ECONOMIES BEYOND AGRICULTURE IN THE CLASSICAL WORLD

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PRODUCTIVE TO SOME PURPOSE?

The problem of ancient economic growth

Paul Millett

I am now fighting a losing battle on another word I dislike - 'growth' - which had a certain medical and agricultural connotation. 'Economic growth' involves more purposeful work than leaving it to nature.

Harold Wilson, Oxford Times 3 December 1962

All the problems dealt with in this book would be settled if we understood the rise and decline of Greece and Rome. Unfortunately, though there is a large literature on this subject, it is still highly speculative.


Economic growth: why bother?

Close to the beginning of his Metaphysics, Aristotle discusses the nature of knowledge (epistēmē) as opposed to skill (technē) and experience (empeiria). He argues that designers (architectones) are more honoured and thought to be wiser than craftsmen (choreotechnai) because they know the causes (aitiai) for which things are done. The ability to teach, as demonstrated by those possessing some technē, is generally taken as a sign of knowledge. Aristotle continues:

It is therefore likely that at first the inventor of any skill which went further than common sense was admired by his fellow-men, not merely because some of his inventions were useful, but as being wise and superior to others. And, as more skills were discovered, some relating to the necessities (pros t' anangkai) and some to the pastimes (pros diagōgēn) of life, the inventors of the latter were always considered wiser than those of the former, because their branches of knowledge did not aim at utility (pros chrēsin). Hence, when all the discoveries of this kind were fully accomplished, those types of knowledge which relate neither to pleasure (pros bēdonēn) nor to the
necessities of life were invented, and first in those places where men had leisure (scholê).

(981b)

Aristotle here seems to draw a three-fold distinction between the simultaneous development of those things which are necessary and those which are pleasurable (almost ‘recreations’), followed by the cultivation of theoretical science or philosophy. The sequence, with its sense of hierarchy, is clarified in a later passage about the origins of philosophy:

And a man who is puzzled and wonders thinks himself ignorant ... therefore since they philosophized in order to escape from ignorance, evidently they were pursuing knowledge in order to know, and not for any utilitarian end (ou chrêsiôs tinôn). And what has happened bears witness to this; for it was when virtually (scholên) all the necessities of life (tôn anangkaion) and things that make for comfort and pastimes (pros thalitômên kai diagôgên) were already present, that such knowledge began to be sought.

(982b)

In both extracts the idea is apparently present in Aristotle's mind that practically all the utilitarian skills and material needs (including leisure) required for a civilized lifestyle are already present in contemporary society. It is therefore possible to get down to the serious business of doing philosophy, without being distracted by having to think further about practical matters.

Aristotle is consistent in his schematic presentation is confirmed 'by what has happened' (to sumbebekôn). His assumption of, as it were, 'the end of economic history' has been enthusiastically endorsed some two and a half thousand years later by Xenophon Zolatas, former Governor of the Bank of Greece. Such is the burden of his study, Economic Growth and Declining Social Welfare, (1981), where, not for the first or last time, the economic history of ancient Greece is pressed into service in order to legitimate modern economic ideology. Zolatas argues (135) that Aristotle in the Metaphysics anticipates his own thesis that human wants are not infinite but may be stabilized at a level making possible the good life without the need for further economic growth. He predicts that, in modern, industrial countries, continued growth will prove counter-productive by reducing social welfare. On the front page of the book is printed an epigram attributed to Epicurus: 'If you wish to make Pythocles rich, do not give him more money, but reduce his desire.'

Whatever the validity of Zolatas' appropriation of Aristotle (and Epicurus), and the overall quality of his arguments, the passages cited do raise some pertinent questions for ancient historians. How representative were Aristotle's views on the ending of progress in practical endeavour and the provision of necessities? Does his thinking owe more to wishful philosophizing, or do his conceptions conform to some kind of material reality, reflecting an economy that was effectively stationary? Was fourth-century Athens typical in antiquity in the rate of accumulations of resources? More generally, to what extent was all the economic activity discussed in other chapters in this volume productive to some greater aggregate purpose or even effect? The analysis that follows is intended to provide, however imperfectly, some kind of theoretical framework for assessing the possibilities for ancient economic growth.

Economic growth: what is it?

Aristotle's conviction of the virtual absence of scope or need for further material improvement is at obvious odds with modern preoccupations about economic growth. Landes' best-selling The Wealth and Poverty of Nations (1998) is, with its echo of Adam Smith, an exploration of the reasons for widely differing growth rates across time and place. 'Causes of the Slow Rate of Economic Growth of the United Kingdom' was the subject chosen by Kaldor for his influential Cambridge Inaugural Lecture (1966). A glance at almost any broadsheet newspaper, with its monthly bulletins on national and international rates of growth, confirms that growth (slow or otherwise) remains high on the public agenda. And not without reason: sustained economic growth conventionally makes possible all sorts of desirable things. Personal prosperity can be increased at no one else's expense; beneficial policy initiatives may be pursued by the state. By the same token, in the absence of adequate growth, hard decisions have to be made about spreading the burden of taxation and the priorities of public expenditure. Small wonder that the rate of growth has come to be seen as a crude indicator of governmental success, with sustained growth as a political imperative (Stewart, 1986, 146–7). It is, in the words of the economist Hywel Jones (1975, 1) 'a national virility symbol'. What Edward Mishan (1971, 27–33) termed 'Growthmania' and Terrence Hutchison (1994, 179) 'Growthmanship' has been a dominant theme of theoretical and applied economics since the Second World War.

All textbook treatments of growth begin with some defining of terms. Broadly speaking, economic growth may be seen as the process whereby the wealth of a given community (city, region, more usually nation-state) increases through time; more specifically, the sustained increase in wealth over time (normally per year) measured in the real per capita production of goods and services. So much seems straightforward: appropriate, as the distinguished economist Simon Kuznets put it (1959, 52), to economic growth in Periclean Athens, Augustan Rome, medieval France and the modern United States. But almost every element in that definition calls for further comment.

'Sustained increase over time' in order to distinguish growth proper from sporadic and temporary fluctuations in output. Such random changes might result, in a non-industrial society, from runs of good harvests or the
redistributive effects of warfare. In modern economies, the periodic fluctuations of what used to be called the ‘trade-cycle’ are well attested; and there has cynically been identified a so-called ‘election-cycle’, whereby consumption, if not output, is artificially boosted in the run-up to elections. The idea of a ‘real’ increase in production reflects the need to relate the money value of production to the rate of inflation. The (to us) breathtakingly low prices for goods and services familiar to our parents and grandparents were accompanied (for most of them) by staggeringly low incomes. Fortunately for our purposes, the rate of inflation through most of antiquity was, in terms of our post-war experience, relatively low. The notion of a ‘per capita’ increase in production expresses the need not just for ‘more in the aggregate’, but ‘more for each person’ (if evenly spread, which is highly unlikely; see n. 62). The rate of economic growth in a society will therefore be, in part, a function of rates of change in population levels (Gould 1972, 43–8). Estimates suggest that, between 1890 and 1990, the Gross Domestic Product of the twelve major European economies grew on average by 2.5 per cent per year, offset by a 0.6 per cent increase in population, giving an annual per capita increase of 1.9 per cent. Even the idea of ‘output’ as the key to measuring and understanding growth has been questioned, with some economists favouring changes in consumption over time (excluding what is saved and either hoarded or reinvested). That, it might be argued, has the advantage of reflecting the portion of production which directly benefits the community, or parts of it. Going a stage further, increased output per unit of production (for example, of food by peasants) might be deployed not so as to raise per capita consumption, but to gain time, which might be channelled into other productive activity (such as handicrafts) or exploited through enhanced scope for leisure. Along these lines, it has been forcefully argued that concepts of overall improvement in ‘welfare’ are more helpful to the historian than numerical increases in output or consumption.

The basic elements of welfare, length and quality of life (as represented by the ‘functionings’ of each individual), are explored by Sen (1988, 15–16). He cites Aristotle in his Politics and Nicomachean Ethics in support of possession of commodities as a key means to the end of an agreeable lifestyle and life. Formal methods of measuring the physical quality of life (‘Physical Quality of Life Index’, ‘Human Development Index’ and the like) are summarized by Todaro (1997, 62–8). Much of the ancient world would score modestly indeed if ranked according to the Human Development Index, which combines (on a scale from 0 to 1) per capita income with the factors of longevity, adult literacy and years of schooling. The relationship between crude economic growth and overall improvements in welfare necessarily varies through time and space. Baran (1973, 128) vigorously opposes the idea (derived from the classic study by Clark, 1957) that growth may automatically be equated with welfare: what of output of investment and export-goods, armaments and the like? To take an extreme and hypothetical case, the ‘Dark Age’ in Greece that followed on from the destruction of the Bronze Age palaces may have seemed to peasant cultivators like a ‘Golden Age’, assuming, that is, that they were freed from the need to generate an additional surplus to support their Mycenaean overlords. Recession may have its beneficiaries. The apparently iron law that personal wants increase over time may well be weakened for the ancient world, where technological constraints diminished Ragnar Nurkse’s so-called ‘demonstration factor’ (the capacity of new wants to spread). Problems of communication combined with traditional preferences may have discouraged the ancient world from beating paths to others’ doors, however attractive the mousetraps on offer (Gould, 1972, 7–8). Sahlins’ concept of the ‘Original Affluent Society’ (1974) as composed of hunter-gatherers represents the extreme case of a notional community whose ‘wants are few’. The title of Sahlins’ paper is unmistakably an echo of Galbraith’s (1958) study of The Affluent Society of North America in the 1950s, characterized by its ‘private affluence and public squalor’. If those advocating an enhanced ‘quality of life’ still take second place to exponents of per capita growth, their terms of reference are increasingly reflected in public policy.

In the broadest terms, economic externalities or social costs restricting the quality of life (pollution, traffic congestion and the like), are creations of the industrial age (Gould 1972, 9). Parallels from the ancient world are exceptional: the effect on the environment of the Laurium silver mines may be a case in point (Rihll, this volume). For the most part, ancient externalities were not so much economic as social and political. So support of the Spartan lifestyle by exploitation of the helots was balanced by their propensity to resist and even revolt; they were both a facility and a disability (Whitby 1994, 89). The issue of welfare as opposed to growth will resturface (see p. 26). For present purposes, ‘growth’ will be taken to refer to increased output of goods and services per head of the population.

Although these efforts in defining economic growth and welfare may seem over-elaborate and even pedantic, loose conceptions of growth tend to mislead. Two books about Greek economy and society are cases in point: French 1964 and Starr 1977. Neither book is rigorously about economic growth as defined above. Instead, both are concerned with socio-economic history, pursuing the broad theme of economic progress in a more or less modernizing vein. None of the standard discussions of the Greek (or Roman) economy introduces the concept of growth. Nor have economic historians (still less economists) been much, if at all, concerned with the ‘pre-history’ of economic growth. For Deane and Cole in their pathbreaking study (1964), what they call ‘the long view’ began in 1688.

Typically, economists have been concerned with growth in the post-war period, and economic historians with growth beginning in the later
eighteenth century, under the impulse of the 'Industrial Revolution' (long under attack as a helpful concept). These preoccupations reflect respectively the growth detectable in industrial and proto-industrial economies. Both deal in concrete figures: Kuznets defined modern economic growth in terms of 10 to 20 per cent per capita growth per decade.15 With few exceptions (to be discussed below), possible growth before the early modern period is dismissed as insignificant or unmeasurable. The alternative has been to describe earlier developments in sociological terms appropriate to qualitative rather than quantitative change.16

Supple pays unusually full attention to pre-modern economy and society (1963, 27-34). He identifies two pre-historic growth spurts which are attributed to the 'convergence of critical technological and organizational innovations'. These are: the perfection some 10,000 years ago of Neolithic techniques (use of fire, specialist stone tools and weapons, domestication of animals, settled agriculture), and the rise about 6,000 years ago of urban civilization in the Middle East (control of water, use of copper and bronze, the wheel, improved building techniques, hierarchy of occupations, writing, administration).

While not denying the occurrence of growth between 2000 BC and AD 1600 or 1700, Supple argues that there was 'no forward surge quite as impressive as that which has just been mentioned.' He notes how the achievements of the Greek city states and Rome were based on essentially derivative technology, with an admixture of modest advances in 'agricultural, commercial, financial and industrial organization and institutions'. On the other hand, Greek and Roman economic systems were extended, first through trade and colonization through most of the Mediterranean, and later through conquest across much of Europe, Asia Minor and North Africa. He concludes that such economic progress as was made (meagre by modern standards) was, at least in the Roman case, parasitic on the exploitation of dependent provinces and the efforts of slave labour. Moreover, the Roman upper class, 'less than wholehearted in its commitment to material progress', diverted capital and entrepreneurial ability away from production and trade in favour of colonial exploitation and administrative careers. All this constituted 'a distinct brake on economic expansion'. But worse was to follow: the 'Dark Ages', from the late fifth to the ninth century, 'witnessed an extended epoch of political disintegration and economic regression'.

I have cited Supple's summary in some detail as, whatever its shortcomings, it marks an attempt to relate the experience of the ancient world to the modern phenomena of growth.17

The exception among ancient historians to this indifference towards the possibilities for growth in antiquity is Hopkins, with his editorial introduction to Garnsey et al. (1983). In a few pages (xiv-xxi), Hopkins sets out elegantly and persuasively (if not quite conclusively) the case for economic growth in the Mediterranean basin during 1,200 years, from 1000 BC to AD 200; after which he sees a corresponding contraction. As Hopkins puts it (xiv), 'the upward trend was gradual, not very large but significant, and with many oscillations either way'. In order to be significant, the trend did not need to be large. We think today of annual growth of 2 per cent as on the low side, but the effect of compound increase 'is such as to stagger the imagination' as Keynes put it (1930, 323-5). Two per cent growth per year maintained across one century gives a sevenfold increase. Just one quarter of one per cent annual growth sustained across the 1,200 or so years between the First Olympic Games and the deposing of Romulus Augustulus would generate a more than 500-fold increase. The potential at least is impressive.18

In the second part of the paper, I examine further the various factors that Hopkins offers as conspiring to generate more or less sustained growth through antiquity.

Economic growth: what causes it?

There is a natural presumption that understanding the elements of growth should make it possible to induce growth in the economy artificially. The modern literature on growth economics is correspondingly massive and complex. General treatments typically begin with either a warning: 'Growth theory is a highly abstract branch of economics which ... is probably more notable for its mathematical than its economic content' (Bannock et al., 1978, 207); or with reassertions: 'Much of the difficulty stems from the plethora of esoteric symbols and concepts, contradictory assumptions and complicated techniques which surround ideas which are often really rather simple' (Jones 1975, 12). What this means in practice may be sampled in the selection of key papers collected some thirty years ago by Sen (1970), whose lucid introduction refers to a further 150 items.

Controversy is intensified by stiff doses of political ideology. There are few works of recent Marxist economics from which students can learn so well. 'A straight Stalinist tract, unrelieved by humour, originality, new facts, close reasoning, ideological deviation or interest of any sort.' Both statements refer to the first edition (1957) of Paul Baran's classic Marxist statement of The Political Economy of Growth (1975). As Sen himself comments (10), the extent of controversy may not be a good guide to the innate importance at issue. What follows is a highly selective and impressionistic account of those aspects of growth theory that seem relevant to ancient historians.19

Modern growth theory had its origins in the problems arising out of the depression of the 1930s20 and the mobilization and rebuilding of economies during and after the Second World War.21 It is therefore overwhelmingly concerned with industrial economy and society, characterized by large-scale industry with its extensive concentration and division of labour, accumulation of capital and rigorous economizing.22 In its simplest form, the so-called
'Harrod-Domar model' suggests that the annual rate of growth will be a function of the volume of output that is not consumed each year, but saved and invested in the stock of productive capital: the familiar idea of having less jam today so as to have more tomorrow. This may be expressed schematically: \( g = s/(C) \), where the rate of growth \( g \) is equal to \( s \) the volume of savings available for investment, divided by the capital-output ratio \( C \); that is, the number of units of capital required to generate a single unit of production.\(^{21}\) This apparently straightforward model has been the basis of much elaboration, broad reinforcement or allaying concerns, originally expressed by Harrod, that resulting growth will prove unstable: savings and even capital-output ratio might deviate from levels required for equilibrium growth. The propensity to save will tend to be the result of external, psychological impulses, and not necessarily a function of rational, economic considerations.\(^{22}\)

Although the Harrod-Domar model was obviously intended as a way of explaining growth and its likely impermanence in an industrial economy, it could conceivably be applied to a primarily agrarian community. Production of grain could be increased for the future by cutting present consumption, with the 'savings' being used as seed-corn the following year. The capital-output ratio would then crudely correspond to the yield of land.\(^{23}\) One of the problems inherent in the Harrod-Domar model — ensuring that all savings are appropriately converted to productive capital — could be paralleled in our rural model by having farmers 'hoard' grain as a precaution against poor harvests. If, in time, stored grain had to be thrown out as unfit to eat (or plant), there would be a loss of productive potential.

Of course, this is no more than telling ancient historians what they already know (and grain that was past its human 'eat-by-date' could presumably be fed to animals). But the mismatch between savings and investment inherent in the Harrod-Domar model prompts another problem for the ancient economy: the weak link between savings and capital investment. Studies of modern economic growth stress the importance of capital markets (in England, from the sixteenth century) in converting savings into investment.\(^{24}\) Such markets were almost entirely absent from the ancient world, where the high incidence of hoarding may help explain relatively low levels of inflation.\(^{25}\)

This is not to deny that resources were available for sizeable capital projects: notably and symbolically, the monumental buildings of which more or less substantial traces remain. But these were typically financed by 'forced saving' (Gould, 1972, 173–4); that is, the earmarking of public revenues, as in the case of public building in Classical Athens. Alternatively, with much building activity in the Roman world, capital flowed directly from the fortunes of the wealthy (Duncan-Jones 1990, 174–84; Jongman 1988, 23 n. 2). Such personal funding was feasible where the distribution of wealth was grossly unequal (Gould 1972, 154–5). 'The splendour goes with vast inequality' says Jongman of the sumptuous private houses of Pompeii (1988, 15–16). Whatever their other merits, fine buildings cannot be seen as productive capital in the conventional sense. 'In such [poor] countries ... productive investment is small because the surplus is used to build pyramids, temples and other durable consumer goods, instead of to create productive capital'. So observes Lewis (1955, 236), who emphasizes a high rate of invested savings (12 per cent of GNP; cf. 208) as the key indicator of a 'progressive economy' (225–6).

In fact, even economically unproductive expenditure can have a multiplier effect on the economy as a whole. Initial payments serve to increase recipients’ incomes and profits, part of which may be spent on, to create a theoretically endless (though diminishing) chain of expenditure. In this way, the net effect on overall income and consequently employment will be several times larger than the initial sum expended. The Parthenon is conservatively reckoned to have cost the Athenians some 470 talents (see Stanier, 1953). Assuming (arbitrarily) that, of the monies received for labour, building materials, transport and other expenses, one quarter was hoarded and one quarter spent on imported goods (foreign wheat for daily bread), there would remain to be spent on, within the Athenian economy, some 235 talents, then 118, 59, and so on, making an eventual, total, increase in effective demand (for goods and services) of approximately 950 talents. The multiplier effect will benefit an economy operating at less than full capacity: surely the case with most of the ancient world much of the time. Such was certainly the position with the world of Keynes when he ironically commended the building of pyramids and cathedrals (and even digging holes in the ground) as remedies for unemployment (1936, 131, 220).

The Harrod-Domar model, equated with Keynesian approaches to the economy, has attracted relatively little attention from historians. Its ramifications are considered too technical and the concepts involved too few. 'Apparent more interesting are 'Neo-Classic' theories of growth, which extend the range of relevant factors beyond savings and capital formation. Here it is necessary to be ruthlessly reductionist on the grounds that too much theorizing may well prove counter-productive. Neo-Classic growth models employ a sequence of different factors of production in a variety of configurations: the so-called 'production-function', relating input to output. In its simplest form, lucidly set out by Meade (1961, 8–18), net output is dependent on three variable factors. Expresed schematically: \[ Y = f(K,L,N) \] where output \( Y \) is a function \( f \) of the existing stock of machines \( K \), the amount of labour \( L \) and the amount of land \( N \). In this way, output may increase in three different ways (all of which are more or less applicable to the ancient world). The stock of machines may increase through the process of saving being converted into investment in capital (as with the Harrod-Domar model); the working population may grow; and the amount of land available may increase through extension of agriculture. Also
envisaged is the possibility of 'factor substitution'; for example, cheap labour in place of expensive capital.  

Other versions of the production-function are more or less elaborate variants of this basic model. But that cannot be the whole story. Empirical studies of modern, industrial economies strongly suggest that increased inputs of land, labour and capital are not by themselves sufficient to account for observed growth. An obvious candidate for explaining away this misleadingly called 'residual growth' (perhaps 50 per cent of actual growth; see below) is ongoing technological progress, which may conveniently be added to the production-function (t). Other suggested residual factors include changes in the quality (not just quantity) of human resources in terms of health, education and outlook, changes in the institutional environment in which the economy functions (communications, financial services, extent of markets) and the overall legal and political structures.  

Neo-Classical growth theory as a whole draws on this range of factors, with particular theories emphasizing one or more of them. What adds massively to the complexity is the degree to which the various factors are held to offset each other and possibly interact. A crucial question, discussed below (pp. 31-5), is the extent to which improvements in technology are determined exogenously ('like manna from heaven' in the customary phrase), as opposed to being endogenously related to specific and possibly controllable economic activities, such as expenditure on education or research and development.  

The mathematical models needed to keep track of these variables are, to say the least, forbidding in their complexity. Even its own exponents confess that Neo-Classical growth theory is perhaps better thought of as an abstraction rather than as an explanation of how things actually work. Says Sen (1970, 9), 'It is as if a poor man collected money for his food and blew it all on alcohol'.  

Much recent theorizing is the outcome of concern over falling growth rates in post-war industrial economies, and is therefore increasingly remote from the circumstances of the Greco-Roman world. An alternative focus for ancient historians is the allied area of economic development, also a product of post-war experience: development economics were in large measure stimulated by the process and aftermath of decolonization. Broadly speaking, theories of development are designed to explain and expedite the process of structural change, whereby Third-World economies 'shift gear' from conditions of low or zero growth to achieve the relatively high rates of growth associated with the modern, industrial West. The overall aim is the eradication of primary poverty, leading to improvements in education and health and the general quality of life.  

The conditions generally thought to prevail in an under-developed economy before sustained growth gets under way provide a context for thinking about growth in antiquity. A typical textbook summary of under-development highlights five features. First of all, the economy will be heavily dominated by agriculture and possibly extractive activity (mining and quarrying). Second, there will be a low level of industrial activity. Third, there is a poor infrastructure, with absence of reliable communications; technology in general is primitive. Fourth, there are low levels of education. Finally, there will be poor development of the financial sector to provide credit and similar services. It would, of course, be simplistic to equate the Greco-Roman world, in all its variety, with the textbook case of an under-developed, Third-World state: as it were, the development economist's nightmare.  

But it does provide orientation (almost a baseline) for our exploration of Keith Hopkins' programme for ancient economic growth.

**Economic growth: what about the ancient world?**

In broad terms, Hopkins sees the production of a progressively larger surplus as the result of two factors: political change, and the spread of technical and social innovations. Conveniently, he breaks down these combined factors into seven components or propositions (below, in italics), which are expressed in what he terms 'a very strong form ... without all the appropriate qualifications'. The rest of this paper aims to supply some of those missing qualifications and suggest further possibilities.  

1. **Total agricultural production rose during classical antiquity, as more land in the Greco-Roman world was brought under arable cultivation. This process went into reverse during the third and fourth centuries AD.**

The idea that the area of land under cultivation expanded through most of antiquity seems unexceptionable. However, a straightforward increase in the aggregate area under cultivation need not necessarily imply economic growth. On the assumption that the best land was the first to be brought under cultivation, extension of the area being farmed would embrace increasingly marginal land, giving a poorer yield. This would actually lower the average output per head of those involved in agriculture. Such is the expectation underlying, to a greater or lesser extent, the work of the originators of growth theory: the Classical economists, Smith 1776, Malthus 1803, Ricardo 1817 and Mill 1848. Although all are associated in time with the emergence of industrial society, that is not consistently reflected in their writings. From our perspective, the later eighteenth and early nineteenth centuries are arresting in terms of what was new: the emergence of modern industry. Contemporary economists very properly concentrated on what was more typical. Their writings reflect the continuing (if diminishing) dominance over English economy and society by the agricultural sector.

The full title of Adam Smith's work of 1776, *An Inquiry into the Nature and Causes of the Wealth of Nations*, makes explicit his concern with differing levels of national prosperity. Hicks (1965) has shown how the gist of the chapter
'Of the Accumulation of Capital' (Bk II, Ch.3) may be expressed algebraically to create what he terms a primitive 'growth model' appropriate for a primarily agrarian economy (36-42). Potential for actual growth will ultimately depend on the increasing production of an agricultural surplus to support the non-agrarian population (Hoselitz 1966b, 63-75). Although Ricardo's model of the economy (again, as reconstructed by Hicks, 42-8) allows for a non-agricultural sector, he presumed that it would be subordinated to the much larger agricultural sector, which would determine the overall rate of profit. As less productive land was brought into cultivation, so the level of profit would fall, until the economy became stationary. Even Mill, writing as late as 1848, assumed that the fixed amount of land would eventually react upon the other factors of production (land and labour) to bring about the 'Stationary State', as he entitled one of his chapters (Bk IV Ch. 6; see also p. 36 and n. 61).

What distinguishes Mill from his predecessors is the scope he rightly envisaged for emigration and technological progress in postponing the end of growth and avoiding the so-called 'Malthusian Trap'. Within half a century (1847–1907), some five million workers made their way from an increasingly crowded Europe to North America (Thomas 1954, viii). The willingness of the Greeks and Romans to migrate so as to break new and often better ground is well attested. Pre-existing local populations had to cope as best they could. Less clear is the extent to which improved technology in the expanding Greco–Roman world postioned any overall decline in productivity as marginal land may have been brought into cultivation (see p. 24 and n. 24). Comparative testimony (medieval and the modern Third World) does suggest at least the possibility for growth in predominantly agricultural economies.

2 The population of the Roman world in the first and second centuries AD was bigger than the population of the same area (a) 1,000 years earlier and (b) 500 years earlier.

Again, that proposition is not difficult to accept. Disputable and probably irresolvable are the tempo and scale of the population increase. What matters is that other factors of production should conspire (through improved quality or increased quality, or both) so as to produce the bigger proportionate output needed for per capita growth as opposed to stagnation or even decline.

3 The proportion of the total population engaged in non-agricultural production and services increased. Hopkins here cites the undeniable increase in urban populations through antiquity, while noting that many craftsmen and petty traders continued to live in villages. It might be added that a proportion of those living in towns and cities were primarily cultivators, walking out to farm their land as required. There is also uncertainty over the extent to which increased numbers in urban communities were matched by correspondingly lower rural populations. Because of the observed association of urban life with economic development, the migration of population from rural to urban sectors is often automatically assumed to generate higher levels of non-agricultural production and growth (Gould 1972, 72-5). In the opinion of Lewis (1955, 337-8): 'It is quite useless to expect real income per head to grow without reducing the rural population below the eighty per cent level'.

The basis of Lewis' influential 'two-sector model' of development is the shift of labour away from the over-populated, rural subsistence sector to the high productivity, urban industrial sector. In fact, the share of the workforce involved in agriculture need not by itself be an accurate indicator of development. The 'spare time' devoted to handcrafts by peasants might make at least some of them economically more productive than that part of an urban population dependent on a combination of casual employment and handouts from patrons or the state.

A strong argument in support of urbanization as promoting economic growth is the enhanced scope for division of labour, made possible by the extent of the market. The past five hundred years or so have seen a clear historical trend in favour of greater specialization (Lewis 1955, 69-78). Hopkins here points to the sophisticated specialization of labour known from Pompeii (85 occupations attested) and Rome (264 named occupations). This ties in with Xenophon's well-known observations from the Greek world on the contrasting scope for division of labour as between small towns and large cities (Cyr. 8, 2. 5). At the time he was writing, the Greek world was primarily a place of small towns with few cities to rival even Roman Pompeii. As will appear below, the nature, scale and pace of urban growth may turn out to be crucial in any assessment of ancient economic growth.

4 Because of the increased division of labour, total non-agricultural production rose. As a crude production index, Hopkins notes that, at least in the western provinces of the Roman empire, more artefacts are found at Roman than pre-Roman levels (more coins, pots, lamps, iron tools, carved stones, ornaments). 'Material culture in the first two centuries AD reached a higher level in a wider level of the Mediterranean than it was to reach again for centuries.' As a general proposition, this seems entirely acceptable. Hopkins adds his own qualification here: that these residues were deposited over a long period, and may also represent accumulation through intensified exploitation (6, below) rather than increased total production. Two supplementary points might be made. First come the difficulties in reading numbers and distribution of artefacts as a detailed index of non-agricultural production.
circumstances of site abandonment obviously affect numbers of objects surviving and remaining. Also, the argument is here (and not for the last time) focused on the Roman world in the first two centuries AD.\textsuperscript{44}

5 This relates to an increase in productivity per capita in both agriculture and non-agricultural production by the application of gradually improving technology.

This is such a central plank of growth theory (ancient and modern) that a detailed discussion may better be postponed until the remaining two propositions have been considered.

6 The total amount and the proportion of total production extracted from primary producers in terms of taxes and rent increased.

Hopkins associates this tendency with the increasing size and power of states in antiquity which needed a larger surplus to support the heavier superstructure (more soldiers) and more extended infrastructure (more bureaucrats). Slavery set the benchmark for exploitation, and Hopkins argues from the Roman experience how use of slave labour provided economies of scale, banishing inefficient peasant proprietors to Rome or distant colonies. Also, the Roman land-tax forced peasants to work harder to produce a surplus which they had probably not produced before. So much seems plausible; to be noted once again is the emphasis on the Roman side of things. The wider problem lies in forming a continuous index of exploitation across time and space. For example, participation in democracy protected the peasants of classical Attica (admittedly, a numerically small group in terms of the whole Mediterranean basin) from financial exploitation. The post-Leucadian descendants of the Messenian helots presumably had extracted from them a smaller surplus than their ancestors, who handed over possibly half their produce. More generally, a welfare economist might pronounce it a perverse kind of economic growth that results from people being made to work harder for the benefit of a larger army and bureaucracy.

7 How raising of taxes in money (as opposed to in kind) in core provinces for expenditure elsewhere served to stimulate long-distance trade.

This amounts to a brief restatement of the argument in Hopkins' paper 'Taxes and trade in the Roman empire' (1980). Towns played a vital role in this process as craftsmen converted locally produced surpluses into higher value goods for transport and sale to raise cash to pay taxes. 'In sum [writes Hopkins], the thickened network of Roman trade provided an underpinning for the state's capacity to exact its money taxes and then spend them in distant locations.' The argument is reinforced by two sub-propositions: that extensive use of land transport was not so rare as often assumed (citing the reasonable cost of mule transport in Diocletian's Prices Edict); and that there was increased monetization across the Roman economy, with the volume of silver and bronze coinage increasing massively in the first two centuries AD. This Hopkins argues is suggestive of increased trade: more transactions, more buying and selling.

Although Hopkins' model linking taxes and trade has not found universal favour, increasing use of money and extension of the market through trade are conventional elements in constructing economic growth.\textsuperscript{45} Once again, the evidence is heavily biased towards the Roman empire in the first and second centuries AD. This skewing of the testimony is apparent in Hopkins' final summing up: 'These seven clauses taken together imply that overall in the first two centuries AD, total production, consumption and trade were greater than they had been in the previous centuries or were in subsequent centuries.' The impression I have from all seven propositions is not so much of gradual growth in the surplus across 1200 years, as a spurt in the last two hundred. What Keynes (1930, 322) termed a 'golden interval' (albeit a long one) in the largely leaden pre-industrial age.\textsuperscript{46}

Economic growth: who needed it?

Recent growth theory highlights the crucial role of developments in technology ('useful knowledge pertaining to the art of production'). In fact, emphasis on the role in production of technological innovation, as pursued by competing entrepreneurs, goes back at least as far as the early years of this century with Schumpeter 1911. It is to the technological and institutional aspects of his growth model that Hopkins gives most attention: his fifth proposition.\textsuperscript{47}

Popular perceptions of accelerating technological change as the key component in growth receive some support from empirical studies. At one extreme, in a classic paper from the 1950s, Solow (1957) argued that only one-eighth of recent per capita non-agricultural output in growth in the United States could be accounted for by increases in the stock of capital. Subsequent studies put the figure for the United States and other developed economies at approximately 50 per cent (Gould 1972, 118-9). Solow himself ascribed the 'Residual Growth' to 'technical change' which others then narrowed to 'technological progress'. Although, as suggested above, other factors (education, health, management, etc.) contribute to the Residual, the part played by enhanced technology remains crucial.\textsuperscript{48} Theories of the origins of 'modern' economic growth continue to emphasize the initial importance of the so-called 'scientific revolution' of the seventeenth century, blurring the line between pure science and applied technology. Such is the burden of the opening chapter of Musson and Robinson 1969. Subsequent chapters plot extensive connections between scientists and entrepreneurs.
The importance of the technological factor is vigorously defended by Musson in his editorial introduction to *Science, Technology and Economic Growth in the Eighteenth Century* (1972). Among the essays there reprinted, Mathias on 'Who unbound Prometheus?' (answer: an increasingly inquisitive, acquisitive society) provides the prelude for Landes' *The Unbound Prometheus* (1969), linking technology with industrial development and economic growth in western Europe from 1750 to the 1960s.

All this sounds suitably classical, but Carlo Cipolla (1981, 183) reminds us how Prometheus (not to mention Icarus) paid a high price for trying to reverse the man-nature relationship. What were the possibilities for progress in technology in the Greco-Roman world?

Hopkins reckons that potential for movement did exist, within the limits imposed by muscle power. Apart from technological advances (he mentions in passing concrete, rotary mills, and improvements in iron smelting), there were increases in the common unit size of production and transport (for example, potteries employing scores of slaves and ships of up to 1,000 tonnes burden). The whole issue of the impact of technology and innovation across classical antiquity awaits definitive resolution. On one side are those unflatteringly labelled 'stagnationists' (Persson 1988, *passim*), whose views may be represented by Finley's influential paper on 'Technical innovation and economic progress in the ancient world'. The message here is one of 'no marked advance in productivity' inasmuch as there was an almost total divorce between science and practice' (1965b, 179-80). Opposing are those who might be called 'progressivists', arguing for a range of inventions from the ancient world which were then applied widely, or at least significantly, to the process of production. This optimism is enthusiastically expressed in White 1984.10

Given a straight choice, the stagnationist view might seem preferable: with certain exceptions (notably, warfare), relationships throughout antiquity between scientific research, technology and practical implementation were weak or non-existent. Even though major breakthroughs occurred (notably, water-power), the pathway from invention to widespread innovation was and remains potentially complex (see *Encyclopedia of the Social Sciences* s.v. 'Innovation'). Well-known anecdotes (retold by Finley) demonstrate emperors' decisions to execute the unsuspecting inventor of unbreakable glass (Pliny, *Historia Naturalis* 36, 195) and suppress a device for cheaply moving stone columns (Suetonius, *Vespasian* 18). The emperors' robust Luddism may be compared with the more enlightened attitude shown in *Gulliver's Travels* (1726) by the King of Brobdignag, who 'gave it for his opinion that whoever could make two ears of corn, or two blades of grass, to grow upon a spot of ground where only one grew before, would deserve better of mankind, and
do more essential service to his country, than the whole race of politicians put together' (Bk. II Ch. 7).

For antiquity, advanced applied technology was the handmaid of the race of politicians rather than serving political economy. Three illustrations are: Suetonius (Claudius 21) describes a mechanical Triton, rising from the bottom of a lake and starting a mock sea-battle by blowing on a conch shell. Included in the 'Grand Procession of Preemly Philadelphia' through the streets of Alexandria was a cart, dragged by sixty men, on which a twelve-foot figure, sumptuously clothed, automatically rose from a sitting position, poured a libation and then sat down again (Athenaeus, 188F). Finally, and deserving more detail, there is from the late Republic the revolving theatre of Curio, as recorded by Pliny. Pliny describes how Curio, unable to match his rival, Scaurus the aedile, in terms of splendour of theatrical performance, turned instead to technological ingenuity:

He built close to each other two very large wooden theatres, each poised and balanced on a revolving point. During the morning a performance of a play was given in both of them and they faced in opposite directions so that the two casts should not drown each other's words. Then, all of a sudden, the theatres revolved (and it is agreed that, after the first few days they did so with some of the spectators actually remaining in their seats), their corners met, and in this way Curio provided an amphitheatre, in which he produced fights between gladiators.

(HN 36, 117-20)

Pliny waxes eloquent in his righteous indignation that Roman citizens should entrust themselves to such a device: 'Here we have the nation that has conquered the earth ... that is heaven's representative, so to speak, among mankind, swaying on a contraption and applauding its own danger.' And much more in the same vein. Then comes the explanation of Curio's ingenuity: 'And the aim, after all, was merely to win favour for the speeches that Curio might make as tribune, so that he might continue to agitate the swaying voters.'

Pliny ruefully admits that virtually the whole of the Roman people turned out to attend the theatre, and this in spite of the fact that Curio was 'not a king, nor an emperor, nor indeed was he particularly rich.' In each of the three cases noted above, the demonstration was about power: either flaunting it or chasing after it. The underlying idea seems to lie in the harnessing of technology as a means of displaying the ability to rival or even transgress nature.51

Stagnationists and progressivists base their respective pessimism and optimism on the assumption that effective technological change is exogenous to
the economic system: major breakthroughs are independently made before being less or more widely applied. In fact, economic historians have long appreciated that, for modern industry, ongoing improvements in existing methods of production may in the longer run count for as much (or more) in raising productivity as major but isolated innovations. Recent and important work on the Roman world strongly suggests that similar considerations applied through antiquity (or parts of it). Foremost among the ‘gradualists’ (as we may tentatively label them) are Kevin Greene and David Mattingly: both of them archaeologists, depending heavily on material as opposed to literary testimony in their reassessment of the scope for technical and technological progress in antiquity.

In a sequence of papers, Greene has argued persuasively for the rejection of the Industrial Revolution (an anomalous ‘one-off’) as the implicit basis for assessment of progress in ancient technology; how productivity may be enhanced by reorganization of existing skills and resources (technical progress); how the scope for technology transfer in the Roman world needs to be reassessed; how recent archaeological discoveries challenge the picture of overall stagnation (the water-mill being a case in point). Detailed support for Greene’s overall arguments comes from Mattingly’s investigation of the technology of olive- and other presses: diffusion, adoption and adaptation of appropriate technology. Gradualists may draw theoretical support from recent work on the medieval European economy, as presented in Karl Persson’s innovative study of Pre-industrial Economic Growth. The author argues in detail for the existence in settled, agrarian economies of weak but ongoing endogenous technical and technological change: the outcome of ‘systematic forces in society’ (1988, 1). This is an unintended and unnoticed by-product of improved practices (and so independent of innate conservatism), accumulated across generations. Persson specifically identifies five interconnected ways in which improvements may occur (7-13): (i) random changes in processes over time, from which the best are selected and retained: early metallurgy may be a case in point (21-4); (ii) so-called ‘economies of practice’: the ‘learning by doing’ famously formulated by Kenneth Arrow 1962; (iii) trial and error, ideally occupying spare resources and leisure time; (iv) division of labour and regional specialization, which are in turn functions of the extent of the market; (v) growth of population, affecting inter alia the scale of the market. Improvements in productivity have historically resulted in land-saving, making feasible further increase in population: medieval agriculturalists required approximately 1/300 as much land as their prehistoric, hunting predecessors (3). It seems that Harold Wilson (as cited at the opening of this paper) may have underestimated the scope for growth, should nature be allowed to take its course.

This is a bold summary of a densely argued but rewarding study. Save for a brief foray into Chinese history (131-4), Persson restricts his detailed analysis to the economy of medieval Europe. Even so, his analysis has obvious relevance to the ancient world, as do his suggested indices of economic development. He tentatively suggests that an increase in the number of separate occupations might indicate an increase in the rate of technological progress (128). His point about increasing specialization in carpentry during the medieval period, with its separation of furniture-making and house-building (125), might almost have been inspired by Xenophon (see p. 29). More generally, Persson argues for a direct relationship between degree of urbanization (ratio of urban producers to the total number of producers) and labour productivity (107-14). This is on the grounds that an increase in net income decreases the average propensity to consume agricultural goods and increases the proportion spent on urban goods (most people buy food first, then spend the residual on manufactured goods), resulting in growth in the urban workforce (110). As Persson himself notes (107-8), the generality of this method makes it appropriate for a range of times and places, including classical antiquity.

There are obvious affinities between Persson’s analysis and Hopkins’ third proposition, which expressly mentions the increasing proportion of the population living in towns, drawing in support on the range of occupations attested. In fact, Persson himself notes the high degree of urbanization of the later Roman world and cites the 150 or so urban crafts known from Rome as similar to the degree of specialization found in larger medieval cities (131-2). He therefore presumes for the Roman empire an associated rise of per-capita income and a positive rate of technological progress (for which he finds some evidence).

Economic growth: who noticed?

It cannot be coincidental that so many of Hopkins’ components of classical growth relate to the first two centuries of the Roman empire. The relative stability and tranquillity of this period (emphasized by Hopkins), and the arguably unified economy of the empire, possibly provided conditions which were conducive to modest but more or less sustained and generalized growth. It is perhaps significant that the majority of papers in this volume are centred on those two centuries; and Edward Gibbon settled on the second century (or most of it) as that period in the whole history of the world when ‘the condition of the human race was most happy and prosperous’ (Chapter 3).

Of course, the corollary of this ‘ante-industrial growth’ is that scope for sustained growth in the centuries BC was elusive or non-existent. This would seem to be supported by an independent observation from Persson that, the smaller an economy, the more vulnerable it is to exogenous shocks, through famine, plague or war (1988, 39, 127). In this way, piecemeal gains through endogenous growth would be swamped out. A case in point might
be the fluctuating fortunes of the Athenians between 431 and 403 BC. Under such circumstances it is hard to imagine any underlying secular improvement in living conditions being apparent to contemporaries, however acute their observation or long their lives. For an analogy from the pre-industrial economy, there are the marked oscillations and longer-term swings in the estimated real wages of building craftsmen in southern England between 1250 and 1800. In 1800, they were apparently no better off than in 1300. Common sense would suggest that this pattern of expansion and contraction prevailed generally. Otherwise, as suggested above, the near-miracle of sustained compound increase would have secured massive growth well in advance of the Industrial Revolution. From Stone Age straight through, as it were, to Golden Age.17

I end where we began, with Aristotle’s (to us) complacent statement that, by his own time, everything needed to support the philosophical life had been secured. This outlook could, of course, be explained in terms of the capacity of the élite to think exclusively of their own interests. An uncharitable person might comment on the fifteen or so household slaves mentioned in Aristotle’s will.18 But Aristotle was not alone among Greek thinkers in his conviction that material progress had more or less (sbedon) reached its natural limit. Edelstein (1967, xi) is out to demonstrate (against Bury 1928) the existence of an ancient concept of progress, as conceived in its widest sense. But even his determined reading of texts yields a thin harvest. There emerges the conviction that either things are getting worse: the Golden Age belongs to the distant past (xxiv, 8, 134); or that things are about as good as they can get: Nature sets a formal limit. The Pre-Socratics reckoned that progress depended on developing the power of Nature, by which bounds are set (27–30); Plato assumed that recurring natural catastrophes would periodically destroy the material side of civilization (102–8).19

Since Nature and the forces of nature placed a limit on the overall quantity of good things, including wealth, the obvious way of increasing one’s personal share was at the expense of someone else. Such was the predictable response in a world that subscribed to the idea of the ‘limited good’.20 Within the household, slaves and other forms of unfree labour could be exploited, appropriating the surplus they produced. ‘There is no time off (schole) for slaves’, quips Aristotle, as often quoting a proverb (Politics 1334a). Across the wider polis community, the outcome was often stasis; which occurred, again according to Aristotle in his Politics (1302a), when the poor strove against the rich for greater equality of material gain (kerdos) and status (time). Analogous (though less turbulent) were perceptions of political agendas held by economic theorists of the later nineteenth and earlier twentieth centuries, preoccupied as they were by questions of distribution rather than growth (Abramowicz 1989, 8–9). The tone was set in 1848 by Mill on ‘The stationary state’ (749): ‘It is only in the backward countries of the world that increased production is still an important object: in those most advanced, what is economically needed is a better distribution.21

The alternative was to seize resources from outside the community: a high-risk strategy, given the potentially ruinous cost of even successful warfare. The campaigns of Alexander provide an illustration. Plutarch preserves a report that, on the eve of his Asian campaign, Alexander was in debt to the tune of 200 talents (Alexander, 15). Although that deficit was apparently made good through the spoils of war, account has to be taken of the cost in human capital. Bosworth 1986 supplies a sombre reckoning of the loss to Macedon in terms of adult males. Whoever wins, warfare is normally a net consumer of resources. Repeated warfare in an attempt to make individual gains predictably results in an ever smaller cake on which the victor may feast (Millett 1993).

The value of the ‘peace dividend’ was appreciated by Xenophon in his pamphlet called Poroi or ‘Resources’ (5, 5–13); perhaps the most inventive piece of economic theorizing to survive from antiquity. The Athenians in the fourth century never quite shook off happy memories of their fifth-century empire; another of Keynes’ ‘golden intervals’, at least for the Athenians. But Athens’ empire was exceptional in the degree to which it benefited poorer citizens.22 The so-called ‘Second Confederacy’ (379), by which the Athenians tentatively tried to recover some of their lost imperial ground, ended in war with their former allies. Xenophon responded creatively to this débâcle with schemes to generate wealth for Athens which would disadvantage neither her allies (1.1) nor even her own wealthiest citizens (5.1). It is a fact that his favoured proposal of systematic exploitation of the Laurium silver mines (where he assumed an almost infinite supply of silver) would have harmed no one, save for the proposed workforce of some ten thousand slaves (4).23

Notes
1 No translation of Aristotle can give satisfaction: the above are based on versions by Tredennick (1936) and Lawson-Tancred (1998). On the interpretation of key terms in both passages, see Ross (1924) ad loc.
3 For problems over Zolotas’ attempts to distinguish welfare from growth, see McCombie 1983; see also p. 21. Epicurus: fr. V. B. 28 in Bailey 1926; the sentiment is commonplace with him (cf. III. 130, IV. 144, V. A. XXV, LX, LXVIII, V. B. 68).
4 I juxtapose the experience of the ancient world with modern economic theory with all possible humility. Those who cross over into different disciplines risk naïveté, ignorance and the justifiable impatience of those who know better (see n. 2). For possible pitfalls when economists and ancient historians try to cooperate (the ‘Delphi effect’), see Carlede 1991. As will be apparent, my own knowledge of the bibliography on growth and development economics is anything but systematic, but the attempt seemed worthwhile. In what follows, particular debts are owed to Gould’s survey and analysis
(1972), who pinpoints problems in uniting the work of historians and economists over growth theory (xv); also to Lewis’s synoptic study (1955).


Matthews 1959; Kaldor 1960, 213-4.


Inflation has accelerated in the present century: in the 650 years before 1935, prices in Britain increased fourteen-fold; in the half century after 1935, they rose 28-fold (Stewart, 1986, 147-8). For the Roman Empire as a whole, Duncan-Jones (1994, 20-32) argues for ‘doubtless real’ recorded bread prices at Ephesus in 68 and 246 (26). Evidence of Diocletian’s Prices Edict suggests that the massive hike in prices for the later third century was utterly unusual (Duncan-Jones 1982, 7-13). Such evidence as exists for the classical Greek world also suggests very slow, secular inflation: rates of pay in Athens approximately doubled in the century between 410 and 320 BC, underlying prices of wheat and barley apparently stayed stable (Markle 1985, 293-7).

-9 Crafts and Toniolo 1996, 2. Closer to home for some of us is the claim by Prime Minister Major’s administration to have increased university funding in the United Kingdom by 23 per cent: somewhat undercut by the accompanying 45 per cent increase in student numbers.

10 Gould, 1972, 78-9; Persson 1988, 2-3. Hesiod in his Works and Days (493-563) emphasizes how, when cold weather keeps everyone else warming themselves at the fire in the smithy, specialist clothing makes it possible to carry on working outdoors. Leisure in the sense of true leisure off was reserved for higher incomes (582-96). Calculations based on the US economy suggest a massive slice of growth potential has been appropriated as leisure time valued at quarterly of the actual increase in GNP between the 1860s and 1960s (Becker 1995, 89). In an essay, Keynes predicts that the combination of technical improvements and capital accumulation under way since approximately 1700 will result in his readers’ grandchildren’s (that’s us) being faced with an aching void of leisure (1930, 328).

11 For a discussion of some implications of The Affluent Society, see Johnson 1966. Opposing sides in the ‘standard of living’ versus ‘quality of life’ debate are represented respectively by Lewis (1955, 420-35), Abramowitz (1989, 322-51), Becker 1995 and Mishan 1967. Meadows et al. 1972, Schumacher 1973. While this paper was being written, the UK Government unveiled plans to supplement economic output as the sole indicator of progress with a further twelve variables or ‘Preuss’s Thirteen Measures of Happiness’ (Daily Telegraph, 24.xii.98).

See the reviews by Finley (1965a) and Cartledge (1979). For non-standard accounts of the economic context, analyzing the possibility of growth, see p. 22 and n. 16.

13 As pointed out by Gould (1972, 16), detailed theorizing about growth becomes possible only with reasonable statistics, such as are hardly available before the arrival on the scene of national income accounting. Hence the speculative nature of Hartwell’s early and isolated attempt (1969) to push consideration of growth as far back as the Norman conquest.


15 The ‘staged’ approach to development will be familiar to ancient historians from the contribution of Bürchner to the so-called ‘Primitivist-Modernist Debate’ (Finley 1979). The work of other members of the ‘German Historical School’ (List, Hildbrand, Rodbertus, Schmoller, Sommert) is summarized critically by Gras (1930) and Hilselst 1960; negatively, by Gould 1972, 421-2. Rostow 1960 is briefly noted below (n. 55).

16 In spite of the pessimism shown by Lewis in one of the quotations which opens this paper, he is not afraid occasionally to chance his arm. The history of the Greeks and Phoenicians at one stage in their history he argues illustrates the possible inverse relationship between resources and growth: those without enough fertile soil to feed themselves take to trading (54). A similar idea is shared by Sir John Hicks (1969, 42-9), who identifies the world of city states as the first phase of the ‘Mercantile Economy’ (42), the remarkable compendium in the excursus, ‘Economic comparisons with the ancient world’ with which Clark ends his otherwise resolutely contemporary Conditions of Economic Progress (1957, 652-84). His analysis rambles across the Greek and Roman worlds, citing statistics wherever possible, aiming to show how ‘economic standards in the ancient world were not altogether out of comparison with those of the present day’ (652).

17 Hopkins’ exposition was intentionally iconoclastic, coming, as it did, in a volume of essays dedicated to Finley (whose vision of The Ancient Economy has no place for growth). Hopkins’ contribution was warmly received in the review by Austin (1985), who notes its Roman bias (see p. 30). Austin subsequently touched on the possibility of growth in the Greek world in his contribution to Grant and Kitzinger 1988, 725-7. In fact, Hopkins had already raised the possibility of growth in the Roman economy in his ‘Economic growth and towns in classical antiquity’. The amazement of a Homeric time-traveller is imagined when confronted with the world of the Roman Empire (1978b, 37-8). Or does this involve as much ‘economic expansion’ as ‘economic growth’? (Longman 1980, 74).

18 In this connection, on Baran from Wiles and Hobson, even more ideological engagement below (n. 55). There are helpful (that is, accessible) introductions to theories of growth by Herrick and Kindleberger (1983, 21-47) and Kregel 1972. Jones 1975, 234-41 provides a flow-chart (extending over seven pages) leading the reader through the literature relative to key models and controversies.


20 Domar 1946; Abramowitz 1989, xii, 328.


22 Basic on the capital-output ratio: Thrall 1994, 114-16; on changes in the ratio over time: Gould 1972, 125-32; for the ratio compared across sectors and between industrial and developing countries: Lewis 1955, 201-13.

23 Per growth, xviii. For a convenient summary of the model: Harrod 1965, 185-205; some implications for short- and longer-term growth: Matthews 1959, 227-54; whether it actually is a model: Harrod 1968. Phelps Brown 1979 places Harrod’s work on growth in context. Problematic (and the difficulties in measuring capital and its malleability (e.g. more or less labour intensive) generate formidable complexities. Hence the Heredias compilation of possible phases of growth by Robinson (1962, 51-9), with its ‘Golden Age’ (steady growth with full employment, therefore mythical), ‘Limping Golden Age’, ‘Restraint Golden Age’, ‘Bastard Golden Age’ and so on (see Sen 1970, 18-20).


The version of the production function given here differs slightly from Meade's (1961): he assumes N (amount of available land) will remain fixed, which is not the case for the ancient world. Meade also includes alongside K, L and N the factor t, representing technical progress through time: a possibility which is considered below (see p. 31-3).

A study of Roman law relating to agency and liability leads Johnston to conclude that commercial legislation was 'firmly anchored in the realities of Roman life' (1997, 65).

On Technology and the residual see Gould 1972, 295-377 (including a helpful 'family tree' of possible sources of increased output); cf. Abramovitz 1989, 13-15, 80-9. It seems unfair that Abramovitz (59) should blame the slow growth of the British economy in the present century on classical education. Harrod (who reads Greats at New College, Oxford) beat Domar by six years in discovering the growth model that bears their names.

As argued by Mowery and Rosenberg 1989; see Thirlwall 1994, 124-4.

The entries in Palgrave's great Dictionary of Economics (Eatwell et al. 1987) on aspects of growth theory are models of lucidity and accessibility. But consider the article on 'Neoclassical Growth Theory', and what is called 'The simple model', which assumes an economy producing a single good with no technical progress. The exposition that follows takes three pages of equations to work out the implications for growth. I confess to having given up on the more complex models.

Defining development: Thirlwall 1994, 9-11; Todaro 1997, 14-18; Sen 1988. Textbooks continue to use 'growth', 'development' and even 'progress' interchangeably: explicitly by Lewis 1955, 8, the content of which Hicks contrasts with his own conception of growth theory (1965, 2). The part to be played by growth theory in development is disputed; for: Thirlwall 1994, 8; against: Chambers 1983. Also ideologically loaded is the terminology: 'backward', 'under-developed', 'developing' (Berrstein 1973, 13-30).

Source of the summary in the text: LEST, s.v. 'Economic Development', for a broader view: Eklan 1973, 13-27, Wagger (1960) stresses as a key factor in underdevelopment the absence of full participation in monetary exchange. On the diversity of types of developing nations: Todaro 97, 26-61; Auy 1995, 3-26. Something of the analogous variety of ancient Greece is conveyed by Gercke's study (1986) of (as he terms it) 'The Third Greek World, outside Athens and Sparta'.

The detailed citation supporting several of the following propositions is supplied in Hopkins 1978b. Aspects of Hopkins' analysis of growth are assessed by Jongman 1988, 21-8.

For links between Classical economists and 'the real world' see Coats 1971. For possible awareness of the phenomenon of growth in the writings of their predecessors, the Physiocrats and Mercantilists, see Spengler 1960; for the pre-history of development theory: Lewis 1988.


Abramovitz 1956, 5-6; Hoselitz 1960b, 113-154. According to Stulec in Banar 1973, 95-6, Marx had argued that only under capitalism (as opposed to socialism) would production fail to keep pace with population growth. To this extent, Marx seems to deserve credit for rescuing economics from its nineteenth century reputation as 'the dismal science'. But Marx's (as opposed to Marxist) theories of growth find no place in the textbooks.


Gould 1972, 70-87; Schultz 1972.
Gulliver's subsequent visit to the Academy of Projectors in Laputa (Bk. III ch. 5), where scientists try (among other things) to extract sunbeams from cucumbers, is a harsh satire on contemporary attempts actually to put science to useful ends. The exceptional attempts at systematic research and development in ancient warfare are well attested: Landells 1878, 99-132. It might be argued that bigger and better catapults did their bit in retarding economic growth by making warfare more destructive. For comparison with technological progress under the impulse of modern war, see the fascinating story of the rapid development of the Spitfire (Quill 1983).

51 The notion of subverting nature may lie behind the emperor's alleged justification for executing the inventor of unbreakable glass: lest gold should be reduced to the value of mud (Petrarchus 51). Polonius's twelve-foot spectacular is discussed by Rice 1983, 62-9; who cites (65) the anecdote of a self-moving sailboat (complete with smelt trail) introduced by Demetrius of Phaleron into the Dioneia of 309/8. She interprets the whole procession (surely correctly) as an affirmation of Alexandria's claim to be the new capital of the Greek world (190-2).

52 Gould 1972, 356-60. The idea of the heroic inventor can, of course, be traced back to antiquity: see the listings in Pliny HN 7: 'The first beginning is the main thing' writes Aristotle in his Sophistic Refutations (34) quoting a proverb (Edelein 1967, 88).

53 The relevant items are: Greene 1986, 1990, 1992, 1994a, 1994b; Mattingly 1990, 1994, 1996. Unsurprisingly, the object of their joint disagreement is Finley 1965b (see esp. Greene 1992, 22-4; 2006; Mattingly 1996, 241-7). In fact, Finley does allow for the possibility of gradual improvements (in, for example, wine and oil presses, 176); and also some economic progress (194). 'Nothing that I have said should be taken to suggest that there was no technical or economic progress whatever in antiquity.'

54 The essential accuracy of 'learning by doing' will be confirmed by anyone who has done a fair amount of amateur woodwork: the finding of short-cuts, neat solutions, and the making of jigs to assist in repeated tasks. 'Labour-saving' seems to matter a lot when it is one's own labour (and leisure time) being saved.

55 Specifically, between the death of Domitian (96 AD) and the accession of Commodus (180 AD); note the scepticism of de Ste Croix 1981, 13-14 on the universality of this happiness and prosperity. Mention may here be made of the best-selling study by Rostow 1960, with its emphasis on the notion of the phase of 'Take Off' by 'Traditional Societies' into sustained growth, through a conjunction of technological progress, access to extra-national markets and an outlook willing to accommodate radical change (36-58; cf. Rostow 1964). The explicit political stance of this self-styled 'Non-Communist Manifesto' brought a predictable (but no less effective) response: Baran and Holbawn 1961; and not only from Marxists: others objected (inter alia) to his impertinence in singling out key relationships in his model (Gould 1972, 424-9; Thirwall 1994, 61-4; Aron 1967, 5-7). Aron cites, against Rostow's reductionist approach, the diversity of the Greek city states, to which might be added Hopkins' conception of the Roman empire.

56 Contrast: the perceptions from the late 1950s of Arthur, the anti-hero of Sillitoe's Saturday Night and Sunday Morning And now he [his father] is a bit down job at the factory, all the Woodbines he could smoke, money for a pint a holiday somewhere, a jaunt on the firm's trip to Blackpool, and a television set to look into at home. The difference between the war and after the war didn't bear thinking about (1958, 20). Dernesthemes (9, 40), in order to persuade his Athenian audience of c. 380 that they have never had it so good (at least in terms of trismes, manpower, revenues and other indications of power) resorts to making the vaguest of comparisons with 'the past' (tot).

57 The figures for builders' wages were famously calculated by Phelps Brown and Hopkins 1956; their graph is reproduced and discussed by Gould 1972, 37-40, 82-4. The point about the cumulative effect of sustained growth, however modest, was made by Kuznets (cited by Gould 1972, 153).

58 Diegenes Laertius 5. 1. 12-16. This is not the place to reopen the discussion of the possible role of slavery in retarding economic growth; see the brief but stimulating analysis in Osbourne 1993.

59 Subsequent discussions by Dodds (1973, 1-25) and Lloyd 1988 broadly support the pervasiveness of the idea that, though progress had been made in the past, it could not be guaranteed for the future.

60 Millett, 1993. The idea of fixed resources persisted through the Middle Ages to influence the thinking of the Mercantilists: see Spengler 1960, 10-11.

61 Which moves Mill to offer up a thoroughly Aristotelian vision of the future (751):... an stationary condition of capital and population implies no stationary state of human improvement. There would be as much scope as ever to all kinds of mental culture and moral and social progress; as much room for improving the Art of Living... when minds cease to be engrossed by the art of getting on.

62 An obvious contrast is the disproportionate benefits gained by the Roman elite from exploitation of their empire (Hokmark 1978a, 37-47). But growth in the modern, developing world has depressingly often failed to benefit the worst off: Todaro 1997, 14-15. Alongside growth, distribution does matter.

63 Xenophon was no Adam Smith': writes Bunciman (1990, 351), who goes on to praise the economic sense (if not political practicability) behind his proposals. He continues: 'The reason for which none of the Greek polis, even Athens, achieved sustained economic growth... was that their mode of production prevented them from seeing that profit... is not zero-sum: one person's gain need not be entirely at another's expense.'

It seems fitting that the paper on which this chapter is based was delivered at Leicester University, where some twenty-five years earlier I lectured to patients: Classics undergraduates on 'Ancient Technology and Economic Growth'. I am indebted for bibliographical help to Lin Foxhall, John McCombie, David Mattingly, Richard Smith and Judith Waring.

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REGIONAL PRODUCTIONS IN EARLY ROMAN GAUL

Greg Woolf

Introduction

One of archaeology's main contributions to the debate over the nature of the ancient economy has been to demonstrate that, during the early Roman period, a number of productions developed to an unprecedented scale, providing mass-produced goods for markets that were large, and sometimes relatively distant. Arretine ware, the Tuscan wine transported in Dressel 1 amphorae, Baetican oil and African grain all come into this category. Moses Finley offered a view of the ancient economy as primitive in nature (that is, organized by kinship, families, and embedded systems of exchange) and minimal in scale (characterized by low levels of surplus production and consumption). While ancient historians have mostly tried to answer this challenge by showing what distinctively Greek and Roman social and legal institutions organized economic life in antiquity, and how complex some apparently 'primitive' kinds of production were in reality, archaeologists have in the main devoted their energy to falsifying Finley's minimalist claims.

But the scale of production and its organization are naturally interdependent. A number of recent studies of the ancient economy have explored the organizational implications of the enormous scale of some ancient production and exchange. This paper offers a contribution to this line of enquiry by considering the implications of the scale of some productions within Rome's Gallic provinces. Naturally, as everywhere in the empire, mass production and consumption certainly took place at a very local scale, and not just in the scattered farms of the Massif Central or in the remote villages of the Low Countries. Nor will I claim that continental Gaul generated mass-productions to rival those of Baetica, Tuscany or Tripolitania. Instead, the productions I shall be concerned with fall in terms of scale between very local productions and the mass-productions mentioned above; for convenience, I shall term them 'regional' productions.
Gaul in the Roman economy

As has been noted several times recently, Rome's Gallic provinces ought to provide a good case study for the workings of the ancient economy as a whole. High quality archaeology combines with an epigraphic and historical record as good as that of any western province. Furthermore, Gaul encompassed a wide range of environments and was criss-crossed by a number of different communications systems. Straddling the Mediterranean world and the European continental interior, the Gauls might be thought especially important in arguments about the ecological constraints on (and stimuli for) Roman economic activity. How far did the northerners' demand for goods like olive oil and marble, that could only be obtained in the Mediterranean world, create a vast market for southern produce? How far did Roman imperialism manage to harness the wealth of temperate Europe to supply an empire based in an area where food crisis was endemic and much agriculture marginal? Or does the case of Gaul illustrate the scale of the obstacles posed by the cost of land transport to all exchanges of bulky low value goods once they had to be moved any distance from the sea or a major river?

Perhaps surprisingly, there is little consensus on these issues. One possibility would be to see continental Gaul as largely excluded from the economic growth that many now believe the Mediterranean world experienced under Roman rule. One contribution that Roman imperialism certainly made to the Mediterranean economy was in promoting urbanism. Not only did the numbers of cities increase, but their mean size also increased, and it is likely that the proportion of the total population that lived in cities rose as well. Many of these urbanites had a small disposable income, and many relied on the market place to supply their basic needs and also some minor luxuries. This growing urban population thus provided new markets for surplus agricultural produce and manufactures alike. Trade was not confined to exchanges between cities and the rural populations that surrounded them: the scale of exchange between the larger cities of the Mediterranean basin is now beginning to be appreciated (Fulford 1987). The most urbanized areas of the empire lay within tax-exporting regions, and so trade between them must have been in addition to any reciprocal flows of taxes and trade between imperial peripheries and centres.

One response to the archaeological demonstration of large-scale production and exchange has been the suggestion that a mercantile economy might have existed within the empire, sheltered and enabled by imperial peace, common systems of law, a single currency system and so forth. After all, the provisioning of the city of Rome depended to a large extent on providing incentives for traders already engaged in trade of this kind. Taken together, these arguments suggest a high level of surplus production, manufacture and exchange within Rome's Mediterranean empire. How far such systems might have extended into the Mediterranean's continental hinterlands is much less clear. The frontier zone is a partial exception. The impact of imperial spending, and the need for troops to be based in areas that might easily be supplied, contributed to drawing a small part of temperate Europe into wider exchange systems, again systems in which private traders and the state often seem to have worked together through the medium of state contracts. Yet between the frontier zone and the Mediterranean, no more - and perhaps much less - than 10 per cent of the population lived in either medium-sized cities or small towns, and production was overwhelmingly located either on rural sites or in small towns and villages. If land transport was really as expensive as is commonly supposed, interior Gaul would have been doubly disadvantaged, especially if Strabo's much quoted enthusiasm for the Gallic river system is tempered with more cautious assessments of the navigability of French rivers before modern canalizations and dredging. Even the relative immunity of the continent from the food crises that were a perennial hazard in the Mediterranean world might act as a disincentive to supralocal exchange. Perhaps, in other words, we should imagine the dynamic economic activity of the Roman Mediterranean as standing in stark contrast to a continental hinterland in which the conditions approximated much more closely to Finley's view of the ancient economy.

But it is not so simple. The most recent survey of the economic structure of the Gallic provinces does indeed argue for a distinction between the continental interior and the Mediterranean south, but with opposite results, concluding that Narbonensis conformed much better to the predictions of the Finley/Jones view of the ancient economy than the north did. This line of thought has a long and respectable pedigree. Max Weber envisaged Rome's temperate empire as an area of greater economic potential than the south: a potential that was slow to be realized, inhibited by the imposition of classical cities during the early empire, but that eventually out-paced the Mediterranean south. The context of this discussion was an account of the long-term shift of political and economic power from the Mediterranean to Europe during the early Middle Ages. That shift in gravity was real and has never been reversed, yet Weber's proposition that classical cities were in some sense 'unnatural' elements in the economies of Roman Europe is not really tenable. Even if Gallo-Roman cities were not the thriving commercial-industrial centres that earlier generations of French scholars imagined them to be, they were not all-devouring consumer cities either. Comatian cities were simply too small either to stifle or to stimulate much economic activity among the large rural populations that surrounded them. If, nevertheless, Weber was right to see temperate Europe as a sleeping giant that, once awoken, would eclipse the power of Mediterranean economies and societies, it remains to be asked how soundly Gaul slept during the early Roman empire. Since Weber wrote, the answer has changed.
late La Tène period, that immediately preceded Roman conquest in the region, strongly suggests that Gaul had been waking up for some time.

A number of indications show modest but sustained economic growth throughout the European Iron Age, and in particular over the last three centuries of the last millennium BC.\textsuperscript{22} Survey evidence suggests an expansion onto new soils and denser settlement throughout Gaul. Palynological evidence suggests that a wider range of crops may have been cultivated as well. It is probable that the increased availability of iron agricultural tools contributed to these developments, but demographic growth may also have been an important factor. Late La Tène settlement is ubiquitous, and the largest centres were very large indeed: much bigger than the 'princely' centres of the preceding Hallstatt period, and enclosing hundreds of hectares with complex ramparts, the construction of which consumed vast amounts of timber and iron.\textsuperscript{23} Classical testimony is the least reliable indicator for these developments, but for what it is worth ancient geographers repeatedly declared themselves impressed by the human and agricultural resources of temperate Europe, while historians reported very large figures for barbarian armies and migrating peoples.

What conclusions and expectations arise from this brief survey? First, that the societies inhabiting non-Mediterranean Gaul on the eve of the Roman conquest were already capable of producing substantial surpluses. Second, that the area was experiencing economic and probably demographic growth, was adopting and developing new technologies and making increased use of some – notably metallurgy – that had been known for some time. Third, that there is good reason to believe that Rome's temperate empire had a different economic history to that of the Mediterranean basin, both in view of the factors just mentioned and in view of the major differences in ecology (especially in terms of rainfall and soils), in transport conditions, and in the level and nature of Roman-period urbanism. Fourth, there is not much reason to think that the early Roman empire, whether through over-taxation or the imposition of inappropriate institutions like the consumer city, did much to inhibit economic activity; indeed in some respects – for instance the introduction of a common coinage, laws, language and peace – the region shared some of the same favourable conditions that have recently been identified as promoting economic growth in the south. It is time to examine some of the evidence for economic growth in early Roman Gaul with these positive expectations in mind.

Regional productions

What follows is a brief survey of a number of early Roman economic activities that exceeded those of the late Iron Age in the scale of their production and the range of their distribution.

One clear example is provided by the development of viticulture in Gaul (Laubenheimer 1990). The vine had been known and cultivated in southern Gaul from well before the conquest, almost certainly having been introduced by Massilians (Leveau \textit{et al.} 1993, 281-3). Beyond limited areas of the Mediterranean coastal plains, however, the greater part of wine consumed in Gaul before the Roman conquest was imported, a little from the south and most from Etruria. The history of that trade, itself a major component of the late Republican boom in Italian agriculture, is well known and has been very well studied.\textsuperscript{24} Immense quantities of wine were imported by a number of societies which made use of it in ways that did not always impress Greek and Roman observers as signs of the adoption of a civilized lifestyle.\textsuperscript{25} From the Augustan period, however, the range of wines imported increases significantly, and the uses to which they were put conform more closely to Italian norms; most important for our purposes, Gallo-Roman production increases in scale and adopts new organizational forms.\textsuperscript{26}

The local production of Roman style wine \textit{amphorae} began in the south at the end of the last century BC. At about the same time a workshop at Lyon was producing Dressel 1 \textit{amphorae} that can only be distinguished from Roman originals on petrological grounds. Two decades of research into Gallo-Roman viticulture has uncovered more than sixty kiln sites which together produced over twenty local types of wine \textit{amphora}.\textsuperscript{27} Wine production was still confined to Narbonensis at the end of the last century BC, but a hundred years later it had spread throughout Aquitaine to the Loire and up the Rhône to Burgundy. Over the second and third centuries AD vines spread a little further north, notably to the valley of the Moselle.

The development of viticulture was more complex than simply the spread of a new cultigen or set of techniques. In the first place, southern vines could not simply be planted further north. Pliny the Elder describes the successful cultivation of vines in the Bordeaux and the middle Rhône as involving experiments with existing and new varieties of grape adapted to the cold.\textsuperscript{28}

Developing temperate viticultures required investment of time and resources. Not all these experiments succeeded, and the vast majority of \textit{amphora} production sites were located in the south throughout the first three centuries AD, while northern sites seem never to have been supplied from local production alone (Baudoux 1996).

Even many of the southern sites produced only small quantities of wine, no doubt often \textit{vins de table} for local consumption, even if some of those described by Pliny were probably more expensive specialist wines and were distributed more widely. But a small number of productions based in the middle Rhône valley were much more significant quantitatively. They succeeded in reaching a 'regional' market, one that included some southern consumers, but also extended well into the Gallic interior, until Gallic examples
came, by the second century AD, to dominate Gallo-Roman assemblages of wine amphorae even in the north-east. One peculiarity of Gallic amphorae is that they have flat bases, suggesting that they were designed for transport on carts or flat-bottom boats rather than in deeper draft vessels. All this indicates a deliberate and successful investment in a project that had involved agricultural innovation and developments in transportation and distribution. Nothing like this is known from late Iron Age Gaul.

**Terra sigillata**

A second set of regional productions is represented by a number of the Gallo-Roman productions of *terra sigillata* (Samian ware) that responded to the revolution in taste created by the phenomenal success of Arretine ware at the end of the last century BC. This story too is well known and does not need to be rehearsed again in detail. *Sigillata* was first imported, then produced within Gaul in a number of centres in Lyon, then in other centres in the south, then in the centre and finally in northern and eastern Gaul.

The technical processes involved in producing *terra sigillata* were complex and not all were familiar to pre-conquest potters. Specific clays were required, the use of a slip was new, as were decorative techniques like moulding and barbotine; and firing took place in temperatures well above those that La Tène kilns could manage. Even the forms were quite different. Producing ‘proper’ *sigillata*, as opposed to one of the many imitations, thus required capital investment, infrastructure and some training. The stages by which this knowledge was transmitted were complex, probably involving some collaboration, some imitation and perhaps something approximating to production under license. Nevertheless, as with viticulture, local productions gradually spread throughout Gaul, and a small number of them managed to achieve large-scale production and to distribute their wares to a ‘regional’ market.

Regional productions of wine and *terra sigillata* illustrate clearly the opportunities offered by the new tastes established in Gaul from the turn of the millennium. Mediterranean imports showed the potential Gallic market. If technical difficulties could be overcome, local producers might hope to outcompete their Mediterranean rivals. It is important not to underestimate the difficulties involved in satisfying tastes formed in a very different environment. It evidently was not too difficult to organize production of *terra sigillata* in central France despite the need to adapt techniques developed for servile labour in an urban environment to the free rural population of the Auvergne. But not all viticultures succeeded, while environmental factors limited the range of olive oil production still further (Brun 1986).

**Pipe-clay figurines**

Not all regional productions were generated by provincial competition with the mass productions of Italy. One characteristically Gallo–Roman production was the manufacture of pipe-clay figurines in central Gaul in more than twenty production sites in the valleys of the Allier and the upper Loire (Bémont and Lahannier 1993). These moulded images, depicting a variety of gods, goddesses and animals, were apparently used as grave goods, as votives and perhaps as cult statues on domestic sites. Both the general iconography of the images and the technology used to produce them are clearly Mediterranean in origin, but the figurine type was created and developed – it seems by potters with fairly typical Gallo–Roman names – in Gaul.

Excavations at Bourbon-Lancy recovered 260 casts and twenty archetypes of images, the most popular types being Venus, feminine busts with Flavian hairstyles, Minerva, Epona, Mercury and a variety of birds and animals (Rouvier-Jeanin et al. 1990). Products have been recovered from all over Burgundy and from the Rhineland, Switzerland and Austria. Other centres apparently specialized in particular subjects, and some kilns produced figurines alongside other ceramic productions. The style was long-lasting, the earliest workshop beginning production in the mid-first century AD and others taking it up at various points until the early third century. It is difficult to be certain what market they were aimed at, but they seem to have been used by both military and civilian populations and are perhaps best seen as a cheaper version of the small bronze images of deities known from sites throughout the empire. As with *vins de table* and *terra sigillata*, then, we are not dealing with production for the rich so much as the provision of small luxuries for those of much lower social status. By the same token, some Gallo-Romans of modest means could afford to make at least occasional purchases of goods manufactured a long way away, and distribution networks existed that enabled them to do so.

**Textiles and livestock**

Another set of regional productions geared to the desires of the humbler consumer was textiles. The textile industry of Belgica is discussed elsewhere in this volume and so does not need to be treated at length here. But it conforms to the pattern outlined here of a production that transcended the scale of any Iron Age predecessor, thereby requiring a more complex organization of production, management and distribution. It also, arguably, depended for most of its existence on a largely ‘regional’ market. Even if some of the textiles produced in eastern Belgica were consumed by the military, it is clear that local styles of clothing were also an important part of its production, and therefore that local consumers were an important component of its market. Textile production was also another area of Gallo-Roman economic
GREG WOOLF

life which received considerable investment in the early Roman period. The
evidence is best not for Belgica, but for the plain of the Crau near Arles in
Provence, where survey and excavation has recently revealed a series of very
large covered sheep-pens indicating a highly organized development of the
potential of this inhospitable environment to provide seasonal pasture for
flocks of sheep that perhaps totalled over 100,000 animals (Badan et al.
1995). Again the scale of this enterprise has no Iron Age precedent.

More generally, Roman period investment in livestock production in tem-
perate Europe is now becoming clearer and clearer from the first major syn-
theses of faunal remains from Iron Age and early Roman sites. A graphic
indication of this is the rapid increase in size of most domesticated species
during the first century AD. Cattle, sheep and goats, and pigs all share in this
development, which reversed a long term trend since the Neolithic towards
smaller and smaller animals. In Belgica, cattle increased in size by 20 per
cent, horses by 15 per cent, pigs by 12.5 per cent and sheep by 9 per cent
(Lepetz 1996a, 76–80). Even chickens got bigger under Roman rule. The
rapidity of the change in some species, together with the absence of animals
of intermediate size in the case of cattle, strongly suggests that breeding stock
were imported in (or possibly just before) the conquest to improve the size of
local breeds. Larger animals were not required just to increase meat produc-
tion, although that was without doubt a major concern. Larger cattle and
horses may have been bred for traction, and larger sheep for milk and wool
production. But larger meat-producing animals also indicate changes in con-
sumption, since the additional meat each animal supplied when slaughtered
required either better preservation techniques, or else the sale of meat for
consumption outside the family unit. From these changes in livestock we
can infer changing patterns of production and consumption that may be
linked with the processes that generated the growth of regional productions
in Gaul.

Building stone

My final example of a regional distribution is another case of Gallo-Roman
production developed to satisfy Mediterranean tastes; but this time the
market was not made up of large numbers of consumers of modest wealth.
The growth of the building-stone industry was necessitated first by new styles
of monumentality, then by new styles of domestic architecture, in
Gallo-Roman cities and finally in the countryside. Stone was not a
common building material in non-Mediterranean Gaul during the Iron Age.
The main exceptions were the ramparts of hillforts in the centre and east
which incorporated rubble cores and stone facing-walls; the material was
quarried from the surrounding ditches, as was normal throughout pre-his-
tory. The quality of the stone used and the masonry skill required were fairly
low. The introduction of Roman architecture thus required the development

of quarries and a series of new professionals. The slow pace of these develop-
ments is illustrated by the first generation of Roman-style town houses in
Gaul, which were built of wood and earth, although they used carpentry
techniques and designs very different from those of the wattle and daub
structures characteristic of the late La Tène period. The existence of this first
phase of urbanism has only been appreciated fairly recently (Lasfargues
1985), but it seems that in northern Gallo-Roman cities at least, houses con-
structed in masonry only appeared in the second half of the first century AD.

Quarries did eventually develop in most parts of Gaul, and their distribu-
tion correlates fairly well with other indices of urbanization. Large cities
such as Trier and Nîmes are at the centre of major clusters of quarries (Bedon
1984). But if most areas could supply the commonest building stones, some
were more difficult to find. This was particularly true of marble, of which
the major suppliers in Gaul were the quarries of the Pyrenees. Marble from
St Béat near St Bertrand-de-Comminges was transported all over Aquitaine
and also reached Rennes, Arles, Marseille and Rouen. A more modest, but
still regional, distribution was achieved by the stone quarried from the Bois
de Lens north-west of Nîmes (Bessac 1996). The outcrop was quarried spo-
radically in the Iron Age, but after the conquest high-quality and accessible
sites were sought out systematically, and then worked using new techniques
on an unprecedented scale. Stone from the Bois de Lens was used in all
major southern cities between Narbonne and the Rhône, and has been identi-
fied in Nice and Fréjus. This series of examples is not comprehensive, but
serves to illustrate a number of general features of production in early
Gaul. A number of productions increased in scale and complexity, or appeared for the first time, in the decades following the Roman conquest.
Some, but not all, catered for new tastes that had originated in the Mediterra-
nean. Most involved significant investment in infrastructure and training.
Their products were consumed well beyond the immediate locality of their
production, but still on the whole within Gaul and some neighbouring prov-
inces. Productions on this scale developed within both Mediterranean and
temperate Gaul, and there seems little essential difference between agricul-
tural productions and non-agricultural ones.

Implications

Gaul clearly experienced economic growth in the early Roman period. Equally
clearly, the situation was not the same as in the Mediterranean world. Only to
a limited extent could Gallo-Roman producers specialize and intensify pro-
duction within traditional areas of the agricultural economy, and they could
not depend for a market on rising urban populations in the vicinity, or for
transport on the pacified Mediterranean sea-routes stretching between
ever-improved harbours. Roman Gaul exceeded the expectations of the mini-
malists, but not for the same reasons that Mediterranean economies did.
A number of factors made the Gallo–Roman success stories possible. The
demographic and agrarian strength of late La Tène Gaul – based to a large
extent on the ecology of temperate Europe as a whole – has already been
discussed. But Gallo–Roman entrepreneurs went further than their ancestors.
Pease, a unified currency, Roman laws of contract and agency no doubt
helped. Technological and specifically agronomic innovations were signifi-
cant for some products, for example in the exploitation of stone, in the
development of viticulture and in transport technology. Less often appreci-
ated is the scale of investment in production by private individuals.
Several examples have been mentioned already, but there were many others.
There is no conflict here with the injunctions of Roman agronomists to maximize
the profitability of one’s estates. Nor were predictive actuarial techniques a
necessity. Experience guided some ventures and some investments
presumably simply failed. But behind virtually all the productions that did succeed in
achieving a regional distribution, it is possible to see some deliberate
investment. Who the investors were, of course, and where the capital came
from, is much more difficult to say.

More efficient production is only part of the story, and, after all, many of
these innovations simply assisted Gallo–Romans to satisfy new tastes. La Tène
economic activity may have been limited less by production factors than trans-
port factors and the connected issue of accessible markets. One very clear
implication of all these productions is that land transport cannot have been
prohibitively expensive within Rome’s continental empire. Brave attempts have
been made to account for terra sigillata distributions and the like through a
combination of the much vaunted Gallic river systems and supposed military
supply routes. Both no doubt helped, but land transport must also have had
a major role to play, as has recently been urged. The people who worked these
trade networks have come into increasingly sharper focus thanks to a series of
mainly epigraphic surveys, and in these too the regional nature of exchange
within the Roman north-west is apparent.

But the most important implication of these arguments concerns con-
sumption and the market for Gallo–Roman wine and ceramics, figurines
and textiles and so forth. New transport and exchange systems may have
increased the range of Gallo–Roman manufactures, but not to the extent
that they could depend on large cities or the army to purchase them. The
primary consumers of Gallo–Roman regional productions were themselves
Gallo–Romans, and most were neither rich nor urban. Typically the pro-
ducts they purchased had a low unit cost. That made them affordable to
individuals poorer than members of the various Gallo–Roman élites, but better
off than subsistence peasants. Members of these intermediate sections of
society could evidently choose, on occasion, to purchase a non-essential item
made some distance away. Equally, some chose to spend more on (say) terra
sigillata or wine than they need have paid for a locally produced, but less
preferable, alternative such as ceramics in an indigenous style, or beer.

Although the cost of each of these purchases was low, their total value was
evidently high enough to sustain some regional productions. What we are
observing is the effect of the aggregate purchasing power of a numerous and
economically comfortable Gallo–Roman peasantry. Ancient historians and
archaeologists working on Mediterranean societies sometimes write as if all
ancient agriculturalists were living in conditions of economic marginality.
Whatever the state of the rural populations of the Mediterranean world,
their counterparts in Rome’s temperate empire were able collectively to gen-
erate enough demand to sustain a modest rise in the standard of living. As
always, that made some individuals rich.

Notes

1 For example, Tchernia 1986; Mattingly 1988. Greene 1986 collects a good deal of the
evidence for large scale production and exchange over long distances. For an
interpreative sketch, see Woolf 1992.

2 Most trenchantly in Finley 1985. The importance of Finley’s contribution is shown by
the inability of his critique plausibly to rearticulate the main theses of those, like
Rostovtzeff, against whose work Finley directed his fiercest polemic, although see
Carandini 1989 for an attempt along these lines.

3 For instance through patronage, freedmen and the family, e.g. d’Arms 1981;
Wallace-Hadrill 1991; and most recently through law, e.g. Aubert 1994. For further
examples, and an illuminating editorial overview see Harris 1993.

4 For instance in the study of subsistence peasantries, with the aid of ethno-archaeology and
various kinds of anthropology, e.g. by Garnsey 1976; 1988, 43–68; of the
complexities of tenantry, e.g. by de Neeve 1984 and Foxhall 1990; or of ancient banking,
illuminated by Andreau 1987.

5 Duncan-Jones 1990 for an important example of this, but considerations of scale also
lie behind a number of other important contributions: e.g. Harris 1980; Hopkins 1980.

6 For convenience, since it is not my case that these productions served markets of a
typical scale, or fell within particular quantitative thresholds. It is clear that a continuum
of distribution sizes existed in antiquity, and many productions - terra sigillata at Arretino
provides a good example - served different-sized markets at different periods. Focusing
on ‘regional productions’ simply means looking at a point on this continuum between
very local (and often subsistence) economies and the great mass-produced exports.
Arguably this level has been relatively neglected as a result of the polarization of research
generated by the polemical nature of the debates between Finley and his critics.

7 The fullest recent survey is Frezouls 1990, with a good bibliography. For a shorter
account, placing more stress on archaeological evidence and relatively less on epigraphy
and the testimony of literary sources, see Goudine 1998 (English translation
forthcoming in CIfF vol xi).


9 On urban populations as a stimulus for trade, see Duncan-Jones 1990, 30–47. On
urbanization in the period, see also Jones 1987; Woolf 1997.

10 Hopkins 1980 on the reciprocity of taxes and trade. Hopkins was careful to argue that
these forms of exchange constituted one exception to Finley’s model, not the only one.
For present purposes, the issue of just how significant fiscally-driven exchanges were
within the economy as a whole is not important.
11 Carandini 1989, evoking Braudel and Rostovtzeff. The term ‘mercantilism’, evoking as it does a particular stage of European history (with special resonances for Marxists interested in the periodization of capitalism) is less helpful than the general idea that the imperial state may have created conditions well suited to entrepreneurial commerce.


13 Nevertheless, there remains no evidence for rich merchant classes in these cities, for the impact of economic policy on civic politics, or for widespread social change generated by economic growth. Finley’s arguments for qualitative differences in the management of trade in antiquity from those employed in medieval or early modern Europe, remain strong ones— even if d’Arms 1981 and others have raised problems with his contention that these differences can be traced to an anti-mercantilist ethic on the part of Greek and Roman elite members.

14 Whittaker 1994, building on a series of earlier studies, has produced a clear analysis of this phenomenon. It remains to be established just how localized the impact of garrisoning was on provincial economies, on which see Fulford 1989, 1992.

15 For some recent calculations see, Millet 1990, 181–6 on Britain, and Wooll 1998, 136–8 on Gaul, both accepting the contention of Drinkwater 1985 that the inhabitants of small towns should be counted within this total. Drinkwater 1983, 169–70 and Frezoulis 1990, 434–5 offer critical overviews of various estimates for the population of Gaul as a whole.

16 See Whittaker 1990 on this, now amply documented by Petit et al. 1994.

17 For a general account of Gallic riverine navigation, see de Izarra 1993, although it contains little documentation. Current work by Philippe Leveau will result in a much more superior understanding of navigability on the Rhône in antiquity.

18 Kneill 1988. The study is based largely on epigraphic data, and an archaeological supplement to it would doubtless add some nuances, but the conclusion that Narbonnensis was much more closely integrated into the economic history of the Mediterranean and shared its economic history and structure seems secure.


20 Grenier 1937, representing a view that can be traced back to Jullian’s monumental account (1908–26) of Roman Gaul. One basis for this view was apparently the prominence of craftsmen and craft activities on tombs from some areas of Gaul.

21 Much the same applies to the proposition that Roman taxation might have acted as a drain on economic activity in Gaul. No calculation is really possible, since too many variables are unknown, among them the level and nature of pre-conquest taxation or tribute, and the extent of taxation in kind in this area under Roman rule. Hopkins 1980 argues that the imposition of Roman taxation might even have stimulated production in areas like Gaul where imperial government spending was minimal, and Fulford 1992 sees temperate Europe as very lightly taxed indeed. Tax levels were, in any case, low during the empire and it is difficult to believe that they limited economic profitability to any great extent in relatively productive areas like the Gallic provinces. For further discussion with bibliography see Wooll 1998, 40–5.


23 Collis 1984b remains the best account of these structures, but see also Audouze and Büchsenhütz 1989, setting La Tène settlements and settlement architecture in a much longer tradition.


27 Laubenheim 1985 is fundamental, now to be read alongside Laubenheim 1992.

28 Laubenheim 1995 is fundamental, now to be read alongside Laubenheim 1992.

29 Bérenguer and Jacob 1988 remains the most up to date survey, up-dated with a helpful map in Guerry 1990. For an interpretation of this material oriented more towards consumption see Wooll 1998, 187–203.

30 By Drinkwater, building on his earlier studies, 1981, and especially 1982.

31 Wild 1988 is fundamental on the distinctive north-west European costume.

32 For a recent general account of production and consumption of textiles in Gaul see Roche-Bernard and Ferrari 1993.


34 Redon 1984 for a clear synthesis of these developments, with Besse 1988 on Narbonnensis.

35 The line is in any case not easy to draw. Gallic viticulture required the creation and mass-production of the Gauloise 4 amphora, and textile production was improved by new kinds of sheep. It is also quite likely that some of those involved in the production of terra sigillata and pipeclay figurines may also have been agriculturists.

36 E.g. by specializing in producing one or other of the ‘Mediterranean triad’. It is possible that some regional markets for traditional Gallic agrarian products were developed in proximity to the frontier, but the evidence is poor. For discussion see, most recently, Whittaker 1994, 98–131.

37 See for instance Leveau et al. 1993, 276–8 for land reclamation near Orange.

38 Most successfully by Middleton 1979 and 1983.


41 Building stone is the exception, unless tombs were represented for some Gallo-Romans a rare but affordable purchase from the same quarries. But the issue is complex: stone grave markers are relatively rare in rural contexts, and not all quarries used for building stone could have supplied tomstone, it only because some were not worked permanently, but for particular projects.

42 I am grateful to audiences at Oxford and Nottingham, to John Drinkwater and to the editors for their many helpful suggestions and constructive criticisms.

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GREG WOOLF

REGIONAL PRODUCTIONS IN EARLY ROMAN GAUL

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THE FOURTH FACTOR
Managing non-agricultural production in the Roman world

Jean-Jacques Aubert

Introduction
Modern scholars of the primitivistic persuasion tend to believe that the conditions of economic production in the ancient world were necessarily and drastically different from those attested in later periods of history. Attitudes and behaviours in the field of economics are admittedly conditioned by the intellectual, technical, material, and social context in which economic actors grow, live, and perform, as well as by their perception of the historical evolution of the material situation in previous times. Thus, the organization of production, agricultural or not, depends at all times on the need and/or the willingness of 'entrepreneurs' to reach a level of productivity that would make their effort worthwhile: only an economic system like those established by some Communist régimes in the twentieth century would be able to subordinate economic rationalism to social priorities, an endeavour that met limited success and saw the development of parallel economies (black market) ruled by profit. As a rule, the production of goods and services implies some degree of organization, which may or may not be affected by the overall structure of the society in which it takes place. Throughout history, the level of sophistication found in such an organizing process may have varied to a great extent, but attempts at theoreticizing that process never went beyond the construction of an empirical science, to the effect that there is no clear divide between an archaic 'timeless, simple managing' and a modern 'positive management'. Sceptics may start with Allen's Winnie-the-Pooh on Management (1994), where management is defined as 'the art and science of directing effort and resources so that the established objectives of an enterprise may be attained in accordance with accepted policies', an activity aimed at getting things done the right way through six distinctive functions:

1 defining the objective(s);
Roman economy, mostly in non-agricultural contexts. My objective is not limited to describing these activities, but includes an attempt at reconstructing the theoretical reflection derived from, or conditioning, the actual practices reported in our sources. In order to understand how business management was envisaged in the Roman world, it is necessary to provide a working definition of the concept of management, then to correlate that definition with the few ancient writers who discussed the theoretical aspects of management, and finally to determine to what extent business practices in ancient Rome, documented by written, architectural, and artefactual evidence from across the Empire, fit both the proposed modern definition and the reconstructed ancient theoretical system (Aubert 1993 and 1994, for further clarification and examples).

**Definition**

At the end of the twentieth century, management is usually understood as the art of organizing and combining several "factors" of heterogeneous nature to achieve a well-defined goal, economic or otherwise. Consequently, good management is regarded as the key to survival and improvement, at either a personal or institutional level, in all facets of social and economic life. Nowadays, specialists have devised ways to assess the optimal use of available resources, given one's personal inclination and agenda, to achieve timely gratification and/or lasting fulfillment.

Two thousand years ago things may have been somewhat similar, but in the field of economics those involved as agents or observers either did not think it worth their while to report their thoughts about such expectations, or did so in a way that has remained heretofore hidden to posterity. However, since no economic activity can be carried out without some basic form of management, we can safely postulate that management as an empirical science predates its scholarly treatment, and that, to some extent, the logical criteria it followed in any given period and place could be reconstructed on the basis of their application in actual economic practices. In other words, modern scholars must collect as much evidence as possible for whatever activity can be shown to be directed toward achieving some degree of efficiency in acquiring, allocating, and using human endeavour, as well as material resources for a definite purpose. Thus, management must take into consideration:

- the technology to be used (depending on availability and affordability);
- the timing of execution (dictated by the market or by nature);
- above all, the best ways to coordinate all possible factors engaged in the production and distribution of goods and/or in the performance of services.

Broadly speaking, management involves two types of decisions:

- strategic, i.e. with global and long-term effects;
- tactical, i.e. with narrower and shorter-term effects.

Strategic decisions are generally made by entrepreneurs, and tactical ones by business managers. It is mostly with this latter aspect that this paper is concerned.

In pre-industrial economies, in which capital investment is small in comparison with modern Western economies, the production of non-agricultural goods seems normally to have been organized on a small scale for local and regional markets (even though archaeological reports tend to emphasize the exceptional elements of long-distance trade). The proximity of centres of production to markets ensured that qualitative and quantitative fluctuations in demand were nevertheless perceived, if not anticipated, by the producers. In small enterprises, strategic and tactical decisions were usually made by one and the same person, the independent craftsman, owner or lessee of the premises in which he or she operated, working alone or with a few associates, assistants, or apprentices. These people often belonged to the same household, as dependants or relatives.

For the Roman world, this type of enterprise is well attested in Greek and Latin inscriptions, and in iconographic representations preserved as reliefs on funerary altars, urns, cippi, sarcophagi, and stelai, or as painted shop-signs, mostly from Pompeii. As an entrepreneur, the owner of a workshop (or, for that matter, of any kind of economic unit) would have to decide:

- what to produce and on what scale;
- what general market to target;
- whether to invest in capital (and how much) or whether to contract out those tasks that required more capital than he or she was ready to acquire;
- whether the enterprise should tend toward vertical or horizontal integration (or both);
- how to organize the distribution process, etc.
As a manager, the same craftsman was in charge of:

- defining the quality-level of the production (for instance, whether to produce luxury goods for an elite or coarser products for a larger market);
- organizing the actual productive process by using the resources in land, buildings and facilities, tools and other form of capital, labour, and raw material available to him/her in what he/she saw as the most efficient way;
- making arrangements for the distribution of the production, etc.

It should be remembered, however, that the time, energy and creativity of such independent craftsmen may mostly have been engaged in the actual productive work, leaving them with little leisure to think about the overall strategic and tactical aspects of their activity. On the other hand, personal involvement in the productive process ensured that the choice between different forms of management was more pragmatic than dogmatic.

Various economic parameters, such as the weight of taxation, the demand of a growing and more diversified market, the improvement of land and sea transportation, the growing needs of the army and bureaucracy, etc. may have provided an impetus for increasing the production of a whole variety of non-agricultural products. Small entrepreneurs were confronted with the challenge of taking advantage of new economic opportunities without much support or incentive coming from the Roman state, with the remarkable exception of the organization of the food supply for major cities (Sirsks 1991). Since potentially large profits were at stake, due to the sheer scale of the operation, some entrepreneurs eventually developed a basic infrastructure and may have pushed for the creation of a legal system that would enable them to increase their productivity, to diversify their production, and to improve channels of distribution. This crucial development can be traced through the study of Roman commercial law, to be reconstructed from the law of contracts, which shows that significant changes were introduced in the field of business management during the late Republican period. Thus, partnerships (societates), joint ventures (negotiationes exercitae per servos communes), and indirect agency (actiones adiectae qualitates) were first regulated by Roman praetors during the second century BC and discussed by jurists from the first century BC onward. The connected phenomena of praetorian regulation and juristic interpretation should be regarded as a reflection of the mutations that occurred in the social and economic life of that period.

Insofar as this paper will focus upon the role of business managers as opposed to entrepreneurs, it will focus primarily on the activities of those managers who were acting as agents on behalf of absentee entrepreneurs. Thus, tactical decisions will predominate, in spite of the fact that, first, it is not always easy to tell strategy and tactics apart, and second, that ancient sources occasionally show business managers as making strategic decisions as well as tactical ones. Moreover, the term 'management' has been used recently to describe either level of decision making, with the effect of somewhat confusing the issue. Thus, the main thesis of Kehoe (1992) is that landowners 'managed' their estates in such a way as to avoid investing too much in capital, resorting instead to tenancy and various kinds of contracts of lease and hire, in order to ensure maximum economic security in relation to their agricultural income. According to the definition proposed above, the landowners studied by Kehoe, from the 'modest' Epimachus of Hersonolis in the first century AD to the 'very powerful' Aurelius Appianus of Alexandria in the third century AD, as well as their counterparts in the West, exemplified by the Younger Pliny, were not managers, since all tactical, and to some extent even strategic, decisions relating to the actual running of individual estates were entrusted as a whole to tenants and sub-tenants, or to appointed managers (phronistai, oikonomoi, proestoi, epiropoi, et al.). A similar situation is attested in non-agricultural enterprises, such as the brick and tile factories located in the vicinity of clay pits in the outskirts of Rome, owned in the second century AD by the Roman aristocracy and the imperial family, and the lead industry which produced water conduits in Rome and in many towns across the empire, as well as in other sectors of the Roman economy. In view of the many levels of management attested in agriculture, the distinction between entrepreneurs and managers may be too simplistic.

Rathbone's detailed study (1991) of the third century AD Heroninus archive shows that large landowners relied on a sophisticated administrative structure, which could have been adopted in the larger-scale enterprises of the non-agricultural sector (Aubert 1994, Ch. 4).

Management thought in the Greco–Roman world

How did ancient people, economic actors and theoretical writers, think about management? We know far less than we should on that question, considering the ancient writers' interests in technical matters and in the moralistic aspect of leadership. However, a few works of primary importance illustrate the basic principles observed by managers and the attention to details required from them.

In the Greek world, several classical authors had written extensive economic treatises emphasizing the moralistic aspects of good management, based on the enforcement of strict discipline upon the work force and the impractical quest for self-sufficiency. In his Works and Days, Hesiod (eighth/seventh century BC) expounds a work ethic in which competition (era) is acknowledged as an important driving force in productivity. Praising hard work, honesty, and good social behaviour as an insurance against misfortune, the poet favours modest growth and self-sufficiency of the
management, their moralistic concerns had a compelling influence upon Roman and medieval treatises on estate management and husbandry (Oschinsky 1971). In spite of their influence upon the development of management thought and practices, the views expressed in these treatises are not always consistent with what we happen to know otherwise of both agricultural and non-agricultural enterprises. They can be regarded as reductionistic and overschematizing, but should not be dismissed altogether, because they provide us with a rare window on management theory in the ancient world.

From the Roman period two categories of writings are concerned with the theoretical aspect of business management. First, we have the works of the Roman agricultural writers, from Cato the Elder, in the second century BC, to Varro in the first century BC, Columella in the first century AD, and finally Palladius at the turn of the fifth century AD. All of them were concerned with the management of agricultural estates owned by absentee landlords and managed by farm managers, usually called vilici. The agronomists devoted several sections of their respective treatises to the role of these managers, the scope of their activities, and the organization of the staff (familia) attached to single managerial units (fundi or praeda). The most striking features of their descriptions are the stress they put on division of labour, and the existence of a rather sophisticated chain of command, from individual workers, skilled or not, to foremen (praefecti, monitores), overseers (vilici), supervisors (actores), administrators (proc(uratores), and landowners (domini). The type of organization discussed by the agronomists clearly recalls that of military units. Since agricultural work is seasonal by nature, it was acknowledged that the regular staff attached to a managerial unit were either supplemented by outsiders, for instance hired hands (mercenarii) or litigants (in a later period), or occupied in other productive activities taking place on the estate or outside, even at some distance from it. The options available to entrepreneurs and their managers were division of labour, hierarchical organization of the staff, diversification of the production within the unit or in connection with other economic or managerial units, horizontal and vertical integration of economic units, sharing of labour resources and other means of production with other units (Aubert 1994, Ch. 3).

Second, we have the juristic writings preserved in Justinian's Corpus Juris Civilis, consisting mostly of the classical jurisprudence relative to some praeatorian remedies created in the late second or early first century BC and called actions ad dictaia quaestatis in modern literature (Dig. 14 and 15). These remedies were originally given to people who had made a contract with an authorized business manager, so that they could sue, on that contract, the principal on whose behalf such managers were acting. The system implied the principal's request (fusum) or authorization (permisiio) for the agent to do business on a specific or general basis, or rested upon the appointment (praeposito) of the business manager by his principal as the head of the managerial unit. The praeposito amounted to an agreement between the principal
and third contracting parties concerning the scope of the manager’s activity. This agreement could be tacit or explicit, then given orally or in writing, before or even after the contract was made. Restricted at first to cases involving legally dependent managers - the principal’s slave or son-in-power - the grant of these remedies was eventually extended to cases involving all kinds of authorized agents.

The Roman jurists were mostly interested in the extent of the liability of the principal on account of his agent's contracts and in the nature of the legal relationship between principal and agent. Modern scholars would like to hear more about the economic aspect of the so-called institorian arrangement, but the legal sources are mute on this topic. They acknowledge, however, the existence of various levels of economic control on the part of the principal, who could decide to retain the right to endorse or veto every single transaction made by his manager, or to issue a general authorization to negotiate any contract related to the management of a well-defined economic unit, or even to give complete freedom to his dependant to engage in whatever economic activity he might choose. The extent of the principal's liability would of course vary accordingly.

Another interesting contribution of the juristic sources concerns the definition of the enterprise as an economic and managerial unit. This is to be found in the discussion of a specific aspect of the law of succession, namely the technicalities surrounding the legacy of an estate fully equipped with a view to undisturbed operation (Dig. 33.7). There we learn that staff and managers, as well as the basic tools necessary for the production, were considered an integrated part of the unit, and would go with it in the event of a succession, and, I surmise, of a sale or lease.

In the legal sources, business managers are called institores, obviously a generic term used to describe a legal position rather than a specific function. An institor was basically a manager who had been appointed (praepositus) to the head of an economic unit, and who, in that capacity, was likely to negotiate various contracts with suppliers of material, labour, and services, as well as with customers. Principals had unrestricted power of control over their managers' activities, and could interfere at any moment and in any way they chose. Whether a principal could also suspend the appointment, temporarily or permanently, depended upon the nature of the legal relationship established between them.

The personal profile of the manager, in terms of freedom (and, of course, citizenship), gender and age, was less relevant in economic terms. What should be investigated at this point is the functional aspect of the institorian arrangement.

MANAGING NON-AGRICULTURAL PRODUCTION

Business managers in ancient Rome: evidence and approaches

Legal, literary, and epigraphical sources

If management is to be understood in a narrow sense as the sum of all tactical decisions made by people appointed as the head of an economic unit in connection with the operation of that unit, the best way to reconstruct Roman management would be to investigate how actual units were run. Of course, the legal sources have little to say about that. But the casuistic approach of classical jurisprudence discloses in which sectors institores were known to be active in Roman society. Whereas most excerpts refer to institores as being in charge of a taberna, a non-specific term used to designate any kind of shop, some texts mention institores employed, for instance, in the garment industry, retail trade, banking, real estate, undertaking and, rather ambiguously, agriculture.

This functional approach could be extended to non-legal sources, that is literary texts and Latin inscriptions. The former category is not helpful, because the word institor is used there in a non-specific, often derogatory meaning, to designate a lower class profiteer whose existence and activity provided no benefit to Roman society. No wonder then that institores as such almost never appear in Latin inscriptions: out of six known cases of probably imperial date (three from Italy, one from Noricum, one from Macedonia, one from Spain), two institores were involved in the perfume industry or trade, respectively as unguentarius and sepulcrarius, one was a shoemaker (sutor caligarum), one possibly a bathkeeper, and one possibly the manager of a relay station. The recent discovery of the epitaph of Aulus Estrilius adds a possible arms dealer, of libertine status and perhaps Italian origin, buried near Cordoba in the province of Baetica. From this scant evidence, we are forced to admit either that the Roman jurists created a fiction in their lengthy discussion of the actio institoria (Dig. 14.3) or that institores went by a variety of different names in real life. This second hypothesis is confirmed by the fact that managers of agricultural estates, explicitly discussed by the jurists Labeo/Ulpian and Paul in connection with the actio institoria, were known as vilici, a term also commonly used in connection with non-agricultural activities in both epigraphic and literary sources (as well as in the Theodosian Code).

This equation/identification (vilici = institor) is of fundamental importance for several reasons. First, it means that the list of economic sectors in which institores were reportedly active is much longer than that provided by the legal sources. However, such a list will never be comprehensive, the evidence being selective by nature. Second, it is possible to build a large, ever growing data-bank of Latin inscriptions featuring vilici, which provides the necessary basis for a prosopographical study revealing possible geographical variations and functional diversity (tax collection, water supply, lead
workshops, etc.). Third, there are good reasons to think that *vilicus* was not the only label used by ancient business managers to refer to their occupational position, and that other Latin or Greek words designating professionals could have been used in the same way (cf. *actor, magister pecoris, insularius, officinator*, etc.), allowing additional prosopographical lists to be built up.

Fourth, the Roman agricultural treatises underline a few concepts relative to the management of agricultural estates, from which it may be possible to extrapolate the methods of management used in other types of economic units. However, the Roman agronomists belong to the most conservative layer of Roman society, namely the landed aristocracy, and their works are more normative than descriptive (they say what *vilicus* should do, not what they were actually doing, and the difference is significant). To what extent these treatises can be used to illustrate the management of, say, a workshop producing terracotta lamps, an inn, or a commercial ship is hard to establish. Fifth, the terminology sometimes reveals controversial technicalities. For instance, the legal sources mention that shipmasters appointed by shippers could occasionally appoint a substitute as sub-agent. The passage by Ulpian, quoting Julianus, has been rejected as interpolated by some scholars, but is vindicated by the manifold occurrences of *subvilicus* and *subactores* in Italian inscriptions.

### Archaeological material

Based on legal, epigraphical, and literary material, the functional and prosopographical approaches remain problematic, because they provide little diachronic perspective on the phenomenon of business management. How long did a particular workshop keep producing the same items? How far away were these distributed? Duration of activity and spatial range of distribution can be seen as the result of managerial decisions if marketing was not carried out by an independent trader. A study of the archaeological material helps to overcome the limitation of written evidence. The remains of various types of clay artefacts, signed by the producer(s), have been found in significant quantities in areas sometimes wide apart, so that the question of a possible distribution or relocation of centres of production and of differentiated marketing practices has arisen. In this respect, petrological analysis of artefacts, their dating on the basis of typology or archaeological context, and the making of distribution maps can reveal specific details about the production and distribution policy chosen by individual enterprises. Admittedly, this sounds more like a matter of strategy than tactics.

Artefacts made in several parts or stages, such as moulded or decorated pottery with stands and handles, or lamps with tanks and lids, occasionally display more than one signature. When any of these signatures is not visible without dismantling the finished object, the addressee is not the customer, but someone involved in the manufacturing process. Thus, it could be suggested that the manufacturing of some parts was contracted out, or carried out in separate sections of a workshop. The signing of individual parts allowed a central authority (the manager?) to apportion blame or praise for the quality of work at a lower level.

Workshops can also be identified through excavated waste dumps, and their output estimated, for example on the basis of the size of kilns, drying sheds, or levigation tanks. In urban workshops located in the front of aristocratic houses, for instance at Pompeii, the relationship between the owner of the house and the manager of the shop has been analysed on the basis of the existence of direct access from shop to dwelling quarters. Though this reveals the involvement of the local elite in retail trade or craft production, it says little about managerial practices other than that supervision by the principal was facilitated by easy access and proximity (Parkins 1995, Chapter 1). However, the evidence suggests that despite certain similarities, the practical application of management in a wide range of different productive activities showed great diversity.

What is needed is more detailed study of the interaction between management and workers within a managerial unit, and the intricacies of the organizational activity of business managers in a given sector of the Roman economy. These are best illustrated by the study of coinage, which suggests the presence of competing workshops within the mint, possibly as a way to foster internal competition and thus increase productivity. But again, we are dealing here with a very specific activity, namely a state monopoly, hardly comparable with more competitive sectors, such as the food, garment, or ceramic industries. Fortunately, we are left with another type of evidence which has not been used so far for this purpose, namely the papyri from Roman Egypt. Because of their particular nature, especially the provincial origin of almost any such document, any extrapolation of the conclusion reached on this basis will have to be critically reviewed.

### Papyrological sources from Roman Egypt

While Egypt may have resembled the rest of the empire to a higher degree than was once thought, some striking differences had a bearing on the nature and organization of the economy. First, rural slaves are almost non-existent in our sources, and urban slaves not very numerous, whereas the sources indicate a different picture for Italy and some other Western provinces, where those who can be identified as business managers were overwhelmingly of servile status or origin. Slaves provided labour, but were regarded as a form of capital investment, whose idleness, like that of draft animals, was costly and therefore to be avoided in any possible way. Italian managers found a solution to this problem in the development of other types of economic activities, some of them agriculture related (such as forestry or quarrying), others of non-agricultural nature, like producing
building material or providing overnight hospitality for travellers. In Egypt, the absence of rural slavery and the exceptional fertility of the soil, as a result of the yearly flooding of the Nile, were favourable to a small peasantry engaged in nothing but agriculture-related activities.

Second, our evidence comes mostly from the chora, so that urban activities are not so precisely documented as could be expected from the number of extant and published papyri. In fact, a survey of all documentary papyri published over sixty-three volumes of the Oxyrhynchus papyri proved rather disappointing from the viewpoint of the importance of non-agricultural economic activities in the written evidence. To what extent the result of such a test reflects the reality of urban economic life is hard to ascertain. The least that can be said is that if urban workshops were numerically or economically important, they simply did not generate the same paperwork as agricultural activities, either qualitatively or quantitatively speaking. Moreover, what has come down to us rarely illustrates the kind of enterprises that our archaeological, legal, and epigraphical sources from Italy and the Western provinces record.

The complexity of the available papyrological evidence for management of agricultural estates is well illustrated by the so-called archive of the descendants of Laches, made of some eighty papyri of the second century AD discovered in the Fayyum village of Tebynis. The estate was composed of scattered plots producing grains, fodder, reeds, wine, and fruits. Since the owners seem to have had little interest in agriculture, the management of the land was entrusted to phrontitai supervising a mixed labour force, composed of workers permanently attached to the estate and of day labourers. The account books of these phrontitai record the volume of daily transactions, the number of hired hands for each day and the rate of remuneration for various tasks. The phrontitai were in charge of organizing the maintenance work of the irrigation system, and the distribution and use of fertilizers (dung); they also contracted out various types of agricultural work, hired regular shepherds and goatherds, rented out draft animals such as oxen, donkeys, mules and horses, drew and copied contracts of leases, and paid out salaries in money and in kind. They were working themselves on a contractual basis, for an unknown period of time, and could be promoted to other positions within the administrative staff of the estate. Because of the general lack of involvement on the part of the landowners, it is reasonable to suggest that one of the phrontitai may have been the designer of the revolutionary and highly successful system of crop rotation used all over the estate (Bagnall 1974).

The archive of Heroninus reveals the level of complexity required by the management of large estates (Rathbone 1991). Some 450 published documents, perhaps only half of what has been preserved, provide detailed evidence for the activity of a phrontitas based in the Fayyum village of Theadelphia between AD 249 and 268 and his relationship with the managers and staff of other similar units, in particular with the central administration of the estate owned by one Aurelius Appianus, a citizen from Alexandria and a member of the provincial élite. Rathbone convincingly showed that Heroninus’ management was geared toward the production of a marketable surplus of agricultural products, mostly wine, while retaining some degree of self-sufficiency, if not at the level of his unit (phrontitis), at least within a group of similar units. What is remarkable is that, in contrast to what has just been said in connection with the management of the estate of the Laches family, a phrontitis like Heroninus was more involved in accounting than in making contracts, this aspect of management being handled by the central administration located in nearby Arsinoe and represented by the local gentry. Also, all non-agricultural tasks, as well as those requiring intensive supervision or implying a financial risk, were contracted out to villagers, i.e. independent craftsmen who were not attached to Appianus’ estate. Thus, wine containers were produced outside, and the management of facilities such as weaving workshops, mills, olive and wine presses, baths, etc. was systematically contracted out. We are admittedly far from the Italian model of the villa economy, but nothing indicates that the management of Appianus’ estate should be considered as the norm in Roman Egypt.

Turning to urban activities, we can only deplore the lack of such integrated collections of documents. Evidence for workshop management has come down to us in the form of isolated contracts or business letters, the context of which is not to be reconstructed as in any way approaching the detailed richness of archives pertaining to agricultural estates. Exceptionally, some clusters appear, such as three famous papyri from Oxyrhynchus preserving mid-third century leases of a potter’s workshop. In the earliest and fullest document (3593, AD 243), the lessee, a potter specializing in the manufacture of wine jars, rented the facilities attached to a large farmstead, fully equipped with store rooms, kiln, potter’s wheel, and all the necessary tools, for a period of two years, on the condition that he would make and deliver on a fixed date to the lessees 15,000 four-chous jars of a specific kind known as Oxyrhynchite, 150 double keramia, 150 two-chous jars, all fully coated with pitch, leak-free, flawless, and brand new, for the price of 4,800 drachmas and a certain quantity of wine and vinegar. All the production exceeding the above quota could be bought by the lessees, if they had a need of it. Clay, firing material, water, and pitch were provided by the lessees, while the necessary labour (potters, assistants, and stokers) was left to the responsibility of the lessee, who promised to return the workshop free of ash and sherds when the lease was up. For all the details of its fifty-three lines (the contract is fully preserved) and the interest that lies in the nature of the legal transaction, this document tells us...
virtually nothing about the actual management of the workshop except for the fact that the lease precisely defines the productivity of the workshop in quantitative and qualitative terms. The two related documents present some minor variants (different potter, workshop, and lessors), but are basically so similar in form and content that nothing can be gained from the clustering of these papyri.

This is not to say that the papyri shed no light on our topic. Some sectors of the economy, for example, the garment industry, are actually well known, and have been the subject of book-length monographs (for instance, Wipszyczka 1965), and new documents keep cropping up. They occasionally illustrate the nature of the relationship between employer and employees. Thus, in a recently published receipt from Oxyrhynchus dated to 304 (P. Oxy. liii, 4353), a tapestry weaver (tapetophoros) acknowledges the advance payment of two talents from the master of the workshop (epistates ergasterion), binding himself to work in the workshop for a fixed salary, and to return the full amount paid in advance in case he ever leaves the workshop (no term is stipulated for the end of the contract). Here again, not much information pertains to the actual management of the workshop, except for the fact that some workers were obviously hired and paid in advance to ensure their co-operation on a long-term basis. The terminology designating the employer and the provision relative to the employee's possible absence are reminiscent of apprenticeship contracts. Another document from Panopolis, dated to 3 September 355, records the lease of part of a linen-weaving workshop (ergasterion linouphikon) equipped with two loom-frames (pigmata = pigma) and their appliances, for an unlimited period of time (as long as the owner, also a weaver, wants to rent it) for the modest sum of 200 silver talents for the premises in addition to ten woven linen items for the loom-frames, the material being provided by the owner.

The papyri are not even very explicit about the application of the insitiorian arrangement in Roman Egypt. It is true that the law in use in that province could be very different from what we know through the Corpus Iuris Civilis. A few papyri, however, can be interpreted as referring to insitiores. Thus, the estate of Tiberius Iulius Theon, a well-to-do Alexandrian who died by 111 (P. Oxy. xliv, 3197), included, before its division among his descendants, between fifty-nine and 100 slaves, an exceptionally high number for Roman Egypt. Some of them were skilled workers, and most of them were living away, scattered through the Oxyrhynchite, Hermopolite, and Arsinoite nomes. It is possible that they had an economic activity more or less independent from their master, to whom they must have paid the apohora, a percentage of their profits (Bizeunska-Malowist 1965). This is a mere conjecture and tells us nothing about the slaves' activities. Their dispersal and the distance between their master's residence and the seat of their activities are consistent with what we know of the insitiorian arrangement, but do not demonstrate it.

Such slaves may have been so successful as to raise suspicion concerning their honesty. We have a letter in Latin, dated to the Augustan period, addressed to a member of the familia Cassarit, and reporting the speculative activities of a slave who had made such an unusual profit that his owner had been dutifully warned by a banker from Oxyrhynchus: 'whoever makes such a big profit out of such a small investment is bent on killing his master.'

This case is not necessarily representative of the ancient attitude toward profit making.

Elsewhere, we read about the 'foreman' of a weaving workshop (ergasteria horchis linouphon) employing 'scores' of workers and supplying the government: for that reason he claims for himself exemption from liturgical services, while his opponent counters that he is nothing but a well-to-do perfume dealer, therefore not entitled to any advantage. And what about that runaway slave, weaver by trade, aged thirty-two, who spoke loud and walked as if he were important? The responsibilities he was entrusted with, and the privileges probably attached to his position, did not prevent him from abandoning it (P. Oxy. li, 3617, third century).

There are also those contracts of apprenticeship, so standard that they tell us virtually nothing about the specifics of workshop management. Training, however, is an important aspect of business management. The duration of such contracts, and the conditions contained in them imply serious concern for the transmission of professional skills. How common and widespread those arrangements were, however, is hard to ascertain.

The mid-fourth century accounts of the relay stations at Tacona and Oxyrhynchus provide some useful insights into non-agricultural management. They list guests staying overnight, with the number of animals they travelled with, and the rations issued on any given day in the months of October to December, and June. Each entry includes the number of travelers in each party, the direction (north or south) in which they travel, the duration of their stay (one day at Tacona, two in Oxyrhynchus, three altogether), the quantity of food and fodder issued to them daily (one sixth of a modius of wheat, one sextarius of wine, half a litra of meat; half a modius of barley and twenty litrai of chaff). Since each party was different in size, some being quite large (up to fifty-two persons in one group), and since two groups travelling in opposite directions could stop the same night at the same relay (up to ninety people with their animals stopped on one night), the amount of food and fodder to be provided clearly varied from one day to the next and was somewhat unpredictable. One can imagine how much planning skill the managers of those relay stations were required to display to satisfy their customers' expectations while cutting the costs of wasting perishable resources (such as meat). From the survey of several thousand papyri found in Oxyrhynchus, it appears that non-agricultural activities are scarcely documented. One category of business agents, however, is often mentioned in the papyri and
would repay a special study: the *praemunienta.* Like their probable Latin equivalents (*actores*), they were tied to a person rather than to a business or managerial unit. Finally, let us say that later documents tend to be longer, more detailed, and more pertinent to the kind of business transactions discussed in this paper. In that regard, a study of the fifth to seventh century Flavius Apion archive would throw lights on interesting aspects of work relationship in both the agricultural and non-agricultural sectors.

**Conclusion: new approaches to palliate the deficiencies of the evidence**

The ancient evidence, for all its diversity, chronological and geographical range, and sheer abundance, still fails to provide an adequate basis for the study of economic aspects of business management. This negative conclusion finds its explanation in the fact that ancient management was mostly approached empirically, and was not deemed worth the trouble of a theoretical discussion on the part of ancient writers, except in the field of agriculture.

Few modern scholars have studied ancient management, and the few exceptions have mostly been content with formulating a list of questions likely to find an obvious answer in the available ancient evidence. This methodological approach has reached its limits. Progress could be made by borrowing from modern theoreticians, such as Frederic Taylor, Henri Fayol, or Max Weber, the basic conceptual framework upon which the study of the evolution of ancient management thought and practice has to be built.

Such an approach should take into account the size of enterprises, their geographical location and distribution, the diversification of the production and the task specialization (division of labour) within each economic unit, the level of globalization of the economy in relation to imports and exports, and their respective economic rationality, as well as the available technical means, including accounting practices, literacy and numeracy levels, and communications. It is necessary to measure the economic and organizational impact of institutional developments, such as that of the imperial, provincial, municipal, and local administrations, the professional and other voluntary associations (Aubert 1999b), the Christian Church, the Roman army, and the *cursus publicus.* By way of comparison, it has been shown that the modern science of management changed drastically with the development of the railroad in nineteenth century America which entitled an unusually large and complex type of enterprise involving an enormous financial capital investment across a huge geographical space (Wren 1994, 75–82).

Ancient historians have given less attention to labour than to the use of land, natural resources, and technology, even though labour in non-agricultural sectors was probably more important than any other factor of production. For instance, we know little about ancient unemployment, permanent or seasonal, and about its impact upon social and economic life in antiquity (Pleket 1988), even though Artemidorus of Daldis, in his book on the interpretation of dreams, reveals that ancient people may have been deeply concerned about it, as he lists no less than twenty-one cases of impending *schola, appraxis, or apragia:* 'if someone dreams that he has been borne by a woman of no particular standing, it means the following: for a poor man, it is positive, because someone will feed him, like a newborn, unless he is a craftsman. In that case, the dream warns of forthcoming unemployment, because newborns are idle and have their hands swaddled.'

Likewise, strikes would repay a new study, to which the papyri have much to contribute. A papyrus from Hermopolis, dated to 16 July, 116, preserves a letter from one Eudaemonis to her daughter Aline, whose husband owned several weaving workshops in Hermopolis. The mother reports experiencing significant difficulties with the workforce employed in one of the workshops. Some workers seem to have been on strike, blocking the whole productive process, in spite of her hiring substitute female workers. The writer also alludes to the fact that some or all of the workers went demonstrating in town in order to get a raise. It sounds as if the mother was acting in the capacity of her daughter's agent or manager while the latter was on maternity leave.

Other demonstrations for the defence of professional interests are known to have occurred, as in the famous case of the silversmith, Demetrius of Ephesus (*Acts* 19: 23–40), who spoke in anger against the threat mounted by early Christianity against the prosperity of the local temple of Artemis, and the trade in silver statues connected with it. The ensuing disorder was put down by Roman forces, after negotiations introduced by the local authorities between the craftsmen on the one hand and Paul and his group of Jews and Christians on the other failed to yield satisfactory results (van Minnen 1987, 57 with bibliography).

Modern studies on labour in the Roman world have traditionally focused on slavery (de Robertis 1963 is an exception), a social phenomenon that precludes any comparison with the modern concept of labour in the capitalist age. Yet some comparisons with modern conditions are sensible, if they are introduced with due caution, because any economic activity that relied on a skilled and sometimes highly specialized workforce necessarily implied good-will and co-operation on the part of all those involved in the productive process. Thus, entrepreneurs and managers had to concentrate on the real, perennial problems of organization, and to provide for the recruitment, training, selection, specialization, promotion, and motivation of workers with regard to short- and long-term objectives. That is where the approach devised by the pioneers of the so-called scientific management era can usefully be tried as a magnifying glass, in spite of the manifold risks of distortion. It is only with such a change in perspective that modern scholars can expect to be able to reconstruct the history of ancient business management.
HISTORICAL DISCOURSE SHOULD NOT BE RELENTLESS TO USE MODERN CONCEPTS AND CRITERIA TO FORMULATE THE THEORETICAL BASIS FOR THE STUDY OF A RANGE OF ACTIVITIES THAT CLEARLY FALL OUTSIDE THE SPHERE OF INTEREST OF ANCIENT WRITERS.

NOTES

1 Paus. Gargola 1996, 1527. Periodization, for instance, is imposed by the appearance and disappearance of the evidence (legal, epigraphic), but does not imply that economic conditions changed drastically at either end of the chronological spectrum (second century BC/mid-third century AD): the papyri sometimes show that continuity is warranted.

2 Wren 1994, 3-33, esp. 17-19 on Greece and Rome.


4 Zimmer 1982: nos. 18 (ombstone of M. Vergilius Euryxaces, pater redemptor, Rome); 38 and 39 (funeral reliefs, woolen artefacts, Florence); 42 and 43 (shop-sign, fullonica of M. Vecellius Verecundus, Pompeii); and 121 (relief, metal workshop, Nafplio).

5 Huvelin 1929, 176-83; Behrends 1981; Serra 1989; Aubert 1994 and 1999a. Time is ripe for a new synthesis on Roman commercial law.


7 Hessiod, Opera et Dies, 11-26 (productivity); 286-319, and pamm (hard work); 320-41 (honesty); 342-60 (good social behaviour); 341, 361-2 (modest growth); 364-5 (self-sufficiency); 370 (contracts); 470, 502, 573, 597-608 (slave labour); and 618-94 (seaborne commerce).

8 Xenophon, Oeconomicus, 6. 6-8 (agriculture vs. crafts); 7 and 9 (staff organization and training); 9, 11-13 (debt and incentive); 12-14 (psychological aspects of management); 15-20 (technical knowledge); 21. 2. 9, and 11 (leadership), with Pomperus' excellent commentary (1994).

9 Pseudo-Aristotle, Oeconomicus 1344 a 26 (acquisition and training of staff); 1344 b 31 and 1345 a 18 (accounting); 1346 a 15 (expenditure vis. income).

10 Evidence, discussion and bibliography in Aubert 1994, chapters 1 and 2.

11 Andreau 1987; Petrucci 1991.

12 CIL vi. 10007 (Rome, umautos); CIL vi. 3027 (Teate Marciusinorum, Regio iv, autort Caesariana); CIL xi. 1621 (Florentia, Regio vii, iepoliassarum); CIL iii. 13232, Tuller/Noricum, fustarii?; CIL iii. 14206.21, Karakava/Macedonia, tabernarii). Aubert 1994, 444 – Appendix A.13

13 CIL ii. 2. 7. 337: Initator armatis f is able to read arm [ionou] (arms maker or dealer), armantendorum [maker or trader in nautical equipment], armantendorum [involved in cattle breeding], armili [supplier of wine containers] or armili [jeweller].

14 Ulpius (28 ad ed.), citing Labeo, Dig. 14. 3. 5. 2: Labeo quoque scriptius, si quis pacem interrassas, agris colendas, mercaturas redemptivam faciendi praepositorii, in sumo tan veri. (Labeo also wrote that if someone appointed a business manager to lend money, to run an agricultural estate or to trade or to carry out public contracts, he would be liable in full...). Paul (29 ad. ed.), Dig. 14. 3. 16: Si cum vinicium aliud contractum si non datur in dominio activo, quo in pacta proprius fructus perigendus; non proprius quantum praepositorii. Si tanem villicum dispendiosum quae meritis praepositorii habuero, non orit requir or eximia institoris actio sine contracte. (If someone has entered into a contract with another farmer's manager, no legal remedy would be given against the latter's master/principal, because the farm manager is supposed to be appointed in order to farm the land, not to trade. However, if I appointed a farm manager in order to sell goods, it would not be unfair to hold me liable on an action on the analogy with the institor's remedy). Cf. Diodorus Sardensitae 8.2 and Aubert 1994, 4-9 for an explanation of the apparent contradiction between Labeo/Ulpian and Paul.
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BRICKS AND MORTAR
Exploring the economics of building techniques at Rome and Ostia

Janet DeLaine

Introduction

The development of a strongly mortared rubble construction (usually but misleadingly called 'concrete') is commonly held to be one of the greatest technical achievements of ancient Rome. The secret lies in the careful mixture of the local volcanic sand (now called pozzolana) and a pure high-quality lime, to produce a hydraulic mortar of great strength easily comparable to the best of modern mortars. Without it, it can be argued, the great domed and vaulted structures of such architectural and engineering masterpieces as the Pantheon and the imperial thermae would not have been possible. On the other hand, Roman 'concrete' has been characterized as a quick and economical substitute for ashlar masonry, being both cheap in terms of the cost of the basic materials and also far less dependent on highly skilled labour. Its relative cheapness is thought to be what made it feasible also for everyday domestic and commercial construction where solidity and fire resistance were sought after, as demonstrated so vividly in the warehouses and apartment blocks of imperial Ostia. Indeed, Coarelli (1977, 16-17) has argued that it was largely the upsurge in private building in Rome during the second century BC that led to the development of the technique in the first place.

The possible socio-economic implications of this technological change have been much discussed in one particular case; the increased regularization of the facing blocks between the early opus incertum and opus reticulatum. The argument is that the change in technique reflects an increased 'industrialization' of the building process and a division of labour between the makers of the individual uniform components (the reticulate blocks), whose work could easily have been done at the quarry or at least away from the building site, and the builders themselves. This is thought to reduce the time taken by the builder to shape and fit the facing stones on site, and possibly also the level of skill needed by the builder. The chronology of this development, beginning in the late second century BC, allows it to be associated with the (assumed) rise in large slave-run estates and the parallel specialization in agriculture. While no precise comparison is made between opus incertum and opus reticulatum, the suggestion is clearly that the latter brought with it some kind of economic advantage.

Despite their potential importance, neither of these hypotheses – that Roman mortared rubble is more economical than ashlar, and that there is a very different distribution of labour between opus incertum and opus reticulatum which has economic implications – has ever been fully explored. Nor has the equally dramatic change from facing in opus reticulatum to facing in brick, or in a mixture of the two, been rigorously assessed, although Torelli (1980, 158-9) has attempted to relate it once more to changes in agricultural production. Even the existing discussions concentrate on isolated factors, such as the change in facing style, despite the fact that concrete construction in particular requires the processing, transport, and combination of several different materials needed for face, mortar and core. Any given wall requires several choices to be made: about the nature of the construction, such as the size of the piece of core aggregate, the proportion of mortar to aggregate, or the type of facing; about the sources of supply of the different materials; and about the amount and quality of processing given to them, for example in shaping facing blocks or burning and slaking the lime for mortar. All of these have labour or transport implications, some more substantial than others, which have to be weighed against each other. If we are to come closer to understanding whether economics, or labour distribution, or ideology, or any other consideration had the most important role in determining the nature of Roman construction, more wide-ranging discussion of all the numerous factors which affected the economics of construction is clearly needed, as is a quantitative approach to the subject which will allow weights to be assigned to the different variables for comparison.

These are matters of more than passing concern. Building is labour intensive, and construction and its allied occupations – the production of building materials and the decorative trades – historically account for a substantial proportion of the productive labour of urban centres. Extrapolating from figures based on the building industry of Severan Rome, it is possible that during much of the last two centuries BC and the first two centuries AD when public building was flourishing, as much as 4-6 per cent of the total population of Rome could have been employed in the building industry. Thus any changes in the technology, materials, or organization of public and domestic construction which could be shown to have economic and/or social implications, would have been particularly significant for the urban population of Rome. In addition, understanding the nature and scale of public and domestic construction is an essential part of understanding urban development as a process, and this is particularly important for domestic and commercial buildings where we have virtually no textual evidence to help identify agency or source of funding.
What is attempted here is only a first step in addressing these problems. The work is presented as three quantitative exercises: the first is intended to identify the most important factors involved in the construction of just a cubic metre of concrete wall; the second is an exploration of the economics of building in *opus reticulatum* compared with building in brick and *opus incertum*, based on the techniques used in Hadrianic Ostia; and the third returns to the question of the relative cost of ashlar and concrete. Initially, however, something must be said about the basic methodology.

The problems of assigning values

It is perhaps not surprising that the economics of Roman construction have rarely been examined in quantitative terms, as the ancient sources seldom inform us directly of the detailed costs of construction. For the Roman period, even the kind of detailed building accounts for specific projects, which have been used so successfully to explore the economics and logistics of construction in the Greek world (e.g. Burford 1969), no longer exist. Very few costs for building labour and materials survive from the Roman world at large, and most of these are from Roman Egypt. The one exception is the related set of maximum prices and wages provided by the Prices Edict of Diocletian, which gives an indication of the general cost of labour per day for various trades in the building industry as well as prices for some building materials such as timber and brick. On its own, however, this cannot be used to determine the difference in cost or labour requirements between ashlar and mortared rubble construction or between different types of facing for mortar-laid rubble; another element is needed. It is a well-established and fundamental principle of quantity surveying that the prime cost of any type of construction is determined by the amount and type of labour expended in producing the necessary building materials and putting them into place, plus the cost of transporting the materials and of the operation of any plant used in the construction process. In any building which uses non-mechanized means of construction, the operation of plant is a minor item, and the basic cost of construction is dependent on the amount and quality of basic labour.

The critical missing factor for the Roman world is any work rates for specific building tasks. In their absence we have to rely on data from more recent building practice, particularly the handbooks for building surveyors and architects, popular all over nineteenth-century Europe, which give time constants of labour for a variety of building tasks. The most useful handbooks for assessing construction in Rome itself are therefore those produced in Italy, since they relate to many of the materials and some of the techniques once used in ancient Rome; the one used here is Pegoretti (1869). These can be supplemented by earlier data, usually in the form of building accounts, and by experimental archaeology. The two threads which link such material to ancient Roman practice are the immutability of physical properties of building materials, and the highly conservative nature of much traditional building practice, clearly illustrated by the very close parallels between the very few surviving depictions of Roman builders at work, such as the famous painting from the Tomb of Trebius Justus, and medieval and later – even quite recent – practice. Traditional stoneworking tools and the bricklayer’s trowel, for example, remain little changed today, while tread-mill operated cranes were still being used as far apart as France and Australia into the late nineteenth-century.

Such use of historical analogy, however, has its problems, which we need to keep in mind. Even in those areas such as bricklaying and ashlar construction where ancient and historical techniques are directly comparable, we have to make allowances for working conditions and expectations of labour output in the Roman world being different from later practice. For example, while we can make an assumption that the maximum working day was twelve hours in the building industry, we have no way of knowing how many hours were actually worked in a day, and if this was standard or not; likewise, we cannot know how hard any individual did work, only what might be the maximum possible expected output per man. For some tasks, such as building in *opus incertum* and *opus reticulatum*, there are no precise, direct parallels, and hence no simple set of figures on which to base calculations. In this case the steps involved in the building technique have to be assessed carefully, alternative ways of doing things considered, and assumptions made about the labour values for various actions. Nevertheless, crude manpower estimates can be made, but they will be less secure than those for historically well-attested techniques. Where it has been necessary to create labour constants in this way, the rationale is discussed in some detail in the text. Throughout, the assumptions are designed to produce the minimum possible overall figure; there is no way of estimating the maximum.

While quantities of labour can therefore be generated for different modes of construction and the production of different building materials, finding a way to calculate relative costs is far more difficult. The point of reference has to be the Prices Edict of Diocletian, despite the problems involved (see p. 232 and n. 8). The most useful section is 7.1, which gives daily rates of pay for, among others, different types of skilled building workers and decorators, and for general unskilled labour. Most skilled but not highly specialized trades earn a maximum of 50 *denarii* per day plus food, while the basic labourers earn half that rate. It is also possible from the Edict to produce rough relative costs of different types of transport, giving a ratio for sea: river downstream: river upstream: ox-cart on land of 1: 3.9: 7.7: 42, although the exercise creates its own difficulties. Furthermore, in order to link the figures for labour with those for transport, the absolute values given in the Edict need to be used, which means that some value has to be assigned to the food element of the labour rates. The simplest line of reasoning would give this at the equivalent of the standard corn dole of 5 *modii* per month.
irrespective of rate of pay;\textsuperscript{13} taking into account the cost of wheat in the Edict, this gives equivalent daily rates for skilled tradesmen and labourers of 61 and 36 denarii. From here we can express all the required rates as multiples of a labourer's daily pay: a skilled workman earns 1.69 times as much, while the cost of moving one tonne one Roman mile costs 1.44 times as much by ox-cart, 0.26 times as much by river upstream, 0.13 times as much by river downstream, and 0.035 times as much by sea. The kind of same exercise can be used for fuel equivalents, giving a possible figure of eleven times a labourer's daily pay for each tonne.

It must be stressed that these relationships are only approximations, which, even if they actually held good at the time of Diocletian, cannot necessarily be held to apply to earlier periods in Rome; but they are the best we have. In addition, calculating the costs of materials production and construction from simple labour and transport costs can only give an estimate of the minimum building cost, as it takes no account of waste, graft, profit or any other intangibles. The distribution of labour between skilled workers of different kinds and labourers is also only approximate. The figures can therefore only be used as a very rough guide, and this is indicated in the final values always being rounded off to only two significant figures although even this gives rather a false sense of accuracy.

### Labour for concrete construction

Unlike modern concrete, where the aggregate is mixed with mortar and poured into formwork, Roman 'concrete' walls were laid more in the manner of modern brickwork. Several rows of the facing on either side of the wall were laid in a fairly stiff mortar, which then formed a permanent formwork for the core of the wall. In the best Roman 'concrete', the core was formed from alternate layers of rubble and a stiff mortar, with the individual pieces of core laid evenly by hand. This can be seen in exposed core of the Baths of Caracalla and other buildings, where in places the mortar clearly lies in layers above and below the layers of rubble, but not always between adjacent pieces. In poorer quality walls the rubble is thrown in more irregularly, but there is no evidence to show that the rubble and mortar were ever mixed together first and then thrown into the core. Thus the labour requirements for a given volume of 'concrete' wall will depend primarily on the number of pieces of rubble core and facing to be put in place, and the speed at which each is laid. All this is simple common sense. To take the argument further requires assigning specific work-rate values to individual actions.

Historical sources offer two approaches. The first is an overall rate per unit volume of rubblework or brickwork, sometimes expressed as a formula to take into account the differential rates for facing and core. The chief difficulty with this approach is that of identifying the size and nature of the elements concerned, and the degree of finish subsumed under the general rate.

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<th>Table II. Historical rates for bricklayers.</th>
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</tbody>
</table>

Pegoretti's formula for brickwork is a partial exception, since it includes a factor which allows for different sized bricks and different proportions of brick to mortar (1869, ii 144-5). The actual formula is: time in hours/m² = t + 0.03(a - 1) + 0.4/g, where a = height of the wall, g = thickness of the wall, and t = 0.8 hour for every 100 bricks used in each cubic metre of finished wall. Such a formula cannot, however, be adjusted to account for, say, laying reticulate pieces as opposed to bricks.

The second, and more appropriate, method is a piecework rate, expressed in the number of bricks laid each day by a bricklayer for different types of work (Table II.1). Rough brickwork forming the inside of walls has no facing joints, ordinary brickwork is reasonably neat but intended to be plastered over, facework includes all kinds of special treatment of bricks and joints for brickwork which is meant for the final surface. The figures assume that the bricklayer has all the materials to hand, which means that these need to be prepared and supplied by one or more labourers, depending on the amount of preparation needed by the materials and the conditions under which the bricklayer is working. Most of the historical figures allow one labourer for every bricklayer, which allows relatively more time for the selection and preparation of bricks and mortar for fine facework by the labourer as well as more time for the bricklayer to put them in place.

The consistency of these figures is reassuring. Since the rate at which a man can lay bricks does not depend on the shape or size of the brick, provided that it can be held in one hand, it is reasonable to apply these figures also to the laying of Roman bricks. For any Roman brickwork without special treatment of the joints, for example on utilitarian structures and interior and exterior walls which were meant to be covered over, a figure of 1000/day (roughly one piece every 35 seconds) seems appropriate, with something between 700 and 500/day (roughly one every 50 to 70 seconds) for the finer work associated with, for example, the facades of buildings like the Markets of Trajan or the fine-jointed polychrome brick facades of some second century tombs.\textsuperscript{14}

Similar values ought also to apply to reticulate. Reticulate blocks appear to have been laid like brick with reasonably uniform joints, so that the speed
Table 11.2 Estimated work rates for concrete construction (mason and labourer) for a 2 ft wall.

<table>
<thead>
<tr>
<th>Example</th>
<th>Building type</th>
<th>Size of facing elements (cm)</th>
<th>No. in 1 m²</th>
<th>Size of aggregate (cm) **</th>
<th>Volume aggregate (cm) **</th>
<th>Rate face</th>
<th>Days/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porticus Aemilia, Rome</td>
<td>Commercial</td>
<td>7-11</td>
<td>136</td>
<td>7 x 11</td>
<td>330</td>
<td>500</td>
<td>1.5</td>
</tr>
<tr>
<td>Casa dei Crii, Rome</td>
<td>Domestic</td>
<td>5-6</td>
<td>348</td>
<td>5 x 7</td>
<td>110</td>
<td>500</td>
<td>1.7</td>
</tr>
<tr>
<td>Casette Tipo, Ostia</td>
<td>Domestic</td>
<td>7-9</td>
<td>166</td>
<td>7 x 12</td>
<td>370</td>
<td>500</td>
<td>1.6</td>
</tr>
</tbody>
</table>

### Opus reticulatum

<table>
<thead>
<tr>
<th>Example</th>
<th>Building type</th>
<th>Size of facing elements (cm)</th>
<th>No. in 1 m²</th>
<th>Size of aggregate (cm) **</th>
<th>Volume aggregate (cm) **</th>
<th>Rate face</th>
<th>Days/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theatre of Pompey, Rome</td>
<td>Public</td>
<td>5 x 5</td>
<td>272</td>
<td>5 x 9</td>
<td>140</td>
<td>700</td>
<td>2.8</td>
</tr>
<tr>
<td>Trajanic forum, Forum</td>
<td>Commercial</td>
<td>10 x 10</td>
<td>82</td>
<td>7.5 x 13</td>
<td>460</td>
<td>700</td>
<td>0.71</td>
</tr>
<tr>
<td>Casa dei Dipinti, Ostia</td>
<td>Domestic</td>
<td>8 x 8</td>
<td>129</td>
<td>7 x 11</td>
<td>330</td>
<td>700</td>
<td>1.1</td>
</tr>
</tbody>
</table>

### Brick ***

<table>
<thead>
<tr>
<th>Example</th>
<th>Building type</th>
<th>Size of facing elements (cm)</th>
<th>No. in 1 m²</th>
<th>Size of aggregate (cm) **</th>
<th>Volume aggregate (cm) **</th>
<th>Rate face</th>
<th>Days/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piccolo Mercato, Ostia (entrance)</td>
<td>Commercial</td>
<td>27.5 x 3.4</td>
<td>103</td>
<td>4.5 x 11</td>
<td>150</td>
<td>500</td>
<td>1.7</td>
</tr>
<tr>
<td>Casa dei Dipinti, Ostia</td>
<td>Domestic</td>
<td>27.5 x 3.4</td>
<td>72</td>
<td>7 x 11</td>
<td>330</td>
<td>1000</td>
<td>0.72</td>
</tr>
<tr>
<td>Baths of Caracalla, Rome</td>
<td>Public</td>
<td>27.5 x 3.4</td>
<td>78</td>
<td>3.5 x 7.5</td>
<td>61</td>
<td>1000</td>
<td>2.90</td>
</tr>
</tbody>
</table>

Notes

* This figure is counted from a typical m² of wall; the variation depends on both the size of the pieces and the amount of mortar between them.
** The volume of each piece is calculated as if a cylinder with rounded ends. This probably gives slightly too large a volume for the overall dimensions as the pieces often have sharp rather than rounded ends, but the formula is convenient. The most common size is about 7 x 11 cm, which is roughly 2 feet.
*** For comparison, Zegorelli's formula for brick (1869, 144-5) gives a rate of 1.0 days/m² for the ordinary brickwork of the Insula dei Dipinti.
important factors appear to be the size of both the facing and core aggregate pieces. Fig. 11.1 shows the effect of changing the core size for the selected examples, and allows comparison of rates across the sample for the same core size. The upper limit has been put at 8 × 15 cm (720 cm³), since this represents the largest sized aggregate usually found in walls, perhaps representing the largest piece that could be held easily in one hand.

The graph (Fig. 11.1) has several interesting features which may throw light on the development of concrete construction. The first is that the time taken begins to increase rather more rapidly for a core aggregate size below 300 cm³, that is about fist-sized, and very dramatically once the pieces are less than 100 cm³; over about 500 cm³ there is no appreciable time gained by using larger pieces of aggregate. The spread of the different types of facing (see Table 11.2) across the graph, which shows the effect of the size and type of the facing on construction rates for any given aggregate size, reveals the small-sized early opus incertum as well clear of the others. After experimentation with both large- and small-sized core pieces in the Republic, fist-sized pieces in fact become the most common average size for rubble in the concrete of the imperial period. It is highly likely that the smaller-sized aggregate brought with it considerable structural advantages; the smaller the aggregate, the more uniformly distributed the mortar is through the resultant material, and the more homogeneous it becomes. Modern concrete uses aggregates no larger than a few centimetres in diameter. Where the aggregate is made of tufa, most of the strength lies in the mortar, so that there is also less chance that failure of the aggregate might affect the overall strength of the material if the individual pieces are small. Altogether it would seem that as Roman builders experimented with aggregate sizes, they learnt to balance speed of construction (and hence manpower requirements and cost) and structural performance.

A second feature also suggests that Roman builders used empirical observations of the effects of changing construction parameters in order to optimize building operations. The brick and reticulate régimes of the extensive Hadrianic reconstruction of Ostia, with an average core size of 300–500 cm³, show a relatively small spread of values for different wall thicknesses and different facings, from 0.66–0.81 days/m² for standard brick over 1.5–4 ft walls; 0.79–0.86 days/m² for brick with some finish; and 1.2–1.0 days/m² for reticulate; this would allow a fairly uniform rate of construction forming a very time-effective group. While this may be accidental, it would have simplified the logistics of a large-scale but diffuse building programme and made the costing of individual building projects simpler. In this fairly uniform environment, the fine facework of the early Hadrianic Piccolo Mercato, used largely in the most prominent public areas of this commercial structure, stands out (Steinby 1974, 397). It requires over twice the labour as standard brickwork, which is found with reticulate in the rest of the building, and represents a deliberate choice to make a clear claim to an elevated status for this important warehouse between Ostia’s forum and the Tiber through its construction technique.

The graph (Fig. 11.1) also demonstrates that the large opus incertum of the Porticus Aemilia and that of the Trajanic Casette Tiro appear to be marginally more labour-saving than the opus reticulatum of the Theatre of Pompey. Even doubling the amount of time allowed here for selection or shaping of pieces in the facing of opus incertum would only just bring the rates for the Casette Tiro up to those for the Theatre of Pompey, with that of the Porticus Aemilia slightly higher. In other words, unless these rates are very wrong either overall or in relation to each other, a straight switch in construction technique from opus incertum to opus reticulatum cannot be explained entirely in terms of labour-saving on site; the size of the elements, in both face and core, is at least as important.

Finally, it is perhaps no coincidence that the two most labour-intensive construction techniques using smaller elements for face and/or core are found in the two most prestigious public buildings: the Theatre of Pompey and the Baths of Caracalla. There is ample evidence, from the Baths of Caracalla at least, that extraordinary types of construction were used for their own sake, such as large numbers of structural iron tie-rods and iron supports for decoration in vaults, or the bronze lattice of the cella solisiris.
The tour de force which ensured the fame of the Baths into the late empire. The excessively labour-intensive construction method using very small aggregate may be part of the same phenomenon. The very act of construction as a visible sign of the power to command resources and the will to expend them in the public good, is one aspect of magnificentera common to many building projects of imperial Rome. In the case of labour-intensive construction, this has the added effect of acting as largesse in the form of employment to the urban poor, who thus stand to gain from the building even before it is finished. The same could be argued for the Theatre of Pompey. As the first permanent theatre in Rome, the act of construction, not just the finished building, may have been a positive statement about Pompey's overwhelming political dominance, and a constant reminder of his outstanding wealth and munificence. For the monument to be permanent, it had to be built to last. In the mid-first century BC, when the Theatre of Pompey was being built, ashlar was still the pre-eminent mode of construction for prestige buildings, and was used for the façade and outer radial walls of the theatre.7 By using the latest technique—opus reticulatum—combined with the most labour-intensive but strongest type of concrete construction for the rest of the building, Pompey, like Caracalla two and a half centuries later, was ensuring the permanence of his monument at the same time as engaging in conspicuous consumption to the common good.

The impact of materials supply and production for concrete construction

Rate of construction is of course only one factor in the economics of building; equally important are materials production and transport. From the results of the previous exercise it is clear that the selected domestic buildings in Hadrianic Ostia, where core size is fairly uniform over all three techniques, provide a useful test case for judging the effect of materials production and transport on overall cost while keeping as many other parameters as possible constant. Since Ostia in this period was being substantially rebuilt, it is also appropriate to test the effect of using materials from demolished structures, particularly ashlar blocks, in place of new materials from the quarry.

The detailed calculations can be found in Appendix 1, nos. 1–3, based on a wall 12 m long by 3 m high by 0.6 m wide.8 A number of other assumptions have been made in the interests of eliminating as many variables as possible: each different type of building material (tufa, pozzolana, lime, brick) is assumed to come from a single source and thus to have the same physical properties; and items such as scaffolding, lifting devices, and the supply and repair of tools, have been omitted on the assumption that they are the same in all cases. No factor has been added for trans-shipment of materials, for extra handling at the production centre, for waste, supervision, administration, or profit.

The production figures for most of the materials (tufa, caementa, brick, pozzolana, and lime) are based on DeLaine (1997, 109-118), and summarized in Appendix 2. Only the difficult question of the production of reticulate pieces needs discussing here. A sample from a building dump excavated in the garden of the Insula dei Difinot (I, iv, 2-4), Ostia, has provided many useful details.9 Saw marks were common on the face of the reticulate tesseræ, and the edges of many were either sawn or carefully chiselled to a depth of 1.5-2 cm to give a precise form to the top surface. The rest of the piece was shaped very roughly to form the point, and in places the body of the block projected beyond the line of the top edge. In a few examples the reticulate tessa was clearly cut from the corner of one edge of a larger squared block, leaving one side of the point neatly at right angles to the reticulate face. This suggests that the tesseræ were cut from much larger squared blocks of roughly the required depth, sawn to give a smooth face which was then marked out by saw or chisel into tesseræ, while the separation and shaping of the rest of each piece was done more roughly. This is in fact not far from the technique used to make the tesseræ for restoration at Ostia today.10 There are no figures extant for work rates for making reticulate tesseræ from the marked-out blocks, so that, as for the shaping of opus incertum above, I have had to rely on a 'guisimate'; while a figure of one every two minutes seems reasonable in physical terms, as this cannot be tested I have also given alternative figures for half that rate. The results are summarized in Table 11.3.

The most striking result of the calculations is that opus reticulatum made from newly quarried material appears to cost in manpower terms about a third again as much as brickwork, even if we accept the faster rate of production for the tesseræ. If the brick had come from closer to Rome, rather than from the middle Tiber Valley or the Monti Sabini (Fig. 11.2), or even from further down the Tiber towards Ostia itself, the discrepancy would be even greater. A different picture emerges, however, if it is assumed that the reticulate tesseræ are made from tufa ashlar blocks recovered from earlier buildings in Ostia. The savings in labour and transport then combine to bring reticulate down to approximately the same cost as brick. No allowance, however, has been made for any second-hand value of tufa ashlar which would increase the overall cost of all types of construction using this material to a greater or lesser extent; at present there seems no obvious way to estimate this.

Obviously these figures are very crude, and further refinements to the methodology may change the picture, but not by very much. Allowing for reused non-ashlar building material, such as old brick and/or reticulate for the core of any building, for example, would probably reduce the costs still further, although there would be some reclamation costs for this as well. Placing the site at Rome, not Ostia, would reduce overall transport costs not at all for new reticulate and only by 1 mle/m² for brick (mle = mandays...
Table 11.3 The relative cost of Hadrianic opus reticolatum, brick-faced concrete, and opus incertum at Ostia (man-days of a labourer equivalents (mle)\(^{\text{*}}\)).

| Cassette Tipo opus incertum | Skilled | | Labourer | | Other (fuel and transport) | | Total mle | | mle/m\(^2\) of wall |
|-----------------------------|---------|---------|---------|---------|-----------------|---------|---------|---------|
|                             | Lowest  | Highest | Lowest  | Highest | Lowest  | Highest | Lowest  | Highest |
| Materials                   | 7       | 7       | 20      | 20      | 24     | 51      | 51      | 2       | 2       |
| Transport                   | -       | -       | -       | -       | 110    | 110     | 110     | 5       | 5       |
| Construction                | 65      | 75      | 44      | 50      | -      | 110     | 130     | 5       | 6       |
| Total                       | 72      | 82      | 64      | 70      | 130    | 270     | 280     | 13      | 13      |
| opus incertum (reused tufa) |         |         |         |         |        |         |         |         |         |
| Materials                   | 2       | 2       | 9       | 9       | 24     | 35      | 35      | 2       | 2       |
| Transport                   | -       | -       | -       | -       | 42     | 42      | 42      | 2       | 2       |
| Construction                | 65      | 75      | 44      | 50      | -      | 110     | 130     | 5       | 6       |
| Total                       | 67      | 77      | 53      | 59      | 66     | 190     | 200     | 9       | 10      |
| Casa dei Dipinti opus reticolatum |     |         |         |         |        |         |         |         |         |
| Materials                   | 180     | 190     | 69      | 84      | 34     | 280     | 310     | 13      | 15      |
| Transport                   | -       | -       | -       | -       | 110    | 110     | 110     | 5       | 5       |
| Construction                | 43      | 43      | 33      | 33      | -      | 76      | 76      | 4       | 4       |
| Total                       | 220     | 240     | 100     | 120     | 140    | 470     | 500     | 22      | 24      |

| Skilled | | Labourer | | Other (fuel and transport) | | Total mle | | mle/m\(^2\) of wall |
|---------|---------|---------|---------|-----------------|---------|---------|---------|
| Lowest  | Highest | Lowest  | Highest | Lowest  | Highest | Lowest  | Highest |

| opus reticolatum (reused tufa) |         |         |         |        |         |         |         |         |         |
| Materials                       | 91      | 110     | 40      | 56     | 34     | 170     | 200     | 8       | 9       |
| Transport                       | -       | -       | -       | -      | 59     | 59      | 59      | 3       | 3       |
| Construction                    | 43      | 43      | 33      | 33     | -      | 76      | 76      | 4       | 4       |
| Total                           | 140     | 150     | 73      | 89     | 93     | 300     | 330     | 14      | 16      |
| Brick                            |         |         |         |        |         |         |         |         |         |
| Materials                       | 12      | 12      | 22      | 22     | 42     | 75      | 75      | 4       | 4       |
| Transport                       | -       | -       | -       | -      | 160    | 160     | 160     | 8       | 8       |
| Construction                    | 35      | 44      | 28      | 34     | -      | 63      | 78      | 3       | 4       |
| Total                           | 47      | 56      | 50      | 56     | 200    | 300     | 310     | 14      | 15      |
| Brick (reused tufa in core)    |         |         |         |        |         |         |         |         |         |
| Materials                       | 9       | 9       | 16      | 16     | 42     | 67      | 67      | 3       | 3       |
| Transport                       | -       | -       | -       | -      | 130    | 130     | 130     | 6       | 6       |
| Construction                    | 35      | 44      | 28      | 34     | -      | 63      | 78      | 3       | 4       |
| Total                           | 44      | 53      | 44      | 50     | 170    | 260     | 270     | 12      | 13      |

Note: The figures in the table have been written as whole integers to two significant figures, in order to reflect the limited degree of reliability that the estimates made here have in reality, and to discourage any misuse of them. The rounding up involved has the effect however of making some rows and columns in the tables appear not to add up. The full figures on which the table is based are given in Appendix 1.
COSTING ROMAN CONSTRUCTION

The cost of ashlar

Despite the variation between the cost of opus incertum, opus reticulatum, and brick noted above, provided the size of the core remains the same and the size of the facing pieces is comparable as in the early second-century examples used here, the resultant figures are all very similar to one significant figure, at 10 m£/m², except for new reticulate at 20 m£/m². Tufa ashlar, however, works out at roughly 40 m£/m² overall, twice as much as even new reticulate, and more like four times as much as the remaining techniques.22 Nor is there any possibility of making savings by reusing material already on the spot. In addition some tufas used at Rome, like the peperino from the Alban Hills, are considerably harder to work than the Anio or Monteverde tufas. Yet nearly all tufa is soft and easily worked compared with limestone and marble; these can be respectively up to 2–3 and 5–8 times as hard to work, and their labour equivalent costs would be more like 100 or 160 m£/m² if the transport conditions were the same as for tufa.23 This is already a different order of magnitude without adding the extra cost of transporting marble from Luna or across the Mediterranean.

Here, then, more than anywhere, the economics are fairly clear; concrete in any of its forms really was a cheap substitute even for tufa ashlar. Any extensive use of ashlar after the first century BC must be making a statement about aesthetics or ideology or the power to command resources, or all three: the Forum of Augustus with its high tufa wall, the facade of the Colosseum,24 and the tufa cellae of Hadrian’s Temple of Venus and Roma or the Temple of Antoninus and Faustina in the Roman Forum are all but a few of the obvious examples. Some of the savings made by building in concrete may, however, have gone on more obvious luxuries like fine marble veneer or architectural ornament, as seems likely even with ostensibly traditional buildings such as the Capitolium at Ostia.

Conclusions

The exercises presented here are an attempt to assess the validity of a number of common assumptions about the economics of Roman construction. The figures themselves, however, can only give a general indication of how things may have been, since they depend on a number of assumptions which we cannot test without further evidence. In giving numerical estimates under these conditions there is always the danger of giving a spurious sense of
accuracy, which I have tried to avoid here by giving the final figures in round numbers, which indicate the order of magnitude and whereabouts within that order of magnitude the actual figure might lie. In fact, the figures are of relatively little value in understanding what any kind of wall might actually have cost, even in labour terms, since the unknowns are too great; but they do help in understanding relative costs between different types of construction and different levels of workmanship and permit the effects of different assumptions to be tested.

Thus some fundamental factors emerge: that the size of the pieces used in core and facing is at least as important in establishing the labour requirements for concrete as is the type of facing used; that reuse of ashlar blocks is essential in understanding the economics of brick and reticulate in Rome and Ostia; and that even tufa ashlar is two to four times more labour-intensive than any form of concrete. Brick, on the other hand, appears as a seemingly economic form of new facing material, and the only obvious choice once the supply of second-hand ashlar is used; it should be remembered, however, that the figures assume large-scale permanent production, with related economies of scale. For all types of construction using new materials, the combination of materials production and transport produces a higher work equivalent rate than construction, reticulate being particularly high in production and brick in transport. The widespread reuse of all building materials – brick and reticulate tesserae alike – in the later empire is therefore no more surprising than the burning of marble to make lime. If anything, the fact that so much new building material, particularly brick, was produced over such a long period of time, despite the large amount of material that must have been available for reuse, speaks strongly of the ideological significance of construction for the emperor and the élite who financed both the public and private building projects in Rome and Ostia.

COSTING ROMAN CONSTRUCTION

Appendix A Costing standard walls

Notes and abbreviations
Volume of wall: \(12 \times 3 \times 0.59\) m = 21.24 m³
Cost of labour: 1 mday skilled = 1.69 mle
mday: man-days
mle: man-days labourer equivalent

Wall 1 Opus incertum of tufa (Cassette Typos, Ostia)

Quantities

FACING
Volume of facing: area of facing \(\times\) depth of facing pieces = \(12 \times 3 \times 2 \times 0.12 = 8.64\) m³
Size of facing pieces: \(0.07 \times 0.09 \times 0.12\) m = 0.00046 m³, face area 0.0049 m²
Number of pieces/m² of wall surface: 166
Total number in 72 m² of facing: 166 \(\times\) 72 = 11,900
Volume of facing pieces = 11,900 \(\times\) 0.00046 = 5.47 m³

CORE
Volume of core: volume of wall less volume of facing = 21.24 – 8.64 = 12.6 m³
Size of rubble for core: 0.07 \(\times\) 0.07 \(\times\) 0.11 m = 0.00033 m³
Number of pieces/m³ core (where rubble is 60% of volume = 1,820 pieces/m³)
Number of pieces in 12.6 m² core @ 1,820 pieces/m³ = 22,900
Volume of core rubble = 22,900 \(\times\) 0.00033 = 7.57 m³
Volume of rubble in facing sections: \(\approx\) 6,000 \(\times\) 0.00033 m³ = 1.98 m³
Total volume of core rubble: 7.57 + 1.98 = 9.55 m³

MORTAR
Allowing for 25% per cent loss of volume on mixing need 6.22 \(\times\) 1.25 = 7.78 m³ materials
If mortar is 1:3 lime: pozzolana
Volume of pozzolana = 0.75 \(\times\) 7.78 = 5.83 m³
Volume of slaked lime = 0.25 \(\times\) 7.78 = 1.94 m³
Volume of quicklime if increases in volume by 250 per cent on slaking = 1.94 \(\div\) 2.5 = 0.78 m³
JANET DELAINE

Materials production

1 Quarrying tufa and making rubble: 5.47 m³ facing + 9.55 m³ core
   = 15.02 m³ tufa × (0.20 skilled + 1.09 labourer mdays/m³) = 3.00 skilled
   + 16.37 labourer mdays
2 Pozzolana: 5.83 m³ × (0.045 skilled + 0.38 labourer mdays/m³) = 0.262
   skilled + 2.22 labourer mdays
3 Lime: 0.78 m³ × (1.45 skilled + 2.25 labourer) mdays/m³ = 1.13 skilled
   + 1.76 labourer mdays
Fuel for lime @2.75 tonnes fuel/m³ and 11 mle/tonne = 0.78 m³ × 2.75
   × 11 = 23.6 mle

Transport

See Fig. 11.2.

1 Tufa from Monteverde quarries (weight = 1.7 tonnes/m³)
   Down river to Ostia 20 miles @ 0.13 mle/tonne mile = 0.13 × 20 miles
   × 1.7t/m³ × 15.02 m³ = 66.4 mle
   Dock to site 0.25 mile by ox-cart @ 1.44 mle/tonne mile = 1.44 × 0.25
   × 1.7 × 15.02 = 9.19 mle
   Total transport for tufa: 66.4 + 9.19 = 75.6 mle

2 Pozzolana from San Paolo fish (weight = 1.5 tonne/m³)
   Quarries to river 0.25 miles by ox-cart = 1.44 mle/tonne mile × 0.25
   miles × 1.5t/m³ × 5.83 m³ = 3.14 mle
   Down river to Ostia 17 miles = 0.13 mle/tonne mile × 17 miles
   × 1.5 t/m³ × 5.83 m³ = 19.3 mle
   River to site by ox-cart 0.25 miles = 3.14 mle
   Total transport pozzolana: 3.14 + 19.3 + 3.14 = 25.6 mle

3 Quicklime from Terracina (weight 1.5 tonne/m³)
   Kiln to port 2 miles by ox-cart = 1.44 mle/tonne mile × 2 miles
   × 1.5 t/m³ × 0.78 m³ = 3.37 mle
   Sea 78 miles @ 0.035 mle/tonne mile = 0.035 mle/tonne mile × 78
   miles × 1.5 t/m³ × 0.78 m³ = 3.19 mle
   Up river 0.5 miles @ 0.26 mle/tonne mile × 0.26 mle/tonne mile × 0.5
   miles × 1.5t/m³ × 0.78 m³ = 0.15 mle
   River to site 0.25 miles by ox-cart = 1.44 mle/tonne mile × 0.25 miles
   × 1.5 t/m³ × 0.78 m³ = 0.42 mle
   Total transport for lime: 3.37 + 3.19 + 0.15 + 0.42 = 7.13 mle

COSTING ROMAN CONSTRUCTION

Construction

Slaking lime 0.78 m³ × 1.2 mdays/m³ = 0.94 mdays unskilled
Mixing mortar 6.22 m³ × 0.7 mdays/m³ = 4.35 mdays unskilled
Laying face @ 500 pieces/mday for 1 skilled + 1 labourer = 11,900/500 = 23.8
   skilled + 23.8 labourer mdays
Laying face @ 400 pieces/mday for 1 skilled + 1 labourer = 11,900/400 = 29.8
   skilled + 29.8 labourer mdays
Laying core @ 2,000 pieces/mday for 1 skilled + 1 labourer = (22,900 +
   6,000)/2,000 = 14.5 skilled + 14.5 labourer mdays

Overall requirements

MATERIALS

3.00 tufa + 0.262 pozzolana + 1.13 lime = 4.39 mdays skilled × 1.69
   = 7.42 mle
16.37 tufa + 2.22 pozzolana + 1.76 lime = 20.35 mdays labourer + 23.6
   mle for fuel
Total for 21.24 m³: 7.42 + 20.35 + 23.6 = 51.4 mle = 2.42 mle/m³ of wall

TRANSPORT

75.6 tufa + 25.6 pozzolana + 7.13 lime = 108 mle = 5.10 mle/m³ of wall

CONSTRUCTION

23.8 face @ 500/day + 14.5 core = 38.3 mdays skilled × 1.69 = 64.7 mle
0.94 lime + 4.35 mortar + 23.8 face @ 500/day + 14.5 core = 43.6 mdays
labourer
Total = 64.7 + 43.6 = 108 mle = 5.10 mle/m³ of wall
or
29.8 face @ 400/day + 14.5 core = 44.3 mdays skilled × 1.69 = 74.9 mle
0.94 lime + 4.35 mortar + 29.8 face @ 400/day + 14.5 core = 49.6 mdays
labourer
Total = 74.9 + 49.6 = 124 mle = 5.86 mle/m³ of wall

TOTAL

51 materials + 108 transport + 108 construction = 267 mle = 12.6 mle/m³ of wall
or
51 materials + 108 transport + 125 construction = 284 mle = 13.3 mle/m³ of wall

Alternative requirements if the opus incertum is made from ashlar blocks
already on site.
COSTING ROMAN CONSTRUCTION

Volume of core rubble = 20,300 \times 0.00033 = 6.70 \text{ m}^3
Volume of rubble in facing sections: c. 4,000 \times 0.00033 = 1.32 \text{ m}^3
Total volume of core rubble: 6.7 + 1.32 = 8.02 \text{ m}^3

MORTAR
Volume of mortar: 21.24 - 4.18 - 8.02 = 9.04 \text{ m}^3
If mortar is 1:3 lime:pozzolana, and allowing for 25 per cent loss of volume on mixing:
Volume of pozzolana = 0.75 \times 9.04 \times 1.25 = 8.47 \text{ m}^3
Volume of slaked lime = 0.25 \times 9.04 \times 1.25 = 2.83 \text{ m}^3
Volume of quicklime = 2.83 + 2.5 = 1.13 \text{ m}^3

Materials Production

1 Tufa reticulate from new blocks
Assume pieces obtained from blocks 3 Roman feet cubed (0.88 \times 0.88 \times 0.88 \text{ m}) in 6 layers of 10 \times 10 = 600 pieces
Quarried volume for 9,290 reticulate pieces: 9,290 \div 600 = 15.5 blocks 
\times 0.88^3 = 10.56 \text{ m}^3
Quarrying ashlar: 10.56 \text{ m}^3 \times 1.2 \text{ days/m}^3 \text{ for 1 skilled man and 2 labourers = 12.68 skilled + 25.35 labourer mdays}
Rough shaping 6 faces each 0.88 \times 0.88 \text{ m} for 15.5 blocks @ 0.5 skilled 
\div 36.0 \text{ skilled mdays}
Sawing 15.5 blocks into 6 layers 0.88 \times 0.88 \text{ m} \times 0.14 \text{ m of cut for 1 sawyer and 1 labourer = 15.5 blocks} 
\times 5 \text{ cuts} \times 0.77 \text{ m}^2/cut \times 0.3 
= 17.9 \text{ mdays skilled + 17.9 labourer}
Cutting face into squares for reticulate blocks @ 181 cuts \times 0.02 
deep/block @ saw rate for sawyer only = 93 layers \times 81 cuts \times 0.02 m 
\times 0.3 \text{ deep/m}^2 = 45.3 \text{ mdays skilled}
Separating blocks and shaping @ 0.0033 mdays per block = 0.0033 \times 
9290 = 30.7 \text{ mdays labourer (i.e. 2 mins per block)}

Total reticulate blocks:
12.68 quarrying + 36 rough shaping + (17.9 + 45.3) sawing = 111.9 mdays skilled
25.35 quarrying +17.9 labourer sawing + 30.7 shaping = 73.9 mdays labourer

or

If cut only 0.015 m deep and shaping blocks only 1 minute/block:
Cutting face into squares for reticulate blocks @ 81 cuts \times 0.015

Materials

WALL 2 Opus reticulatum of tufa (Casa dei Dipinti, Ostia)

Quantities

FACING
Volume of facing: 72 \text{ m}^2 \times 0.14 = 10.1 \text{ m}^3
Size of reticulate tesserae: 0.08 \times 0.08 \times 0.14 deep, volume 0.00045 \text{ m}^3,
face area 0.0064 \text{ m}^2
Size of joints: 0.008 \text{ m}
Number of pieces/\text{m}^2 of wall surface: 129
Total number in 72 \text{ m}^2 of facing: 129 \times 72 = 9,290
Volume of facing blocks: 0.00045 \times 9,290 = 4.18 \text{ m}^3

CORE
Volume of core: 21.24 - (72 \times 0.14) = 11.2 \text{ m}^3
Size of rubble for core: 0.07 \times 0.07 \times 0.11 = 0.00033 \text{ m}^3
Number of pieces in 11.2 \text{ m}^2 of core @ 1,820 pieces/\text{m}^2 = 1,820 \times 11.2 
= 20,300

TRANSPORT
Tufa 0.25 mile within Ostia by ox-cart = 1.44 \times 0.25 \times 1.7 \times 15.02 
= 9.19 mle
Total 9.19 tufa + 25.6 pozzolana + 7.13 lime = 41.9 mle = 1.97 mle/\text{m}^3 of wall

CONSTRUCTION
no change = 108 mle (5.10 mle/\text{m}^3)
or
125 mle (5.86 mle/\text{m}^3)

TOTAL
35 + 42 + 108 = 185 mle = 8.7 mle/\text{m}^3 of wall
or
35 + 42 + 125 = 202 mle = 9.5 mle/\text{m}^3 of wall

JANET DELAINE
deep/block @ saw rate for sawyer only = 93 layers × 81 cuts × 0.015 m
deep × 0.3 days/m³ = 33.9 m³ days skilled
Separating blocks and shaping @ 0.00165 m³ days per block = 0.00165 × 9,290 = 15.3 m³ days labourer

Total reticulate blocks:
12.68 quarrying + 36 rough shaping + (17.9 + 33.9) sawing = 100.5 m³ days skilled
25.35 quarrying + 17.9 labourer sawing + 15.3 shaping = 58.6 m³ days labourer

2 Tufa rubble and mortar
Rubble from waste from reticulate blocks²: 9,300 × (0.08 × 0.08 × 0.14) = 4.17 = 4.16 m³
Quarrying extra tufa and making rubble: (8.02 - 4.16) = 3.86 m³ × (0.20 skilled + 1.09 labourer m³ days) = 0.77 skilled + 4.21 labourer m³ days
Pozzolana: 8.47 m³ × (0.045 skilled + 0.38 labourer m³ days) = 0.38 skilled + 3.22 labourer m³ days
Lime: 1.13 m³ × (1.45 skilled + 2.25 labourer) m³ days/m³ = 1.64 skilled + 2.54 labourer m³ days
Fuel for lime @ 2.75 tonnes fuel/m³ and 11 m³/tonne = 1.13 m³ × 2.75 × 11 = 34.2 m³

Transport
1 Tufa from Monteverde quarries (weight = 1.7 tonnes/m³)
Down river to Ostia 20 miles = 0.13 × 20 × 1.7 = 12.2 m³ = 53.9 m³
Dock to construction site 0.25 mile by ox-cart = 1.44 × 0.25 × 1.7 = 12.2
= 7.47 m³
Total transport for tufa: 53.9 + 7.47 = 61.4 m³

2 Pozzolana from San Paolo flm (weight = 1.5 tonne/m³)
Quarries to river 0.25 miles from quarries = 1.44 × 0.25 × 1.5 × 8.48 m³
= 4.58 m³
Down river to Ostia 17 miles = 0.13 × 17 × 1.7 = 31.9 m³
River to site 0.25 miles by ox-cart = 4.58 m³
Total transport for pozzolana: 4.58 + 31.9 + 4.58 = 41.1 m³

3 Quicklime from Terracina (weight 1.5 tonne/m³)
Kiln site to port 2 miles by ox-cart = 1.44 × 2 × 1.5 × 1.13 m³ = 4.88 m³
Sea 78 miles = 0.035 × 78 × 1.5 × 1.13 = 4.63 m³
Up river 0.5 miles = 0.26 × 0.5 × 1.5 × 1.13 = 0.22 m³
Ox-cart to site from river 0.25 miles = 0.61 m³
Total transport for lime: 4.88 + 4.63 + 0.22 + 0.61 = 10.3 m³

COSTING ROMAN CONSTRUCTION

Construction
Slaking lime 1.13 m³ × 1.2 m³ days/m³ = 1.36 m³ days skilled
Mixing mortar 9.05 m³ × 0.7 d/m³ = 6.34 m³ days unskilled
Laying face @ 700 pieces/m³ for 1 skilled + 1 labourer = 9.290/700 = 13.3 skilled + 13.3 labourer m³ days
Laying core @ 2,000 pieces/m³ for 1 skilled + 1 labourer = (20,300 + 4,000)/2,000 = 12.2 skilled + 12.2 labourer m³ days

Overall Requirements

MATERIALS

\[\begin{align*}
112 + 0.77 \text{ tufa} + 0.38 \text{ pozzolana} + 1.64 \text{ lime} &= 115 \text{ m³ days skilled} \times 1.69 = 194 \text{ mle} \\
73.9 + 4.21 \text{ tufa} + 3.22 \text{ pozzolana} + 2.54 \text{ lime} &= 83.9 \text{ m³ days labourer} + 34.2 \\
&\text{mle for fuel}
\end{align*}\]

Total for 21.24 m³: 194 + 83.9 + 34.2 = 312 mle = 14.7 mle/m³ of wall

\[\begin{align*}
100.5 + 0.77 \text{ tufa} + 0.38 \text{ pozzolana} + 1.64 \text{ lime} &= 103 \text{ m³ days skilled} \times 1.69 = 175 \text{ mle} \\
58.6 + 4.21 \text{ tufa} + 3.22 \text{ pozzolana} + 2.54 \text{ lime} &= 68.6 \text{ m³ days labourer} + 34.2 \\
&\text{mle for fuel}
\end{align*}\]

Total for 21.24 m³: 175 + 68.6 + 34.2 = 278 mle = 13.1 mle/m³ of wall

TRANSPORT

61.4 tufa + 41.1 pozzolana + 10.3 lime = 113 mle = 5.31 mle/m³ of wall

CONSTRUCTION

13.3 face @ 700/day + 12.2 core = 25.2 m³ days skilled × 1.69 = 43.1 mle
1.36 lime + 6.34 mortar + 13.3 face @ 700/day + 12.2 core = 33.2 m³ days labourer

Total 43.1+ 33.2 = 76.3 mle = 3.59 mle/m³ of wall

TOTAL

312 materials + 113 transport + 76 Construction = 501 mle = 23.6 mle/m³ of wall

OR

278 materials + 113 transport + 76 Construction = 467 mle = 22.0 mle/m³ of wall

Alternative requirements if the opus reticulatum is made from ashlar blocks already on site.

253
MATERIALS

Make reticulate from existing blocks if blocks are already 0.88 x 0.88 x 0.88m:
17.9 sawing + 45.3 cutting = 63.2 mdays skilled x 1.69 = 107 mle
17.9 sawing + 30.7 shaping = 48.6 mdays labourer

or

if cut only 0.015 deep and shaping reticulate pieces only 1 minute/piece
17.9 sawing + 33.9 cutting = 51.8 mdays skilled x 1.69 = 87.5 mle
17.9 sawing + 15.3 shaping = 33.2 mdays labourer
Process tufa into rubble for core & 0.333 m days/m³: 0.333 x (8.02 - 4.16) m³ = 1.29 mdays labourer
0.38 pozzolana + 1.64 lime = 2.02 mdays skilled x 1.69 = 3.41 mle
3.22 pozzolana + 2.54 lime = 5.76 mdays labourer + 34.2 mle for fuel
Total for 21.24 m³: 107 + 48.6 + 1.29 + 3.41 + 5.76 + 34.2 = 200 mle
= 9.42 mle/m³ of wall

or

87.5 + 33.2 + 1.29 + 3.41 + 5.76 + 34.2 = 165 mle = 7.78 mle/m³ of wall

TRANSPORT

Tufa 0.25 mile within Ostia by ox-cart = 1.44 x 0.25 x 1.7 x (4.17 + 8.02) = 7.46 mle
Total 7.46 tufa + 4.11 pozzolana + 10.3 lime = 58.9 mle = 2.77 mle/m³ of wall

CONSTRUCTION

no change = 76.3 mle (3.59 mle/m³ of wall)

TOTAL

200 + 59 + 76 = 335 mle = 15.8 mle/m³ of wall

or

165 + 59 + 76 = 300 mle = 14.1 mle/m³ of wall

Wall 3 Brick-faced concrete (Casa dei Dipinti, Ostia)

Quantities

FACING

Volume of facing sections: 72 x 0.14 = 10.08 m³
Size of bricks: 0.275 x 0.034 m in face, 0.14 m deep, vol = 0.00066 m³

254
2 Tufa from Monteverde quarries (weight = 1.7 tonnes/m³)
   Down river to Ostia 20 miles = 0.13 mle/tonne mile × 20 miles × 1.7 t/m³ × 7.69 m³ = 34 mle
   River to site 0.25 mile by ox-cart = 4.7 mle
3 Pozzolana from San Paolo fium (weight = 1.5 tonnes/m³)
   As for reticulate, 8.3m³ = 29 mle
4 Quicklime from Terracina (weight 1.5 tonne/m³)
   As for reticulate, 1.1 m³ = 10 mle

Construction

Slaking lime 1.1 m³ × 1.2 mdays/m³ = 1.3 mdays unskilled
Mixing mortar 8.9 m³ × 0.7 d/m³ = 6.2 mdays unskilled
Laying face @ 1,000 pieces/day for 1 skilled + 1 labourer = 5,180/1,000 = 5.2 skilled + 5.2 labourer mdays

OR

if fine face-work @ 500 pieces/mday = 10.4 skilled + 10.4 labourer mdays
Laying core @ 2,000 pieces/mday for 1 skilled + 1 labourer = 30,900/2,000 = 15.5 skilled + 15.5 labourer mdays

Overall Requirements

MATERIALS

1.54 tufa + 0.37 pozzolana + 1.6 lime + 3.34 brick = 6.85 mdays skilled
   × 1.69 = 11.6 mle
8.38 tufa + 3.15 pozzolana + 2.48 lime + 7.8 brick = 21.8 mdays labourer + 42 mle for fuel
Total for 21.24 m³ = 11.6 + 21.8 + 42 = 75.4 mle = 3.52 mle/m³ wall

TRANSPORT

38.7 tufa + 29 pozzolana + 10.1 lime + 82.7 brick = 161 mle = 7.6 mle/m³ wall

CONSTRUCTION

5.2 face + 15.5 core = 20.7 mdays skilled × 1.69 = 35.0 mle
1.3 lime + 6.2 mortar + 5.2 face + 15.5 core = 28.2 mdays labourer
Total for 21.24 m³ = 63.2 mle = 3.0 mle/m³ wall

OR

10.4 face + 15.5 core = 25.9 mdays skilled × 1.69 = 43.8 mle
1.3 lime + 6.2 mortar + 10.4 face + 15.5 core = 33.8 mdays labourer
Total for 21.24 m² = 77.6 mle = 3.7 mle/m² wall

COSTING ROMAN CONSTRUCTION

TOTAL

75 materials + 161 transport + 63 construction = 299 mle = 14.1 mle/m³ wall
OR

75 materials + 161 transport + 78 construction = 314 mle = 14.8 mle/m³ wall

Alternative requirements if the rubble is made from waste material available on site:

MATERIALS

Process tufa into rubble @ 0.333 mdays/m³; 0.333 × 7.69 m³ = 2.56 mdays labourer
0.37 pozzolana + 1.6 lime + 3.34 brick = 5.31 mdays skilled × 1.69 = 8.97 mle
3.15 pozzolana + 2.48 lime + 7.8 brick = 13.4 mdays labourer + 42 mle for fuel
Total for 21.24 m³ = 2.56 + 8.97 + 13.4 + 42 = 66.9 mle = 3.15 mle/m³ wall

TRANSPORT

Tufa 0.25 mile within Ostia by ox-cart = 1.44 × 0.25 × 1.7 × 7.69 = 4.7 mle
Total 4.7 tufa + 29 pozzolana + 10.1 lime + 82.7 brick = 127 mle = 6 mle/m³ wall

CONSTRUCTION

no change = 63 mle (3.0 mle/m³) OR 77.6 mle (3.7 mle/m³)

TOTAL

66.9 + 127 + 63 = 257 mle (12.1 mle/m³)

OR

66.9 + 127 + 78 = 272 mle (12.8 mle/m³)

Wall 4 Tufa ashlars

Quantities

Size of undressed blocks: 0.6 × 0.6 × 1.2 m
Number of blocks in wall: 50
Total surface area of each block: 4 × (0.6 × 0.6 × 1.2) + 2 × (0.6 × 0.6)
   = 3.6 m²
Volume of each block: 0.432 m³
Weight of each block @ 1.7 tonnes/m³: 0.734 t
Total quarried volume allowing for waste: $0.432 \times 50 \times 1.1 = 23.8 \text{ m}^3$

**Materials Production**

Quarrying $23.8 \text{ m}^3$ lithoidal tufa @ 1.2 m/day/m² for 1 skilled man and 2 labourers $= 23.8 \times (1.2 \text{ skilled} + 2.4 \text{ labourer m/day}) = 29 \text{ m/day skilled} + 57 \text{ labourer}

Rough squaring of 3.6 m² surface area for each of 50 blocks @ 0.5 m/day skilled/m² $= 3.6 \times 50 \times 0.5 = 90 \text{ m/day skilled}$

**Transport**

Loading $50 \times 0.432 \text{ m}^3 = 21.6 \text{ m}^3$ onto boats @ 0.05 m/day/m² for 2 skilled men and 2 labourers $= 21.6 \times (0.05 \times 2 \text{ skilled} + 0.05 \times 2 \text{ labourer}) = 2.4 \text{ m/day skilled} + 2.4 \text{ m/day labourer}

Down river to Ostia 20 miles @ 0.13 m/day/tonne mile $= 0.13 \times 20 \text{ miles} \times 0.734 \text{ t/block} \times 50 \text{ blocks} = 95 \text{ m/day}

Dock to site 0.25 m by ox-cart @ 1.44 m/day/tonne mile $= 1.44 \times 0.25 \times 0.734 \times 50 = 13 \text{ m/day}

Labour for trans-shipment @ 0.1 d/m³ for 2 skilled men and 2 labourers $= 4.8 \text{ m/day skilled} + 4.8 \text{ m/day labourer}$

**Construction**

Shaping on 50 blocks over 3.6 m² per block @ 0.43 d/m² skilled + 0.11 labourer $= 77 \text{ skilled} + 19 \text{ labourer m/day}$

Fine finishing and squaring on 2.16 m² x 50 joining faces @ 0.57 d/m² skilled + 0.14 labourer $= 62 \text{ skilled} + 15 \text{ labourer m/day}$

Drafting edges for fitting blocks over 50 x 3.6 m @ 0.023d/m skilled + 0.006 labourer = 4 skilled + 1 labourer m/day

For every tonne it takes 3 skilled men and 4 labourers:

0.02 + 0.033d + 0.02h + 0.01 days, where d = horizontal distance and h = height to which block has to be raised.

So for 50 blocks of 0.734t, where d = 10 m, and h av. = 1.2 m

Time taken = $50 \times 0.38 \times 0.734 = 14.0 \times (3 + 4) = 42 \text{ m/day skilled} + 56 \text{ labourer}$

Fine finishing to one exterior face of each block @ 0.88 m/day/m² skilled $= 50 \text{ blocks} \times (0.6 \times 1.2) \text{ m}^2 \times 0.88 = 32 \text{ m/day skilled}$

**Overall Requirements**

29 quarry + 90 rough shape = 119 m/day skilled $\times 1.69 = 201 \text{ mle}$

**Costing Roman Construction**

Quarry 57 m/day labourer
Total: 201 + 57 = 258 mle = 12 mle/m³ wall

**Transport**

$(2.4 + 4.8) \times 1.69 \text{ skilled} + (2.4 + 4.8) \text{ labourer} + 95 + 13 = 127 \text{ mle}$

$= 6 \text{ mle/m}³$

**Construction**

77 shaping + 62 finishing + 4 edges + 42 lifting + 32 fine finish $= 217$

$= 1.69 \times 367 \text{ mle}$

19 shaping + 15 finishing + 1 edges + 56 lifting = 91 labourer
Total: 367 + 91 = 458 mle = 22 mle/m³ wall

**Total:**

258 materials + 127 transport + 458 construction = 843 mle = 40 mle/m³ wall

**Appendix B: Labour constants for materials production**

Lateral pozzolana show little cohesion and can be quarried simply with a pick, but are sufficiently tenacious to be mined by tunnels, leaving pierc of the material to support the strata above. Quarrying the relatively friable tufa also is scarcely more difficult than quarrying pozzolana, and the two activities were often related. Since large squared blocks were not required, the tufa could be cut roughly from the face using a pick producing pieces small enough to be moved by hand. Both these materials required some further processing before they were ready to be used on site. Pozzolana for mortar had to be sieved to remove the large aggregate, and graded depending on the use to which the mortar was put (Blake 1947, 314). Tufa had to be broken further into rubble of the required size. It is reasonable to assume that all the processing took place at the quarry; this would certainly save space on the construction site.

The transportation of materials within the production site is the most uncertain factor, since there is no way of knowing how far the material had to be moved. In the interests of maintaining minimum figures, a distance of 25 m from the face will be assumed in all cases, each trip then taking 0.001 man-days.
Table 11.81 Estimated labour constants for pozzolana and tufa production.

<table>
<thead>
<tr>
<th>Action</th>
<th>Pozzolana mdays/m³</th>
<th>Tufa mdays/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unskilled</td>
<td>Skilled</td>
</tr>
<tr>
<td>Quarry</td>
<td>0.045⁴</td>
<td>0.045</td>
</tr>
<tr>
<td>Load and carry 25m³</td>
<td>0.165</td>
<td>0.260</td>
</tr>
<tr>
<td>Process</td>
<td>0.120⁴</td>
<td>0.533⁵</td>
</tr>
<tr>
<td>Load into carts⁴</td>
<td>0.050</td>
<td>0.096</td>
</tr>
<tr>
<td>Total</td>
<td>0.380</td>
<td>0.045</td>
</tr>
</tbody>
</table>

**Notes**

a De Marchi 1894.
b Pegoretti 1869, i 192.
c Pegoretti 1869, i 155-5, a rate of 0.000444 hours/m including return for a man carrying a load on flat ground; loading 0.3 hr/m² for cars, 0.6 hr for baskets, assuming that earth and pozzolana are equivalent.
d Pegoretti 1869, i 188.
e There are no figures for breaking tufa into rubble. Pegoretti 1869, i 183 gives a figure of 1 mday/m³ of rubble (from 0.66 m³ of solid stone) to break hard limestone into coarse gravel. Elsewhere limestone is given as two in three times as hard to work as tufa, so that a figure of 0.33 mday/m³ of rubble = 0.533 mdays/m³ solid should allow also for the rarer larger pieces of tufa and its ease of working.
f Pegoretti 1869, i 157

**Lime**

Given the nature of lime production, it is necessary to assume a hypothetical production unit in order to calculate manpower requirements per unit volume. A moderately large kiln of total volume 100 m³ would produce 60 m³ of lime from 66 m³ of limestone. For a fixed kiln, even if installed near the source of stone, the transport distance would on average be greater than that suggested for the simple quarried materials discussed above, say 100 m. As before, this factor introduces the largest element of uncertainty into the calculations. Further uncertainty comes from the need to estimate the firing time for this size of kiln. Recorded firing times from later periods range from one to seven days, and do not seem to be necessarily related directly to the size of the kiln; other factors are the type of stone and the size of the pieces, the design, location, and efficiency of the kilns, and the type of fuel used. Experimental firings at the military kiln site at Iversheim, Germany took six to seven days including the cooling (Söller 1970, 40), of which three to four days were presumably used in the actual firing, a common value in later records; given the high quality of Roman lime used for mortar, a relatively long firing time of seven days can be assumed. In all cases the kilns must be operated continuously, and a careful eye kept on them to ensure correct burning; the fireman was a skilled worker. At least two men must have been on hand at all times: one to watch the kiln and feed the fire, the other to ensure a continual supply of fuel. Cooling times are also variable, but should certainly be longer for the larger kilns.

The volume of fuel required necessarily depends on the species of tree and type of material – brush or heartwood – and this will also to some extent affect the length of firing. The amount of labour required will in turn be influenced by the volume of material, although the accessibility of the various fuels will also be an important factor. Fortunately, all wood and brush in a dry state has the same calorific value of 4.5 Kcal/g, which decreases with the increase in moisture content, being about 3.5 Kcal/g in green timber. Thus the weight of dry material required will remain constant, and it is possible to compare the different volumes of fuel used in different situations for firing kilns by converting the figures as far as possible into weights. The experimental firing at Iversheim used 4 m³ of beech to produce each m³ of lime, which can be compared with the 1.7 m³ of oak or 3.3 m³ of pine in nineteenth-century England (Burnell 1850, 36-7). Assuming that these all refer to partially dry but not seasoned wood, and given the range of densities for these materials, this suggests that between 1.6 and 3.3 tonnes of wood are needed for each cubic metre of lime; 2.5 tonnes can be taken as a reasonable average.

**Brick**

The labour requirements for digging the clay pose no problems, and we can assume that the raw clay is carried on average 250 m for processing. Estimating the manpower required to mould the bricks is more difficult. Pegoretti provides a table of values for making bricks of different sizes, some of which are close equivalents to imperial Roman types. His figures, which include the time taken to prepare the clay, include 1000/day for a brickmaker and an assistant for the
Table 11.B3 Estimated labour constants for brick production.*

<table>
<thead>
<tr>
<th>Action</th>
<th>Unskilled days</th>
<th>Skilled days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarry 93 m$^3$ clay</td>
<td>14</td>
<td>—</td>
</tr>
<tr>
<td>Load and carry</td>
<td>59</td>
<td>—</td>
</tr>
<tr>
<td>Prepare clay and form 52,000 bales</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>Carry and load kiln</td>
<td>19</td>
<td>10</td>
</tr>
<tr>
<td>Fire kiln using 23.4 t wood</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Unload</td>
<td>8</td>
<td>—</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>157</strong></td>
<td><strong>67</strong></td>
</tr>
<tr>
<td><strong>Total/1000 + 0.45 tonnes fuel</strong></td>
<td><strong>3.02</strong></td>
<td><strong>1.29</strong></td>
</tr>
</tbody>
</table>

* Based on a large kiln of 100 m$^3$ overall volume.

Table 11.B4 Brickkiln firings.

<table>
<thead>
<tr>
<th>Place</th>
<th>Date</th>
<th>No. bricks or size of kiln</th>
<th>Equivalent no. bales</th>
<th>Firing time in hours</th>
<th>Wood or equivalent in tonnes (t)</th>
<th>Wood in t/1000 bales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italy</td>
<td>1800s</td>
<td>65 m$^3$</td>
<td>52,000</td>
<td>180</td>
<td>40</td>
<td>0.48</td>
</tr>
<tr>
<td>Staffor</td>
<td>1800s</td>
<td>8,000</td>
<td>16,000</td>
<td>36-38</td>
<td>6.2-7.1</td>
<td>0.39-0.44</td>
</tr>
<tr>
<td>Suffolk</td>
<td>1800s</td>
<td>50,000</td>
<td>100,000</td>
<td>60</td>
<td>44.5</td>
<td>0.45</td>
</tr>
<tr>
<td>Suffolk</td>
<td>1800s</td>
<td>35,000</td>
<td>70,000</td>
<td>40</td>
<td>21.8</td>
<td>0.31</td>
</tr>
<tr>
<td>Barton</td>
<td>1960s</td>
<td>0.79 m$^3$</td>
<td>470</td>
<td>?</td>
<td>0.2</td>
<td>0.43</td>
</tr>
<tr>
<td>Italy</td>
<td>1960s</td>
<td>5.78 m$^3$</td>
<td>3,500</td>
<td>12</td>
<td>1-6**</td>
<td>0.29-1.7</td>
</tr>
</tbody>
</table>

* experimental firing in Romano-British circular kiln.
** 200 bundles of twigs were used. At the most these would be about 1 m long and 0.13 m in diameter, weighing 30 kg each, at least about 0.4 m long and 0.2 m in diameter, weighing roughly 5 kg, comparable to the bundles of twigs listed in the Prices Edict.

*Pegoretti implies that the optimum for nineteenth-century Italian kilns, which produced bricks of similar form and dimensions to the Roman ones, is five to six weeks, although this was often shorter in practice (1869, i.296).

While the firing time seems to be roughly proportional to the size of the kiln and the quantity of material fired, the weight of fuel required seems remarkably constant. The percentage of water in brush and twigs is much higher than that in cut wood, so we should expect a rather higher figure where faggots are used rather than heartwood. If the fuel is assumed to be at least partly wood, a figure of 0.45 tonnes/1000 bales would appear reasonable.

Notes

4. See DeLaine 1997, 200-1. This is based on a high figure for the total population of Rome of 1 million; if a lower estimate is accepted, the overall proportion of building workers would rise.
6 See Anderson 1997, 68-179 for a summary of what can be done without attempting quantitative analysis.
7 Johnson 1936, 306-10, 363-4 (bricklaying), 472 (timber, brick, stone), 477 (stone cutting), 693 (ironmongery).
9 The few ancient figures we have are inconsistent and largely concerned with agricultural tasks. See White 1965, 102-7 for the internal inconsistencies in Columella, who provides most of the ancient figures, and cf. Duncan-Jones 1982, 327-33.
10 For the tomb of Trebius Gaius see Marucchi 1911, and for other depictions of Roman builders and tools Adam 1984, figs. 87, 88, 90, 164, 203-5. Cf. Coldstream 1991, figs. 1, 6, 9, 49, 54, for scenes of medieval builders at work.
11 See Adam 1984, 34-8, Figs. 45 and 46 for stone-working tools; 48-9, figs. 92, 94, 96, and 97 for Roman, medieval and recent treadmill cranes. The use of treadmill cranes in Australia is documented by Cottrell and Kaminng 1990, 39-41.
12 See DeLaine 1997, 210-11 for the detailed working. Cf. the use of river bed material produced by a Nile transport as the river component; he compares this to the historical sees of river bed material produced by a Nile transport as the river component; he compares this to the historical see of river bed material produced by a Nile transport as the river component; he compares this to the historical see of river bed material produced by a Nile transport as the river component; he compares this to the historical see of river bed material produced by a Nile transport as the river component. Mosley 1996, 63-8 argues from this that the differential between land sea transport is small, as long as it appears in the Prices Edict, and discusses the importance of producer-owned transport animals as a way of reducing basic cost for food-stuffs. The bulky nature of building materials, and the volume of building in Rome and Ostia, however, make it more likely that there was a reduced system for the overall transport of the materials and subtransporting materials.
13 Note that free labourers in the quarries of Mount Claudianus were given only a measure of wheat in addition to their wages (Cumungi 1996, 139-40). The measure was a 1 ar termination = 39.5 litres per month; this compares very closely to the 5 modii = 43.7 litres assumed here.
14 A number of Ostian bushes as well as several tombstone tablets from the Via Appia and from the Isola Sacra necropolis serving Ostia and Portus show marked differences in the quality of brickwork in different parts of the structure, suggesting an attempt to produce the best display for the lowest cost. The work often varies between carefully selected, uniform bricks with very fine joints and a few millimetres thick on the front façade, a face version of the standard brickwork using good bricks with neatly raked 3-5 mm joint on the sides and back, and a much coarser brickwork with wider, rougher joints and some use of broken or reused brick inside. For the Ostian material see Steinby 1974, 397-402.
15 Given the marked differential between the assumed rates for the core and the facework, the thickness of the wall will also have an effect on the overall rate. For most types of Roman concrete, the facing is between 0.1 and 0.15 m deep, so that a wall 0.5 m thick (2 Roman feet) is almost half core and half face, while a 0.44 m wall (1.5 Roman feet) is more face than core, and in the 0.27 m (0.9 Roman feet) walls of the Baths of Caracalla the facing is a very small proportion of the whole. In practice, the effect of this is insignificant for values to the lower right of the graph in Fig. 11.1, with ordinary brick and a flat-sized core giving 0.66 d/m for a wall 0.44 m (1.5 Roman feet) thick; 0.72 d/m for a wall 0.6 m thick; 0.78 d/m for a wall 0.88 m (3 Roman feet) thick; and 0.81 d/m for a wall 1.18 m (4 Roman feet) thick. The greatest range is for the early opus incertum with a small core size, from 5.0 to 3.6 d/m, but here decreasing with increasing width.
16 DeLaine 1985, 1987, 1997, 126, 165-6, 169. 17 See Pellegrini 1865. The façade was in travertine and the inner walls in tufa. The opus reticulatum was used in the inner passages and substructures. On the quality of the reticulatum see Correlli 1977, 11.
18 The exercise was carried out over a standard wall because of the effects of the core facing differentials, and the implications for raising materials and working at a height which are particularly critical for ashlar construction (see next section, p. 245). The specific construction details for brick and reticulatum are taken from the Casa dei Dipinti (L. iv, 4), Ostia, which is also assumed as the common destination when calculating transport distances.
19 My thanks to Christian Biggi who catalogued the sample, and for his many useful observations on the material.
20 The making of reticulatum tesserae may be represented on a sarcophagus lid from the necropolis of Isola Sacra, near Ostia (best illustrated in Adam 1984, fig. 49). The scene shows two seated workmen working with adzes (?) on the sides of pyramidal blocks set on their flat faces; a basket of square-faced blocks lies at their feet, and behind are two men carrying sacks, presumably containing the finished products and/or the waste from the process, while a third man holding a tally supervises the proceedings.
21 Economies of scale for brick production include the use of permanent plant (kilns, drying sheds, etc.), the use of multiple kilns and continuous cycles of operation, and the availability of a more or less permanent skilled workforce. Grimes 1930 discusses economies of scale in the context of a military pottery and tile-making site with six kilns near Chester. The size of the major brick production centres serving Rome and Ostia, such as those belonging to the Domitii, may be deduced from the number and range of bricks bearing their stamps over a long period of time. For further different views on the organization of the Roman brick industry see Helen 1975 and Steinby 1982 and 1993; for different models of operation suggested for brick production in Roman Britain see Darvill and Mays 1984.
22 See Appendix 1, Wall 4. The figures could be reduced by removing the final finishing elements, giving a rusticated effect; but this would only bring it down to 38 or 39 m.c. Equally, any mouldings or finer dressing, say with drafted edges to a fine face, would add to the manpower requirements.
23 The figures have been calculated as for Appendix 1, Wall 4, using values for working different kinds of limestone and marble from Peugeot 1805, i 280-4.
24 The extensive reuse of travertine blocks from the part of the Forum damaged in the fire of AD 217 may reflect the economic realities of this material as well as problems at the quarries; new travertine was quarried only when necessary to repair the visible parts of the façade (Lancaster 1998, 170-1).
25 See Appendix 2 and DeLaine 1997, 109-14 for the explanation of the labour rates of production used here, and the inherent assumptions.
26 The sources of materials are based partly on known sources used in Ostia, partly on common sense. The Montevideo quarries on the bank of the Tiber (Fig. 11.2) seem to have provided some of the travertine for Ostia, and the brickworks allowed us to locate much of the brick production in the middle Tiber Valley above Rome and the Monti Sabini. For this and on the question of lime from Terracina, see DeLaine 1995, 559-60.
27 As some material will be lost irrecoverably during the sawing process, it is assumed that the waste is that left over when a reticulatum piece is cut from a rectangular solid of overall dimensions the same as the finished piece. More waste material would presumably be available from the quarrying process, but there is no way that this can be factored in to the calculations, unless we assume that no extra labour is required for the mill. It is assumed that all the brick triangles are made from standard Roman 8 inch square bricks (Jesus). In fact this intusa uses a mixture of these and an unusual form of small tile. Calculations done for larger square bricks (2 foot bipedales and 18 inch sesquipedales)
show that the unit manpower production requirements per triangle vary very little (DeLaine 1997, 118).

29 Pegoretti 1869, i 192, 281-3.

30 Method and work-rate values from Pegoretti 1869, i 438-45, adopting his lowest values for working tufa. Figures for raising the blocks and moving them into place have been added here as they form a significant element in the manpower requirements for construction. The cost of the material for the metal clamps which hold the stones together and the work required to fit these have however been omitted.

31 The following is largely taken from DeLaine 1997, ch. 5, but is included for the benefit of those who do not have that work to hand.

32 Cf. the close similarities in the cost of tufa and pozzolana in the nineteenth century (DeMarchi 1882, 94 and 105).

33 Italy, nineteenth century: 1.5-2 days for 10-20 m², 3-4 days for 20-30 m², and 4-5 days for 30-45 m² (Pegoretti 1869, ii 296). Florence, sixteenth century: 6 days, 26 m² = 10,900 bricks (Goldswaite 1980, 197-8); Rome, sixteenth to eighteenth century: 3-4 days, 65-180 m² (Scavizzi 1983, 29). Surrey, eighteenth to nineteenth century: 1-1.5 days, 12 m²; England, nineteenth century: 3 days, no size given (Burnell 1850, 36-7); traditional contemporary kilns: 3-4 days, 25-30 m² and 7 days, 120 m² (Adam 1848, 72-3).

34 Cf. four days suggested for Tipasa (Baradec 1957, 293), six inferred by D’IX for Iversheim (1982, 336), but only one day given by Burnell (1850, 38).

35 Information kindly supplied by the late Dr H. C. Dawkins of St John’s College, Oxford, formerly of the Oxford Forestry Institute.

36 Pegoretti 1869, i 286-99. Other sources provide a bewildering range of figures, some very high, such as 7-8,000/day in Holland, Belgium, Britain, northern France, and 2-3,000 for Bourgogne (Chabat 1886, 218), with 5,000/day in London (Dobson 1850, ii 24). A more normal range is perhaps 500-2,000/day, depending on the number of helpers, two at the most compared with the six or seven employed in the other cases. At Ashburnham in the 1840s, a moulder working alone could produce 3-400 bricks/day, and 1,000 with an assistant (Peacock 1842, 47), while 700/day was usual in the Oxfordshire brickworks (Bond et al.1980, 25). In modern Italy 800-1,000 curved roof tiles, identical to the Roman imbricae, could be produced by a moulder and assistant (Hampe and Winter 1965, 49-50). The figures from north west Europe are all for house-bricks, averaging 0.23 x 0.11 x 0.076 m = 0.002 m³, which is roughly twice the volume of a tessell.

37 Wood averages 19 MJ/kg @ 0.9 tonne/m³, bituminous coal averages 31-35 MJ/kg @ 1.14-1.14 tonnes/m³. Thus for the same calorific content the weight of wood has to be 1.63-1.64 times the weight of coal. An average value of 1.75 is used in the following calculations.

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TEXTILE PRODUCTION
THE GALLO-ROMAN WOOLLEN INDUSTRY AND THE GREAT DEBATE

The Igel column revisited

J. F. Drinkwater

Introduction

The 1970s and early 1980s were a momentous period in the study of Greco-Roman economic and social history. The appearance of Finley's *Ancient Economy* swiftly provoked debate between 'primitivists/minimalists' and 'modernists/maximalists' as to the robustness of ancient economic activity and thinking. In this there is no doubt that the most influential refutation of Finley's line of thought has been that of Hopkins, whose positive assessment of economic development under the Roman empire first saw light of day in 1978, but is now better known in its revised and extended version of 1980. During this time, but independent of the 'great debate', I published three articles on the economy and society of early imperial Gaul (Drinkwater 1978; 1977/78; 1981).

The general argument of these, in particular the second and third, was that the Gallo-Roman economy was a complex and vibrant organism in which was discernible, for example, long-distance trade in raw materials and finished products and a real market for goods and labour. Such an interpretation - in terms of the theme of this volume, of an economy well beyond agriculture - did not suit the Finley model, and part of it was cited approvingly by Hopkins (1980, 104, n. 14).

Since then the debate has rolled on, but now appears to some degree in danger of being resolved. In brief, it seems to me that, with rare exceptions, most Roman archaeologists and historians are 'Hopkinsites' now (see e.g. Greene 1986, 170–1). Or, perhaps better expressed, since it has been frequently pointed out that Hopkins himself was in the end unable to escape completely from Finley's model (see e.g. Love 1991, 214), it seems to me that many Romanists are 'ultra Hopkinsites' now, given their very modernizing, one might even say 'Rostovtzeffian', view of the imperial economy (e.g. Mattingly 1996, 244). In addition, though I concede that I may have
misinterpreted what I have read and heard, it appears that many Greek archaeologists and historians are becoming almost equally bullish about developments in the ancient Greek economy. Such unanimity is worrying. Finley was a uniquely accomplished historian, but his Ancient Economy is densely packed and so easy to misunderstand and misrepresent; and recently, reconsideration of certain aspects of my own 'vibrant' Gallic economy has caused me to re-examine my ideas. I therefore welcome the opportunity to go back almost twenty years in order to restate my thinking, see how far it has been accepted, and pose and attempt to answer the different questions which now occur to me.

The Igel column

The Igel column is an early third-century funerary monument, built not far from Trier in memory of members of the Gallo-Roman Secundinii family. It is important because it stands in situ; and is more or less complete, being richly decorated with reliefs illustrating social, economic and mythological scenes. The business scenes make it clear that the family was highly involved in the cloth trade. In my Latomus paper I suggested that the nature of this involvement might repay closer attention; and in my Trierer Zeitschrift article, basing my thinking on medieval practices, I urged that the Secundinii should not be regarded loosely as just 'merchants', but as specialized 'clothiers', engaged in the production and sale of high quality woolen cloth: in the words of the sixteenth-century English Statute of Artificers, 'men who put cloth to making and sale'. I proposed that:

1. the family became prosperous by buying high grade raw materials from, and selling high quality fabrics into, distant markets; and
2. that they produced these fabrics in and around Trier, by recruiting and orchestrating a large and specialized, and therefore highly dependent, workforce, of spinners, weavers, fullers, dyers etc., paid by the piece.

In my BAR article, I further examined the evidence for these, and other, out-payments and discussed the likely social tension involved in maintaining such dependents.

The reception of this reconstruction has been a little mixed, but never totally hostile and, as far as I can judge, has become increasingly favourable.' I believe that I can say that there is now general acceptance that the Belgic wool textile industry was a complex organism; and that, in Finley's terms, it was based on a conglomerate of interdependent markets*, as those who controlled it - professionals, proud of their professionalism - imported and exported quite bulky objects over long distances, making full use of the excellent road and river network of Gaul (Finley 1973, 32, 34, 126–8). In other words, again in terms of the theme of this volume, the Gallic woolen industry amounted to a significant economic activity that transcended the limits of subsistence agriculture.

On the other hand, I now believe that these conclusions are not the most interesting aspect of the topic, because they are inescapable. In brief, it is impossible to manufacture high quality woolen cloth for large scale commercial distribution without a very high level of expertise in the organization of supplies of raw materials, their processing and the sale and distribution of the finished products: none of this can be part-time work.' In fact, all that I did was to attempt to prove what no less a figure than Eleanor Carus-Wilson had long ago intuited as being simply obvious: that the Secundinii of Igel were great clothiers in the medieval sense of the term, who possessed 'expert knowledge of the foreign markets on which the very life of the industry depended' (Carus-Wilson 1952, 362). I will proceed, therefore, by leaving the obvious aside to consider other issues which arise from the study of the Gallo-Roman woollen industry, under the broad headings 'Potential' and (as we shall see, socio-political as opposed to, say, technical) 'Failure'.

Potential

If there was a significant development in a major sector of the Gallic economy under the Roman empire, then it surely had the potential to generate wider socio-economic change. I must emphasize that what I propose here is not immediate or major change, and certainly not that likely to produce the sort of society that emerged in Britain from the sixteenth century and precipitated the Industrial Revolution. Rather, I have in mind the slow but constant - one might term it 'glacial' - technological, economic, social and political change of the Middle Ages, which produced the highly sophisticated pre-industrial economies of western Europe in the seventeenth and early eighteenth centuries (see e.g. F. and J. Gies 1994). In this, the textile industries of Italy, England and Flanders (ancient Belgica) played an indispensable role. It is surely permissible to argue that, given the more favourable conditions (in terms of peace and communications) of the High Empire, a significant Belgic woolen industry should have been in a much stronger position to influence society than its medieval successor.

Amongst potential changes are those which one can categorize as 'technical'. Finley, following Weber, insisted on the primitive book-keeping and accountability techniques of the Greeks and Romans, claiming that these must have inhibited economic progress because they prevented the scientific understanding and management of business (Finley 1973, 116). However, as Love has recently pointed out, this is to put the cart before the horse: as in the Middle Ages, the pressure of continuing business success would surely, in the end, have produced more sophisticated financial practices (Love 1991, 248). Indeed, as Finley himself conceded and others have subsequently remarked, some of the basic skills in the collection and manipulation of...
data, and in financial processes and instruments, were already in existence. It is also not impossible that a fundamental medieval and modern accounting technique, that of double-entry book-keeping ('every credit has a debit and every debit has a credit'), might have had its roots in Roman times. Smith's proposals along these lines (1954) provoked severe criticism from Ste Croix (1956, 72-4). However, while de Ste Croix was undoubtedly right to argue for a general ignorance of sophisticated book-keeping techniques in the Greco-Roman world, his study reveals (e.g. 35-6) interesting experimentations which, under different circumstances, might have led to progress in this respect. In the context of this paper it should be noted that he was dismissive of the potential of the ancient economy, explaining its undeveloped nature principally on the grounds that 'the Greco-Roman econo
cen failed to develop to the point at which an advanced system of book-keeping would have become generally necessary' (15).

More wide-ranging, however, is what might be called potential soci
c change. In general, what I have in mind here is the possibility of succe
allowing a rise in the status (in Finley's sense) and hence the self-confidence
of businessmen, especially with reference to the traditional leaders of
the landowners (Finley 1973, 51, 58-61, 94). In other words, and perhaps
especially so in the less hidebound society of the provinces, there shou
have been the opportunity to change the social matrix (Frederiksen 197
165-6). In particular, it may be argued that this opportunity should hav
been especially available to the Secundini, for they belonged to a people, the
Treveri, and a region that, to judge from inscriptions, was exceptionally
involved in industry and trade (Wierschowski 1995, 206-7). This invol
ment was probably stimulated early in the first century AD by the proxim
of the Rhine army, but from the late first and into the second century it m
well have been accelerated by the destruction of the Treveran landowne
nobility as a result of the political troubles of 69-70 (Tacitus, Histories 5, 19

This earlier aristocracy appears to have been replaced by a new decur
class that was not averse to trade, created from traders who were ready to con
continue trading, or lesser aristocrats happy to receive traders into their ran
and be involved in their continuing activities, or both. So emerged (A
pronius Raptor, formally honed as 'wholesaler in wine, Saône shippe
der of the civitas of the Treveri, patron of the Saône shippers, patron of the
wholesalers in wine currently resident in Lyon.' It is surely plausible th
existence of such a person might indicate a blurring in social distinction
between landowners and traders among the Treveri, possibly even the emer
gence of a Treveran bourgeoisie.

More generally, it has even been proposed that realization of social pote
tial on the Treveran model may be detected elsewhere in Gaul. This ide
which I first advanced in my Latomus article, has remained in circulation a
has been adopted most recently by Wierschowski. In the meantime, how
ever, it has been carried much further by Picard. Picard has developed n

suggestion, based on the Treveran experience, that there may have been a
more general displacement of early Gallo-Roman aristocratic families from
the late first century by newcomers grown wealthy through industry and
trade, who were still inclined to maintain their trading contacts after becom
landowners (Drinkwater 1978, 833-5, 845-6). In two lengthy articles he
has argued that the ill-fated Antonine consular, M. Sedatius Severianus, was a
Picardian whose immediate ancestors made enough money through tradin
ing in the first century to allow his father to marry into an established, but
impecunious, Gallo-Roman noble house. He then supposes that, despite its
increasing prominence, the new family maintained its interest in industry
and trade (Picard 1981; 1991). These hypotheses are attractive, though not
without their problems. However, I will not go into them here. My current
concern is rather what I consider to be a more significant feature of the
Gallo-Roman economy: its failure to generate sustained growth.

Failure

However much we may argue for the existence of great economic and social
potential in Gaul under the High Empire, we have to concede that this was
never realized. Belgica was no Flanders. The Gallic woollen industry did not
act as the locomotive of continuing economic, social and political change.
Consequently, it seems to me that, among the great questions to be answered
in understanding 'economies beyond agriculture' in the ancient world,
'What was not happening?' is just as important as 'What was happening?' In
other words, though the amassing of archaeological and historical material
on individual industries and sites is crucial, equal attention should be given
to the devising of a model or models the better to understand this data. I use
the word 'model' deliberately, to suggest that this is an issue that can and
should be approached in the fashion advocated by Finley. Finley never
denied that there was an enormous amount of shifting of materials and
goods in the ancient world, through sub-systems of relative complexity.
What interested him was how these sub-systems engaged, or not, with each
other and with the whole: whether the starter motor fired the engine.

In this respect, I propose that we should work towards a model that can
explain why, in Love's words, the Roman imperial economy 'lacked the
impetus to expand beyond a certain point' or, more simply, why in the end
this economy never amounted to more than the sum of its parts (Love 1991,
234). That the empire ran into the third-century 'crisis' is certainly insufficien
t explanation (contra Hopkins 1980, 122-3). The crisis was not as bad as
is generally supposed, and the medieval world suffered equal or worse calami
ties, but continued to develop. What such a model must identify are the
structural defects of Roman economic life which caused it to stagnate, i.e. to
fail to generate even the most marginal long term increase in productivity
(C. R. Whittaker, pers. comm.). To establish a model comprehensive enough
to locate all such flaws is impossible; and even a brave attempt would require a long book. (It is an enormous pity that Finley never fleshed out his *Ancient Economy.* ) Here, therefore, I will offer a modest ‘part-model’ – a series of thoughts derived solely from a study of the Gallic woollen industry and its medieval successor, and which even then are restricted to cultural and political issues and so do not address, for example, the equally significant question of technological change.

In a much-cited passage in the *Ancient Economy,* Finley remarked that there is no ancient equivalent of the Grande Place in Brussels (Finley 1973, 137). This was a highly acute observation that remains valid despite recent exciting excavation and identification of guild halls and market places in Italy or Africa. Rather, to borrow Finley’s own words, albeit from a rather different context, it should be seen as the perception of an ‘aesthetic architectural’ reflection of a ‘political and social’ reality (Finley 1973, 124). In this case, I propose, the reality was the failure of Gallo-Roman manufacturers and traders, unlike their Flemish successors, to achieve political power as manufacturers and traders: they dominated no forums. My basic part-model consists, therefore, of three hypotheses:

1. Political failure prevented Gallo-Roman manufacturers and traders from attaining levels of wealth and status beyond those accessible through commercial activity alone.

2. This limitation prevented them from promoting the interests of industry and commerce to such a degree that the distinct identity and importance of these activities remained unrecognized by the society that accommodated them and depended upon them.

3. The result was that Finley’s ‘common psychological framework’ remained unchanged, and the basic economic values of a peasant-society, self-sufficiency based on landholding, remained unchallenged: a major factor in preventing the take-off of the ancient economy (Finley 1973, 19, 34, 36, 108-11, 160).

Let me now explain and develop these proposals, first returning to the Igel column. The monument suggests that the Secundinii enjoyed enviable prosperity, but not great wealth. It can be located at the top end of a series of funerary memorials erected by artisans and traders of the region that first, does not directly suggest great landowning activity; second, depicts scenes of commercial *negotium* that we would hardly expect great landowners to have engraved on their tombs; and third (possibly most significantly) does not contain any indication of municipal office (Drinkwater 1978, 839-41). This relatively modest level of achievement may be explained in a number of ways. For example, despite the possible positive transformation of Treverian society, it may be argued that the Treveri were at the same time unfortunate because, more or less when the regional economy developed, Trier itself became important as a centre of imperial administration - as seat of a procurator, then of a governor and then, from the mid-third century, as imperial sub-capital. It is surely plausible that the presence of imperial personnel inhibited the social development of the area as a highly commercialized *civitas* by reinforcing traditional social prejudices against trade. This argument that Treveran society may not have changed as radically as I, and others, have previously believed forces reconsideration of the activities of Apronius Raptor. Thus, though Raptor was clearly aware of, and profited from, trade and industry, and may even have owed his initial social prominence to his involvement in these, one may question the extent to which he, once a decurion, would have been directly involved in commercial ventures. It is perhaps more likely that, now as patron of shippers and wine-wholesalers, his contacts with these businesses became more indirect, through agents, after the manner proposed more generally by Frederiksen, Pleket and Kloft. If this is accepted, it is not impossible to envisage the Secundinii as clients of such a personage: in other words, to concede that even among the Treveri, political power and accompanying high status were still monopolized by landowners. ‘Basic’ manufacturers and traders who wanted to emulate them would be compelled to buy land in their turn, and then take on the municipal and imperial *aratus* in full competition with established families: commerce alone was no short cut to power and status.

This takes me to consideration of the nature of power and status, how these might be possessed by traders, and how such possession might help industry and trade. I offer two axioms:

1. In any pre-industrial economy, however sophisticated, no one becomes very rich or powerful solely through manufacture, trade or even the direct profits of farming (McFarlane 1971, 10-11).

2. In such an economy, significant wealth and power are available only to those able to tap state resources, made up of taxation, bribes and booty: Finley’s ‘political moneymaking’ (1973, 55) and McFarlane’s ‘service’ and ‘war’ (1971, 163).

In such a society, these resources are usually the preserve of great landowners. However, if traders can gain access to them as traders (i.e. not as landowners with a commercial past), then multiple benefits can accrue, not only to the individuals concerned but also to the relevant industries or trades in general. For example, individual manufacturers and traders who win power and status for themselves may serve to raise the status of manufacturers and traders as a whole, forcing some erosion of the dominant social position of landowners. Equally, individual manufacturers and traders who use their power and status to wring commercial concessions, rights and privileges from an administration to promote their own trading interests may well help to improve the operating environment of manufacture and trade as a whole.
And finally, the raising of the status of manufacturers and traders, and the pressing of commercial interests, may compel recognition of the important place of manufacture and trade in contemporary society. Medieval clothiers, and other manufacturers and traders, made this breakthrough. In England, for example, to take an extreme but highly illuminating case, the clothier William de la Pole founded a baronial house as a result of his influence with Edward III (McFarlane 1971, 12, 165). Why did Gallo-Roman clothiers fail to achieve anything like this success?

When I first considered this question in my BAR article, I believed that I had found a significant piece of the answer in 'the absence of significant state-borrowing' in the Roman empire. Though this was only a passing remark, I hoped that it would be taken up and developed by others. In the event, however, the only attention of which I am aware is in an equally brief aside by Pleket (1983, n. 49), so I welcome the opportunity to explain this thought here. What I had in mind was the custom of medieval wool merchants to make the profit which they earned from trade work harder for them by lending to princes short of funds (usually for war). If all went well, they enjoyed bigger incomes. However, in addition, they won the royal ear, since rulers, dependent on such loans, took advice from such clothier-financiers and rewarded them for their service with state wealth and titles. As merchant-financiers, and not primarily great landlords (though most would, as a matter of course, buy into land), these people formed what might be termed small, but significant, 'commercial lobbies', promoting trade for its own sake. In short, in this society, trade, via usury, was a route to political power, which could then be deployed to benefit trade. As far as I am aware, neither state-borrowing nor the commercial breading of the imperial ear played any important part in the economic life of the Roman empire. Their absence may, therefore, be identified as a structural weakness.

What was the cause of this weakness? I propose that, in Finley's terms, the answer lies in contemporary socio-political ideology, in this case the still prevailing ethos of the city-state, and perhaps even of the city-state as a permanent machine for war (cf. Love 1991, 224, 229). In short, there was an acceptance that 'the authority of the state was total' (Finley 1973, 154); in the last resort, the state was entitled to full access to the property of its subjects. As time progressed, the city-state had come to be represented by Roman emperors, who simply inherited this absolute authority (Milner 1977, 158–63, 199). In particular, Roman emperors, as rulers of an imperial polis that, for all its strength, was kept constantly on a war footing, were accepted as controlling all the wealth of the empire. In times of financial difficulty they had no need to borrow. They simply took: nakedly, in the confiscation of the goods of individuals; deceitfully, dressing up their demands as 'extraordinary' taxes; surreptitiously, through debasement of the coinage; and, finally, in the late Empire, administratively, in an attempt to set up a control economy, the Zwangstaat. I would argue that though such expedients usually worked in the short term, they were frequently difficult to implement (in some instances, leading to revolt), they prevented imperial contact with and development of commerce and, by being intrusive, parasitic and disruptive, they actually damaged the imperial economy.

I still believe that the absence of state-borrowing was an important limiting factor for the Roman economy. However, I believe that more recently I have detected a second, similar, but possibly even more fundamental, flaw in imperial fiscal practices that requires to be built into my part-model. This flaw is interesting because it demonstrates that both Finley and Hopkins may be right about the imperial economy, the first for urging consideration of its basic weaknesses, the second for appreciating the potential of taxation for remedying at least some of these flaws. For my second proposal is that commerce and industry did not flourish as well as they might have done under the Roman empire because emperors failed to subject them to significant selective taxation.

My thinking derives from a (typically) brief but powerful observation by Finley and from comparison with the medieval woollen industry. He pointed out (1973, 164–5) that in the ancient world 'taxes were not used as economic levers'. In contrast, it is clear that English kings were very aware of the advantages of the existence of the woollen cloth industry, quite apart from the fact that it permitted clothiers to supply them with war loans. Indeed, recognizing that this was 'the country's greatest trade', they showed themselves fully able to exploit it directly, for example, by:

1 taxing imports and exports of raw materials and finished and semi-finished cloths;
2 preventing such exports and imports (usually to cajole foreign enemies); and
3 in especially difficult circumstances, forcing loans and fines from the industry qua industry (i.e. not via clothier-financiers).

Now all this will hardly appear benign, and indeed on occasions it did harm the industry and, through this, the economy as a whole. However, it can be argued that on the whole royal interference actually benefitted the woollen trade. For example, one cannot tax an industry effectively unless one knows something about it, or is well counselled by people who do. Thus, in 1270, the need to police the taxation of wool exports from England created the creation of a panel of experts, comprising royal officials and leading wool merchants (Lloyd 1977, 33–4). In this way, traders as traders became part of the government machinery, gaining access to state office, state privileges and state wealth: 'political moneymaking'. Generally, indeed, it is clear that the constant disputes of the English Crown with producers and merchants over royal interference in the wool trade compelled even those at the highest levels of society to acquire and publicly deploy a working knowledge of what
was in question (Lloyd 1977, 38–9). In Finley’s terms, I would say that this knowledge and understanding, however imperfect, was the beginning of an awareness of the existence and importance of the operation of vital economic processes, of economic rationality (cf. Andreau 1995, 955) — even if not, at this very early stage, of an awareness of ’the economy’ in abstract.

As far as the Roman and Gallo–Roman world is concerned, the contrast could not be more complete. Modern historians can characterize Edward III as ’woolmonger extraordinary’ and not offend the ear (Lloyd 1977, 114); but Antoninus Pius, ’merchant emperor’, rings wholly false. I would argue that this difference came about because Roman emperors had a cultural blind spot. They remained unaware of the potential, and hence the advantage to themselves, of the woollen or any other industry. This is proved, I would further propose, in their completely uncreative approach to indirect taxation. They, like most modern historians of the empire (cf. France 1994, 134), seem to have been obsessed by direct taxation (principally on land) and by extraordinary levies. In other words, they gave insufficient attention to customs duties, accepting standard charges, usually at relatively low rates, at external and internal borders, as the only way of doing things.

To my mind, it was this failure to impose selective indirect taxes, at varying and variable rates (cf. France 1994, 143), that was in the end highly detrimental to all concerned. It deprived emperors of money, often at times when, unable to raise funds in normal ways, they sorely needed it, and had to resort to the sorts of unpopular and damaging irregular exactions already mentioned; it meant that manufacturers and traders were not brought to the forefront, the status and the fortunes of themselves and of the trades with which they were connected; it prevented any quickening of the perception of ’the economy’; and in the end it was a major factor in forcing the empire to lose whatever economic dynamism it had ever possessed by turning itself into a ‘Zwangstaat’. And the fundamental factor in this neglect must again have been Finley’s ’common psychological framework’, those ever-enduring peasant values which bred, to borrow Rathbone’s recent description, ’a defensive ideology of fiscal minimalism’ (Rathbone 1996, 312). In such conditions there could be no change to allow rulers to gain a practical understanding of the massive economic and financial potential of the empire they controlled.14

Notes

1 Finley 1973; Frederiksen 1975; D’Arms 1977, 159–79; Garnsey et al. 1983, xxiv.
2 Hopkins 1978, 1980; and cf. Hopkins 1995/96 for a fascinating review and revision of his model.

10 E.g. Lloyd 1977, 41, on the rise of the florentines.
11 Cf. Rathbone 1996, 312: ’all Rome’s subjects and even her own citizens remained liable to random summary exploitation’.
12 Of course they mounted up over long distances: cf. France 1994, 137.
13 In the case of Gaul, 2½% per cent on all goods entering and leaving: Drinkwater 1983, 100.
14 I am very grateful to the editors and referees, and to Jérôme France, Wolf Liebeschuetz, Dick Whittaker and Thomas Wiedemann, for their very helpful comments and suggestions on earlier drafts of this paper.

Bibliography


