Economic History Review, 60, 2 (2007), pp. 313–332

The organization of the grain trade in the early Roman Empire

By DAVID KESSLER AND PETER TEMIN

SUMMARY

Rome was an exceedingly large city at the start of the Roman Empire, and it required massive grain imports to feed its population. We argue that Roman merchants organized these imports and that they used a variety of mechanisms to deal with the informational problems of long-distance trade at that time. They used general institutions of Rome, such as its legal and social structures, as well as specific mercantile institutions, such as contracts, companies, and invoices. They exploited information in the Roman social structure as well as in the facilities for trade. This combination of social and economic institutions enabled Roman merchants to operate on as large a scale as any other pre-industrial merchant group.

I

Long-distance trade in the many centuries before the telegraph was beset by information problems. There was the uncertainty present to all when ships set out and people awaited their return with little or no news in the interim. There was also the need to transact business at a distance when information travelled slowly, often by using an imperfectly controlled agent. The problem of finding good agents and providing proper incentives for them has been studied for the early modern world and even occasionally for the medieval world. In this article we extend this exploration back into the ancient world, analysing how Roman merchants dealt with asymmetric information in the centuries surrounding the beginning of the Christian era.

Historians know that Rome was the largest city before London at the time of the Industrial Revolution. The multitudinous Romans ate a great deal of grain, much of it as wheat. This simple fact becomes more surprising when one considers how easily and conveniently Romans could buy that grain. Shipped from distant provinces, the grain changed hands many times before it reached Rome. This trade was organized by the state and by private merchants who did not have the benefit of modern means of transportation or communication, and merchants faced high transaction costs from several sources. At times, merchants had to wait weeks to find out if their ships had sunk or if a harvest had wiped out the grain supply in a particular location. The Roman government cleared the Mediterranean of pirates in 67 BC, thereby reducing greatly one major source of risk for merchants.

In addition to these problems resulting from incomplete information, merchants in Rome had to rely on potentially corrupt agents—whom they could not monitor—operating in far away provinces for months at a time. This arrangement created adverse selection and moral hazard problems from the asymmetric information available to merchants and their agents. In this article we reconcile the success of the Roman grain market with the apparent barriers to that success, arguing that grain merchants used a sophisticated set of institutions to mitigate their information problems.

These information problems were not unique to the Roman merchants. In fact, they troubled merchants throughout history. Eleventh-century Genoese and Muslim traders, joint-stock companies in England and Holland, the Hudson Bay Company, the East India Company, and colonial American traders all struggled with corrupt agents, vast distances, and poor communications.[1] Such problems remain prominent in today's marketplace as well.[2] In order to reduce the transaction costs of these information problems, merchants throughout history have turned to institutions to coordinate, disseminate, and share information. Yet no one has asked how such an institutional strategy was used in the ancient world, despite a growing interest in Roman economic activity.

We suggest that, like later merchants, Roman merchants used a system of legal, social, and cultural institutions to access otherwise unavailable information, thereby mitigating the effects of potential information problems. They used a mix of specially designed and 'found' institutions to help them; they exploited the information implicit in several well-known social and cultural institutions of Rome. Merchants lessened the threat of adverse selection and moral hazard by using dependants and friends as agents and through use of a peer-monitored information network, lawsuits, and guilds that were more trustworthy than individuals. Merchants increased their available information about the market through public institutions such as the government's office of the *annona* and private institutions such as merchant organizations—similar to modern companies in some ways—that shared information and worked closely with each other. Lastly, a system of informal and even formal financing options helped reduce the unforeseen risks of trading. Our approach emphasizes the interactions between Roman economic and social structures. Roman institutions reduced transaction costs to at least the level where the grain market, based on long-distance trade, was viable; we can say little else about how much more efficient the institutions made the market. The similarities between these Roman institutions and those created by later merchants are considerable, and many Roman social structures were analogous to later ones. This Roman network of institutions may have been more elaborate and more effective than any other system that arose in the following 1,600 years.

[1] Greif, 'Reputation and coalitions'; Greif, 'Cultural beliefs'; Jones and Ville, 'Efficient transactors'; Carlos and Nicholas, 'Agency problems'; Price, 'What did merchants do?'; Bruchey, *Colonial merchant*.
[2] Akerlof, 'Market for "lemons" '; Spence, 'Signaling in retrospect'; Stiglitz, 'Information'.

The rest of this article is organized as follows. We provide historical background in section II and discuss the theory of imperfect and asymmetric information in section III. In section IV we explore the qualitative evidence available and show how it supports the argument that Roman merchants used institutions to alleviate their information problems. Section V summarizes our findings.

II

The Roman Empire was more urban than most agrarian societies. There were at least half a dozen cities with populations above 100,000 in the Principate, of which Rome was far and away the largest. Roman agriculture must have been quite efficient in order to feed all these urban residents. To feed the Roman metropolis, it was necessary to have extensive food imports in addition to a prosperous local agriculture. It is the organization of this trade that we discuss here.

We do not know how many people lived in Rome around the time of Augustus, the first Roman emperor, and there are a variety of estimates. Ancient historians typically use Hopkins's estimate of one million inhabitants. A few historians prefer a larger figure; none suggest a much lower one.[3] The diet of these residents was based on wheat, olive oil, and wine, supplemented by dry legumes and other locally grown produce. The amounts consumed of these foods are not known, and ancient historians have inferred the average consumption from 'subsistence levels' in less-developed countries today. A generous estimate is that each person consumed on average around 300 kg of wheat, for a total Roman consumption of approximately 300 million kg a year.[4]

This large amount of wheat could not have been grown locally or even in Italy as a whole. It was imported from around the Mediterranean Sea. The average size of Roman ships has been estimated from 'thin but nicely random' data to be around 70,000 kg, although the extant information suggests that larger ships were used on the main large-scale routes such as bringing food to Rome.[5] The combination of these highly imprecise estimates implies that it required between two and three thousand voyages across the Mediterranean to feed Rome. Since Rome was upriver from its ports of Ostia and Portus, and large ships had to put in at Puteoli until the time of Claudius, the importation of wheat also required trans-shipping to river barges and storage in granaries. There was a very large amount of traffic that needed to be organized.

The republican and imperial governments of Rome were very much involved in the import of grain. They provided a distribution of grain, the *annona*, for some of the residents of Rome. The government gave around

[3] Hopkins, *Conquerors and slaves*, pp. 96–8. See also Lo Cascio, 'Size of the Roman population'.
[4] Garnsey, *Cities, peasants and food*, pp. 239–45.
[5] Rathbone, 'Financing of maritime commerce', p. 201; Erdkamp, *Grain market*, ch. 4.

400 kg (60 *modii*) per year to each male head of a household. The number of households receiving this largesse is unclear, but it is generally agreed that it was between 200,000 and 250,000 during the reign of Augustus.[6] Using the larger figure, the government's distribution accounted for about one-third of total consumption; using the lower figure, even less. A prominent book on the *annona* put the share at 15 per cent; a recent description of the grain market put it at one-third.[7] The bulk of wheat imports to Rome consequently were private, that is, either sold or consumed by absentee landowners in Rome and not ordered or funded by the government. In addition, the government obtained the wheat it distributed by contracting with private merchants and shippers and sold any surplus to them.[8] Almost all the wheat imports to Rome were handled through markets as a result.

The literature about the ancient world is full of speculations about how this economic activity was organized. Modern thought has focused on the informal parts of this system, friendship and patronage, but it increasingly acknowledges that the ancient economy operated primarily on the basis of private markets. It is one thing to say that Cicero transmitted business through people he called his friends; it is quite another to specify how these agents made their decisions or how the many inhabitants of Rome who were not his friends were fed. The volume of goods being traded was too large to be dealt with informally, and the government was too small to have administered it directly.[9] These broad generalizations, however, do not specify how individual markets operated.

The government intervened in the wheat market when prices rose too high. The government was distributing wheat in ordinary years to keep the residents content; it also tried to moderate price rises when the supply of wheat was interrupted by harvest failures or shipping disasters. There are many instances when the Roman emperors tried to keep the price of wheat in Rome low, but these interventions were the exception rather than the rule. While we know of many instances, they are spread among even more years.[10] The forms of these interventions—setting maximum prices, searching for more supplies, subsidizing purchasing—show that they were attempts to control a free market. The frequent mention of grain prices in our sources reveals the existence of a market where prices were variable and important. Roman merchants were operating in relatively free markets with occasional government intervention.

Some of the risks from which the government tried to insulate consumers were risks to merchants as well. Shipping in particular was uncertain.

[6] Virlouvet, *Tessera frumentaria*; Garnsey, *Cities, peasants and food*, p. 236.
[7] Sirks, *Food for Rome*, p. 21; Erdkamp, *Grain market*, ch. 5.
[8] Badian, *Publicans and sinners*.
[9] Hopkins, 'Taxes and trade,' said there were only 150 civil servants in the Roman provinces (p. 121), not nearly enough to manage the import of wheat to feed a million urban residents. See also Rathbone, *Economic rationalism*; Temin, 'Market economy'; Wilson, 'Machines, power, and the ancient economy'; Verboven, *Economy of friends*.
[10] Garnsey, *Famine and food supply*; Rickman, *Corn supply*, pp. 150–4; Höbenreich, *Annona*.

Shipwrecks were common enough that modern historians have used their frequency to estimate the pace of economic activity.[11] In addition to the uncertainty of knowing whether your ship would come back, merchants also had to cope with the time that even a successful voyage took. Favourable winds made the trip from Ostia to Alexandria—where much of the wheat for imperial Rome originated—a matter of a few weeks, but the return trip was going against the prevailing winds and could take far longer.[12] Merchants consequently had to be ready to operate at a distance in the absence of current information. Merchants employed agents for this task and faced the problems that merchants in other times and places have faced.

In order to fully explore the relationship between these merchants and agents, it is necessary to understand the social backgrounds of merchants and agents, as well as how those merchants and agents were organized. The social structure and business structure closely parallel one another, and the intimate relationship between them motivates many of the institutional solutions we discuss later.

All the actors in the grain trade hailed from the upper three groups in Roman social hierarchy. The highest group, the senators, included only about 600 politically active members with a 1,000,000 *sesterces* property qualification.[13] Senators all came from the same homogenous, aristocratic background; they were the major landholders of the empire. In theory, law and custom openly frowned on senators who engaged in business; Cicero even derided one entrepreneurial senator as a 'business hog'.[14] Behind this façade of legal restriction, however, many senators were active businessmen. They financed a variety of operations such as vineyards, and many senators held 'unregistered' interests in numerous companies and supplied an 'important part' of their capital.[15] In essence, senators were the—barely—silent partners in Rome's important businesses.

The most visibly active businessmen came from the knights and wealthy freedmen. The knights were the slightly poorer relations of the senators, although some knights were wealthier than some senators. The knights had a 400,000 *sesterces* property qualification and were more numerous than senators, numbering about 5,000. Senators and knights formed a single class of educated, wealthy men.[16] Since they had the leverage of high social standing without the legal and cultural constraints faced by senators,

[11] Hopkins, 'Taxes and trade'; Saller, 'Framing the debate'.

[12] Rickman, *Corn supply*; Casson, *Ancient mariners*. Josephus, *Jewish war*, 2.383, 386, said that Egypt fed Rome for four months and that food for the rest of the year came from Africa. Erdkamp, *Grain market*, ch. 5, disputes the interpretation of Josephus that says only one-third of Rome's wheat came from Egypt.

[13] Hopkins, 'Rome, taxes, rents and trade.' The *sestertius* was the dominant coin of Rome, equal to one-fourth a *denarius*. Wheat in Rome generally cost somewhere around six *sesterces* per *modius* of wheat or one *sestertius* per kg on the private market.

[14] Cicero, *Atticus*, 14.12.3.

[15] D'Arms, *Commerce and social standing*, pp. 54–6.

[16] Jongman, *Economy and society of Pompeii*.

knights could become central figures in business. Below the senators and knights were the privileged freedmen, literally a first generation of educated slaves who either had been manumitted or had purchased their own freedom. Freedmen could sometimes be quite wealthy, owning such properties as mansions, villas, and farms worth more than 50,000 *sesterces* each.[17] Freedmen sometimes could reach the rank of knights, and knights could become senators if they were successful in farming, marriage, or business, and interested in politics.[18]

The grain merchants responsible for supplying Rome, who might be senators, knights, or freedmen, worked in Rome and provided capital, contacts, and organization. They hired agents from among the knights or freedmen to go abroad, purchase and sell grain, and oversee its shipping. Knights themselves sometimes functioned as merchants, hiring other knights or freedmen to be their agents. Independent freedmen merchants hired other freedmen as agents. Many studies have identified the nature of these agents and commented on their long-standing ties to their merchant principals, but little attention has been paid to the need to monitor agents, even those identified as friends and relations.[19]

While they sometimes acted alone, merchants often were organized into companies. We have few details about those companies, which were almost certainly smaller than modern corporations, but we do know that the group of merchants who had invested in the company met regularly, as do shareholders in modern corporations. Senators often were shareholders who had invested much of the necessary capital for the company. There is evidence showing that at least some Roman companies functioned similarly to the joint-stock companies of the English and the Dutch in the sixteenth and seventeenth centuries.[20] Those Roman companies obtained a legal identity separate from that of their investors and could exist even after the deaths of important shareholders. The most well-known companies were combinations of *publicani*, or tax farmers. Tax farming was a staple of the Roman Republic, with the auctioning of tax-collection contracts a yearly occurrence. It appears to have been phased out gradually in the early Roman Empire in favour of direct administrative tax collection.

Cato's famous statement that he would take a one-fiftieth share in a *societas* that operated 50 ships appears to be an example of such a company, but Verboven insisted to the contrary that 'Cato and the 50 traders simply joined hands to minimize the risks involved in the overseas merchant venture. When the journey was over and Cato's loan to finance the venture repaid, the *societas* would automatically be ended'.[21] This statement expands

[17] For details, see Cicero, *Atticus*, 3.196.3 and Cicero, *Rosco Amerino*, 133.
[18] For more information on Roman society, see Hopkins, *Death and renewal*; Alfody, *Social history of Rome*; Garnsey and Saller, *Roman Empire*.
[19] Kirschenbaum, *Sons, slaves and freedmen*; Aubert, *Business managers*.
[20] Malmendier, 'Shares in Ancient Rome'.
[21] Plutarch, *Cato*, p. 21; Verboven, *Economy of friends*, p. 285.

on the source. There is no way to know that this *societas* 'automatically' would be ended, and if 50 ships were involved, many journeys would have to be completed for the *societas* to end. Merchants and financiers in colonial Massachusetts engaged in continuing shifting partnerships that expired after a voyage, but none of them had anywhere near 50 investors or 50 ships.[22] Unless Plutarch was exaggerating greatly, Cato was doing something far more sophisticated than financing a single merchant voyage.

In most companies, a separation existed between ownership and management. The merchants who owned the company selected executives, called *magistri*, to actually run the company. Badian suggested that companies were 'hollow' in the middle, consisting mostly of capital contributors and top management as well as low-level staff. Most members were 'employers' rather than 'employees'. Operating over extensive areas, some companies even had offices stretching from Arles to Beirut.[23] Unfortunately, there are no surviving examples of the company records and reports that must have existed in ancient times.

III

Roman grain merchants contended with the consequences of highly limited information and of adverse selection and moral hazard, or principal-agent problems. There were large barriers of distance and time between merchants and their agents, making the coordination of buying and selling difficult to manage. Merchants could not ascertain quickly when the price of grain in Egypt, Africa, or Rome might be high or low, or even if their ship had sunk in a storm. The advent of the telegraph and then the wireless would reduce some of those problems in the nineteenth century, but merchants had already faced these problems for several millennia by then.

Roman grain merchants, like merchants in other times and places, had to find capable, trustworthy agents under conditions of adverse selection. As Akerlof explained in his famous 'lemons' paper, when the buyer of a good or a service (the merchant in our case) has no clear way of discerning the quality of the good or service itself (the agent), the buyer typically faces an adverse selection of goods.[24] The provider of goods and services (the agent) has an incentive to provide only lower quality goods, and so the market for that product may even disappear entirely. Stiglitz and Spence both outline modern examples of these screening problems that have become particularly pertinent recently in areas such as the management of American health maintenance organizations.[25]

The merchant–agent relationship also established conditions for moral hazard, a problem closely related to adverse selection. Agents working in

[22] Bailyn and Bailyn, *Massachusetts shipping*.
[23] Sirks, *Food for Rome*, p. 99.
[24] Akerlof, 'Market for "lemons" '.
[25] Altman, Cutler, and Zeckhauser, 'Changing market'.

distant and therefore unobservable settings could skim profits or steal cargos from owners with little fear of reprisal. The moral hazard was exacerbated by adverse selection, since the merchants might hire agents with an inclination to cheat. This problem has been mitigated from time immemorial by using family and friends as agents whenever possible. This proclivity to use known agents is pervasive in all societies; only the details change. The Rothschilds succeeded in part because Mayer Amschel had five trustworthy sons, and the current President of the United States was helped in business by family connections.[26]

Many papers have demonstrated that institutions play a critical role in reducing the costs of these asymmetric and incomplete information problems when family or household connections are not enough. Akerlof suggests that business institutions such as warranties, brand names, and reputation provide means to reduce the problem of adverse selection because those types of 'signalling'—proactive identification of quality or ability—increase the available information.[27] Sixteenth- and seventeenth-century North American merchant groups hired people from within specific families or communities that were already considered trustworthy and promoted people from entry-level positions once their level of ability was clear.[28] Similarly, Greif argues that the Maghribi Muslim traders depended on a different kind of social signalling—membership in a common religious group—to mark the reputable agents. Genoese traders, on the other hand, relied on the enforcement mechanism inherent in their legal framework to ensure a selection of honest agents.[29] In general, common ways to reduce moral hazard include paying high wages to raise the costs of being fired for cheating and implementing peer-monitoring institutions.[30] Early trading companies relied on those monitoring systems and also required agents to take oaths to work solely in the best interests of the company.[31]

These studies often take the legal environment as given, but North and others have stressed the importance of a functioning legal system.[32] The relations between merchants and agents are simplified greatly if they have contractual relations that are enforceable in a court of law. Trade itself can be done without contracts—purely for cash and only on spot markets—but the ability to write contracts facilitates the expansion of economic activity. Recent papers have questioned the relative advantages of differing legal systems, arguments that are based on the importance of this underlying institution.[33]

[26] Ashton, *Industrial revolution*; Mathias, 'Minorities and elites'; Ferguson, *House of Rothschild*; Phillips, *American dynasty*.

[27] Akerlof, 'Behavioral macroeconomics'.

[28] For a discussion of these institutions and differing analyses on their efficacy, see: Carlos and Nicholas, 'Agency problems'; Jones and Ville, 'Efficient transactors'.

[29] Greif, 'Cultural beliefs'.

[30] Shapiro and Sitglitz, 'Equilibrium unemployment'; Arnott and Stiglitz, 'Moral hazard'.

[31] Carlos, 'Historical perspectives'.

[32] North, *Structure and change*.

[33] Beck and Levine, 'Legal institutions'; Lamoreau and Rosenthal, 'Legal regime'.

One strand of the new institutional economics regards legal rules and other institutional aids to commerce as endogenous, that is, as designed to make the economy more efficient. We cannot ascribe this degree of rationality to the Roman economy. Some measures, those specific to maritime risks and principal-agent concerns, may have been introduced to facilitate trade. But the bulk of the formal and informal rules and practices of the early Roman Empire grew for other reasons and were adapted to aid commerce. It is this mix of 'found' and created measures that makes historical description so interesting.

IV

We describe the ways in which Roman merchants dealt with problems of information in four steps, going from the formal to the informal. Roman law set the stage for all specific measures. Particular maritime practices increased the ability of merchants to monitor agent activity. Merchants also exploited the information derived from the group identification of agents to serve as less formal guarantees. And, lastly, merchants relied on the incentives to preserve reputations in order to promote honesty and fair dealing.

If agents were afraid of being punished, they would be less likely to cheat. Rome had a sophisticated legal framework that could enforce judgments, especially fines, against agents who were found to be untrustworthy. A merchant knew that any agent he selected had a lower probability of cheating and could spend less time worrying about discerning the true 'trustworthiness' of an agent. Rome had a set of courts for both public and private disputes, as well as justices, lawyers, and government officials who were in charge of enforcement.

Roman law famously lacked a law of agency; contracts in general only bound the contracting parties. Roman jurists, however, understood that provisions for agency operations were needed, and they provided a variety of legal categories in which such contracts were binding. Agents from a merchant's household such as sons and slaves could make binding commitments for a *peculium*, a sum of money designated for the purpose at hand. *Actiones institoriae* and *actiones exercitoriae* allowed ship captains to commit merchants and agents more generally to commit principals. *Actiones adiecticiae qualitatis* provided a legal basis for more complex delegation of authority and responsibility.[34]

For a light-hearted but pertinent example of legal enforcement, we can look at an incident involving a donkey in 4 AD.[35] A merchant had hired an agent to carry goods using a donkey; the agent broke the contract within a year, however, by stealing the merchant's goods (and killing one of the donkeys). The merchant then filed a petition for legal redress and damages.

[34] di Porto, *Impreso collettiva*; Aubert, *Business managers*; Johnston, *Roman law in context*.
[35] Wolfe, 'Transportation in Augustan Egypt'.

The public authority resolved the issue in a way that preserved a record of the broken contract. Any punishment meted out was made more severe by the public nature of the legal system, the proceedings in a large proportion of cases being circulated in writing afterwards.

Private judges were responsible for resolving disputes about private contracts, and Cicero's letters demonstrate that partners in a commercial venture could and did sue one another.[36] State cases were judged in more public courts, and the state had the option of suing all the guarantors of the contract consecutively, an advantage not accorded to private contracts.[37] Thus an agent who violated a contract could expect a fine or other punishment. The public office of the *annona*, which acted as merchant and contracted with its own agents to import government grain, could also punish corrupt agents. That office could and did refuse to deal with whomever it wanted, denying them government accounts forever.[38]

In addition to directly refusing contracts, the office of the *annona* investigated merchants who attempted to defraud the government. For instance, once the Emperor Claudius introduced a plan to increase the rewards for merchants involved in the *annona*, and merchants gained an incentive to claim that they were participating in that plan even if they were not. Some shippers simply claimed that they had built ships for the *annona*, but then they either used the ships for other purposes or never built them at all.[39] The office of the Prefect employed at least one person in Ostia to investigate such claims. Identification and punishment of those 'phantom shippers' provided information for agents and merchants that they might not be able to ascertain themselves.

While the courts and the government helped to protect against moral hazard, there were both public and private formal institutions that helped combat woefully incomplete information. The Prefect of the *annona* had the power to issue contracts for the provision of state grain, as mentioned above, and his office in Ostia was surrounded by the offices of private merchants. The Prefect appears to have engaged only a small staff, suggesting that his main tasks were to gather information about the grain trade and to coordinate with important merchants rather than to organize the entire market.[40]

The Prefect's office therefore may have functioned as an information-clearing house. Because the Prefect of the *annona* dealt with many merchants, he was privy to information from each of them, either through official discussion or through casual conversation. The issuing of certain public contracts could signal private merchants about expected prices and fluctuations in the market, as well as about shortages or surpluses in areas in which they did not normally deal. In essence, this information distribu-

[36] Sirks, *Food for Rome*, p. 29.
[37] Meiggs, *Roman Ostia*, p. 29.
[38] Sirks, *Food for Rome*, p. 91.
[39] Garnsey, *Famine and food supply*, p. 234.
[40] Sirks, *Food for Rome*, p. 14.

tion is similar to speeches given today by individuals such as the chairman of the Federal Reserve Board, who, with a massive amount of economic information, take actions that signal market conditions to private businessmen. Industry associations perform similar functions.

Although merchants could not collectively concentrate their information in one place, as did the Prefect's office, they could still develop private, formal networks to share that information. The Roman 'company' was a sophisticated information-sharing institution. Companies kept copies (or originals) of letters sent by their agents, so they presumably had the ability to trace pricing and quantity trends over time, as well as to compare older contracts with newer ones.[41] Some companies had physical offices in multiple provinces, an arrangement that suggests further information-gathering capabilities. The group of top managers could pass information easily among themselves since different companies were owned or controlled by men from the same social circles. They might have discussed minutiae like the spot price of wheat in this farm versus that one, and, more importantly, it does not seem unreasonable to imagine them sharing information about employees, profits, and ships through their many social interactions.

Another way in which grain merchants limited risk was through private financing, just as more recent long-distance traders do.[42] Athenian merchants in the fourth century BC used loans to finance maritime trade that did not have to be repaid if a ship was wrecked.[43] Roman financing followed the same model, and merchants and shippers were able to borrow conditional on a safe return. The interest rate charged was higher than usual and not subject to the normal limitation of 1 per cent per month in an explicit acknowledgement that the payment included both interest and insurance: 'Money lent on maritime loans (*traiecticia pecunia*) can bear interest at any rate because it is at the risk of the lender as long as the voyage lasts'.[44] Rathbone argues that maritime loans were common enough to warrant a standard loan contract, and Temin adds that contemporary Roman commentators discussed market interest rates for such loans. Rathbone concludes that a particularly large amount of financing occurred during the first and second centuries AD, precisely the time period in which the operations of these grain merchants were at their height.[45] The existence of this financing is particularly substantial if there was little or no government control over the grain trade. Merchants had to bear the risks privately.

While formal, legal institutions like the court system and Roman companies helped combat both asymmetric and incomplete information, other formal institutions, while not codified under law, increased the ability of merchants to monitor agent activity. Just as the legal enforcement of

[41] Badian, *Publicans and sinners*, p. 78.
[42] Temin, 'Financial intermediation'; Rathbone, ' "Muziris" Papyrus'; Rathbone, 'Financing of maritime commerce'.
[43] Cohen, *Athenian economy and society*.
[44] Paulus, *Sent*. II, xiv, 3, quoted in de Ste. Croix, 'Maritime loans'; Johnston, *Roman law in context*.
[45] Rathbone, ' "Muziris" Papyrus.'

contracts raised the cost to an agent of being caught, a complicated system of documentation increased the agent's risk of being caught. These documents all provided information about the owner, amount, and quality of grain to third parties, either another agent purchasing the grain from an agent or a port official. This elaborate peer-monitoring system helped to ensure that, though an agent could cheat or steal on a long voyage or in a distant land, he would be exposed once he returned.

The problems of agency arose in gathering both public and private supplies of wheat. The public administration used a system of receipts to record important information about grain cargoes that were available for merchants buying grain or by other third parties. The following receipt, issued in 211 AD, is representative:[46]

> Given to Didymus, strategos of the Oxyrhynchite nome, by Posidonius also called Triadelphus, master of eight boats carrying 40,000 artabae in the Neapolis administration, I have received and had measured out to me the amount ordered by you the strategos and by basilicogrammateus of the same nome, from the sitologoi of the Psobthis district, in accordance with the order of his excellency the procurator Neaspoleos, from the public granaries of the said village at river Tomis, [a specified amount of] wheat, produce of the [year] specified, unadulterated, with no admixture of earth or barley, untrodden and sifted, which I will carry to Alexandria and deliver to the officials of the administration safely, free of all risk, and damage by ship. This receipt is valid, there being three copies of it, which I have issued two to you the strategos and one to the sitologoi. Date.[47]

The receipt identified to whom the cargo belonged and to whom it was being shipped. It also explained specific attributes of the grain, such as the year of harvest and the quality of the product. By identifying its attributes, the receipt made the grain more difficult to steal.

This receipt also suggests the complexity of the system of documentation that Roman officials and merchants used. That the receipts existed in triplicate and were sent to different offices provides evidence for a system of quasi-permanent record-keeping; that two copies of the receipt went to the same person is even stronger evidence, since there could be few other reasons for duplicates. The statement 'this receipt is valid' implies that there was some legal or understood code of conduct in which three receipts were required in order to make a transaction valid. Since no record exists in documents concerning Roman trade law about such a requirement, merchants may have taken it upon themselves to create such a system of receipts. Not surprisingly, there are even reports that businesses kept archives with letters and other documents, although no records remain of the archived documents.[48] Other evidence stresses the critical importance of receipts to merchants.

[46] The passage was originally Greek, a language often used in Roman Egypt because of that province's traditions of Greek administration under the Ptolemies (330–23 BC).

[47] Rickman, *Corn supply*, pp. 121–2.

[48] Badian, *Publicans and sinners*, pp. 72–3.

Several documents tell of ship crews who waited as much as 15 days, often in the middle of prime sailing season, for a receipt of the cargo to be issued in Ostia.[49] It is unlikely that the crews would simply have waited for a receipt were it not an indispensable part of conducting business. The captain of each ship involved in government shipping was also given a document attesting to the quality of that grain; he had to surrender that receipt to the Prefect of the *annona* at Ostia upon his arrival. Ship captains must have carried additional information, since a ship arriving at Ostia or Portus had to present identification papers to be assigned a berth by the harbourmaster.[50]

In addition to the straightforward receipts discussed above, merchants used even more clever alternatives, such as the labelling of cargo, to assist them in controlling the behaviour of agents. A particularly ingenious form of 'receipt' involved separate sample containers. Throughout the late Republic and early Empire, grain merchants sent sealed pots or pouches containing a sample of the grain cargo on trading ships. When the cargo arrived at its destination, the recipient could open the sealed container and test the grain held in it against the grain in the ship's main hold; any difference suggested that the bulk of the grain had been doctored in some way. These seals were signed by the granary official and a merchant, with an additional signature from a witness.[51] Such a safeguard against fraud made it extremely difficult for an agent to 'cut' his grain with barley or dirt in order to increase the size of his sale. This procedure was doubly valuable, ensuring that the merchant who was ultimately selling the grain would not be embarrassed by a wayward agent and that the merchant ultimately purchasing the grain would not be defrauded.

Other simple tricks helped raise the cost of moral hazard. For instance, when grain was poured directly into a hold rather than into sacks, merchants could draw a line on the inside of the hold to mark the height of the grain when it was loaded.[52] Indirect, comparative evidence of other product labelling bolstered the practices' viability. Wine merchants labelled their *amphorae* to identify both the contents of the jug and its owner and sometimes a great deal more. One intact pot contained the following label:

> Received; Hispalis; value 20 sest [*sesterces*]; weight 215 lbs.; from estate of Capito; export duty: 2 asses; name of clerk; consular date (AD 179).[53]

Grain was carried in sacks, not in *amphorae*, and, though no sacks have survived, it would not have been difficult to label sacks with paint, or even coloured thread to signal the merchants, the quality of grain, or other pertinent information.

[49] Sirks, *Food for Rome*, pp. 43, 156.
[50] Casson, 'Harbour and river boats'.
[51] Rickman, *Corn supply*, p. 122.
[52] Sirks, *Food for Rome*, p. 100.
[53] Frank, 'Notes on Roman commerce', p. 72.

The guild system, especially in Ostia, provided another institutional barrier against moral hazard. Since each transaction involving grain increased an agent's opportunities to cheat, merchants sought to limit the amount of exposure their agents had to the grain with which they were entrusted. The existence of a developed guild system in Ostia and other ports made it unnecessary for agents to perform certain functions, such as unloading the ships, storing the grain, and bringing it from Ostia to Rome.[54] Merchants preferred that guilds perform these tasks, because the guilds already had internal checks against moral hazard—guild members came pre-screened.

To understand how guilds could be so tightly controlled, it is useful to review the inner workings of the guilds. While guilds were formal organizations of men tied together by a common occupation, they differed from the European craft guilds of the middle ages and early modern period. Many Roman guilds, such as the sack-carriers, or longshoremen, did not require mastery of a specific artisanal skill; their work was unskilled. The guilds of skilled workers focused more on cerebral tasks such as piloting ships. All guilds allowed their members to compete freely with each other, and non-guild workers could also find employment in tasks normally performed by guild members. There were significant benefits to membership, as we shall see, although there is no evidence that guilds acted as unions to control wages.

Guilds could prevent crime because they functioned as self-enforcing cartels; a guild could easily refuse membership and its benefits to an outsider or punish active members who stole or behaved corruptly. Elections ultimately determined guild membership, although some guilds required an entry fee in addition. Some guilds, such as the public grain-measurers, forced new members to 'take a valid oath to do honest work'.[55] The guild members collectively elected officers and managed business operations. Those officers held terms of between two and five years, depending on the guild. While membership was not a hereditary right, sons often followed fathers into the same guilds, and freedmen similarly followed the families from which they had won their freedom and now considered their patrons.[56] It is unclear how many members each guild had; Casson reports that sizes ranged from 19 to 250.[57]

The strong organization of the guild and its ability to exert collective action made guild membership desirable. Guilds often pooled resources, and most guilds had guild houses stocked with gifts and decorations given

[54] There were at least four Ostian guilds that directly concerned the grain merchants: The sack-carriers, similar to longshoremen, unloaded grain from ships; the grain measurers weighed the government's grain upon arrival and departure; the shippers owned small boats that they used to carry grain to Rome, and they may also have checked an incoming ship's documentation; the barge-men guided barges full of grain that were pulled by oxen to Rome. There was even a guild of divers who recovered cargo that fell into the water. See Sirks, *Food for Rome*, and Meiggs, *Roman Ostia*, for more discussion.

[55] Frank, *Economic survey*, pp. 247–9.

[56] Meiggs, *Roman Ostia*, pp. 316–23.

[57] Casson, 'Grain trade'.

by members. Many also had their own temples, while others used their resources to engage in civic life. The measurers, for instance, were one of the guilds who erected statues to the Prefects of the *annona*. Guilds also elected 'patrons', men of varying influence and wealth, giving members access to those men. Less powerful guilds invited reputable local men to be their patrons; more significant guilds, like the shippers, included a handful of senators on their list of patrons. A guild member would not lightly throw away such positive social benefits.[58]

Guilds must have monitored their members' behaviour closely. The common treasury would have produced a strong interest in members to monitor one another. More importantly, the reputation of the entire guild could have suffered from the bad acts of one of its members. Even if corrupt members were not expelled, it is unlikely that they would ever have been voted into officer status or given special honours by their peers.

Legal systems, and other formal organizations do not exist in a vacuum; it is often informal social custom that proves even more effective than official sanctions.[59] Merchants, in fact, relied on informal institutions to promote honesty and trustworthiness. The guarantee of reputation is the most likely candidate for the unofficial enforcement mechanism in Rome. This *ex-ante* solution would have pre-screened the agents available to the merchants.

If the Romans used a reputation mechanism, what was the signal that established trustworthiness? Roman religion did not involve an ethical code, as is present in Judaism, Christianity, and Islam, so an appeal to religious values could not ensure trustworthiness. Instead, it seems plausible that the criterion for establishing trustworthiness was the recommendation of another merchant knight or senator, especially given the homogeneity of the two primary classes of senators and knights and the close proximity in which merchants worked in Ostia, as we shall see later. In addition, honour and probity were important secular values among the Roman aristocracy; men of these higher ranks were considered to be *de facto* trustworthy, and could explicitly lend that trustworthiness to others. Naturally, not all members of these classes were, in fact, trustworthy, but the small, close-knit community ensured that a deviant individual could not hide behind his rank indefinitely.

A letter from Cicero provides evidence of this reputation mechanism. In the letter, Cicero, a wealthy senator, writes to a merchant principal, Titus, about an agent, Avianius. Avianius worked for Pompey, one of Cicero's friends and also a merchant principal:

> What I beg of you is this—that you would accommodate Avianius as to the place and time for landing his corn: for which he obtained by my influence a three years' licence whilst Pompey was at the head of that business.[60]

[58] Meiggs, *Roman Ostia*, pp. 316, 324; Sirks, *Food for Rome*, p. 261.
[59] Milgrom, North, and Weingast, 'Role of institutions'.
[60] Cicero, *Familiares*, 13.75.

This letter contains two instances of the reputation mechanism. First, Cicero clearly used his social ties to Pompey, another merchant principal and member of the senatorial circle, to secure Avianius a contract in the first place. Second, Cicero, with his personal reputation, persuades Titus to give Avianius a favourable reception. Cicero's letter 'brands' Avianius as a trustworthy agent, just as a personal endorsement from a standing president might brand a candidate 'honest' or 'trustworthy'.

The use of the same agent by multiple senators strengthened the reputation mechanism. Since some agents worked for several wealthy families, information about their reputations could travel particularly rapidly. Cicero gives an example of this phenomenon by writing about Atticus, his own agent as well as the agent for four other aristocratic families, including that of Marc Antony.[61]

While the aristocratic ownership of Roman companies bolstered the reputation mechanism through their personal communications, the companies themselves helped minimize the damage a dishonest agent could cause. At least some merchant groups offered to replace a failing agent with another one. Associations even used their own property as collateral to guarantee fulfillment of a contract and threatened their own criminal members with fines or prosecution for criminal activity.[62] These pledges were not legally binding, but they did control anyone who wished to remain part of an association.

If an agent were caught cheating, the costs could be high. Through a straightforward procedure, a private merchant could simply end his contract with an agent who cheated. The government could also refuse to work with cheating agents in the future. The reputation-based enforcement mechanism would ensure that any agent who had been fired would be unlikely to find any work whatsoever. The legal framework that helped create more trustworthy agents also increased the chance that cheating agents would be punished if caught.

Informal Roman institutions also proved useful in addressing problems of incomplete information. Merchants typically came from the same elite social groups, and their informal relations supported and aided their commercial transactions. Various authors have presented an economy of friends as a substitute for a more formal market, but in fact they are complements. As noted earlier, families, extended households of slaves and freedmen, and friends were used to reduce the extent of adverse selection. They also conveyed information that reduced the opportunity for moral hazard. Kirschenbaum concluded, 'These were relations that never reached the inside of a courtroom. Their entire tone precludes contract and suit, action and liability; yet they were most effective in fulfilling the roles and needs lawyers

[61] Cornelius Nepos, *Great generals*, 25.15.
[62] Garnsey, *Cities, peasants and food*, p. 77.

associate with agency'. Verboven added, 'Little of what we have found can be considered unique for the Roman Economy'.[63]

Given the level of communications technology, no one had access to all the information about the grain trade. Because numerous people had access to different pieces of information, merchants participated in institutions that helped share or diffuse information. This information sharing evolved in two ways: merchants collectively sought information from a public source, the government's Prefect of the *annona*, and merchants could acquire information privately from other merchants. In addition, those private merchants could also reduce the risks of incomplete information through a system of financing that was surprisingly modern in several ways.

A second way for merchants to more efficiently spread information was to work physically near each other. Knowing each other, seeing each other each day, and gossiping together would undoubtedly increase the information flow between the merchants. The Piazzale delle Corporazioni was the primary physical institution for grain information exchange in Ostia.[64] The building is decorated with mosaics, including many depicting grain ships. Located near the harbour, this large building housed numerous types of merchants and consisted of a colonnade surrounded by many small offices. Such a space would lend itself to the casual communication between merchants.

With no indication that the Prefect of the *annona* ordered any of these merchants to establish their offices in the Piazzale, it appears that merchants came there deliberately to coordinate among themselves. There were no offices in the Piazzale large enough to hold goods, further suggesting that these offices existed so that representatives could place orders and negotiate. Larger shippers certainly had agents who either had an office in the Piazzale or frequented the space at a minimum. Wine merchants enjoyed a similar arrangement in the Forum Vinarium, where wine merchants from Rome and from Ostia worked side-by-side. This open-air, public coordination could also be found among the Maghribi traders. Greif reports that their 'important business dealings were conducted in public'.[65]

Merchants could use both public and private institutions to overcome problems of inadequate information. The Prefect of the *annona* may have served as an information clearing-house about the grain market, while private merchants shared information through their company ties and the proximity of their offices.

While asymmetric information remains a major problem in the modern economy, lack of information has become a decreasing concern as improvements in technology have built stronger communication networks. Incomplete information, however, posed a serious problem for merchants until

[63] Kirschenbaum, *Sons, slaves and freedmen*, p. 180; Verboven, *Economy of friends*, p. 351.
[64] Meiggs, *Roman Ostia*, pp. 284–8.
[65] Meiggs, *Roman Ostia*, p. 283; Greif, 'Cultural beliefs', pp. 923–4.

the nineteenth century. One strategy earlier merchants used to reduce the effect of their poor information was to place total control for an operation in the hands of agents. For instance, some traders in colonial America gave their agents a broad set of general orders and hoped they would be followed. In November 1736, Captain James Brown wrote the following to one of his agents:

> If you can Sell your pitch, rice, & Turpentine for a good price in money Sell it all but Twenty barrels of pitch and two barrels of Rice and two ditto of Turpentine, which I Shall want for my own Youse [sic]. And if you Cannot Sell it to your Satisfaction Schooner and all together if you can find any room take a hundred bushels of Salt of Capt. Whipple or any body else that you can get it Cheapest off, and make what dispatch possible you can home.[66]

Rather than attempt to increase the information available to the merchants, the strategy exemplified by this letter works by placing complete responsibility for the operation in the agent's hands. This is an extreme example in which the merchant acknowledged that he could not control his agent, and hoped for the best. Roman merchants, facing similar asymmetric and incomplete information problems, employed all sorts of formal and informal institutions to avoid being forced to rely solely on the good offices of their agents.

V

Roman grain merchants faced asymmetric and incomplete information concerns, contending with the selection and monitoring of agents, as well as incomplete information about price shocks, shipwrecks, and other conditions. We argue that merchants used economic and social institutions to reduce the transaction costs resulting from their uncertainty. Those institutions increased the amount of available information and reduced its cost. Some institutions, such as early banks, could help reduce the risks of incomplete information, even if they did not create or provide additional information themselves. This analysis suggests that the Roman market rivaled early modern European and colonial American markets in terms of institutional complexity and, perhaps, efficiency. Greif assumed that medieval merchant groups had to choose between two types of institutions to increase information about agents: they could develop either an enforcement-based mechanism or a reputation-based mechanism, depending on the institutions that already existed in their society. Unlike the groups of traders in Greif's paper about eleventh-century merchants, the Romans utilized both methods. While we have not made systematic comparisons with other informational systems, we have argued that Roman merchants in the early Roman Empire had a system that was as good as any existing

[66] Captain James Brown, quoted in Bruchey, *Colonial merchant*, p. 176.

before industrialization and perhaps not equalled for another millennium and a half.

Massachusetts Institute of Economics

Date submitted *27 April 2004*
Revised version submitted *4 April 2005*
Accepted *2 October 2005*

DOI: 10.1111/j.1468-0289.2006.00360.x

Footnote references

Akerlof, G. A., 'The market for "lemons": quality uncertainty and the market mechanism', *Quarterly Journal of Economics*, 84 (1970), pp. 488–500.
Akerlof, G. A., 'Behavioral macroeconomics and macroeconomic behavior', *American Economic Review*, 92 (2002), pp. 411–33.
Alfody, G., *The social history of Rome*, trans. D. Braund and F. Pollock (Baltimore, 1988).
Altman, D., Cutler, D. M., and Zeckhauser, R. J., 'The changing market for health insurance: adverse selection and adverse retention', *American Economic Review*, 88 (1998), pp. 122–6.
Arnott, R. and Stiglitz, J. E., 'Moral hazard and nonmarket institutions: dysfunctional crowding out of peer monitoring?' *American Economic Review*, 81 (1991), pp. 179–90.
Ashton, T. S., *The industrial revolution: 1760–1830* (1948).
Aubert, J-J., *Business managers in Ancient Rome: a social and economic study of institores, 200 BC—AD 250* (Leiden, 1994).
Badian, E., *Publicans and sinners* (Oxford, 1972).
Bailyn, B. and Bailyn, L., *Massachusetts shipping, 1697–1714* (Cambridge, Mass., 1959).
Beck, T. and Levine, R., 'Legal institutions and financial development', NBER Working Paper 10126 (2003).
Bruchey, S., *The colonial merchant: sources and readings* (New York, 1966).
Carlos, A. M., 'Historical perspectives on the economics of trade principal-agent problems in early trading companies: a tale of two firms', *American Economic Review*, 82 (1992), pp. 140–5.
Carlos, A. M. and Nicholas, S., 'Agency problems in early chartered companies: the case of the Hudson's Bay Company', *Journal of Economic History*, 50 (1990), pp. 853–75.
Casson, L., 'The grain trade of the Hellenistic world', *Transactions and Proceedings of the American Philological Association*, 85 (1954), pp. 168–87.
Casson, L., 'Harbour and river boats of Ancient Rome', *Journal of Roman Studies*, 55 (1965), pp. 31–9.
Casson, L., *The ancient mariners* (Princeton, 1991).
Cicero, M. T., *Letters to Atticus*, trans. D. R. Shackleton Bailey (Cambridge, 1999).
Cicero, M. T., *Letters to friends; epistolae ad familiares*, trans. D. R. Shackleton Bailey (Cambridge, Mass., 2001).
Cicero, M. T., *Pro rosco Amerino*, trans. J. H. Freese (Cambridge, 1930).
Cohen, E., *Athenian economy and society: a banking perspective* (Princeton, 1992).
Cornelius Nepos, *On great generals*, trans. J. C. Rolfe (Cambridge, Mass., 1984).
D'Arms, J. H., *Commerce and social standing in Ancient Rome* (Cambridge, 1981).
de Ste. Croix, G. E. M., 'Ancient Greek and Roman maritime loans', in H. Edey and B. S. Yamey, eds., *Debits, finance and profits* (1974), pp. 41–59.
di Porto, A., *Impreso collettiva e schiavo manager in Roma antica* (Milan, 1984).
Erdkamp, P., *The grain market in the Roman Empire* (Cambridge, 2005).
Ferguson, N., *The house of Rothschild: money's prophets, 1798–1848* (New York, 1998).
Frank, T., 'Notes on Roman commerce', *Journal of Roman Studies*, 27 (1937), pp. 72–9.
Frank, T., *An economic survey of Ancient Rome, volume 5: Rome and Italy of the Empire* (Paterson, NJ, 1959).
Garnsey, P., *Famine and food supply in the Graeco-Roman world: responses to risk and crisis* (Cambridge, 1988).
Garnsey, P., *Cities, peasants and food in classical antiquity* (Cambridge, 1998).
Garnsey, P. and Saller, R., *The Roman Empire: economy, society and culture* (Berkeley, 1987).

Greif, A., 'Reputation and coalitions in medieval trade: evidence on the Maghribi traders', *Journal of Economic History*, 49 (1989), pp. 857–82.
Greif, A., 'Cultural beliefs and the organization of society: a historical and theoretical reflection on collectivist and individualist societies', *Journal of Political Economy*, 102 (1994), pp. 912–50.
Höbenreich, E., *Annona. Juristische Aspekte der stadtrömischen Lebensmittelversorgung im Prinzipat* (Graz, 1997).
Hopkins, K., *Conquerors and slaves* (Cambridge, 1978).
Hopkins, K., 'Taxes and trade', *Journal of Roman Studies*, 70 (1980), pp. 101–25.
Hopkins, K., *Death and renewal* (Cambridge, 1983).
Johnston, D., *Roman law in context* (Cambridge, 1999).
Jones, S. R. H. and Ville, S. P., 'Efficient transactors or rent-seeking monopolists? The rationale for early chartered trading companies', *Journal of Economic History*, 56 (1996), pp. 898–915.
Jongman, W., *The economy and society of Pompeii* (Amsterdam, 1988).
Josephus, *The Jewish war*, trans. H. St. J. Thackeray (Cambridge, 1927–28).
Kirschenbaum, A., *Sons, slaves and freedmen in Roman commerce* (Washington D.C., 1987).
Lamoreau, N. R. and Rosenthal, J. L., 'Legal regime and business organizational choice: a comparison of France and the United States during the mid-nineteenth century', NBER Working Paper 10288 (2004).
Lo Cascio, E., 'The size of the Roman population: Beloch and the meaning of the Augustan census figures', *Journal of Roman Studies*, 84 (1994), pp. 23–40.
Malmendier, U., 'Shares in Ancient Rome', in K. Geert Rouwhenhorst and W. Goetzmann, eds., *Origins of value: innovations in the history of finance*, (Oxford, 2005), pp. 31–42.
Mathias, P., 'Minorities and elites: how do minorities become elites?' in E. Brezis and P. Temin, eds., *Elites, minorities, and economic growth* (Amsterdam, 1999), pp. 115–28.
Meiggs, R., *Roman Ostia* (Oxford, 1973).
Milgrom, P. R., North, D. C., and Weingast, B. R., 'The role of institutions in the revival of trade: the law merchant, private judges, and the champagne fairs', in D. B. Klein, ed., *Reputation: studies in the voluntary elicitation of good conduct* (Ann Arbor, 1997), pp. 243–66.
North, D. C., Structure and change in economic history (New York, 1981).
Phillips, K. P., *American dynasty: aristocracy, fortune and the politics of deceit in the house of Bush* (New York, 2004).
Plutarch, *Cato Major*, trans. B. Perrin (Cambridge, 1914).
Price, J. M., 'What did merchants do? Reflection on British overseas trade, 1660–1790', *Journal of Economic History*, 49 (1989), pp. 267–84.
Rathbone, D., *Economic rationalism and rural society in third century A.D. Egypt* (Cambridge, 1991).
Rathbone, D., 'The "Muziris" Papyrus (SB XVIII 13167): financing Roman trade with India', in M. Abd-el-Ghani, S. Z. Bassiouni, and W. A. Farag, eds., *Alexandrian studies II in honor of Mostafa el Abbadi*, Societé Archéologie d'Alexandrie, Bulletin 46 (2000), (Alexandria, 2001), pp. 39–50.
Rathbone, D., 'The financing of maritime commerce in the Roman Empire, I-II AD', in E. Lo Cascio, ed., *Credito e moneta nel mondo Romano* (Bari-S. Spirito, 2004), pp. 199–229.
Rickman, G., *The corn supply of Ancient Rome* (Oxford, 1980).
Saller, R., 'Framing the debate over growth in the ancient economy', in J. Manning and I. Morris, eds., *The ancient economy: evidence and models* (Stanford, Cal., 2005), pp. 223–38. Reprinted in W. Scheidel and S. von Reden, eds., *The ancient economy* (New York, 2002), pp. 251–69.
Shapiro, C. and Sitglitz, J. E., 'Equilibrium unemployment as a worker discipline device', *American Economic Review*, 74 (1984), pp. 433–44.
Sirks, B., *Food for Rome* (Amsterdam, 1991).
Spence, A. M., 'Signaling in retrospect and the informational structure of markets', *American Economic Review*, 92 (2002), pp. 434–59.
Stiglitz, J. E., 'Information and the change in the paradigm in economics', *American Economic Review*, 92 (2002), pp. 460–501.
Temin, P., 'A market economy in the early Roman Empire', *Journal of Roman Studies*, 91 (2001), pp. 169–81.
Temin, P., 'Financial intermediation in the early Roman Empire', *Journal of Economic History*, 64 (September 2004), pp. 705–33.
Verboven, K., *The economy of friends: economic aspects of amicitia and patronage in the late Republic* (Brussels, 2002).
Virlouvet, C., *Tessera frumentaria: les procedures de distribution du blé public à la fin de la République et au début de l'Empire* (Rome, 1995).
Wilson, A., 'Machines, power, and the ancient economy', *Journal of Roman Studies*, 92 (2002), pp. 1–32.
Wolfe, E. R., 'Transportation in Augustan Egypt', *Transactions and Proceedings of the American Philological Association*, 83 (1952), pp. 80–99.