

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<sup>90</sup>Mazzaoui (1981)

<sup>91</sup>Laven (1966) Ch. 3.

<sup>92</sup>Christiensen (1941); Unger (1998 [1979])

from Constantinople was 37 days, the maximum 81, and the minimum 15.<sup>93</sup> Uncertain voyage times increased risk for shipowners, who generally charged a fixed freight while facing costs that varied with the duration of the voyage.

To some extent, the sailing time was constrained by technology. Medieval ships could not weather severe storms at sea, and they therefore had to seek refuge at the first sign of bad weather. This was one reason they favored roundabout coastal routes over more direct routes across open water. Medieval ships also had limited ability to make way against an unfavorable wind, so they were frequently stuck in port for extended periods waiting for the wind to change. However, organization more than technology was the limiting factor. Ships were delayed in port waiting for cargo or for convoy no less frequently than they were delayed by the weather. The main reason ships had to take circuitous coastal routes rather than more direct routes across open water was organization rather than navigation. They had to hop from port to port to find cargo. In addition, because of the limitations of overland transportation, they had to come as close as possible to their cargo's origin or ultimate destination.<sup>94</sup>

### **The hazards of the sea**

The hazards of maritime transportation added to its cost. In addition to the danger of pirates, there were plenty of natural hazards:

...vessels on passage were at risk to a degree now difficult to appreciate. Seas, coasts and harbours were ill-marked and ill-charted. A ship stranded, particularly in any remote area, was viewed by the natives as manna from heaven, and was unlikely ever to sail again. Vessels were taken unawares by storms and calms since there was no equivalent to modern weather-forecasting, and even had there been, no means whereby such predictions—nor for that matter any other information—could be rapidly transmitted to ships at sea.<sup>95</sup>

The risks of nature were compounded by the failings of ships and crews. Ships were hard to control—partly due to their design and partly to rapid fouling—and often poorly

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<sup>93</sup>Braudel (1972) p 362. Letters generally traveled faster than freight, since they were carried by the fastest ship available.

<sup>94</sup>Lopez (1976)

constructed. They were damaged or lost by being blown ashore, dismasted, or simply falling apart. Even when the ship itself was not lost, cargo was often spoiled, jettisoned, or washed overboard. There was no system of licensing, and masters varied widely in competence. Crews were often ill-disciplined and might broach the cargo or even hijack the ship. The rate of loss before 1600 is largely unknown, but it was certainly high: even in the seventeenth and eighteenth centuries loss rates of 10-30% a year were not unusual.<sup>96</sup>

Improving technology reduced the risks to some extent.<sup>97</sup> The full-rigged ship that was developed from the mid-fifteenth century was more easily controlled, more seaworthy, and could sail closer to the wind. Compasses and other instruments, marine charts, and 'rutters' (written sailing directions) all improved navigation. Better navigation reduced the risk of running aground on coastal routes and made open-water sailing easier. Nonetheless, the risks remained substantial.

Better organization could not reduce the risks directly, but it could lower the cost of bearing them. As we shall see presently, shipowners found ways to divide and to diversify their risks. Their customers, too, divided their risks: merchants commonly split a shipment to a particular destination among several ships: the well-organized market for shipping in Amsterdam made this particularly easy to do there.<sup>98</sup> And merchants and merchant bankers developed methods of risk-sharing and insurance.<sup>99</sup>

### **The best ship for the job**

In the design and employment of ships, shipowners and merchants faced a number of choices. One was between galleys and sailing ships. Galleys were equipped for both oar and sail. They were fast and maneuverable, and because of their large crews, well defended. Being powered by oar, they did not have to wait for a favorable wind and they could easily use small harbors or even beaches for loading and unloading. However, before 1300, galleys were quite small, and because of the space taken by crews and food,

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<sup>95</sup>Scammell (1972)

<sup>96</sup>Scammell (1972)

<sup>97</sup>Menard (1991); Postan (1987)

<sup>98</sup>Christiensen (1941); Barbour (1929)

<sup>99</sup>See Chapters 11 and 12.

they could carry no more than 20 tons of cargo each or 1/8 ton per man. Galleys grew larger in the fourteenth century, but even the ‘great galleys’ of the fifteenth, which carried close to 300 tons, could manage no better than 1.5 tons per man.<sup>100</sup> Sailing ships, in contrast, were slower, less maneuverable, and less well defended. Powered by sail alone, they were completely dependent on the weather. The larger ones needed deep harbors for loading and unloading. However, sailing ships were much more economical. Even the small *naves* of the thirteenth century could carry four times the freight of a galley and achieve a manning ratio of 5 to 8 tons per crewman. By the fifteenth century, ships in the Baltic trade were managing 10 tons per man, and by the sixteenth, large full-rigged ships could carry as much as 13 tons per man.<sup>101</sup>

The choice, then, was between speed, maneuverability and security on the one hand and cost on the other. Merchants relied on galleys to carry goods of high value relative to bulk or weight such as silks, spices, bullion, and luxury manufactures. Greater safety from predation lowered the risk of loss and this together with greater speed lowered financing costs. For such cargoes, these advantages more than compensated for the increased cost of carriage, which anyhow was easily covered by the substantial margins on such goods. Merchants used galleys too to carry light goods over short distances—for example, to distribute goods to the smaller ports of the Adriatic and Western Mediterranean.<sup>102</sup>

On the other hand, merchants used sailing ships to carry commodities that were heavy and bulky relative to their value—such as foodstuffs, raw materials, and minerals. For goods such as grain and oil, wool and cotton, beer and wine, alum and potash, the greater risk of loss and longer voyage times were less important than the lower cost of carriage: narrower margins made considerations of cost paramount.<sup>103</sup> Since bulk goods were far more important in trade than luxury goods, sailing ships far outnumbered galleys.<sup>104</sup> Even

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<sup>100</sup>Lane (1986) The great galleys used sail as well as oarsmen.

<sup>101</sup>Lane (1986); Unger (1980).

<sup>102</sup>Unger (1980)

<sup>103</sup>There were similar considerations with respect to passenger traffic. Wealthy pilgrims and merchants could afford to pay a premium for speed and traveled by galley (‘Concorde’). Poorer travelers sailed on sailing ships (‘coach’).

<sup>104</sup>See Kohn (2001)b on the relative importance of bulk goods and luxury goods.

in Venice, famous for its galley fleets, sailing ships predominated. A census of Venetian shipping in 1423 counted some 45 galleys, totaling 7,000 tons, and 3,300 sailing ships, totaling over 70,000 tons.<sup>105</sup>

A second choice facing merchants and shipowners was between large ships and small. Here again there were tradeoffs. Large ships were more efficient in that they could carry more tons per crewman. They were also more secure against pirates—at least before the advent of guns. Nonetheless, the overwhelming majority of ships throughout the period were small.<sup>106</sup> Of the 3,300 Venetian sailing ships mentioned above, some 3,000 were of less than 100 tons—most of them much less—and only 35 were of over 240 tons.<sup>107</sup> The picture was no different elsewhere. Ships passing through the Sound to and from the Baltic in the sixteenth century were mostly in the range of 60 to 200 tons<sup>108</sup>; the 2,400 ships built in Lübeck between 1560 and 1600 averaged 120 tons.<sup>109</sup> Spanish, English, and Breton ships plying the Atlantic coast were even smaller: a third of wine cargoes out of Bordeaux in the late fifteenth century were carried in ships of less than 20 tons; even in the seventeenth century, the typical English ship trading to Spain was of 20 to 40 tons.<sup>110</sup>

Most small ships were engaged in short-haul transportation for local and regional trade. It was so much cheaper to carry cargo by water, and roads in most areas were so poor, that much of the traffic of regions bordering the sea was carried by coastal shipping. Navigable rivers generally had ports at or near their mouths, where goods could be transferred to sea-going ships.<sup>111</sup> Coastal shipping also gathered cargoes for the major ports, for transshipment to long-distance carriers, and distributed goods from these ports to other regions. Coastal shipping was especially important transporting bulk

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<sup>105</sup>Lane (1934) p 102

<sup>106</sup>“In the Atlantic as well as in the Mediterranean, boats of small tonnage were an overwhelming majority.” Braudel (1972) p296

<sup>107</sup>Lane (1934) p 102

<sup>108</sup>Parry (1967)

<sup>109</sup>Braudel (1972)

<sup>110</sup>Ball (1977) Ch. 8

<sup>111</sup>Willan (1976)

commodities such as grain and coal.<sup>112</sup> Good access to coastal shipping was a major advantage of the island countries of England and Sicily.

Small ships were preferred, however, not only for short-haul transportation but also for most long-distance shipping in both zones of European trade. Small ships were more easily able to enter smaller harbors or ports that were located upstream such as London, Antwerp, and Rouen, while larger ships were forced to transfer their cargoes to lighters.<sup>113</sup> Where coastal routes were interrupted by land masses—at Lübeck, for example, before Baltic shipping began to use the Sound—it was easier to load and unload smaller ships. Because it was easier to find sufficient cargo for smaller ships, they spent less time waiting in port.<sup>114</sup> And it was less risky to carry cargo in several small ships than in a single large one. For example, after the loss of a large grain ship between Danzig and Venice in 1591, the Venetian agent in Danzig, Marco Ottobon, decided to rely on smaller ships of 240 to 300 tons: "...they do not hold a great quantity, but as a result the grain is not likely to perish on the way... and, since we are not insured, the potential loss will be smaller".<sup>115</sup>

The choice of size, therefore, was a matter of economics rather than of technology. As the economics changed, so did the size of ships. When the risk of loss increased, the size of ships shrank. For example, around 1300, before the Hundred Years' War, the average size of wine ships was 120 tons; by 1410, with the much greater risk of predation, the average size had fallen to only 70 tons.<sup>116</sup> When improved commercial organization made it easier to fill large ships, the size of ships grew. For example, the Genoese of the fifteenth century, with their hub-and-spoke system, routinely employed carracks of 500 tons on their long-distance routes.<sup>117</sup> Similarly, the regular sailing dates of the Spanish

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<sup>112</sup>Willan (1976) The cost of carrying coal overland for 10 miles equaled its price at the pit head.

<sup>113</sup>Postan (1987)

<sup>114</sup>The iron exports of Biscay were carried almost exclusively by small ships. In 1579, an investigation by the *Governo* of Viscaya attributed this to the need to enter small ports with shallow water or poor facilities and to the more rapid turnaround. (Ball (1977) Ch. 8)

<sup>115</sup>Braudel (1972) p 306. He also noted the faster turnaround and the greater ease of loading smaller ships.

<sup>116</sup>Menard (1991)

<sup>117</sup>Unger (1980) "With fixed and known sailings, ships could be built larger."

and Portuguese transoceanic trade made possible the use of larger ships.<sup>118</sup> The construction of even larger ships than these was certainly feasible technologically. Indeed, some very large ships were built because of their military value (with government subsidies).<sup>119</sup> However, these behemoths did not prove economical. The Portuguese, for example, constructed a number of carracks of around 2,000 tons for their Indies trade; but, after several were lost, they went back to relying on ships of under 500 tons.<sup>120</sup>

### **THE ORGANIZATION OF SHIPPING**

The shipping enterprise, like the enterprise in agriculture or in industry, was a web of relationships among the parties involved—suppliers, producers, and customers. As in agriculture and industry, the nature of those relationships—especially the location of ownership rights—evolved to address the particular problems the sector faced.<sup>121</sup> The many very small ships engaged in local traffic and carrying low-value cargoes were usually owned and operated by individual mariners or simple partnerships, and they often found cargo simply by ‘tramping’ from port to port.<sup>122</sup> For these elementary enterprises, there seems to have been no reason to deviate from straightforward owner management with its obvious incentive advantages. However, as the size of the ship increased, so did the problems.

One major problem, as we have seen, was finding cargo: the larger the ship, the less likely that chance would provide sufficient cargo to keep it employed. A second major problem was risk—the risk of loss due to predation or natural hazards and business risk due to the uncertainty of voyage times and the difficulty of finding cargo. Of course, the risk of loss was a concern not only for shipowners, but also for their merchant customers. The value of the cargo was often larger, sometimes much larger, than the value of the ship itself. For example, the cargoes of the great galleys of the fifteenth century were valued in the hundreds of thousands of ducats, while the ships themselves were worth no

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<sup>118</sup>Unger (1980)

<sup>119</sup>In the fifteenth and sixteenth centuries, the governments of Venice, Genoa, England, France, and Spain all subsidized the construction of large ships. Kings competed to have the largest warships, although these were not necessarily the most effective militarily (Unger (1980)).

<sup>120</sup>Unger (1990)

<sup>121</sup>See Chapters 3 and 4.

more than a few hundred.<sup>123</sup> But even in the more humble wine trade, cargoes out of Bordeaux were considerably more valuable than the ships that carried them.<sup>124</sup>

It was these two problems of operating large ships—the difficulty of filling them and the high level of risk faced jointly by shipowners and their merchant customers—that shaped the shipping enterprise.<sup>125</sup> The need to fill ships fostered close ties between shipowners and merchants. The magnitude of the risk—large relative to the wealth of the individual shipowner or merchant—gave rise to ways of breaking the risk down and sharing it with others. Moreover, since, in terms of risk, merchants and shipowners were literally ‘in the same boat’, merchants wanted a say in managing the ships that carried their goods.

### **The share partnership**

The earliest organizational structure devised to address these problems, and one that survived for most of the period, was the share partnership. Beginning in twelfth-century Genoa, the construction and operation of large ships was financed by dividing ownership into shares or *loca*.<sup>126</sup> The number of shares, from 16 to 70, seems initially to have corresponded to the size of the crew, with each shareholder financing the pay and keep of a single crewman in addition to his share of the cost of the ship. The duration of the enterprise was generally a single voyage, with the partnership liquidated on the return of the ship. If successful, the partnership might be reconstituted with the same shareholders for another voyage.<sup>127</sup> Share partnerships later caught on elsewhere, both in the Mediterranean and in the North. They were very common among the Hanseatic cities, and known, if less common, in England. The share partnership (*rederij*) developed to an

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<sup>122</sup>Byrne (1930) Ch. IV; Unger (1998 [1979])

<sup>123</sup>Fryde (1976) p 347; Lane (1973) Ch. 24

<sup>124</sup>Renouard (1970) Ch. 6

<sup>125</sup>“Large ships were in the top class of capital goods—so much so that their construction, ownership, chartering, and operation gave occasion to credit arrangements, investment pools, and risk-and-profit sharing contracts as complex as those of commerce proper.” (Lopez (1976)p 80)

<sup>126</sup>The idea was not new: the *locum maris* has its origins in Classical antiquity.

<sup>127</sup>Parker (1977)

extraordinary degree in the Netherlands: indeed, it played a vital role in financing the ten-fold expansion that took place in the Dutch fleet during the sixteenth century.<sup>128</sup>

The principal shareholders in a share partnership were the merchants whose cargo the ship carried. Large ships were generally built to order for groups of merchants who planned to employ them: building such a major piece of capital equipment ‘on spec’ would have been folly.<sup>129</sup> One advantage to a merchant of owning a share in a ship was that it guaranteed his cargo a place on board; conversely, the shipping enterprise, organized in this way was assured of sufficient cargo. Another advantage for the merchant was that ownership gave him a degree of control over the conduct of the voyage.<sup>130</sup> Early in the period, when it was still common for merchants to travel with their goods, merchants on board played a direct role in managing the voyage (shareholders who remained at home gave their ‘proxy’ to those on board). All business decisions, such as changes in routes or ports of call, were decided by a vote of the merchants.<sup>131</sup> Later, when merchants generally sent their goods unaccompanied to overseas factors or agents, authority to make business decisions was delegated to the ship’s master or to a purser who represented the owners.<sup>132</sup> Typically, ships’ masters, and sometimes mates and pilots, were sold or given shares in the enterprise “...in the hope of

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<sup>128</sup>Sella (1977); Unger (1998 [1979])

<sup>129</sup>Byrne (1930) Ch VI; Lane (1934) Ch. VII. The group would engage a master shipbuilder, who would be responsible for hiring labor and specialized subcontractors. The owners supplied the necessary materials—especially timber, which might have to be obtained at considerable cost from a distant source.

<sup>130</sup>Scammell (1972) “A merchant might get a cargo shipped by buying a share in a vessel either for the duration of a voyage or for a longer period. Aliens invested in English ships and Englishmen in alien to gain access to markets which might otherwise be closed.” p 400-401

<sup>131</sup>de Roover (1971) p 59. The crew also had a say in many decisions. Crew members were of high social status—fighters as much as workers (slaves only began to be used on galleys in the fifteenth century, because of a very tight labor market). Crewmen were allowed to bring on board some cargo free of charge, which they traded at the destination. In some cases, merchants sailing with the ship chose to enroll as crewmen. (Lane (1973) Ch. 5; Unger (1980); Lopez (1976)).

<sup>132</sup>Unger (1998 [1979]) This was the practice with Dutch *rederijen*. With the increasing authority of the master came a decrease in the status of the sailors. During the sixteenth century, ‘on-board democracy’ largely disappeared.

ensuring their wholehearted dedication to the pursuit of profit.”<sup>133</sup> Merchants, shipowners, and ship’s captains belonged to the same social group, often being related by blood or marriage, and they moved easily from one role to another.<sup>134</sup>

The second important group of shareholders was financial investors. These were individuals who had no direct interest in the enterprise, but were willing to provide some of the financing and bear some of the risk in exchange for a share in the profits. Initially, such financial investors were friends and relatives of the merchant shareholders, who could rely on such connections to give them some assurance that their interests would be protected. However, as the practice of shareholding developed, and as the risks and rewards became more calculable, shares in shipping enterprises became a popular investment among broad segments of the population. Financial investors included, in addition to merchants and mariners not directly involved in the voyage, lawyers, soldiers, widows, bankers, and even farmers and artisans.<sup>135</sup>

Each financial investor would take only a small stake in the enterprise: there might be as many as a hundred financial shareholders in addition to the dozen or so merchant shareholders.<sup>136</sup> Sometimes relatives would pool their resources to purchase a single share; sometimes shares would be subdivided to accommodate small investors. Investors diversified their risk by purchasing shares in a number of different ships.<sup>137</sup> It was much more important for financial investors, as opposed to merchant investors committed to the enterprise, to be able to liquidate their investment at short notice. Consequently, shares were easy to sell, to mortgage, and to transfer directly in settlement of debts.<sup>138</sup> This liquidity and the small size of the necessary investment were the key difference between participation in a share partnership and in ordinary partnership. The popularity of shares as a financial investment had much to do with the very high rates of return that they promised, commensurate with their risk: in some trades, the cost of a ship could be

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<sup>133</sup>Scammell (1972) p 400-401. Alternatively, a master might be engaged by means of a *commenda* contract, which also gave him an equity interest in the success of the venture. (Byrne (1930) Ch. IV)

<sup>134</sup>Lopez (1976); Christiensen (1941)

<sup>135</sup>Scammell (1972); Barbour (1929); Unger (1980)

<sup>136</sup>Lane (1973) Ch. 5

<sup>137</sup>Parker (1977); Byrne (1930) Ch. IV

<sup>138</sup>Scammell (1972) p 400-401

recovered in a single successful voyage.<sup>139</sup> Indeed, shares were sufficiently attractive that they were sometimes issued in lieu of cash to pay shipbuilders and suppliers.<sup>140</sup>

Reliance on share partnerships declined as other ways developed to address the fundamental problems of the shipping business. Improvements in commercial organization, especially in the bulk trades, made it easier for owners to keep their ships employed. As a result, close ties between shipowners and customers became less necessary. The share partnership seems to have largely disappeared in Genoa by the middle of the thirteenth century, at about the same time that Genoa refocused its trade on bulk commodities and developed its hub-and-spoke network.<sup>141</sup> And there emerged in fourteenth-century Italy an alternative way of dealing with risk—marine insurance.

### **Insurance**

The crucial difference between insurance and the share company as a way of dealing with risk was that insurance separated casualty risk from business risk. Unlike shareholders, underwriters of insurance did not have to worry about the profitability of the shipping enterprise and therefore did not require an ownership stake in the enterprise to protect their interests. This separation of risks considerably expanded the pool of potential risk-sharers, which should have lowered the cost of risk-bearing.<sup>142</sup> The ability to insure should also have lowered shipping costs by reducing the need for certain adaptations to risk that reduced efficiency. Merchants no longer had to diversify their risks by dividing cargoes among ships, and they no longer needed to send their cargoes in several small ships rather than in one large one.<sup>143</sup> Indeed, in Venice, the availability of insurance increased the attractiveness of caracks (large sailing ships) relative to galleys, and so hastened the disappearance of the latter.<sup>144</sup>

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<sup>139</sup>Scammell (1972). In the fourteenth century, Catalan shippers expected to recoup their investment within six months, with four or five roundtrips between Barcelona and North Africa (Unger (1980) Ch. 4).

<sup>140</sup>Scammell (1972)

<sup>141</sup>Byrne (1930) Ch. IV

<sup>142</sup>Insurance also separated the bearing of casualty risk from the provision of finance, potentially lowering the cost of both. This separation distinguished insurance both from the share company and from the sea loan, another early mechanism of risk-sharing. (See Kohn (1999)b).

<sup>143</sup>Unger (1998 [1979])

<sup>144</sup>Lane (1973) Ch. 26

Despite its apparent advantages, however, insurance was much more widely used in the Mediterranean during this period than it was in the North. One possible explanation is the difference in the nature of the risks in the two zones. As we have seen, piracy was a chronic problem in the Mediterranean while in the North it was rare during peacetime. On the other hand, shipwreck was much more common in the North than it was in the Mediterranean.<sup>145</sup> Insurance suffered from its own incentive problems, and these may have been greater in the risk environment of the North, making insurance more expensive there.<sup>146</sup> A second possible explanation for the greater popularity of insurance in the Mediterranean may have been a difference in the types of cargoes: high-value, high-margin cargoes were relatively more common in the Mediterranean; ships in the North mainly carried less valuable, lower-margin bulk commodities. Insurance was expensive, and traders in bulk commodities were much more sensitive to costs and therefore less likely to find it attractive. For example, one Dutch merchant sending ships to Italy in 1591 gagged at the 18-20% premiums. He preferred to bear the risk himself: as he put it “God was the insurer”. His decision may not have been a wise one: of thirty ships that he sent to the Mediterranean, two foundered and ten were seized en route, although some of these were eventually recovered.<sup>147</sup>

### **Government involvement in shipping**

Governments became involved in shipping for several reasons. Perhaps the most important was military. Until the sixteenth century, when specialized warships first began to be built, governments did not maintain standing navies. Rather, they relied on mobilizing merchant ships in times of war. They therefore took a close interest in their merchant fleets, conducting surveys to assess availability and promoting the building of larger ships that were more useful militarily. A second reason for government involvement was fiscal: one reason for forcing merchants to carry their goods on government-controlled fleets, such as those of Venice, Portugal, and Spain, was to ensure

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<sup>145</sup>A writer in the fourteenth century suggested it was twenty times more common. (Unger (1980) )

<sup>146</sup>See Kohn (1999)b for a discussion of the problems of insurance.

<sup>147</sup>Ball (1977) p 183. Merchants trading bulk commodities also tended to operate on a larger scale than those trading luxury goods. As this example illustrates, the larger scale meant more shipments and so more opportunity for ‘self-insurance’.

that they paid their tolls and taxes. A third reason for government involvement was joint action to exploit economies of scale and to address reputational externalities. As we have seen, governments provided their merchants ships with protection through the organization of convoys and the provision of convoying warships. Governments also regulated their merchant ships. In the competition among maritime nations for freight and passengers, reputation for safety and reliability was an important selling point.<sup>148</sup> Official safety regulations governed the building of ships, the size of crews and their armament, the amount of cargo that could be carried and how it could be packed, and the seasons in which ships were permitted to sail.<sup>149</sup>

The government most closely involved in shipping was that of Venice, which, beginning in the fourteenth century, developed a system of state-owned galley fleets. Its motivation initially was to find peacetime employment for its war galleys and peacetime business for its naval shipyard, the *Arsenale*, in order to defray some of the costs. Venice had been sending military fleets to Romania and the Black Sea in support of its possessions there. In the 1320s, however, these voyages became less military and more commercial in nature and the Senate decided on their ‘privatization’. Although the galleys themselves remained under government ownership, the management of the fleet was put out for public auction. This arrangement worked so well that it was extended to other routes, and by the end of the fourteenth century there were regular departures of state-owned, but privately managed, fleets for Romania, the Levant (Cyprus or Syria), Alexandria, and Bruges.<sup>150</sup>

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<sup>148</sup>They regulated manufacturing, mainly through the guilds, for much the same reason. See Kohn (2001)d.

<sup>149</sup>Unger (1980)

<sup>150</sup>Lane (1973) CH. 10. In the fifteenth century, Florence, long envious of its Venetian rival, instituted its own system of state-owned galley fleets. Because of over-regulation and difficulty in finding suitable cargo to defray the high costs, the Florentine experiment was not a success. (Mallett (1967))

## TECHNOLOGICAL PROGRESS

### The nature of technological progress<sup>151</sup>

The ships of the eleventh century were small and of limited seaworthiness and sailability. Voyages were mostly short, and routes generally hugged the coast. However, by 1600 European ships were regularly crossing the oceans to the Americas and to the Indies. The ships that made these voyages bore little resemblance to the flimsy craft of the beginning of the period.

The technological progress that brought about this transformation was slow and cumulative.<sup>152</sup> This was not because of any innate aversion to change, but because shipbuilders were sensibly cautious. Since there was no way to predict the effect of a given change on a ship's performance, they had to rely on trial and error. A bad guess could mean the loss of the vessel, so conservatism was only natural. Because of cost of experimentation was lower for smaller ships, that was where many innovations first appeared. The large number of small ships being built provided plenty of opportunity for experiment, and vigorous competition among shipbuilders gave them the incentive to try to outdo their fellows. Small ships also tended to be more specialized and differentiated: specialization was risky for a large ship, because it made it harder for it to find suitable employment.

The transformation of ship design was not the result of any great breakthrough or invention. Indeed, there was little change in the basic elements of ship design throughout the period: a shipbuilder transported from the eleventh century to the sixteenth would have seen little there that he did not recognize. However, the same basic elements were combined and recombined in new and creative ways that completely changed the characteristics of the ships being built. Indeed, by the late sixteenth century, the potential of wooden construction and sail propulsion had just about been exhausted, and there was relatively little further change until the nineteenth century and the introduction of iron construction and the steam engine.

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<sup>151</sup>Most of the following is based on Unger (1980).

<sup>152</sup>The extent of the change has therefore sometimes been underestimated. See, for example, Lopez (1987) (see p 362).

Of the two types of vessel that existed in the eleventh century, the galley and the sailing ship, it was in the design of the latter that the greater advances occurred. There were some improvements in the design of the galley, producing larger vessels able to carry bigger cargoes. However, even the improved galley was unable to compete—economically or, with the advent of guns, militarily—with the newer types of sailing ship.

In the evolution of the sailing ship, there were two major stages—the cog and the full-rigged ship. The cog developed in the thirteenth century as a combination of a number of other designs that already existed in northern Europe. Its keel made it more seaworthy than earlier designs, and its castles and fighting top made it more defensible. Contemporary advances in textile manufacture provided larger, stronger sails.<sup>153</sup> In the fourteenth century, the cog was introduced into the Mediterranean where it underwent further refinement. Builders of cogs there relied on skeleton construction, as was normal in the Mediterranean, rather than on the shell construction that was usual in the North. This, together with additional masts and the use of cotton canvas sails—lighter and more flexible than the linen sails used in the North<sup>154</sup>—permitted the building of larger ships.

The full-rigged ship evolved in the fifteenth century out of the Mediterranean cog, combining with it features of other vessels found in the Mediterranean. It had an improved stern rudder, triple masts and bowsprit, and, in place of the large, single square sail of the cog, multiple small sails, both square and lateen. These changes greatly improved the ship's handling, making it more maneuverable and enabling it to drive closer to the wind. The result was not only improved safety, but also lower costs, because less time was wasted in port waiting for a favorable wind. Dividing the sails also lowered labor costs by reduced the size of crew needed to work the ship: hands could work on sails one after the other. Multiple sails also made possible larger ships: the size of the cog had been limited by the maximum feasible size of its single sail.

Towards the end of the sixteenth century, the full-rigged ship began to undergo differentiation and specialization. There emerged on the one hand the ideal cargo carrier—the Dutch *fluitschip*. Light, inexpensive, and usually unarmed, it required only a

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<sup>153</sup>Mokyr (1990)

<sup>154</sup>Mazzaoui (1981)

very small crew. It was not to be surpassed in efficiency before the advent of iron-hulled ships in the nineteenth century.<sup>155</sup> On the other hand, the gun-carrying Venetian galleon emerged as the ideal warship. It was soon imitated throughout Europe by navies and pirates alike, and it was used to carry cargo on the more dangerous routes.

Improvements in ship design were matched by improvements in navigation. By the thirteenth century, the combination of pivoted compass, portolan sailing charts, and traverse tables allowed ships in the Mediterranean to navigate by dead reckoning.<sup>156</sup> This technology spread only slowly to the shallower waters of the North, where sailors managed well enough using soundings, celestial observation, and pilotage. Tides were, however, a greater problem in the North and tide tables were available there by the late fourteenth century. In the fifteenth century, the Portuguese—motivated by the difficulties of navigating the African coast—developed methods and instruments that enabled them to calculate a ship’s latitude.<sup>157</sup> By the early sixteenth century, publishers were bringing out printed charts, tables, and rutters (books of sailing instructions). Better navigation improved both safety and productivity. Sailing across open water reduced the likelihood of encountering pirates, of running aground, or of being driven onto a lee shore. Indeed, a fourteenth-century observer attributed the much lower rate of shipwreck in the Mediterranean to the superior methods of navigation used there compared to the North.<sup>158</sup> Direct open-water routes also shortened sailing times, and better navigation extended the sailing season into the winter. The result was more voyages per year and better utilization of ships and crew.<sup>159</sup>

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<sup>155</sup>de Vries (1976) The fluit could carry 14 tons per crewman, compared to 10 for a cog. The fluit had a characteristic bulbous shape that was partly a response to the toll at the Sound, which was based on the length and breadth of a ship measured at deck level.

<sup>156</sup>Lane (1986)

<sup>157</sup>Prince Henry of Portugal (‘the Navigator’) gave extensive support to research in navigation. (Unger (1980) Ch. 5)

<sup>158</sup>Unger (1980)

<sup>159</sup>Mazzaoui (1981) p 48-53. The obstacle to winter voyages in the Mediterranean had been the cloud cover which made celestial navigation impossible. Sailing by dead reckoning overcame this obstacle.

### **The endogeneity of technological progress**

Technological progress in shipping, even more clearly than in agriculture or industry, was a gradual evolutionary process molded by economic forces. The expanding volume of trade increased the demand for new ships, and as the pace of construction accelerated, so did the pace of technological change. The direction of technological change was dictated by demand.

As we have seen, all but the smallest ships were built to order, and the merchants who commissioned them took a keen interest in their design. Owners were quite sensitive to construction costs. For example, in the fifteenth century, the rising price of timber in the North led to the adoption there of skeleton building as it had earlier in the Mediterranean.<sup>160</sup> And owners were sensitive to operating costs: the rising cost of labor in the fourteenth century, for example, spurred the adoption of the cog in the Mediterranean because of its superior labor productivity. The size of the ships that merchants commissioned depended both on what was possible technologically and on what made sense commercially. In particular, improvements in commercial organization made it easier to fill larger ships and so encouraged designers to find ways to build them.

Advances in ship design were driven, above all, by the trade in bulk commodities.<sup>161</sup> While the cost of carriage was rarely decisive for trade in high-value goods, it could make an enormous difference to the profitability of trade in goods that were heavy or bulky relative to their weight. Some examples: carrying grain from Sicily to northern Italy around 1300 cost about 40% of its original value; carrying grain from the Baltic to the Low Countries in the fifteenth century cost 100%; carrying salt from Portugal to Bruges cost 600%.<sup>162</sup> Even for wine, a relatively expensive commodity, carriage from Bordeaux to markets in the British Isles and Low Countries in the thirteenth century cost something like 10% of its original value.<sup>163</sup> Consequently, merchants trading in bulk commodities

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<sup>160</sup>Unger (1980) Ch. 5. Skeleton construction required less timber than shell construction.

<sup>161</sup>The following is again mainly based on Unger (1980).

<sup>162</sup>Unger (1980)

<sup>163</sup>Leighton (1972); Postan (1987)

were much more cognizant of the costs of carriage and much more eager to bring them down in order to increase their margins and expand their markets.<sup>164</sup>

It was specifically to meet the needs of northern merchants trading in wine, beer, and grain that the cog evolved in the thirteenth and fourteenth centuries. The cog probably originated in the Anglo-Gascon wine trade, where there was a need for ships large enough to permit large wine barrels to be rolled on, stored efficiently, and rolled off.<sup>165</sup> At the peak of this trade around 1300, some 170 ships a year were carrying wine out of Bordeaux. In the fourteenth century, German merchants adopted the cog to ship beer from the Baltic to the Low Countries (beer, too, was shipped in barrels), and there were further refinements in its design.<sup>166</sup> In fact, so successful were shipbuilders in lowering shipping costs that they undermined the Baltic beer trade. While grain was always much cheaper in the Baltic than in the Low Countries, shipping costs had been prohibitive. Merchants had shipped grain ‘embodied’ in beer as an alternative way to exploit the differential in grain prices—beer being sufficiently valuable to justify the shipping costs. However, as shipping costs continued to fall in the fifteenth century, it began to be profitable to ship grain. As a result, the Dutch began to import grain from the Baltic to produce beer that competed with the German product and eventually took over its principal market in the Low Countries.<sup>167</sup>

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<sup>164</sup>“The transport of mundane industrial commodities was at the heart of a complex system of commercial financing and capital investment which attracted the wealth and attention of the greatest merchants of the period. The search for new sources of supply and more efficient means of transport for low-cost bulky goods materially altered the physiognomy of Mediterranean trade and contributed to long-range improvements in navigation and shipping in the late Middle Ages.” (Mazzaoui (1981), p 28)

“Trades that were safe and operated on a large scale under competitive conditions for long periods permitted the acquisition of knowledge and encouraged the experimentation necessary for technical improvements.” (Menard (1991) p 232)

<sup>165</sup>Unger (1980) The Baltic trade was at this increasingly being carried in Dutch ships.

<sup>166</sup>Unger (1989) They developed a new design that combined the best features of the existing cog with those of another type, the hulk. The result had a shallower draft, and this allowed the building of much larger ships that were still able to enter the smaller ports. These design improvements were motivated by a desire to broaden the market for grain in the face of falling grain prices in the Baltic.

<sup>167</sup>Unger (1989) The Dutch had some other advantages—tariff protection and a product that was not damaged by shipping long distances.

When the cog was introduced into the Mediterranean in the fourteenth century, it was again the bulk trades that adopted it and developed it further. Compared to the traditional bulk carrier of the Mediterranean—the classical roundship—the huge new cogs, displacing from 200 to 1,000 tons, promised to lower labor requirements by as much as 50%.<sup>168</sup> Falling shipping rates stimulated Mediterranean trade in bulk commodities such as alum, grain, salt, wine, and cotton. Imports of cotton to northern Italy, for example, increased threefold during the fifteenth century as shipping rates fell by 25%, despite rising wages.<sup>169</sup>

The great explorations and the subsequent opening up of maritime trade with Asia and the Americas in spices and bullion were made possible by the development of the full-rigged ship. However, it was not created for this purpose. Rather, it too evolved to meet the needs of merchants trading in humble bulk commodities. Basque and Breton shippers carrying iron and salt across the Bay of Biscay faced some of the worst sailing conditions in the world. Local shipbuilders developed the full-rigged ship to meet the challenge of those conditions. Compared to the Bay of Biscay, the oceans turned out to be easy.

Trade not only drove the development of new designs, it also promoted their diffusion. Shipbuilders typically started out as ships' carpenters, and as they sailed from port to port they observed a range of types on which they would later base their own designs. The merchants who employed them to build their ships learned about possible designs in much the same way. Consequently, so long as maritime trade in the two zones of European trade remained largely separate, so did the design of ships: the cog developed in the North, the galley and the classical roundship in the South. It was the opening of maritime trade between the two zones around 1400 that first brought Mediterranean shipbuilders into contact with the cog, and only then did they begin to imitate it and to improve upon it. By 1500, the pattern of ship development was general

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<sup>168</sup>They could carry 10 tons per man instead of 5, and they came close to achieving this potential, since they were relatively easily defended and did not require additional crewmen for defense. (Lane (1986))

<sup>169</sup>Mazzaoui (1981) p 48-53

across Europe, with any remaining variations in design due to differences in local needs rather than to differences in knowledge.<sup>170</sup>

### **INLAND TRANSPORTATION**

We turn now from carriage by sea to carriage by land. The issues here are a little different. First, as we have seen, predation on land generally took the form of tolls rather than of brigandage, so defense was less important and avoidance more so. Second, while in maritime transportation the focus is on the vehicle—the ship—in inland transportation it is more on the infrastructure that carries the vehicles—on roads and waterways.

#### **THE NATURE OF INLAND TRANSPORTATION**

Throughout Europe, most roads were unpaved—often little more than dirt tracks.<sup>171</sup> Major highways were few, with towns linked instead by a network of minor roads that offered plenty of redundancy should a particular route become blocked by bad weather, tolls, or brigandage.<sup>172</sup> Although the road system did not look as impressive as that of Rome, it was a good deal more useful. Roman roads were centrally planned with military and administrative purposes in mind. They were often ill suited to commercial needs, both in where they went and in their reliance on fords to cross rivers—useless for carts and wagons. In contrast, the roads of the Middle Ages were generally not ‘planned’ at all, but rather evolved in response to local needs. Bridges to accommodate wheeled traffic were numerous.<sup>173</sup>

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<sup>170</sup>Techniques of shipbuilding, like techniques of production in general, were jealously guarded and handed down from father to son as a patrimony (see Kohn (2001)d). Usually, the only way to acquire a new technique was to hire an artisan who had mastered it. For example, when Dutch shipbuilders wished to produce the new full-rigged ships that were proving so successful, they brought in Breton shipwrights who were versed in their construction. ( de Vries and van der Woude (1997) p 355)

<sup>171</sup>Postan (1987) Some paved Roman roads had survived and there were a few stretches of surfaced road in and about the towns.

<sup>172</sup>Lopez (1976)

<sup>173</sup>Postan (1987). “The medieval performance in land transport was superior to that of the Romans with respect to costs.... The medieval vehicles and the routes over which they passed were better adapted to each other than the Roman vehicles and roads had been.” (Leighton (1972) p165).

On the roads, freight was carried either by wheeled vehicle or by pack animal.<sup>174</sup> The relative importance of the two depended on the nature of the terrain and on the type of goods being carried. Pack animals—horses, mules, oxen, and men—did better on inferior roads and on hilly terrain, and they traveled faster. Wheeled vehicles, on the other hand, could carry larger loads: even a two-wheeled cart could manage two to four times the 400lb carried by a mule.<sup>175</sup> Consequently, pack animals dominated long-distance trade, which involved less bulky, high-value items, and which often had to cross mountain ranges. For example, the *vectuarii* of Genoa and Asti who carried the trade between northern Italy and the fairs of Champagne relied principally on trains of horses.<sup>176</sup> Carts and wagons played a much more important role in local and regional trade, carrying over shorter distances bulky or heavy goods such as grain and other foodstuffs, building supplies, and industrial raw materials.<sup>177</sup>

However, the preferred means of moving heavy and bulky goods, especially over longer distances, was the inland waterway. If a cart could carry the load of four mules, a riverboat could carry the load of four hundred.<sup>178</sup> Carriage by water was slower than carriage by road, but much cheaper—a quarter or less of the cost.<sup>179</sup> So water transportation was generally used for bulk cargo whenever it was available; road, when it was not. For some goods, water was the only alternative. For example, carrying barrels by wagon over bumpy roads resulted in too much damage: “Without a waterway there would have been no wine.”<sup>180</sup> Medieval waterways were principally rivers, sometimes improved, and occasionally linked by short stretches of canal. Downstream navigation relied mainly on the current. Upstream navigation was more problematic: on some rivers, gangs of hauliers were available to drag boats back upstream.<sup>181</sup> Because of the advantage

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<sup>174</sup>The roads also carried considerable livestock, driven to market under its own power

<sup>175</sup>Ball (1977) Ch. 8

<sup>176</sup>Postan (1987)

<sup>177</sup>Masschaele (1997) Ch. 9. Foodstuffs were carried by pack animal too, especially perishable items such as fish.

<sup>178</sup>Ball (1977) Ch. 8

<sup>179</sup>Ball (1977) Ch. 8

<sup>180</sup>Favier (1998) p 12

<sup>181</sup>Vance (1990)

of water transportation, most inland towns that played any significant role in commerce were located on navigable rivers.

Inland freight traveled quite slowly—an average of 15 to 25 miles per day by road and perhaps 10 miles per day by water.<sup>182</sup> Travel times were not as uncertain as those by sea, but they were uncertain nonetheless.<sup>183</sup> Roads could be closed by bad weather, especially where they passed through the mountains. Inland waterways could be rendered useless by freezing, by high water which turned bridges into obstacles, or by low water (the Seine, for example, was usually closed from June to September).<sup>184</sup> Pack animals went lame, and wagons broke down. The collection of tolls slowed traffic, sometimes requiring long detours and significant delays.

The quality of inland transportation varied widely from region to region. In general, relatively flat regions were better served: the construction of roads and canals was more expensive in hilly or mountainous terrain and the faster-flowing rivers there were often unsuitable for navigation. The wetter regions of the North had a larger number of navigable rivers than the more arid regions of the Mediterranean.

The southern and northern Low Countries were particularly blessed with inland waterways—rivers, inland seas and channels, and canals; the Rhine provided a link with Germany. The improvement of natural waterways began in Flanders in the eleventh century and the construction of canals in the twelfth. Canals were built to link rivers or to provide towns with access to the sea. For example, Bruges dug the Reie canal in 1180 to connect it with the port it established at Damme. Other canals were constructed by improving drainage ditches that had been dug in the process of land reclamation. A major motive for constructing canals was to connect towns to sources of peat for domestic heating. The northern Netherlands followed a very similar pattern of land reclamation and canal building in later centuries.<sup>185</sup> The road system in both these regions was much less developed.

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<sup>182</sup>Cipolla (1956); Masschaele (1997) Ch. 9

<sup>183</sup>Braudel (1972)

<sup>184</sup>Favier (1998)

<sup>185</sup>See Nicholas (1992), Nicholas (1997), van Werveke (1971) on Flanders and de Vries and van der Woude (1997) on the Netherlands.

Italy was very different: the terrain was hilly, and there were few useful rivers. The major exception was the Po river system that connected Lombardy and Milan to Venice and the Adriatic. In the vicinity of Milan, the rivers were augmented by canals, developed in this case from irrigation ditches.<sup>186</sup> Another exception was the Arno, which connected Florence to Pisa and the sea. Many roads traced the coast, going from port to port. Inland, because the valleys were marshy, early roads stayed on the ridges, making them useless for wheeled traffic and lengthening routes considerably. However, during the thirteenth century, there was a wave of construction of paved roads along the valley bottoms. For example, an all-weather road built along the Arno provided Florence with a good connection with Venice and the North.<sup>187</sup>

England was well served both by rivers and by roads. Much of the country was within easy reach of inland waterways that provided access to the sea—mostly rivers, with a few short canals. The road system was well developed, and foreign visitors commented on the large number of stone bridges.<sup>188</sup> France, Spain, and Germany were less well served. France and Germany had plenty of rivers, but the terrain was generally less favorable for roads. Spain had few useful rivers and relied more on road transportation than any other country in Western Europe. The hilly terrain required the use of pack animals rather than wheeled vehicles: some 400,000 mules plied Spanish roads in the 1540s.<sup>189</sup>

Technological progress in inland transportation was gradual but steady. Better breeding and nutrition produced continuing improvement in the quality of pack and draft animals. From the twelfth century, with the introduction of the nailed shoe, the rigid collar, and improved methods of harnessing teams, horses came increasingly to replace oxen in drawing carts and wagons.<sup>190</sup> The carts and wagons themselves improved too,

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<sup>186</sup>Vance (1990)

<sup>187</sup>Herlihy (1958) Ch. 7

<sup>188</sup>Harrison (1992); Farmer (1991); Masschaele (1997) Ch. 9. Palliser (1983) suggests that increasing complaints about the road system in the sixteenth century may have reflected increasing traffic more than poor roads.

<sup>189</sup>Ball (1977) Ch. 8

<sup>190</sup>Parry (1967). Horses were much slower to replace oxen in plowing. The ox had some important advantages over the horse—cheaper fodder, better health, higher ‘scrap’ value. The horse was not always

especially in the sixteenth century, which saw the introduction of the turning front carriage and iron tires.<sup>191</sup> Improvement in vehicles, however, was limited by the quality of the roads. The major problem for the expansion of inland waterways, natural and artificial, was gradient. This obstacle was slowly overcome with technological progress in the building of locks. Flanders led the way initially, but Italy took the lead in the fifteenth century: Leonardo Da Vinci made important contributions.<sup>192</sup>

### THE ORGANIZATION OF INLAND TRANSPORTATION

Compared to maritime transportation, the organization of inland transportation was simple and elementary. The major dilemma that shaped the organization of shipping—the cost advantage of scale versus its logistical and risk disadvantages—was entirely absent. There was no need, therefore, to deviate from the basic organizational form—the owner-operator. Inland transportation required little capital—no more than needed to purchase a horse, a cart, or a barge—and entry was easy. While some merchants owned their own boats and barges, most relied on independent specialized entrepreneurs for inland transportation.

Most road transportation was local and was in the hands of very small operators. In the countryside, transportation—like rural industry—was a seasonal side-occupation of agricultural workers and small farmers. Carts and animals, used day to day in agriculture, were mobilized at harvest time to bring foodstuffs to market.<sup>193</sup>

Long-distance transportation was more specialized, because it required greater organization, and because merchants were more likely to entrust their goods to carriers

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the better choice economically, and the relative popularity of the two animals depended very much on circumstances (Jordan (1996)).

<sup>191</sup>Actually, the reintroduction: both, as well as the use of leather suspension, were known to the Romans. The 'new' technology was first applied by Central European producers of passenger vehicles (the 'coach', apparently named after Kocs in Hungary); its use then spread to freight vehicles. (Parry (1967))

<sup>192</sup>Vance (1990)

<sup>193</sup>Postan (1987); Willan (1976). Before the restructuring of agriculture (see Kohn (2001)c), customary tenants provided their lords with transportation services or *averagia* as part of their feudal obligations. As agriculture became commercialized, this was largely replaced by work for hire. (Farmer (1991) p 347)

with an established reputation. For example, as the roads between northern Italy and Champagne became safer in the thirteenth century, Italian merchants increasingly relied on companies of *vectuarii*, mainly from Genoa and Asti, to carry their goods to and from the Fairs. The service offered weekly departures, carried letters and documents such as bills of exchange as well as goods, and took about five weeks each way.<sup>194</sup> The trade between Italy, Germany and Antwerp in the fifteenth and sixteenth centuries was similarly served by specialized carriers. By the 1540s, the business was dominated by about half a dozen firms, the largest being from Milan, with others from Genoa, Germany, and Lorraine.<sup>195</sup> In England, there are records of specialized common carriers from the thirteenth century, and by the late sixteenth century, there existed an extensive network of professional carriers providing weekly or fortnightly service between London and all major towns.<sup>196</sup>

Water transportation, too, tended to be more professionalized. Beginning in the sixteenth century, and fully developed by the seventeenth, the Netherlands put together a particularly extensive and well-organized system. Pairs of towns entered into bilateral agreements to provide scheduled water transportation between them—the *beurtveren*. Boats from each town took turns (*beurten*) in providing service, carrying freight, parcels, and passengers. Skippers were required to depart at the scheduled time whether they had a full cargo or not. Villagers were served by a regular system of *marktschepen* that carried them and their goods to town on market days. Merchants who shipped large volumes of goods or bulk commodities (especially peat) generally found the common carriers too expensive and preferred to charter private vessels.<sup>197</sup>

Long-distance transportation involved a great deal of organization. Pegolotti, a merchant of the early fourteenth century, described what was involved in sending wool, mainly overland, from London to Florence. First, agents in England had to clear the wool through customs, wining and tipping the officials involved, and have it loaded onto ships for Libourne in Gascony. There an innkeeper saw to its onward transportation by road to

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<sup>194</sup>de Roover (1971) p 72; Abu-Lughod (1989) Ch 2.

<sup>195</sup>Laven (1966)

<sup>196</sup>Postan (1987) p 192; Clay (1984) p 181.

<sup>197</sup>de Vries (1981); de Vries and van der Woude (1997) Ch. 5

Montpellier, paying the carters and the turnpike fees. A second innkeeper arranged the next leg of the journey to Aigues-Mortes on the Mediterranean. From there it was shipped to Pisa. At Pisa, an innkeeper had it loaded onto carts for Signa on the Arno, arranging to pay the three tolls along the way. At Signa, if the level of the Arno permitted, it was loaded onto barges for Florence; if not, it was again loaded onto carts for the final leg of the journey.<sup>198</sup>

As this example illustrates, innkeepers or *osti* played a vital role in coordinating the system. In addition to providing food and lodging for travelers they also functioned as transportation brokers—finding carriers for merchants, dealing with local officials, and providing financing.<sup>199</sup> The number of inns was enormous: St. Albans, a small town on the route between London and the northwest, boasted 27 of them in 1577.<sup>200</sup> In a major center such as London, different inns specialized in different destinations: merchants knew that carriers from, say, Norwich could always be found at a particular establishment.<sup>201</sup> The main service provided by the transportation companies on the overland routes from Germany and Italy to Antwerp was to relieve merchants of the need to make arrangements themselves with a host of innkeepers along the way. The transportation companies took this on themselves, quoting merchants inclusive rates for the whole journey, which they could pay in a single sum.<sup>202</sup>

## INFRASTRUCTURE

Inland transportation depended on infrastructure—on roads, bridges, causeways, passes, rivers, and canals. Not only had infrastructure to be built, it also had to be maintained. Roads developed holes and ruts and needed to be smoothed. They might be blocked by fallen trees, by rock falls, or by farmers plowing them up. Waterways became choked with weeds or silted up and had to be cleared or dredged; trees and other

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<sup>198</sup>Pegolotti (1936), quoted in Hunt and Murray (1999) Ch 2.

<sup>199</sup>Hunt and Murray (1999) Ch 2.

<sup>200</sup>C lay (1984) p 180.

<sup>201</sup>Willan (1976)

<sup>202</sup>Ball (1977) Ch. 8. When necessary, they also organized armed caravans, for example when crossing the Ligurian mountains or the Neapolitan Appenines (Laven (1966), p 87).

vegetation along the banks made it hard to tow boats or blocked the wind from their sails. Waterways were obstructed by the building of dams and weirs or by sunken boats.<sup>203</sup>

As we have seen, infrastructure was generally rudimentary. However, this was not inappropriate given the low population densities of the time and the modest volume of traffic.<sup>204</sup> For example, in the thirteenth century, the St. Gotthard was the principal Alpine pass on the route that linked the two urbanized central regions of Europe. Even so, no more than 1,200 tons of freight a year passed through it—an average of perhaps 20 carts a day in the months it was open.<sup>205</sup> At this level of use, the investment and upkeep required for something like the Roman system of roads would have been uneconomical, and indeed the remaining Roman roads were allowed to deteriorate through neglect.<sup>206</sup> However, as the volume of traffic rose, infrastructure improvements became increasingly worthwhile.<sup>207</sup> For example, the Commercial Revolution of the twelfth and thirteenth centuries saw a flurry of such investments all over Western Europe—all-weather roads in Italy, bridges in England, river improvements in France, and canals in Flanders.

Of course, infrastructure did not just magically appear as it was needed. Its provision required the solution to some basic institutional problems.<sup>208</sup> Infrastructure is something of a ‘public good’ in that it is often difficult to exclude those who do not pay for it.<sup>209</sup> Purely private initiative was therefore largely limited to projects where this was least a

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<sup>203</sup>Masschaele (1997) Ch. 9; Favier (1998)

<sup>204</sup>Willan (1976)

<sup>205</sup>Samhaber (1964)

<sup>206</sup>Lopez (1976)

<sup>207</sup>“Transport improvements, however, were as much the result of growing trade as its cause and the underlying reasons for the expansion of trade were the growth of population and incomes.” (Clarkson (1971)p 118)

<sup>208</sup>Szostak (1991)

<sup>209</sup>Public goods in general, and infrastructure in particular, are characterized by another property: use by one individual does not preclude use by another, at least up to the point of congestion. Consequently, until that point is reached, the imposition of a toll is ‘inefficient’, in that it discourages use even though there is no cost to carrying additional traffic. The practical importance of this theoretical inefficiency is, however, unclear: it depends on the alternatives. Infrastructure provided inefficiently may be preferable to no infrastructure.

problem—bridges, causeways, canals, and passes.<sup>210</sup> The provision of infrastructure also involved conflicts of interest. One was between users and abutters. For example, despite its social value, a farmer might have objected to a road that divided his land or at least had very little interest in maintaining it. Or a riparian landowner might have wished to build a watermill that blocked the river to boat traffic. There were conflicts too that derived from rivalry over the collection of tolls. A town that collected tolls from a particular route might oppose, politically or even by force, infrastructure projects that diverted traffic away from it. The solution of these problems required some sort of joint action, involving either city or territorial government.

Cities had an obvious interest in the quality of the roads and waterways that connected them with their markets and sources of supply. It was the cities of Northern Italy that were responsible for the ‘road revolution’ that occurred there in the thirteenth century.<sup>211</sup> Genoa was responsible for opening the de Giovi pass that connected it to Piedmont and Lombardy: subsequently, mule convoys to and from the North became so important to the city’s economy that it created special pathways for them along the city’s streets.<sup>212</sup> In Flanders, it was the cities that built and maintained the canals that connected them with the sea and with sources of peat fuel.<sup>213</sup> Cities and major towns everywhere paved their streets and levied taxes to pay for them.<sup>214</sup> While cities had no difficulty executing projects within their walls, their ability to act outside their own boundaries depended on their authority over the countryside or on the cooperation of the territorial government.

Territorial governments had the power to force landowners to yield a right of way for new infrastructure projects and to require them to maintain roads or waterways that passed through or by their land.<sup>215</sup> River improvements in Flanders during the

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<sup>210</sup>Postan (1987)

<sup>211</sup>Jones (1997). The term ‘road revolution’ is due to Plesner (1938).

<sup>212</sup>Scammell (1981) Ch. 4

<sup>213</sup>Nicholas (1992) p 129

<sup>214</sup>Postan (1987)

<sup>215</sup>Favier (1998). “To make a river navigable required a right of access, a right of passage and a right to acquire land for works on the river. Such rights could only be acquired by consent of the riparian landowners, which was difficult to achieve, or by royal grant or by Act of Parliament.” (Willan (1976) p23)

Commercial Revolution needed permission from the Count, because he had jurisdiction over navigable rivers. The construction of canals there required the Count to enforce compulsory purchase of the land through which the canals passed (with appropriate compensation).<sup>216</sup> The English government was particularly effective in ensuring the maintenance of infrastructure. From the thirteenth to the sixteenth centuries, it enacted and enforced a series of statutes requiring landowners and local communities to maintain an expanding network of ‘king’s highways’.<sup>217</sup> Strong territorial governments also had the power to resolve conflicts of interest between local governments. One that notoriously failed to do so was the government of the Netherlands. In the sixteenth century, “The jealous protection of longstanding toll privileges held by the cities of Dordrecht, Gouda, and Haarlem—and repeatedly confirmed by Holland’s High Court—forced the other cities to abandon their hopes for improved interregional transportation.”<sup>218</sup>

While invoking the power of the territorial government was necessary for infrastructure improvements, it was not generally sufficient. Territorial governments could provide the legal basis for infrastructure improvements, but they lacked the funds to finance them. Elizabethan England, for example, relied on local taxes to fund public works. While this worked well enough for the relatively small sums involved in maintenance, the tax increases needed to fund large-scale construction projects aroused strong opposition and very few were undertaken.<sup>219</sup> Larger projects generally required private funding, and private funding was forthcoming only when a profit could be made. In England, for example, while small bridges were often financed from charitable bequests, larger bridges were built by local entrepreneurs under royal grants of ‘pontage’-

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<sup>216</sup>van Werveke (1971). The exercise of eminent domain is necessary, because a single landowner along the route can block an entire project or demand extortionate compensation. Given the need for unanimous consent of the many parties involved, the transactions costs of private bargaining are likely to be prohibitive. Szostak (1991) suggests that the reluctance of the French government to exercise eminent domain was one reason for the inferiority of France’s transportation infrastructure relative to England’s in the eighteenth century.

<sup>217</sup>Masschaele (1997) Ch. 9; Farmer (1991) p 347

<sup>218</sup>de Vries and van der Woude (1997) p 33

<sup>219</sup>Willan (1976)

the right to collect a toll.<sup>220</sup> Only when this idea was extended to waterways and to roads in the seventeenth century did England begin to see any widespread construction of new infrastructure.<sup>221</sup> Profitability did not always, however, require the collection of tolls. Private entrepreneurs were willing to invest in infrastructure to provide access to their agricultural developments or mineral resources. For example, much of the canal construction in Flanders and later in the Netherlands was financed by developers of peat bogs in order to bring their product to urban markets.<sup>222</sup>

### CHOICE OF MODE AND ROUTE

Merchants frequently had a choice between transporting goods by sea and transporting them by land, especially in long-distance trade. For example, merchants trading between the urbanized central regions of Northern Italy and the Low Countries, could choose between sending their goods by sea through the Straits of Gibraltar or sending them overland through the Alps. The alternative modes of transportation—road, inland waterway, and sea—differed in the cost of carriage and in speed, and they differed in the cost of predation.

Carriage by road was the most expensive, carriage by sea the least, and carriage by inland waterway somewhere in between. Various estimates suggest that carriage by road was from 8 to 20 times more expensive than carriage by sea and 4 to 12 times more expensive than carriage by inland waterway.<sup>223</sup> In good conditions, ships could cover 60 to 100 miles a day; carts and pack animals could manage 15 to 25; and riverboats and

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<sup>220</sup>Masschaele (1997) Ch. 9. There was considerable interest in road improvement—presumably to benefit pilgrims—among religious orders and foundations and among pious private benefactors. Projects included bridges and causeways, as well as hospices along roads that passed through uninhabited regions. (Postan (1987); Lopez (1987) p 317; Harrison (1992) p 255)

<sup>221</sup>Willan (1976)

<sup>222</sup>Nicholas (1992) p 129 on Flanders; de Vries and van der Woude (1997), de Vries (1974) on the Netherlands.

<sup>223</sup>Cipolla (1956) quotes a sea to road ratio of 1:20 for 1300. Willan (1976) quotes a similar ratio for the seventeenth century, and a ratio of 1:12 for inland water to road. Masschaele (1993) quotes a ratio of 1:4:8 for sea to inland water to road in the fourteenth century. Ball (1977) quotes a ratio of 1:4 for grain carried by inland water or road in the sixteenth century.

barges perhaps 10.<sup>224</sup> However, because sea routes were more circuitous, they generally involved greater distances. For example, the distance between Venice and Bruges or Antwerp by sea was roughly five times the distance by land.<sup>225</sup> Moreover, conditions at sea were often far from good, and, as we have seen, ships faced frequent and lengthy delays waiting for better weather or sitting in port for lack of sufficient cargo. Land transportation suffered fewer delays, because it was less dependent on the weather. Also, because the individual vehicle was much smaller, departures were more frequent. As a result, carriage by land was often faster.<sup>226</sup>

Given these differences in cost and speed, the preferred mode of transportation depended on the nature of the goods being shipped. For goods that were valuable relative to bulk and weight, the cost of carriage was generally less important and speed more so, and they usually went by road wherever possible. For example, in times of peace, trade between the two zones of Europe in luxury goods and manufactures—principally, silks, spices and woolen cloth—was carried overland between Northern Italy and the Low Countries. For goods such as these, the cost of carriage by road was modest. For example, transportation by land from Bruges to Florence in the early fourteenth century added only 8% to the cost of Caen says, a relatively inexpensive woolen.<sup>227</sup>

For goods that were bulky or heavy relative to their value, the cost of carriage was more important. In sixteenth-century England, for example, the cost of carrying coal by road was 10% of its value *per mile*.<sup>228</sup> Grain was more valuable relative to weight, so the cost of carriage was proportionately less onerous. The cost of carrying grain by road in fourteenth-century England averaged only 0.4% of its value per mile.<sup>229</sup> Nonetheless, carrying grain long distances by land remained prohibitive. A Venetian official on a

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<sup>224</sup>Favier (1998) on speed by sea. Cipolla (1956), Nicholas (1992) on speed by road. Lopez (1987) p 362 and Herlihy (1958) Ch. 7 on speed by inland water.

<sup>225</sup>Munro (1997)

<sup>226</sup>Favier (1998). However, Laven (1966) reports that a cargo of silk from Genoa to Flanders could be delivered faster by sea.

<sup>227</sup>Munro (1997)

<sup>228</sup>Willan (1976)

<sup>229</sup>Masschaele (1993). For comparison, in 1970 carrying grain by rail from Kansas City to Chicago cost about 0.006% of its value per mile (Leighton (1972)).

purchasing mission to Poland in 1590, found that transporting grain by land to Venice would quadruple its price.<sup>230</sup> In contrast, the cost of shipping by sea was much more reasonable. Carrying grain by sea from Sicily to Spain in the sixteenth century or to Northern Italy in the thirteenth cost about 40% of its value.<sup>231</sup> For more valuable bulk commodities, the cost of shipping by sea was proportionally lower: carrying cotton from Sicily to Northern Italy in the thirteenth century cost only about 7% of its value<sup>232</sup>; carrying wine from Gascony to England, about 10%<sup>233</sup>; carrying alum from Genoa to England around 1400 cost 7% of its value, and wool from England to Genoa, 4%<sup>234</sup>.

In the choice of mode of transportation and route, however, a careful weighing of costs of carriage and speed was often swept aside by more urgent consideration of predation costs. In the trade in Asian spices, for example, "...the routes were determined less by freights than by taxes, less by the cost of transport than by the costs of protection".<sup>235</sup> Some examples from the Mediterranean, with its chronic piracy, suggest the relative importance of the cost of predation and the cost of carriage. The cost of grain at the farm gate in sixteenth-century Sicily was 10 Spanish *reales* per *fanega*. Carriage by land to the nearest port cost 3 *reales* and carriage by sea to Spain another 3.5, for a total cost of carriage of 6.5 *reales*. The cost of predation included 5 *reales* per *fanega* for an export license (tolls) and 1 *real* for insurance (a measure of the cost of piracy), for a total of 6 *reales*.<sup>236</sup> In another example, carrying a consignment of cloth from Genoa to Turkey in the mid-fourteenth century cost 3.5 ducats, while insurance cost 3.8 ducats.<sup>237</sup>

As we saw earlier, war could raise the cost of predation precipitously. This would cause merchants to switch from one mode of transportation to another or from one route to another. The widespread warfare that began in the late thirteenth century and continued for a century and a half raised the cost of transportation by land between the two zones of

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<sup>230</sup>Braudel (1972) p 577

<sup>231</sup>Braudel (1972) p 578 for the former; Herlihy (1958) Ch. 7 for the latter.

<sup>232</sup>Herlihy (1958) Ch. 7 communications

<sup>233</sup>Postan (1987)

<sup>234</sup>[Fryde, 1976 #2005

<sup>235</sup>Lane (1973) p 71

<sup>236</sup>Parry (1967)

<sup>237</sup>Ball (1977)

Europe to the point that it was preferable to send even high-value goods by sea.<sup>238</sup> For example, a Flemish merchant writing in 1398 estimated that shipping Wervik woolens to Barcelona by land cost 22% of their value, compared to 15% by sea.<sup>239</sup> He commented, that some merchants who had sent their cloths by land “[had] lost all their profit”.<sup>240</sup> When war abated in the mid-fifteenth century, overland trade between the two zones resumed. However, beginning in the late sixteenth century and continuing into the seventeenth, widespread warfare again raised the relative cost of land transportation, and once again merchants found it preferable to send their goods by sea.<sup>241</sup>

### FLUCTUATIONS AND TRENDS IN TRANSPORTATION COSTS

The cost of transportation declined over time. Was technological progress the cause of this decline or was it lower 'transactions costs'—falling protection costs and better organization? This question has been debated by economic historians, who have focused mainly on the nineteenth century.<sup>242</sup> However, the longer perspective of the pre-industrial period suggests an alternative dichotomy that may be more illuminating—one between the cost of predation and the cost of carriage. It was changes in the cost of predation that caused major fluctuations in transportation costs—both in the short run and over periods as long as a century and more. However, beneath these fluctuations, there was a long-term downward trend in the cost of carriage, especially in the cost of carriage by sea. As we have seen, this decline depended less on technological progress than on improvements in organization—on better ways of filling ships, for example, and on better ways of

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<sup>238</sup>See Kohn (2001)a on the wars of the thirteenth century.

<sup>239</sup>Munro (1997) Recall that a century earlier, sending Caen says—a much cheaper cloth—to Florence by land had cost only 8% of their value.

<sup>240</sup>Fryde (1976)

<sup>241</sup>Munro (1997)

<sup>242</sup>North (1968) makes the case for protection costs and organization: “Among economic historians, technological change has always held the pre-eminent position as a source of economic growth.... The conclusion which emerges from this study is that a decline in piracy and an improvement in economic organization account for most of the productivity change observed.” (p 953). Harley (1988) makes the case for technological progress, at least for the second half of the nineteenth century.

handling risk.<sup>243</sup> Moreover, even where technological progress was important, it was largely endogenous. The development of new technology and, even more, its adoption depended on organizational advances that made the use of the new technology profitable.<sup>244</sup>

There is something of a chicken-and-egg relationship between transportation costs and the volume of trade. High transportation costs hold back the expansion of trade; but the low volume of trade in turn holds back the investments in organization, infrastructure, and technology that lower the cost of transportation.<sup>245</sup> Distinguishing between the cost of predation and the cost of carriage helps to resolve this conundrum. So long as predation costs remained high, the volume of trade was small, and it made little sense to invest in lowering the cost of carriage. However, whenever predation costs fell, trade expanded. The cost of carriage came to the fore and received increasing attention. The contrast in this respect between the Mediterranean, with its chronic piracy, and the safer northern seas is illuminating. In the Mediterranean, the focus was on predation costs and on joint action to mitigate them: Venice was the great success in this respect.<sup>246</sup> In the North, the focus was more on reducing the cost of carriage: here, it was the Dutch who were the masters.<sup>247</sup> It is no coincidence, then, that most of the advances in cost reduction came from the bulk trades of the North. The diffusion of these advances to other trades and to other seas largely depended on the suitability of the circumstances—in particular, on the level of predation costs.<sup>248</sup>

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<sup>243</sup>This is the conclusion of Menard (1991), whose excellent study of the pre-industrial period largely supports North's position (see footnote 240).

<sup>244</sup>"New techniques were applied only when their use was made profitable by the commercial situation and particularly by the degree of political and military security at sea." (Lane (1986) p 234)

<sup>245</sup>"The comparative smallness of trade was probably both the cause and consequence of inadequacy of the revolution in transport." (Lopez (1987) p 362) Reed (1973) suggests that there are scale economies in transportation—large fixed costs and low marginal costs, because of the indivisible nature of investments in infrastructure and in the elimination of piracy.

<sup>246</sup>Lane (1966) Chs. 22-25

<sup>247</sup>de Vries and van der Woude (1997)

<sup>248</sup>"The enigma to be explained, therefore, is why the flute (or ships of similar design) took so long to spread to all the commodity routes in the world, once it had entered the Baltic route and the English coal trade in the first half of the seventeenth century. The answer lies in the very nature of the flute... [Its]

How significant was the long-term decline in the cost of carriage? Data are scarce and their interpretation problematic. However, there is one useful series: freight charges for shipping wine from a variety of ports to England between the end of the thirteenth century and the end of the eighteenth.<sup>249</sup> In this series, one can discern, underlying the large upward fluctuations due to the wars of the fourteenth and seventeenth centuries, a gradual downward trend.<sup>250</sup> In contrast, what little evidence that exists on the cost of inland transportation does not suggest much, if any, decline: neither organizational improvement in inland transportation nor technological progress were particularly conspicuous over the period.<sup>251</sup> Nonetheless, the costs of carriage over land were not excessive, except for the cheapest and bulkiest of commodities.

While the direct evidence for a long-term decline in the costs of carriage by sea is weak, there is considerable indirect evidence. The many cases of expansion in the scope and in the range of trade testify to a decline in transportation costs. In the northern zone, the scope of trade with the Baltic expanded over time from herring, beer, and cloth, to include grain, timber, and salt as the Dutch in particular succeeded in lowering the cost of freight.<sup>252</sup> In the Mediterranean zone, too, falling transportation costs in the wake of the introduction of the cog led to an expansion in the scope and volume of trade in bulky commodities.<sup>253</sup> Of course, the decline in the cost of carriage was most important for the trade in bulk commodities and in cheap manufactures where profit margins were modest. However, it was precisely these trades that were the driving force in agricultural and industrial development.<sup>254</sup>

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characteristics had all come about because the Dutch enjoyed a large-volume bulk trade in the Baltic, where piracy had already been eliminated. Only as privateering was driven from the seas and as improvements took place in market organization was it possible to put into general service ships designed exclusively for the carrying trade.” (North (1968) p 964)

<sup>249</sup>Menard (1991) See, especially, Figure 6.2.

<sup>250</sup>Freight charges include both predation costs and the costs of carriage.

<sup>251</sup>Masschaele (1993)

<sup>252</sup>de Vries (1974); Unger (1989)

<sup>253</sup>Unger (1980); Mazzaoui (1981) p 48-53

<sup>254</sup>See Chapters 3 and 4.

## REFERENCES

Abu-Lughod, J. L. (1989). *Before European hegemony : the world system A.D. 1250-1350* /. New York :, Oxford University Press,.

Ball, J. N. (1977). *Merchants and Merchandise: The Expansion of Trade in Europe 1500-1630*. New York, St. Martin's Press.

Barbour, V. (1929). "Marine risks and insurance in the seventeenth century." *Journal of Economic and Business History* 1 (4)(August): 561-596.

Bergier, J. F. (1970). Trade and transport in Swiss economic history. *Essays in French economic history*. R. Cameron. Homewood, Ill, Published for the American Economic Association by R. D. Irwin: 110-122.

Bogucka, M. (1996). The Role of Baltic Trade in European Development from the XVIth; to; the XVIIIth Centuries. *Trade in the pre-modern era, 1400-1700. Volume 2*. D. A. e. Irwin: 165-80.

Braudel, F. (1972). *The Mediterranean and the Mediterranean world in the age of Philip II*. New York, Harper & Row.

Byrne, E. H. (1930). *Genoese shipping in the twelfth and thirteenth centuries*. Cambridge, Mass.,, The Mediaeval Academy of America,.

Cheyette, F. L. (1970). "The sovereign and the pirates, 1332." *Speculum* 45 (1)(Jan.): 40-68.

Christiensen, A. E. (1941). *Dutch Trade to the Baltic About 1600: Studies in the Toll Register and Dutch Shipping Records*. Copenhagen, Einar Munksgaard.

Cipolla, C. M. (1956). *Money, Prices, and Civilization in the Mediterranean World*. Princeton, Princeton University Press.

Clarkson, L. A. (1971). *The pre-industrial economy in England, 1500-1750*. London,, Batsford,.

Clay, C. G. A. (1984). *Economic expansion and social change: England 1500-1700*. Cambridge, Cambridge University Press.

de Roover, R. (1971). The organization of trade. *Economic organization and policies in the middle ages*. M. M. Postan, E. E. Rich and E. Miller. Cambridge, Cambridge University Press.

de Vries, J. (1974). *The Dutch rural economy in the Golden Age, 1500-1700*. New Haven, Yale University Press.

de Vries, J. (1976). *Economy of Europe in an Age of Crisis 1600-1750*. Cambridge, Cambridge University Press.

de Vries, J. (1981). *Barges and Capitalism: Passenger Transportation in the Dutch Economy, 1632-1839*. Utrecht, HES.

de Vries, J. and A. van der Woude (1997). *The First Modern Economy: Success, Failure, and Persistence of the Dutch Economy, 1500-1815*. Cambridge, Cambridge University Press.

Dotson, J. E. (1986). Stowage factors in medieval shipping. *Trasporti e sviluppo economico. Secolo XIII-XVIII*, A. V. Marx. Florence, Istituto Internazionale di Storia Economica 'F. Datini'. Pubblicazioni, 2nd ser., 5: 273-8.

Epstein, S. R. (1999). "Market structures", Department of Economics, London School of Economics.

Farmer, D. (1991). Marketing the produce of the countryside, 1200-1500. *The Agrarian history of England and Wales: Vol. III 1348-1500*. E. Miller. London, Cambridge U.P.

Favier, J. (1998). *Gold & spices: the rise of commerce in the Middle Ages*. New York, Holmes & Meier.

Fryde, E. B. (1974). "Italian maritime trade with medieval England (c1270-c1530)." *Recueils de la Société Jean Bodin* 32.

Fryde, E. B. (1976). The English cloth industry and the trade with the Mediterranean c1370-c1480. *Produzione, Commercio e Consumo dei Panni di Lana*. Florence, Olschki.

Harley, C. K. (1988). "Ocean freight rates and productivity, 1740-1913: the primacy of mechanical invention reaffirmed." *Journal of Economic History* 48 (4)(Dec.): 851-876.

Harrison, D. F. (1992). "Bridges and Economic Development, 1300-1800." *Economic History Review* v45 n2(May): 240-61.

Herlihy, D. (1958). *Pisa in the early Renaissance; a study of urban growth*. New Haven, Yale University Press.

Hunt, E. S. and J. M. Murray (1999). *A History of Business in Medieval Europe, 1200-1550*. New York, Cambridge University Press.

Jones, P. J. (1997). *The Italian city-state : from commune to signoria*. Oxford ;, New York : Clarendon Press,.

Jordan, W. C. (1996). *The great famine: northern Europe in the early fourteenth century*. Princeton, Princeton University Press.

Kohn, M. (1999)a. "The capital market before 1600", Department of Economics, Dartmouth College, <http://www.dartmouth.edu/~mkohn/99-06.pdf>

Kohn, M. (1999)b. "Risk instruments in the medieval and early modern economy", Department of Economics, Dartmouth College, <http://www.dartmouth.edu/~mkohn/99-07.pdf>

Kohn, M. (2001)a. "Trading costs, the expansion of trade, and economic growth in pre-industrial Europe", Department of Economics, Dartmouth College, <http://www.dartmouth.edu/~mkohn/00-05.PDF>

Kohn, M. (2001)b. "Trading costs and the pattern of trade in pre-industrial Europe", Department of Economics, Dartmouth College, <http://www.dartmouth.edu/~mkohn/00-06.PDF>

Kohn, M. (2001)c. "The Expansion of Trade and the Transformation of Agriculture in Pre-Industrial Europe", Department of Economics, Dartmouth College, <http://www.dartmouth.edu/~mkohn/00-13.PDF>

Kohn, M. (2001)d. "The Expansion of Trade and the Development of European Industry to 1600", Department of Economics, Dartmouth College, <http://www.dartmouth.edu/~mkohn/00-20.pdf>

Lane, F. C. (1934). *Venetian ships and shipbuilders of the Renaissance*. Baltimore, The Johns Hopkins press.

- Lane, F. C. (1966). *Venice and history; the collected papers of Frederic C. Lane*. Baltimore, Johns Hopkins Press.
- Lane, F. C. (1973). *Venice, a maritime republic*. Baltimore, Johns Hopkins University Press.
- Lane, F. C. (1986). Technology and productivity in seaborne transportation. *Trasporti e sviluppo economico. Secolo XIII-XVIII*,. A. V. Marx. Florence, Istituto Internazionale di Storia Economica 'F. Datini'. Pubblicazioni, 2nd ser., 5: 233-44.
- Laven, P. (1966). *Renaissance Italy, 1464-1534*. London,, Batsford.
- Leighton, A. C. (1972). *Transport and communication in early medieval Europe AD 500-1100*. Newton Abbot, David & Charles.
- Lopez, R. S. (1976). *The Commercial Revolution of the Middle Ages, 950-1350*. Cambridge, Cambridge University Press.
- Lopez, R. S. (1987). The trade of medieval Europe: the South. *Cambridge Economic History of Europe: V II, Trade and Industry in the Middles Ages*. M. M. Postan and E. Miller. Cambridge, Cambridge University Press: 379-401.
- Mallett, M. E. (1967). *The Florentine galleys in the fifteenth century*. Oxford, Clarendon P.
- Masschaele, J. (1993). "Transport costs in medieval England." *Economic History Review* 46 (2): 266-279.
- Masschaele, J. (1997). *Peasants, merchants, and markets: inland trade in medieval England, 1150-1350*. New York, St. Martin's Press.
- Mazzaoui, M. F. (1981). *The Italian cotton industry in the later Middle Ages, 1100-1600*. Cambridge, Cambridge University Press.
- McNeill, W. H. (1982). *The Pursuit of Power: Technology, Armed Force, and Society*. Chicago, University of Chicago Press.
- Menard, R. R. (1991). Transport costs and long-range trade, 1300-1800: Was there a European 'transport revolution' in the early modern era? *The Political Economy of Merchant Empires*. J. D. Tracy. Cambridge, Cambridge University Press: 228-275.

- Mokyr, J. (1990). *The lever of riches : technological creativity and economic progress* /. New York :, Oxford University Press,.
- Munro, J. H. (1997). The origin of the English 'new draperies': the resurrection of an old Flemish industry, 1270-1570. *The New Draperies in the Low Countries and England, 1300-1800*. N. B. Harte. Oxford, Oxford University Press: 35-128.
- Munro, J. H. (1998). "The Symbiosis of Towns and Textiles: Urban Institutions and the Changing Fortunes of Cloth Manufacturing in the Low Countries and England, 1280 - 1570", Department of Economics, University of Toronto,
- Musgrave, P. (1981). The economics of uncertainty: the structural revolution in the spice trade, 1480-1640. *Shipping, Trade and Commerce*. P. L. Cottrell and D. H. Aldcroft. Leicester, Leicester University Press.
- Nicholas, D. (1992). *Medieval Flanders*. London, Longman.
- Nicholas, D. (1997). *The growth of the medieval city : from late antiquity to the early fourteenth century*. London ; New York, Longman.
- Nielsen, R. A. (1998). *The state and the market: the evolution of early modern grain markets*, Washington University.
- North, D. C. (1968). "Sources of productivity change in ocean shipping, 1600-1850." *The Journal of Political Economy* 76 (5)(Sep.-Oct.): 953-970.
- Olson, M. (2000). *Power and Prosperity: Outgrowing Communist and Capitalist Dictatorships*. New York, Basic Books.
- Palliser, D. M. (1983). *The Age of Elizabeth : England under the later Tudors, 1547-1603*. London ; New York :, Longman,.
- Parker, G. (1977). The emergence of modern finance in Europe 1500-1730. *The Fontana Economic History of Europe. Volume 2: The Sixteenth and Seventeenth Centuries*. C. M. Cipolla. New York, Harvester Press: 527-594.
- Parry, J. H. (1967). Transport and trade routes. *The Economy of Expanding Europe in the Sixteenth and Seventeenth Centuries*. E. E. Rich and C. H. Wilson. Cambridge, Cambridge University Press: 155-222.

Pegolotti, F. (1936). *La pratica della mercatura*, edited by Allen Evans. Cambridge, Mass., The Mediaeval Academy of America.

Plesner, J. (1938). "Una rivaluzione stradale nel nugento." *Acta Jutlandica* 1.

Postan, M. (1987). The trade of medieval Europe: the North. *Cambridge Economic History of Europe: V II, Trade and Industry in the Middles Ages*. M. M. Postan and E. Miller. Cambridge, Cambridge University Press.

Pryor, J. H. (1992). *Geography, technology, and war : studies in the maritime history of the Mediterranean, 649-1571*. Cambridge New York, Cambridge University Press.

Reed, C. G. (1973). "Transactions costs and differential growth in seventeenth century Western Europe." *Journal of Economic History* 33: 177-190.

Renouard, Y. (1970). The wine trade of Gascony in the Middle Ages. *Essays in French economic history*. R. Cameron. Homewood, Ill, Published for the American Economic Association by R. D. Irwin: 64-90.

Samhaber, E. (1964). *Merchants make history*. New York, John Day Co.

Sawyer, P. (1986). Early fairs and markets in England and Scandinavia. *The Market in History*. B. L. Anderson and A. J. H. Latham. London, Croom Helm.

Scammell, G. V. (1972). "Shipowning in the economy and politics of early modern England." *The Historical Journal* 15: 385-407.

Scammell, G. V. (1981). *The world encompassed: the first European maritime empires, c. 800-1650*. Berkeley, University of California Press.

Sella, D. (1977). European Industries 1500-1700. *The Sixteenth and Seventeenth Centuries*. C. M. Cipolla. NY, Harper & Row: 354-426.

Smith, R. S. (1966). Medieval agrarian society in its prime: Spain. *The Cambridge economic history of Europe 2nd ed.. v. 1. The agrarian life of the Middle Ages*. M. M. Postan and H. J. Habakkuk. Cambridge, Cambridge U. P.

Stenton, F. M. (1936-8). "The road system of medieval England." *Economic History Review* VII (1)(November): 7-21.

Szostak, R. (1991). "Institutional inheritance and early American industrialization." *Research in Economic History Suppl.* 6: 287-308.

Thirsk, J. (1978). *Horses in early modern England: for service, for pleasure, for power*. Reading, [Eng.], University of Reading.

Unger, R. W. (1980). *The ship in the medieval economy, 600-1600*. London, Croom Helm.

Unger, R. W. (1989). Grain, beer and shipping in the North and Baltic seas. *Medieval Ships and the Birth of Technological Societies I: Northern Europe*. C. Villain-Gandossi, S. Busuttill and P. Adam. Malta, Foundation for International Studies: 121-135.

Unger, R. W. (1990). The technical development of shipbuilding and government policies in the fifteenth and sixteenth centuries. *Atti del V Convegno Internazionale di Studi Colombiani Navi e Navigazioni Nei Secoli XV e XVI*. Genoa, Civico Istituto Colombiano: 199-211.

Unger, R. W. (1998 [1979]). Shipping in the Northern Netherlands 1490-1580. *Ships and Shipping in the North Sea and Atlantic, 1400-1800*. R. W. Unger. Aldershot, Ashgate Variorum.

Van der Wee, H. (1993). *The Low Countries in the Early Modern World*. Aldershot, Variorum.

van Werveke, H. (1971). The economic policies of governments: the Low Countries. *Economic organization and policies in the middle ages*. M. M. Postan, E. E. Rich and E. Miller. Cambridge, Cambridge University Press.

Vance, J. E. (1990). *Capturing the horizon: the historical geography of transportation since the sixteenth century*. Baltimore, Johns Hopkins University Press.

Willan, T. S. (1976). *The Inland Trade: Studies in English Internal Trade in the Sixteenth and Seventeenth Centuries*. Manchester, Manchester University Press.

Willard, J. F. (1926). "Inland transportation in England during the fourteenth century." *Speculum* 1 (4)(October): 361-374.